# HOMININ DISPERSALS AND THE MIDDLE PALAEOLITHIC OF ARABIA

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**Abstract for *Hominin Dispersals and the Middle Palaeolithic of Arabia* (Huw S. Groucutt, Wolfson College). Thesis submitted for the degree of Doctor of Philosophy. Michaelmas 2012**

This thesis tests models on the dispersal of hominin populations in the Upper Pleistocene, specifically in relation to the Arabian Peninsula. It does so by conducting a quantified comparison of lithic assemblages from northeast Africa and southwest Asia. Lithic data from new excavations at the Jubbah Palaeolake in northern Saudi Arabia is compared to assemblages from Ethiopia, Sudan, Egypt, Jordan, Iran, Oman and other localities in Saudi Arabia. This is the first detailed inter-regional study of this area for Marine Isotope Stages 5 to 3, a critical spatial and temporal context in debates on both early modern human and Neanderthal demography and dispersal. The spatial and temporal character of the rich Arabian archaeological record correlate with emerging evidence for environmental change in Arabia; in particular the repeated dating of archaeological contexts to periods of climatic amelioration suggests that demographic growth was associated with periods of increased precipitation. The various factors influencing lithic variability and the methodologies by which they can be elucidated are reviewed. In particular this highlights the need for quantified and comparative analyses. A variety of analytical approaches are applied in this thesis, including the use of Correspondence and Principal Components Analyses to develop a nuanced view of lithic variability. Variability in cores is shown to largely reflect the related factors of size and reduction intensity. With analyses of debitage and retouched lithics a broadly similar picture emerges: assemblages which are heavily reduced have small cores and blanks and higher levels of retouch, and elements of shape variation also change in relation to reduction intensity. Elements of residual variability may reflect cultural differences. While it is felt that the evidence presented broadly orientates the Upper Pleistocene Middle Palaeolithic of Arabia to dispersals from Africa, this suggestion is subsumed with a problematization of using lithic evidence to understand dispersals. Aside from the need for further dated archaeological material from Arabia and surrounding countries, lithic analyses need to more thoroughly consider factors such as reduction intensity if we are to make robust inferences on population dispersals.

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# Chapter 1: Introduction

Nature has been defined as a principle of motion and change, and it is the subject of our enquiry. We must therefore see that we understand the meaning of motion for if it were unknown the meaning of nature too would be unknown. - **Aristotle**, *Physics* III, 1.

## 1.1) Research context. The Arabian Middle Palaeolithic and the role of dispersals in Palaeolithic archaeology.

It is perhaps most apt to begin this thesis by stating what it is not. It is not an attempt to declare any immutable 'truth' about the Arabian Middle Palaeolithic, nor of hominin dispersal processes. Our understandings of both topics are effectively in their infancy. We talk about 'Out of Africa' dispersals, but Africa is three times the size of Europe. The Arabian Peninsula is well over 100 times the size of Israel, yet the contrast between our knowledge on the Palaeolithic of the two areas is striking (Groucutt and Petraglia 2012). Likewise, the recently prominent debates on 'modern human behaviour' are here put into a state of abeyance. A more pressing focus, it is suggested, should be the clarification of the spatial and temporal character of demographic change in the Upper Pleistocene, a key element of which is the dispersal of hominin populations. Dispersal related hypotheses are widespread in the literature (e.g. Mellars 2006; Petraglia *et al.* 2010), yet are poorly tested using archaeological data. The specific aims and character of this thesis will be addressed after a discussion of the wider academic context of the topics addressed.

The Arabian Peninsula as a connection between Africa and the rest of Eurasia occupies a critical position in understanding Upper Pleistocene hominin dispersals, which are here primarily seen as an aspect of demography. Despite this importance the archaeology of Arabia is very poorly known for all of prehistory. While it may no longer quite be the *terra incognita* it was until just a few years ago (e.g. Rose 2006), for vast areas of the peninsula, it is not far off. When the research for this thesis was initiated in 2009 not a single stratified Middle Palaeolithic archaeological site had been published for the more than 3,000,000km$^2$ which make up Arabia. Since then several important discoveries have been published, particularly for southern Arabia (Armitage *et al.* 2011; Petraglia *et al.* 2011, 2012; Rose *et al.* 2011; Delagnes *et al.* 2012).

The Middle Palaeolithic (and African Middle Stone age which is here treated as synonymous term) saw the evolution of *Homo sapiens*, significant changes to hominin behaviour (e.g. Clark 1988), and the dispersal of our species out of Africa (e.g. Petraglia *et al.* 2010). Despite its importance for such reasons the Middle Palaeolithic is best known from Western Europe (e.g. Mellars 1996), an area with a fascinating archaeological record, but one which was arguably peripheral in the terms of the *longue durée* of hominin evolution. The specific character of the European record, namely the correlation of Neanderthals with the Middle Palaeolithic and modern humans with the Upper Palaeolithic is not repeated in other parts of the world (e.g. Hovers 2009). Arguably as a result of the development of Palaeolithic archaeology in Europe, with its atypical archaeological record, the Middle Palaeolithic is too often seen as merely a prelude to the Upper Palaeolithic. Even recent attempts aimed at countering the 'Eurocentric' view are themselves drawn in this direction, and much recent focus on the Middle Palaeolithic has been in terms of 'transitions' (e.g. Hovers and Kuhn 2006; Camps and Chauhan 2009).

The role of the Arabian Peninsula in hypotheses on the Upper Pleistocene dispersal of hominin populations has primarily consisted of being a convenient space on the map on which arrows can be added. The nature of the hominin occupation of Arabia is central to testing competing hypotheses on hominin dispersals, yet little research has been conducted in the area, although the situation is improving. One will struggle to find a single reference to Arabia in the textbooks of hominin evolutionary studies (e.g. Klein 2009). Likewise, even in *Desert Peoples: Archaeological Perspectives* (Veth *et al.* 2005) not a single chapter addresses Arabia, nor indeed any Asian desert. While the more common approach has largely been to ignore or denigrate Arabia, this has not always been the case, Henry Field (1932), for instance, saw Arabia as being at the centre of a hypothesised "cradle of *Homo sapiens*".

What is the wider role of dispersals in hominin evolutionary narratives? Here sharply dichotomous views have been expressed, from Clark's (1994) critique of 'migration as an explanatory concept' to Dennell's (e.g. 2003, 2009) suggestions that dispersals are fundamental to structuring hominin evolution. Dichotomous perspectives on population dispersals have an ancient history. The Bible,

for instance, is very much a narrative of dispersals. In contrast in the era of Turgot and Adam Smith the common sense view of the academy was that all societies would progress in a similar way and dispersals were downplayed in accounts of the human past. Numerous other examples could be given from the entire history of thought on human origins and evolution.

A central underlying theme of this thesis is that, in reality, both 'evolution' and 'dispersal' are different reflections of the same evolutionary process and there is no antagonistic contradiction between them. It is arguably the case that our understanding of dispersals in the Palaeolithic are underdeveloped (but see Gamble 1993). All too often dispersals are simplified to two 'events', labelled 'out of Africa 1' and 'Out of Africa' 2. That these relate to the origin of our genus and species respectively shows more about the aspirations of modern analysts than about any reality of hominin evolution.

As this thesis was being written our understanding of 'Out of Africa 2' was undergoing a process of rapid change. The idea that a single population of *Homo sapiens* left Africa by crossing the Red Sea at 70-50 ka and then following the coastline into southern Asia rapidly became apparently accepted as fact to some (e.g. Mellars 2006a,b), despite the basically complete absence of any archaeological support for this narrative. The only 'evidence' related to estimates of genetic mutation rates, yet emerging evidence suggests the estimates of the early 21st century in this regard were significantly flawed (e.g. Scally and Durbin 2012). Scally and Durbin (2012) review new evidence on mutation rates which suggestions they were probably consider faster than the consensus view had accepted over recent years. One effect of this is to make genetic estimates for dispersal out of Africa concordant with the view advanced by many archaeologists that MIS 5 was a more probable time for major dispersals to have occurred. Likewise claims by some geneticists that all non-African populations came from a single dispersal of a small population out of Africa (e.g. Macaulay *et al.* 2005), have been criticised by other geneticists (e.g. Rasmussen *et al.* 2011). Likewise the idea that genetic evidence indicated that no-interbreeding took place between *Homo sapiens* and Neanderthals has been challenged (e.g. Green *et al.* 2010), and another hominin taxa, who also interbred with modern humans discovered along the way (Reich *et al.* 2010).

Rather than seeking contextualisation in terms of biogeography and ethnography, the major accounts of dispersals in Palaeolithic archaeology centre on drawing a line on a map between two points. Where evidence does not fit a perceived narrative it is simply declared a 'failed dispersal', the example of the MIS 5 occupation of the Levant being a clear example. As commonly portrayed, *Homo sapiens* appears to have left East Africa and headed straight for the tiny area of the Levant, ignoring all other geographical areas. To borrow a metaphor from Mellars (2006a), this may be a case analogous to a drunk looking for their keys under a street light, rather than where they dropped them. The broader context of this thesis is that we need to move beyond extremely simplistic conceptions of dispersals. Models should framed by palaeoenvironmental conditions, tested by archaeological and genetic evidence and supplemented by ethnographic and biogeographical information. Robust narratives of Upper Pleistocene dispersals will be thoroughly interdisciplinary. This thesis attempts to address a particular aspect of this debate, that of the Arabian Peninsula. It does so by exploring the variability of lithic artefacts in Arabia and contiguous regions as a way of testing various models for dispersals which have been put forward (Table 1.1)

### 1.2) Models for dispersals

A number of models for Upper Pleistocene hominin dispersals have, to varying levels of explicitness, made hypotheses on the character of archaeological and other evidences which they hypothesise will be found in Arabia. Groucutt and Petraglia (in press) describe and discuss key models in relation to out of Africa dispersals. To these – which can be labelled the 'Upper Palaeolithic', 'Microlithic', 'Two-stage', and 'Middle Palaeolithic' models – we can add what could be called the 'Neanderthal model', suggesting that Neanderthal populations may have moved into Arabia from the north. Table 1.1 provides a summary of the major models for Upper Pleistocene dispersals.

This thesis has two aspects. On the hand there is an element stressing the need to gather data in Arabia in an essentially inductivist manner. When so little is known and, as Chapter 2 discusses, each new discovery presents a picture different from what was previously known, any attempt to apply a strongly falsificationist method will be frustrated by a simple lack of data. On the other

hand testing the predictions of particular models for hominin dispersals, particularly from an archaeological perspective, provides a framework by which new discoveries can be contextualised. In particular the thesis seeks to test and expand the 'Middle Palaeolithic' dispersal model, while fieldwork seeks to locate evidence which might support other models.

| Model | Summary/key points | Timing | Key evidence | Key refs. |
|---|---|---|---|---|
| ***Upper Palaeolithic Model*** | Overall process similar to traditional 'Upper Palaeolithic Revolution' perspective. Focus on archaeological evidence, particularly Levantine Early/Initial Upper Palaeolithic. Reasons for behavioural changes and dispersal range from a neural mutation creating the capacity for modern culture to the demographic effects of the development of complex projectile technology | MIS 3, ~50-40 ka. | Fossil - Crania at Ksar Akil and Qafzeh (35-30ka), teeth at Üçagizli (>40ka).<br>Genetic – conservative interpretation of mtDNA variation.<br>Archaeological – 'trait list' of derived behaviours such as Upper Palaeolithic (particularly blade based ) technology.<br>Route – typically a northern route out of Africa to the Levant.<br>. | Bar-Yosef 2007; Klein 2009. |
| ***Microlithic Model*** | Environmental changes in southern Africa ~80-70 ka, which the model suggests led to significant demographic and behavioural changes, most clearly seen in the Howiesons Poort and Still Bay industries, led to a single coastal dispersal out of Africa. The chronology of this is based on genetic evidence. | MIS 4, ~65-60 ka. | Fossil - Lake Mungo. Batadombalena (~36ka, Sri Lanka).<br>Genetic – similar age estimates for M and N mtDNA macro-haplogroups.<br>Archaeological – microlithic technology in South Africa and India<br>Route – southern coastal. | Macaulay *et al.* 2005; Mellars 2006a, b. |
| ***Two-stage Model*** | The structure of modern human populations reflects multiple Upper Pleistocene dispersals. Out of Africa dispersals occurred in both MIS 4 and 3, following population subdivision within Africa. Originally a fossil model, reinvigorated by genetic findings. | MIS 4+3, ~70 ka, ~45 ka. | Lake Mungo.<br>~70 ka dispersal – robust anatomy.<br>~45 ka dispersal more gracile.<br>An Australian genomic sequence supports model of at least two dispersals, similar evidence emerging elsewhere.<br>~70 ka dispersal associated with mode 3 (Middle Palaeolithic) technology. ~45 ka associated with Mode 4 (Upper Palaeolithic).<br>Southern, coastal route around Indian Ocean rim ~70 ka. Northern route through Sinai ~45 ka. | Lahr and Foley 1994, 1998; Rasmussen *et al.* 2011. |
| ***Middle Palaeolithic Model*** | Climatic amelioration allowed *Homo sapiens* to enter Arabia in MIS 5e, and South Asia by MIS 5a. Dispersals marked by presence of Middle Palaeolithic technology, similar to that of the African MSA. MIS 5 *Homo sapiens* in SW Asia as seen in the Levant may not be a 'failed dispersal', even if a localised extinction occurs in the Levant. | MIS 5, 130-75 ka. | Skhul /Qafzeh in SW Asia and Lake Mungo in Australia as upper and lower constraints on age. Predicts MIS 5*Homo sapiens* fossils in S Asia.<br>Demographic fluctuation means genetic record complex. Various open questions in relation to genetic evidence, but compatible with new age estimates of L3.<br>Technological analysis reveals similarities of S and SW Asian lithic technology to the MSA.<br>Broadly southern, split between Sinai and Bab al Mandab routes. | Petraglia *et al.* 2010; Armitage *et al.* 2011; Rose *et al.* 2011. |
| ***Neanderthal Dispersal Model.*** | Neanderthals dispersed into Asia post-MIS 5, meaning that late in their existence they were primarily an Asian species (Dennell in press). As they are known to have inhabited the Levant it is possible that they continued south into Arabia | MIS 4/3 | Presence of Neanderthals and Late Middle Palaeolithic assemblages in the Levant, close to Arabia. | Has not been clearly developed |

Table 1.1. Models for Upper Pleistocene dispersals into Arabia, partly modified from Groucutt and Petraglia (in press).

### 1.3) Research questions and hypotheses

The central question underlying this thesis can be stated as follows:

How does the Upper Pleistocene Middle Palaeolithic archaeological record of Arabia affect our understanding of hominin dispersal processes?

This broad question can be divided into a number of sub-questions:

- At a theoretical level, what can variability in lithic technology tell us about the dispersal of Middle Palaeolithic hominin populations? How, for instance, can we distinguish factors associated with mobility strategies and raw material variation from 'cultural' factors implying population dispersals?
- What is the character of the Arabian Middle Palaeolithic (e.g. chronology, regional variability, similarities and differences to the record of surrounding regions)? How do core reduction strategies differ within Arabia and what connections to these imply to surrounding regions?
- Are Arabian Middle Palaeolithic assemblages similar to African Middle Stone Age assemblages associated with *Homo sapiens*, are they similar to those associated with Neanderthals in the Levant, or do they primarily reflect a distinctive regional phenomenon?
- How do patterns of retouch vary, and what does this indicate on emic and etic conceptions of Middle Palaeolithic technology?
- Applying a quantified technological approach, how do traditional concepts and divisions of the Palaeolithic record relate to the new proposed patterns of variability?

Three broad hypotheses are used to orientate the research. These are:

- Given the frequent aridity of Pleistocene Arabia, dispersals into Arabia will be associated with periods of increased precipitation (pluvial episodes). Fluvial and lacustrine

environments will have played a critical role in hominin dispersals and occupations in Arabia.

- The Middle Palaeolithic record of Arabia primarily reflects the dispersal of African populations into the area in MIS 5. Lithic technology will therefore be analogous to that of the African Middle Stone Age.
- Environmental deterioration post-MIS 5 will have led to population contraction and isolation in refugia, leading to autochthonous cultural and hence technological developments.

### 1.4) Research methodology

The methodology used to address the three questions can be divided into four central components:

- A comprehensive literature review of pertinent material. This relates to an analysis of all data on Arabian Middle Palaeolithic sites, as well as related information on palaeoenvironmental change and biogeographical context. The second core element of literature review relates to an exploration of the causes of variability in lithic assemblages with the aim of understanding how lithic technology can aid understanding of dispersal processes.
- A programme of detailed and quantified recordations and analyses of selected lithic assemblages from Saudi Arabia, Oman, Sudan, Ethiopia, Jordan and Iran. Assemblages have been selected for their spatial and temporal character.
- Excavation of Middle Palaeolithic sites at Jubbah, northern Saudi Arabia. Background research, including a reconnaissance trip by an interdisciplinary team including the author (Petraglia *et al.* 2011) revealed both the importance and potential of this area. Whereas most recent advances have focussed on southern Arabia, this thesis aims to factor in evidence from interior, northern Arabia.
- A detailed comparative study using a variety of qualitative and particularly quantitative techniques to analyse patterns of similarity and difference between the lithic assemblages

studied. This will provide an objective insight into lithic variability in north-east Africa and south-western Asia and provide firm foundations on which hypotheses can be generated. The character of spatial and temporal variability in the lithics offers a way to test hypotheses on dispersals.

### 1.5) Structure of the thesis

The thesis is composed of nine chapters, which are organised as follows.

Chapter 2 reviews archaeological and palaeoenvironmental evidence for the Arabian Peninsula, specifically focussing on the Upper Pleistocene. The environmental evidence presents a picture of significant change in Pleistocene Arabia. In a broad sense, periods of increased and decreased precipitation correlate with global glacial and interglacial periods. Within this picture, however, developing evidence suggests a more complicated picture, with, for example, evidence for pluvial episodes in MIS 6 and early MIS 3 becoming increasingly well known. While there are no hominin fossils from Arabia and very few Pleistocene faunal discoveries, it is possible to use biogeography to contextualise hominin dispersals into Arabia. Baboons, for example, dispersed into Arabia from Africa at several points of the Pleistocene. The history of research on the Middle Palaeolithic in Arabia is summarised. This reveals a record which is extremely rich, but poorly understood due to unsystematic research and the surface context of many archaeological sites. Over the last decade considerable advances have been made and stratified Middle Palaeolithic sites reported in the UAE, Yemen, Dhofar and Saudi Arabia. Cumulatively these suggest MIS 5 dispersals from Africa followed by autochthonous trajectories in southern Arabia. There is also considerable regional variability. Significant problems identified include a lack of knowledge on interior Arabia and the need for a 'theoretical' and not 'empiricist' perspective on lithic variability.

Chapter 3 reviews debates on the causes, character and implications of Middle Palaeolithic lithic variability. Lithics are by far the most common source of information on Palaeolithic hominins and, it is argued, they contain important behavioural information. Numerous factors underlying lithic

variability are reviewed and assessed. It is argued that a key consideration concerns the units of analysis of lithic studies. In contrast to traditional accounts focussing on individual artefact typology, or industrial complexes it is argued that the assemblage, which is seen as a constellation of attributes, should form the basic unit of analysis. Recent methodological developments, while offering fascinating insights into the Palaeolithic, pay little attention to comparability. It is argued that a move towards a more quantified methodology is necessary to develop comparative analyses, and that this be done within a theoretical framework which recognises the diverse causes of lithic variability.

Chapter 4 introduces the assemblages used in this study. This has two components. Firstly, the results of fieldwork at Jubbah, northern Saudi Arabia are presented to give context to the lithic assemblages from these sites. The area around the Jubbah palaeolake has revealed a number of remarkable stratified Palaeolithic sites which were studied in 2010 and 2011. OSL dating puts most of the sites in MIS 5, with a small assemblage dating to MIS 7 forming the oldest well dated evidence for human occupation anywhere in Arabia. The site of Jebel-Katefeh 1 produced the richest assemblage, with well over 1000 lithics discovered including several hundred from a single archaeological horizon dating to ~87 ka. The second part of the chapter introduces the comparative samples used from elsewhere in Arabia and surrounding countries. These are Porc Epic in Ethiopia, 1010-8 in Sudan, Bir Sahara-1 in Egypt, Tor Faraj in Jordan, Warwasi in Iran and Mudayy as Sodh (123-b) in Oman. In addition Saudi Arabian core data collected by Prof. Michael Petraglia is used to increase the spatial coverage of the Arabian record. The comparative sites are described and discussed and, critically, shown to be spatially and temporally representative.

Chapter 5 presents the methodology used for this study. The approach taken combines a variety of methods, focussing on attribute analysis and quantitative comparisons of attributes and metric recording. The lithic assemblage is divided into the heuristic components of cores, debitage and retouched blanks. The typology of each of these groups is described and the implications of particular attributes discussed. The main statistical methods of Correspondence Analysis and Principal Components Analysis are introduced.

Chapter 6 presents the results of the analysis of core technology. Intra-assemblage variability is shown to largely reflect reduction intensity. Core typology appears to correlate strongly with indications of size and reduction intensity. Cores at sites such as Warwasi and Porc Epic are small and heavily reduced, and therefore give a somewhat misleading perspective on the character of reduction. It is shown that considerable equifinality occurs as reduction proceeds, and that important elements of shape correlate with size in some ways, while in others shape variation appears to be more culturally specific. On the whole raw material factors appear to have been overemphasized and the character of morphology primarily reflects reduction intensity which reflects factors such as occupational intensity.

Chapter 7 presents the analysis of blank variability, which forms the largest component of the comparative analysis. There again appears to be a considerable element of equifinality, but the use of the quantitative methods demonstrates interesting patterns which have not previously been emphasised. For instance, at both Porc Epic and Warwasi considerable intra-assemblage differences are demonstrated, such as dramatic changes in blank laminarity and striking platform characteristics. These show that entities such as the East African Middle Stone Age and Zagros Middle Palaeolithic are not homogenous, and that progress in the understanding of dispersals strongly relies on an improved chronological framework for archaeological sequences. Variability in factors such as blank size largely mirror those observed for cores. It is argued that the consideration of factors such as distal termination types allow a more robust and theorised perspective on lithic variability than traditional accounts. The results suggest that in the case of the Jubbah assemblages factors such as raw material variation and mobility patterns play important but complicated roles in structuring variability which make simple statements on dispersals problematic.

Chapter 8 presents the final set of results, those of retouched lithics. It is again demonstrated that considerable intra-assemblage variability characterises retouch, with the younger assemblages at Porc Epic and Warwasi being considerably less retouched than the older assemblages at these sites. Arabian sites typically feature little retouch, which appears to reflect occupational intensity and

mobility patterns. It is shown that typological variability of retouched blanks correlates with the number of retouched pieces present in an assemblage. The evidence suggests that variation in retouch primarily reflects variation in function and site type, and does not appear to suggest a strong role for culturally specific retouched 'tool' types. Multivariate statistics show that, for example, in most cases the retouched component is typically representative of the upper size range of variability of blanks in an assemblage. In the case of Warwasi, however, the retouched pieces are typically considerably larger than the unretouched debitage, which is hypothesised to represent a strategy of 'provisioning the individual'.

Chapter 9 presents a discussion and conclusion of the results. The major conclusion of this thesis is the demonstration that simplistic dispersal narratives are not supported by lithic evidence. Considerable variability is shown to relate to factors such as reduction intensity. It is argued that it is by considering such factors that dispersals will be most clearly be understood. Residual variability in lithic assemblages suggests cultural patterning, but at present numerous possible scenarios explain the character of the Arabian record. Given the considerable equifinality of lithic technology the Arabian evidence and the paucity of excavated and dated archaeological material, the evidence from Arabia can be interpreted in various ways. It is suggested that the most parsimonious interpretation at present in relation to Upper Pleistocene dispersals is that hominins dispersed from Africa into Arabia in MIS 5. Within such a broad hypothesis numerous alternative dispersal routes and chronologies can be imagined. The key way forward is to combine further archaeological research with quantified comparisons of lithic assemblages as similar stages of reduction.

## Chapter 2: Environmental and archaeological records of Upper Pleistocene Arabia

'You look at a land that is dead, then as soon as we shower it with water, it vibrates with life and grows all kinds of luxuriant herbs'

*- Al Qur'an* (22:5)

### 2.1) Introduction

This chapter aims to summarise existing knowledge of the Middle Palaeolithic (MP) archaeological record of the Arabian Peninsula. It does so from a foundation of geography, biogeography and palaeoenvironmental variation. Particularly important in terms of the latter is our knowledge of the chronology and character of pluvial episodes, periods of increased rainfall which are likely to have played an important role in demographic change in Arabia and interaction with surrounding areas. The history of pertinent archaeological discoveries in Arabia is presented in an approximately chronological manner. For a broader perspective on the prehistory of Arabia the reader should consult Groucutt and Petraglia (2012). The initial discoveries at Jubbah, made in 2010 (Petraglia *et al.* 2011), are omitted from this chapter as they are combined with discoveries made subsequently which are integral to the data presented in this thesis. Information on the Middle Palaeolithic at Jubbah is given in chapter 4.

### 2.2) The geographical and faunal structure of the Arabian Peninsula

The character of the hominin occupation of Arabia is rooted in the geographical and environmental structure of the more than three million km$^2$ which make up the peninsula (see e.g. Thompson 2000; Edgell 2006; Vincent 2008; Sanlaville 2011). The ecological and topographic variability across contemporary Arabia indicates the likely complexity of hominin evolutionary and demographic processes in the past, and this is exaggerated by evidence for dramatic environmental change through time. There exist no fundamental barriers to hominin dispersal in northern Arabia, and likewise the Sinai Peninsula provides a terrestrial connection to Africa during periods of climatic

amelioration (e.g. Waldmann *et al.* 2010). Variant dispersal routes into Arabia are the subject of considerable debate (e.g. Petraglia 2011), as discussed below.

Despite evidence for a rich pre-Pleistocene fossil record (e.g. Whybrow and Hill 1999; Zalmout *et al.* 2010) the Upper Pleistocene fossil record of Arabia is at present very limited. No pre-Holocene hominin fossils have been discovered in Arabia. Faunal remains from two areas provide some context for the Palaeolithic occupation of Arabia. McClure (1984) reports a number of seemingly Pleistocene fossils from the Mundafan and other palaeolakes in the Rub' al Khali. Taxa represented include buffalo, hippopotamus, oryx, gazelle and ostrich. Given that the Mundafan palaeolake was recently re-dated to MIS 5 (Rosenberg *et al.* 2011), a detailed study of these fossils is warranted. McClure (1984, 181) emphasises the prevalence and diversity of bovid fossils, indicating the existence of "at least moderate, if not locally lush" grasslands. Alongside vertebrate fauna (McClure 1984, 179), a variety of fossil taxa (diatoms, ostracods, etc.) are present in these palaeolakes and promise to cast considerable light on their environmental context.

Secondly, Thomas *et al.* (1998) identified faunal remains (n=139) at three palaeolake localities in the An Nafud desert. Taxa include giant buffalo (*Pelorovis* cf. *oldowayensis*), elephant, horse, hippopotami (*Hexaprotodon* sp.), tortoise, fish at least a metre long, and carnivores including *Crocuta crocuta*, *Panthera cf. gombaszoegensis* and *Vulpes* cf. *vulpes*. This has been described as a broadly Afro-tropical composition, which the discoverers assigned, despite lacking chronometric age estimates, to the Early Pleistocene (Thomas *et al.* 1998). Thomas Rosenberg and colleagues recently re-dated the fossils using the OSL technique, and they suggest that they are actually much younger than previously believed and that the three localities are not synchronous (Rosenberg 2011). The taxa represented, as well as isotopic values derived from teeth (Thomas *et al.* 1998), indicate a savannah-like environment with at least fairly large lakes. The discoveries in the An Nafud and at Mundafan demonstrate that Pleistocene fossils can be found in Arabia, and that their paucity reflects a lack of research not any real absence.

The role of the Bab al Mandab and Persian Gulf as Pleistocene dispersal 'corridors', 'filters', or 'barriers' is much debated. Aside from their relationship to hominin evolution and dispersals, their

permeability or otherwise has been an element of the long recognition of Arabia as an interface between biogeographical zones (e.g. Wallace 1876; Delany 1989). As environmental conditions have fluctuated the predominance of either the 'Afrotropical' or 'Palearctic' biotas has altered, with environmental variability within Arabia leading to various relict populations and indigenous evolutionary trajectories. To take the example of snails, populations in northern Oman are primarily Palaearctic, whilst those in Dhofar and westwards are essentially Afrotropical (Mordan 1980). A number of authors have addressed Arabian flora and fauna (e.g. Zohary 1973; Harrison and Bates 1991; Neubert 1998; Ghazanfar 1999).

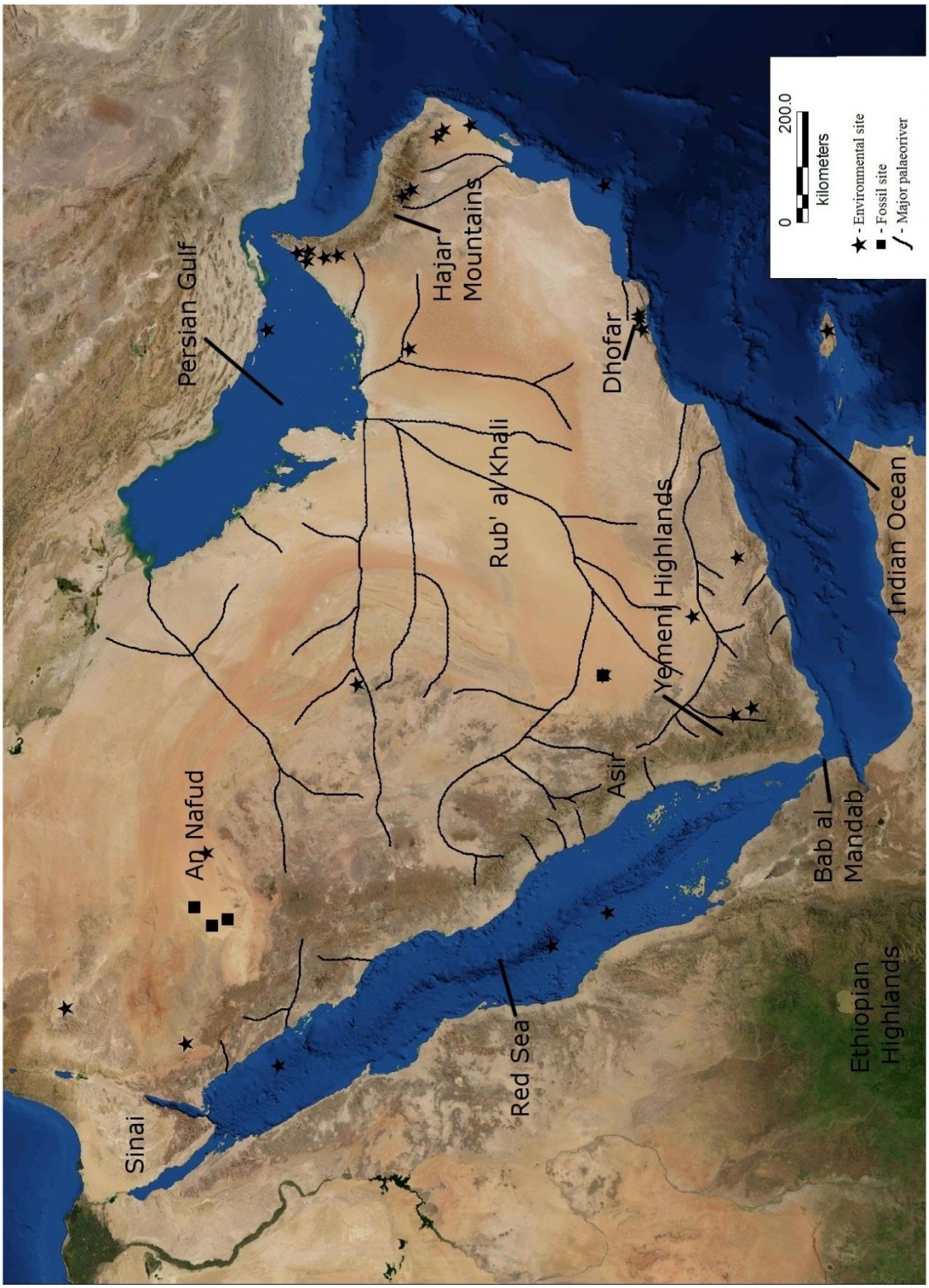



Figure 2.1. Key geographical features of the Arabian Peninsula (modified from Groucutt and Petraglia 2012. Basemap courtesy of NASA's Earth Observatory).

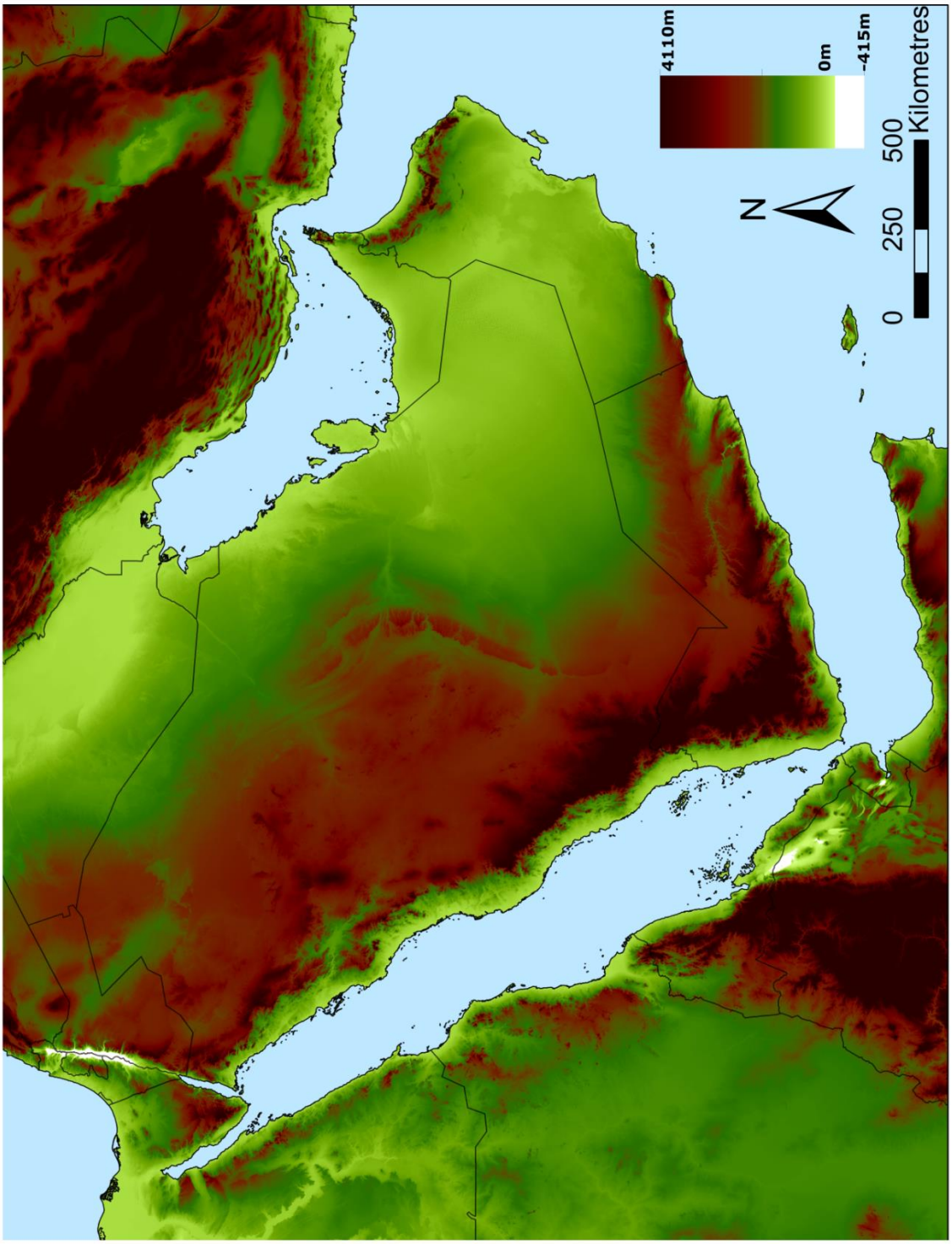



Figure 2.2. Digital elevation model of the Arabian Peninsula (DEM data courtesy of the International Centre for Tropical Agriculture [Jarvis *et al.* 2008], basemap image courtesy of Nick Drake and Paul Breeze, King's College, London).

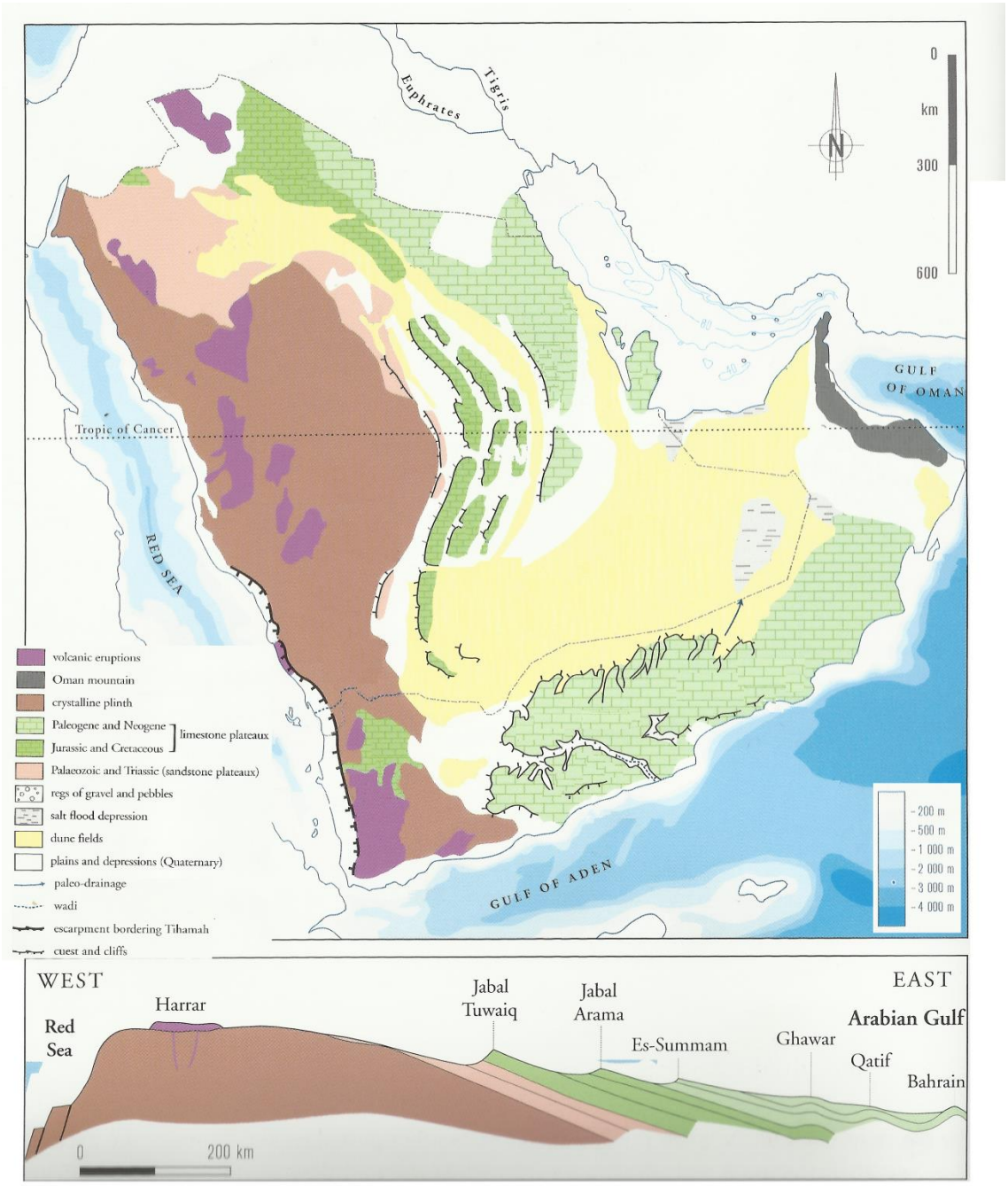



Figure 2.3. Geological map of the Arabian Peninsula (modified from Sanlaville 2011).

*Papio hamadryas* groups in south-western Arabia are the only natural populations of baboons outside sub-Saharan Africa, and provide a case study for contextualising hominin occupations and dispersals. They are the only taxa in Arabia which have been studied to some detail in terms of both genetics and behaviour. Suggestions that the baboons were taken to Arabia in the Holocene by Egyptians have been falsified by the application of genetic analyses, which indicate that the primates arrived in the Middle and Upper Pleistocene (Wildman *et al.* 2004; Winney *et al.* 2004; Fernandes 2009). The most recent dispersal of *Papio hamadryas* into Arabia is estimated as having occurring at broadly 103 ka (Winney *et al.* 2004), 105 ka (Fernandes 2009), or 109 ka (Wildman *et al.* 2004). Although care is clearly needed when considering such estimates (Scally and Durbin 2012), they establish a Pleistocene heritage for the baboons. The subdivided population structure indicates multiple dispersals into Arabia, with estimates for the earlier expansions corresponding with Middle Pleistocene interglacial periods. This population structure and genetic diversity suggests their presence in Arabia cannot be explained by a 'sweepstake' event (*sensu* Simpson 1940) across the Red Sea. Fernandes (2009) suggests the more northerly Arabian populations are most closely related to modern African populations, which could be taken as supporting a dispersal through the Sinai Peninsula during MIS 5. A previous study, however, suggested that southern populations were more 'African' (Winney *et al.* 2004). Larger and more representative samples of complete *Papio hamadryas* genomes are needed to cast light on this question.

Another example of the way in which fauna can be used to cast light the hominin story comes from Richter *et al.*'s (2008) study of the giant clam species *Tridacna costata* in the Red Sea. Their research suggests that both the total population numbers and the size of individuals crashed dramatically following MIS 5. Richter *et al.* (2008) suggest a human role as in causing these changes. If true this supports the use of coastal resources by hominins in the sea bordering western Arabia in MIS 5. However, caution must be exercised, and other strong possibilities include inter-specific competition and alterations in the timing of plankton blooming (see e.g. Fenton *et al.* 2000) are also considerations. To demonstrate a human role, evolutionary trends in *Triadacna costata* will have to be analysed through several glacial-interglacial cycles. Richter *et al.*'s (2009) evidence can perhaps be

seen as being stronger than claims for a last-interglacial 'oyster bar' at Abdur Reef, Eritrea (Walter *et al.* 2000), which actually appears to represent a natural death assemblage (Bruggemann *et al.* 2004)

The examples above demonstrate the significance of the Red Sea region in understanding the biogeographical context of Arabia, although we must not forget the role of the Persian Gulf (e.g. Rose 2010; Armitage *et al.* 2011) and further east in terms of hominin dispersals. In recent years the role of the Red Sea region has been reinforced by a number of studies which seek to explain patterns of contemporary human genetic variability by suggesting that early *Homo sapiens* crossed the Bab al Mandab (e.g. Quintana-Murci *et al.* 1999; Macaulay *et al.* 2005; Thangaraj *et al.* 2005). The genetic structure perhaps certainly supports the 'southern dispersal' hypothesis in its broad sense (i.e. *Homo sapiens* arrived in Australia before Europe). However, given the error ranges of chronological estimates and the poorly understood demographic processes of the Upper Pleistocene and Holocene, the idea that a Bab al Mandab route can be 'proven', as opposed to the 'northern route', is currently exaggerated (see also Bailey 2009 for discussion). At present, debate has in essence been a contemplation of the likelihood, or otherwise, of hominins crossing the Red Sea.

Claims for periodic landbridges across the Red Sea (e.g. Winney *et al.* 2004) are not supported by isotopic studies, which suggest a sea crossing has been necessary since the Miocene (Fernandes *et al.* 2006). Today the Red Sea at its narrowest point is less than 30km across, while small islands mean no single crossings of more than 18km. While times of lower sea level would have reduced this distance, perhaps to as little as 4km (Lambeck *et al.* 2011), dispersing hominins would have faced the problem that such times were concordantly arid in Arabia. To bypass this paradox the hypothesis of the significant role of 'coastal oases' (Faure *et al.* 2002), springs exposed by reduced sea levels, is often cited. Whilst there is no doubt that such springs would have constituted a potentially important source of water, how spatially and temporally continuous they would have been in the Pleistocene is currently unclear. An alternative is that hominins were able to exploit the lag between environmental amelioration in Arabia and the associated rise in sea levels (Armitage *et al.* 2011).

**2.3) Upper Pleistocene environmental change in Arabia (~130-40ka)**

In light of the preceeding discussion it it likely that the Arabian peninsula played a significant but complicated role in hominin dispersal and adaptive processes. In recent years our knowledge of Upper Pleistocene environmental change in Arabia, which forms *the* critical context for the dispersal of hominin populations, has improved rapidly (e.g. Parker and Rose 2008; Parker 2009; Fleitmann *et al.* 2011; Rosenberg *et al.* 2011, 2012) (see Figures 2.4, 2.5, 2.23.) Here the focus is on environmental change between 130 and 40 thousand years ago. It also important to stress that a considerable role exists for analogies from the more robustly understood 'Holocene Wet Phase' between ~10-6 ka (see e.g. Schultz and Whitney 1986; Cleuziou *et al.* 1992; Sanlaville 1992; Parker *et al.* 2004, 2006a,b,c; Radies *et al.* 2005; Lézine *et al.* 2007, 2010; Fleitmann *et al.* 2011; Berger *et al.* 2012). A recent study suggested that even in the far north of Saudi Arabia, this period saw precipitation levels at least 300% greater than at present (Engel *et al.* 2011). Given that the wet phases of the Pleistocene saw higher precipiation than the Holocene wet phase, as indicated by evidence such as oxygen isotopes in speleothems, such evidence indicates that a fundamental transformation of Arabia must have taken place during pluvial episodes.

Given the prominence of models positing the significance of 'coastal adaptation' as an explanation for hypothesised Upper Pleistocene hominin dispersals, exploring the role of sea level change on the environments of Arabia is clearly significant. The key area affected by sea level change is the Persian Gulf (as emphasised by Rose 2010). Likewise, the width of the southern Red Sea changed significantly (see discussion above; Lambeck *et al.* 2011). In addition, the southern eastern coast of Oman has a relatively substantial coastal shelf. However, along most of the southern coast of Arabia, and the northern part of the Red Sea, the topography descends very steeply from modern sea level, so that sea level change will not have had a particularly dramatic effect here. Consequently, in these areas we should expect to find evidence for Upper Pleistocene 'coastal adaptation', if this was a real phenomenon. Despite systematic survey near the coast, and the identification of both Lower Palaeolithic and Neolithic material, Rose *et al.* (2011) did not identify *any* Middle Palaeolithic material in proximity to the coast.

The most significant palaeoenvironmental oscillation in Arabia concerns widescale variation between wet and dry conditions at a subcontinental level, with the concordant effects these will have had in terms of effects on flora and fauna. The dry side of Arabia is relatively familiar to modern observers, as most iconically demonstrated by the vast deserts such as the Rub' al Khali (~600,000km$^2$). Other significant sand seas include the An Nafud in the north and Wahiba Sands in the east. A variety of records demonstrate that Upper Pleistocene Arabia saw periods which were characterised by significantly higher periods of precipitation, with the effects of changes in evaporation also of great importance. There were also some times when it will have been drier than in the present interglacial. The variation in the availability of water in Arabia reflects the varying inputs of two sources. First, are the winter rains from the Mediterranean (see e.g. Bar-Matthews *et al.* 2003). Second, and more important, are the summer rains from the south, known as *mawsim* in Arabic, which are associated with the Indian Ocean Monsoon System.

During wet periods of the Pleistocene the landscape of Arabia was transformed. Most spectacularly, this took the form of the presence of a large number of palaeolakes and palaeorivers. The chronology of the latter is poorly understood so their role in the Upper Pleistocene is unclear. As shown in Figure 2.1 a number of vast palaeoriver systems extend across Arabia, mostly trending from west to east. Several recent studies have addressed Upper Pleistocene palaeolakes. Palaeolakes varied from the tiny, via the small such as Jubbah, to the vast such as Lake Sawain in Oman at ~1,400km$^2$ (Rosenberg *et al.* 2012) and ~2,000km$^2$ at Mudawwara in northern Saudi Arabia and extending into Jordan (e.g. Petit-Maire *et al.* 2010). Both of the latter examples were active in MIS 5. A number of radiocarbon-based claims for a wet phase demonstrated by lacustrine sediments at ~30-25 ka have been made (e.g. McClure 1976, 1984; Schulz and Whitney 1986; Whitney *et al.* 1983). Radiocarbon dates from these contexts face several problems; they were typically 'bulk organic' samples, largely in 'open' contexts and processed without modern techniques of pretreatment. For such reasons many published Pleistocene radiocarbon dates are problematic (see e.g. Immenhauser *et al.* 2007; Parker 2009) and as such as not used in this thesis. The issues with the radiocarbon chronology are demonstrated by Rosenberg *et al.*'s (2011) re-dating of the Mundafan palaeolake by OSL to MIS 5, in contrast to McClure's (1976) late MIS 3 radiocarbon dates.

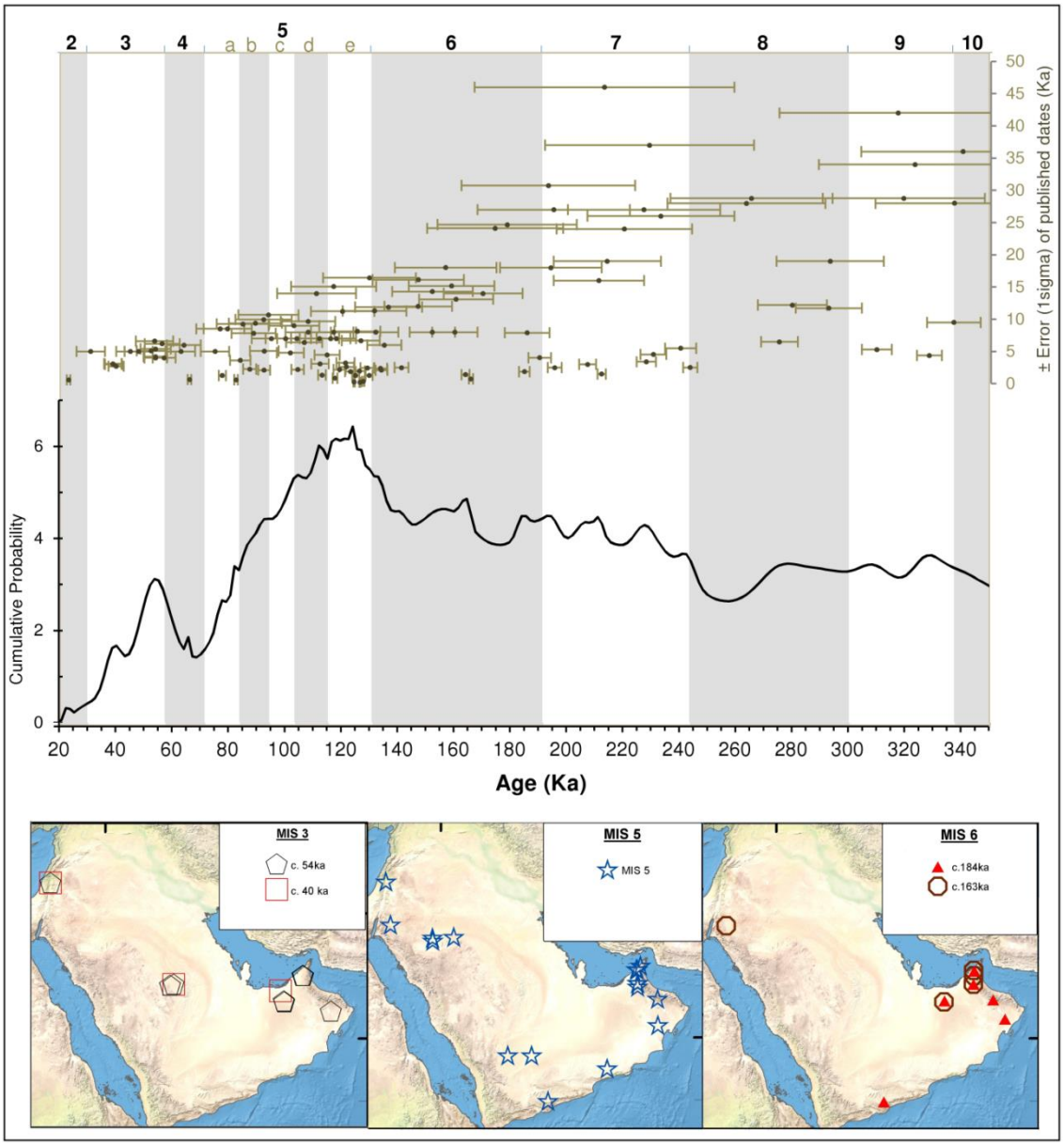



Figure 2.4. Probablility distribution funtion of evidence for humid conditions in Arabia (top). Spatial localities of archives for 3 key Marine Isotope Stages. Figure modified from Drake *et al.* (in press).

Figure 2.4 shows a compilation of evidence for humid conditions in Arabia, presented by Drake *et al.* (in press). Their probability density function (pdf) plot shows clear temporal variation in indications of humidity. In particular MIS 5 was a time of great humiditiy. Before this the error ranges of dated deposits are considerable and hinder a fine grained understanding of environmental variation. There is, however, clearly evidence for at least short phases of increased rainfall in MIS 6 and 7.

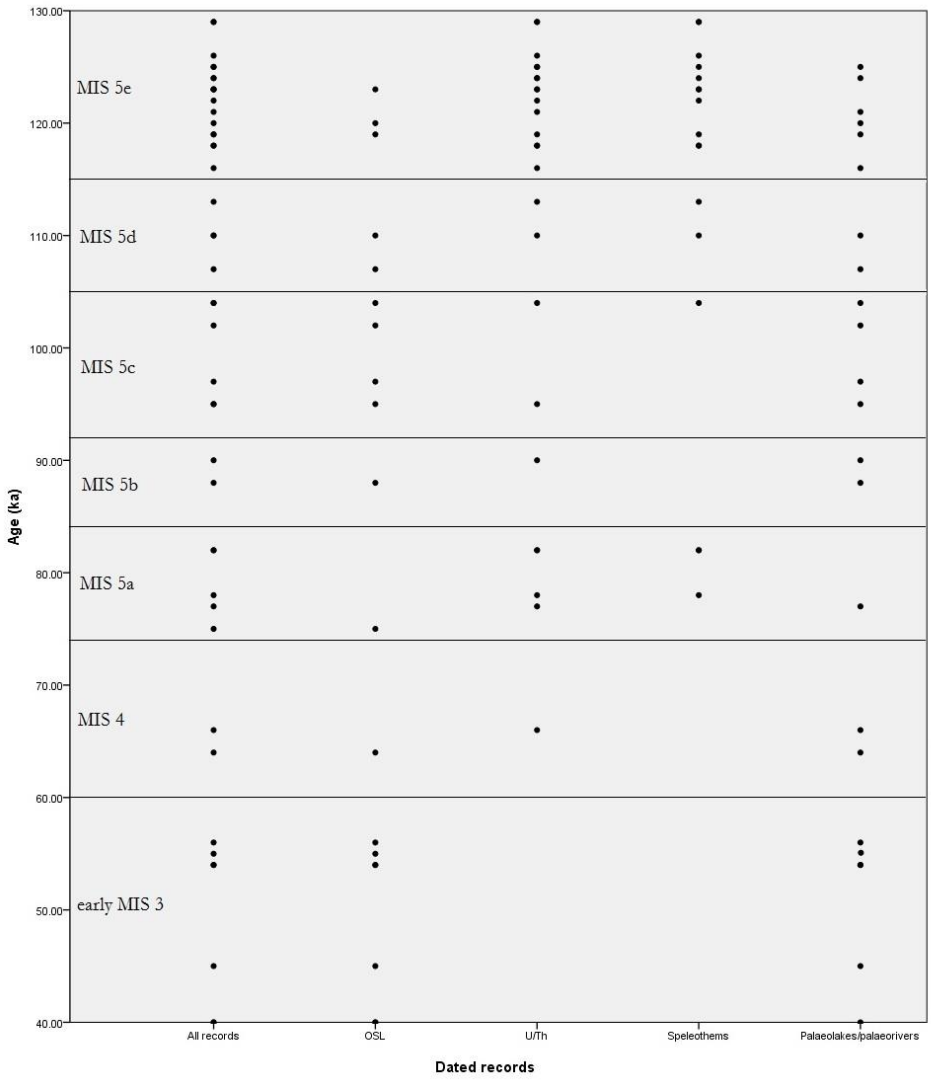



Figure 2.5. Published dated records indicating wet conditions in Arabia between 130 and 40 ka. This gives a simplified summary, without error ranges. Studies using radiocarbon dating are not included, as at this age they are problematic. For situations where several dates are clustered closely together (e.g. a large speleothem) only a single, centre date is shown. Likewise, overlapping dots are represented by a single point for clarity. Includes results from southern Jordan, as the Mudawwara palaeolake extends across the border into Saudi Arabia. 'Palaeolakes/palaeorivers' includes spring deposits. (Data from Goodall 1995; Neff *et al.* 2001; Glennie and Singhvi 2002; Petit-Maire *et al.* 2002, 2010; Fleitmann *et al.* 2003, 2011; Wood *et al.* 2003; Holzkamper & Mangini 2008; Blechschmidt *et al.* 2009; McLaren *et al.* 2009; Parton *et al.* 2010; Armitage *et al.* 2011; Rose *et al.* 2011; Rosenberg *et al.* 2011, 2012).

In addition to the extended wet phases of MIS 5 there is growing evidence for short term wet conditions post-MIS 5 (see Figure 2.5.). In particular this relates to a wet phase at ~60-55ka, which is now supported by evidence from four localities (Wood *et al.* 2003; McLaren *et al.* 2009; Parton *et al.* 2010, in press; Delagnes *et al.* 2012). As the simplified summary of evidence for increased precipitation shown in Figure 2.5 indicates, after MIS 5e, the last interglacial (*sensu stricto*), there is actually quite a wide temporal spread of evidence for wet conditions in Arabia.

The absence of known post-MIS 5 speleothems in Arabia suggests there were not extended periods of heavily increased precipitation, although it must be recognised that there is a precipitation threshold below which speleothems will not form. A critical issue is in determining whether hominins were able to survive in conditions characterised by precipitation less than that needed to produce speleothems. Speleothem formation is also significantly advanced by the presence of soil cover, as this is where much carbon dioxide dissolves into water. Short wet periods probably occurred on a landscape with limited soil, so the increased rainfall will either not be represented in speleothems or will be underrepresented.

Parton *et al.* (in press) and Sitzia *et al.* (2012) address the early MIS 3 wet phase in the eastern UAE and Yemen respectively. In the former case the evidence relates to five phases of lake formation, while at the latter, correlating with the archaeological discoveries in Wadi Surdud discussed later in this chapter, a considerable depth of alluvial sediments accumulated from overbank flooding events. In contrast to the speleothem evidence, such studies indicate that early MIS 3 saw considerable precipitation in at least some spatial and temporal contexts.

**2.4) The early phase of research on the Middle Palaeolithic of Arabia**

Early observations of Palaeolithic assemblages in Arabia were made by the western explorers of the early twentieth century (e.g. Philby 1933). The first explicit recognition of Middle Palaeolithic sites by trained archaeologists appears to have been made in 1927 (Field 1960). The discovery resulted from a series of surveys in the 'North Arabian Desert', which took place between 1925 and 1950. Most of the work focussed further north than the area addressed in this thesis, but Henry Field, who had trained at Oxford, and his colleagues drifted across the border into northern Saudi Arabia and recognised Middle Palaeolithic sites at Jebel Umm Wual, Tell el-Hibr and other localities. As Field (1960, 47) reported:

> At dawn on November 25 {1927}…we drove with the Rolls-Royce and Cadillac…toward Jebel Umm Wual, which soon became visible on the distant skyline…and continued for about 2 hours across rolling, rough, flint country continually broken by small wadis. We eventually reached a small mud flat…the northern part was strewn with worked flints and a collection was rapidly made…On the top {of the jebel} we found typologically Mousterian flints bearing both a magnificent desert varnish and a deep brown patina. Here we found a

> perfect, small, typologically Mousterian hand ax. In the brief time we had at our disposal only a relatively small collection could be made.

The Arabian Peninsula now had a Middle Palaeolithic record. Similar discoveries were made by others over the following years (e.g. Rhotert 1938). In southern Arabia, Gertrude Caton-Thompson conducted pioneering research on the Palaeolithic of Yemen in 1937/1938 (Caton-Thompson and Gardner 1939; Caton-Thompson 1953, 1957; see discussion in Rose 2006). Caton-Thompson identified a number of assemblages of Middle Palaeolithic ('Levalloisian') character, with several coming from stratified contexts. The lithics were described as being "almost uniformly crude" and as perhaps representing "a genuinely low ebb in contemporary Palaeolithic standards" (Caton-Thompson and Gardner 1939, 30). This, it was suggested, might reflect the difficult environment of southern Arabia and isolation from other populations. Caton-Thompson (1953, 216) was more explicit in her later work, describing:

> a pebble-casual flake culture feeling its way towards a sort of half-completed Levalloisian technique handicapped from advance to a better level by its continued addiction to unfaceted high angling and poverty of retouch and types.

Caton-Thompson described a large number of the lithics she found as 'choppers' and 'chopping tools'. With the problems of typology in mind, many of them could perhaps be more adequately defined as cores. From the figures in her publications, it appears that Caton-Thompson was relatively conservative and strict in her descriptions by contemporary standards. A variety of reduction methods are represented, with uni- and bidirectional reduction seeming to be particularly common, although centripetal scar patterns are also represented. The examples shown in Figure 2.6 demonstrate a diversity of core forms. Caton-Thompson did not see strong evidence for connections with surrounding regions, although, critically, the African Middle Stone Age was very poorly understood at this point.

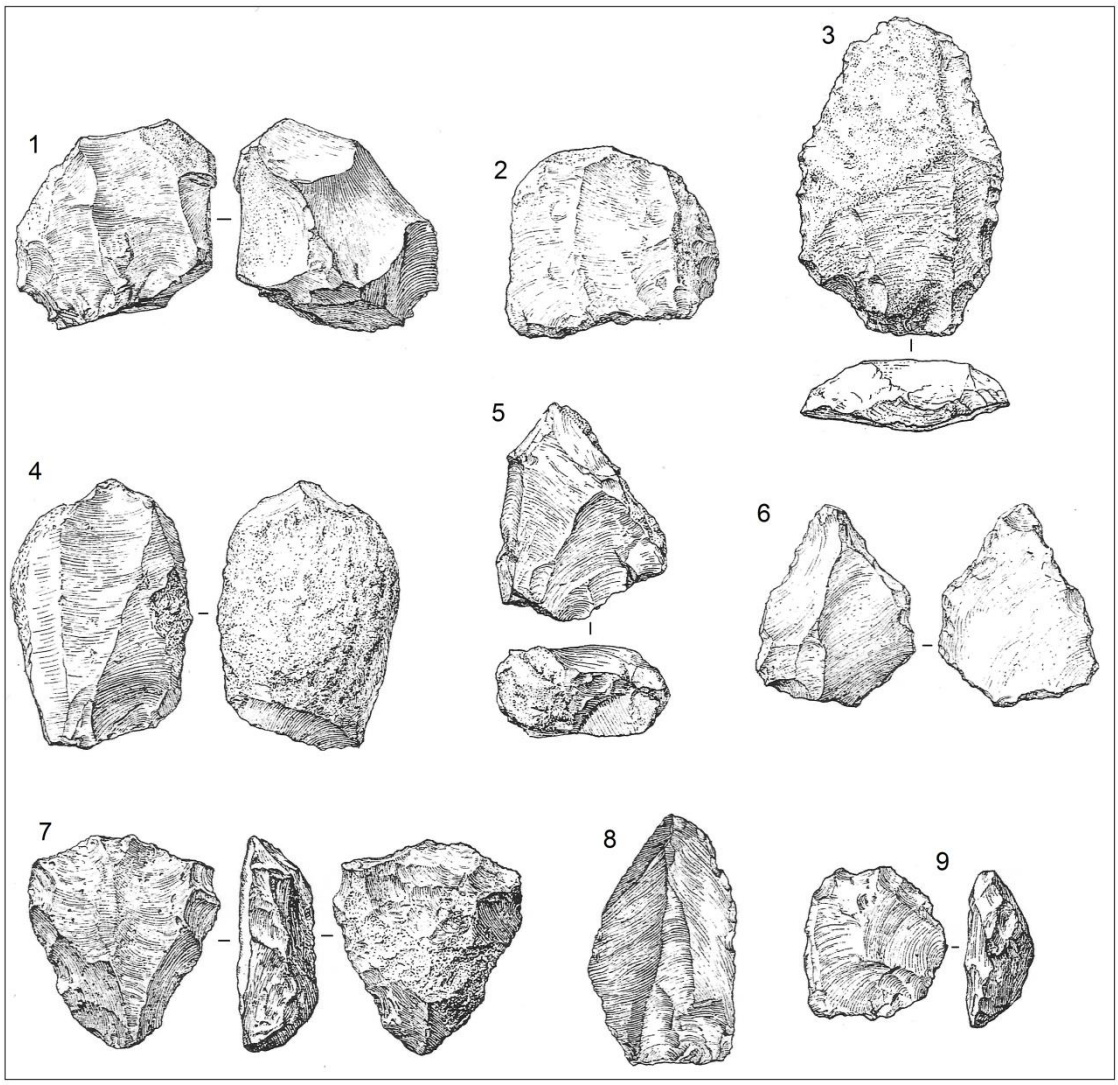


Figure 2.6. Illustrations of selected lithics from Wadi 'Amd and Tarim, Yemen (modified from Caton Thompson 1953).

To understand Caton-Thompson's contribution to the study of the Arabian Middle Palaeolithic – an important endeavour given its importance in influencing subsequent research – it is necessary to put her empirical findings in perspective with her theoretical framework. From her earlier work it can be argued that Caton-Thompson (e.g. 1946) downplayed the role of hominin dispersals and interactions between populations in the Pleistocene. Additionally and understandably given the contemporary zeitgeist, the idea of inevitable progress guided her work. For instance, in contrasting Yemeni assemblages from Shibam with those from Wadi Amd she declared the latter "so superior"

that they must be seen as a "technically developed descendent, and decidedly later in time" (Caton Thompson 1953, 211). She made a similar argument in relation to the size of artefacts (*ibid* 217). Most scholars would now agree there is no 'straight line' in prehistory. It may, in fact, be the case that earlier examples will be 'superior', as they will be more closely related to the well-established technical traditions of source populations and less affected by demographic and other processes in environmentally unstable southern Arabia.

Kapel (1967) suggested the possibility that 'Group A' in his division of lithic assemblages in Qatar may have belonged to the Middle Palaeolithic period, although this was shown to be problematic, when a subsequent excavation in Qatar found similar lithics in a Holocene context (Inizan 1978, 1980). This was to set back research on the Palaeolithic in Arabia many years and cast considerable scepticism on claims for Pleistocene occupations.

Van Beek *et al.* (1963; see also discussion in Rose 2006) failed to find the deep sequences of Pleistocene deposits which they had aimed to discover in Yemen, but did find a number of surface Middle Palaeolithic sites. They describe lithic assemblages from these sites as being technologically homogenous, with unidirectionally and bidirectionally prepared Levallois cores with little platform preparation. Sometimes preparatory scars were convergent, producing pointed blanks. Other cores are described as discoidal. Typologically the assemblage included points, some retouched, and 'scrapers'. Garbini (1970) discovered Middle Palaeolithic material in northern Yemen in 1969, but provided little information on his discoveries.

**2.5) The Comprehensive Survey of the Kingdom and its analogues**

From the 1970's onwards a new phase in the study of the Arabian Middle Palaeolithic began. In part this reflected changes in Middle Eastern geopolitics, the Iranian Revolution for instance largely ending archaeological research in Iran, and a number of scholars turned their attention to the Arabian Peninsula, which was itself being transformed by the development of the oil industry (see Tosi 1986). In Saudi Arabia the 'Comprehensive Survey of the Kingdom' (1976-1981) saw the discovery of thousands of archaeological sites, including hundreds assigned to the Middle Palaeolithic (see Petraglia and Alsharekh 2003 for discussion). Surveys covered vast areas very

rapidly, which as Gilmore *et al.* (1982, 9-10) put it, "rendered any but the most general statements on site distribution invalid". Where artefact collections were made, they were neither random nor systematic, and never exceeded a few hundred lithics. Consequently, detailed inter- and intra-regional comparisons are problematic using these small and biased collections.

The background of the surveyors in European and Levantine prehistory must also be recognised. Zarins *et al.* (1979, 13), for instance, are explicit on the Levantine-derived criteria used to assign an Arabian site to the Middle Palaeolithic. This is very problematic as the Levantine Middle Palaeolithic has a distinctive character in contrast to elsewhere. For instance, the African MSA is characterised by the widespread presence of a façonnage component, which is apparently unknown in the Levantine MP (Armitage *et al.* 2011). The presence of bifaces in an Arabian assemblage may therefore, wrongly, have sometimes been taken as suggesting a Lower Palaeolithic age.

The initial surveys – Adams *et al.* (1977) of central, eastern and northern Saudi Arabia and Potts *et al.* (1978) on eastern Arabia - found little evidence for Middle Palaeolithic sites. The picture began to change with the survey of Parr *et al.* (1978, 35), who noted in their survey of northern Arabia that "practically every site" showed evidence for a Middle Palaeolithic phase.

Juris Zarins and colleagues (1979) surveyed from close to Riyadh southwards to ~20°N. Their 'flake group' is here hypothesised to belong to the Middle Palaeolithic. The following year Zarins *et al.* (1980) reported on their survey of a broad-wedge shaped area between Riyadh and Jeddah. Zarins *et al.* (1981) addressed the archaeologically rich southwest of Saudi Arabia. In all of these surveys a large number of Middle Palaeolithic sites were identified.

Norman Whalen and colleagues (1981) surveyed in western Saudi Arabia, from Medina southwards to ~18.5°N, identifying 14 Middle Palaeolithic sites on the way. In the same year Ingraham *et al.* (1981) surveyed from west of Medina northwards to the border with Jordan, although in this case only three Middle Palaeolithic sites were identified. At the same time Garrard *et al.* (1981) revisited the Jubbah palaeolake in northern Saudi Arabia, whose archaeological importance had been confirmed by Parr *et al.* (1978). More on the discovery of Middle Palaeolithic sites at Jubbah is given in Chapter 4.

The final surveys were conducted in 1981. That of Gilmore *et al.* (1982) was in northern Saudi Arabia, and again found a spectacular Middle Palaeolithic record. In fact, the Middle Palaeolithic was identified at more than 80% of the Palaeolithic sites they discovered. The final survey was that of Zarins *et al.* (1982) in the environs of Riyadh. Once again, the Middle Palaeolithic was found to be very widespread.

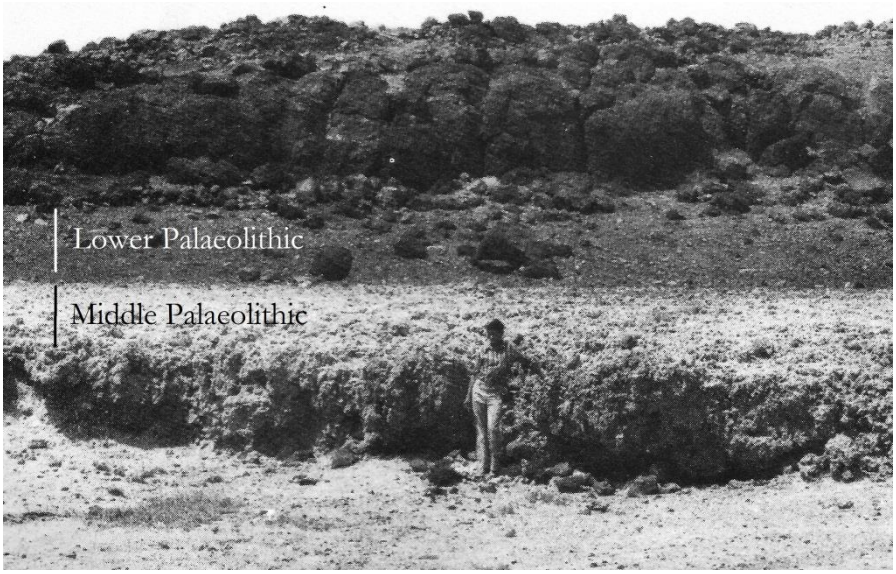
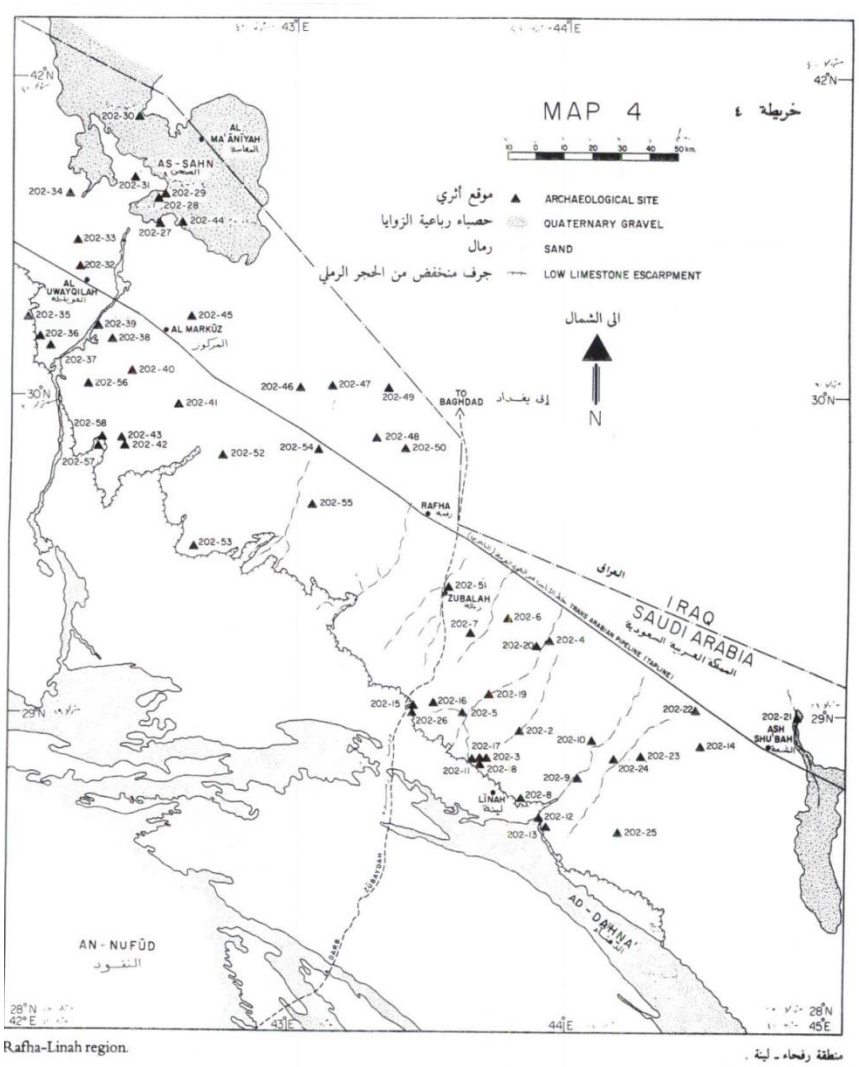



Figure 2.7. Photograph of Middle Palaeolithic site 216-208, lithics associated with a raised coral terrace on the Red Sea coast (modified from Zarins *et al.* 1981).

It is unfortunate that the standards of reporting on the distribution and character of Middle Palaeolithic sites discovered in the Comprehensive Survey vary considerably. However, from the available information it is possible to make some generalisations. Sites are commonly associated with raw material sources, particularly quartzite, andesite, rhyolite and flint (see Petraglia and Alsharekh 2003 for discussion of such topics). They often have the appearance of 'quarry' or 'factory' sites, an impression perhaps reinforced by the relative rarity of retouch and apparent dominance of local raw materials in these assemblages. Their position in the landscape is typically one enjoying wide views over the surrounding area. In other cases sites are located in proximity to lakes and rivers, and in the case of the survey Zarins *et al.* (1982) a few sites were identified embedded in raised coral terraces close to the modern coast (see Figure 2.7.).



Rafha-Linah region.

منطقة رفحاء ـ لينة .

Figure 2.8. An example of the comprehensive survey, archaeological sites of northern Saudi Arabia (from Gilmore *et al.* 1982).

In virtually all cases sites took the form of deflated surface scatters of lithics. An exception to the surface nature of the sites was identified at 217-42, located on the eastern fringe of the western highlands. Aside from having "one of the largest and densest scatters of Mousterian material found on the entire survey" (Zarins *et al.* 1981, 17), some of the assemblage was eroding from wadi deposits "up to 1.5m below the surface". 217-42 repeated the demonstration of Caton-Thompson that stratified Middle Palaeolithic could be identified in Arabia. Once again, however, the identified locality was not revisited and excavated.

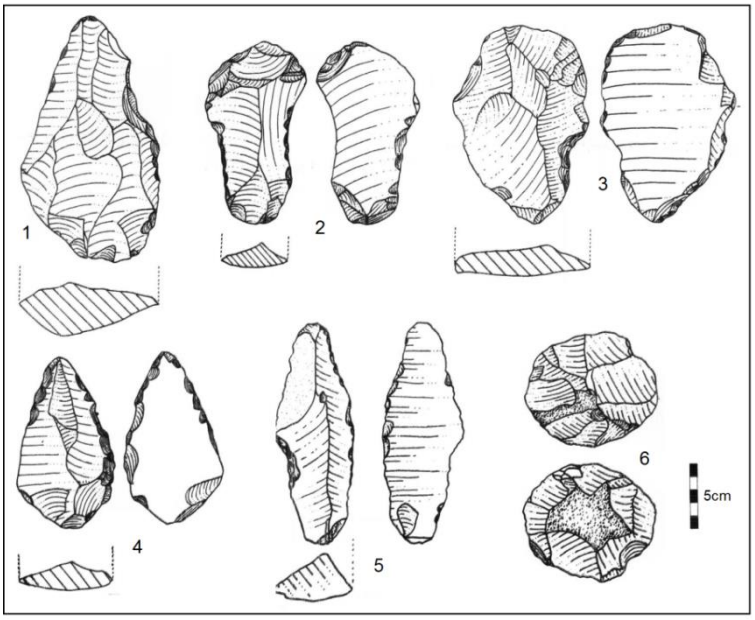
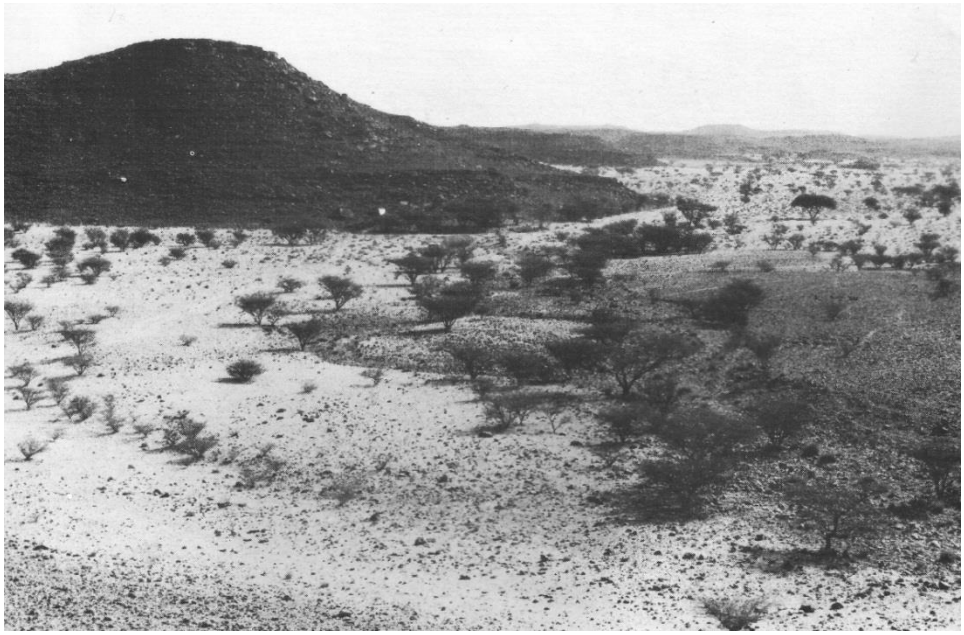


Figure 2.9. Illustrations of selected lithics from 217-42 (modified from Zarins *et al.* 1981).


Figure 2.10. Photograph of site 217-42. A spectacular Middle Palaeolithic in southwestern Saudi Arabia, located on the western edge of the Rub' al Khali and the first demonstration that stratified Middle Palaeolithic sites were present in Saudi Arabia (modified from Zarins *et al.* 1981).

The different survey and analytical methodologies render systematic intra- and inter-regional comparisons of the assemblages identified in the Comprehensive Survey problematic. Comments, then, will be primarily qualitative in character, which is not to say that such observations are not

important. The benefit of the Comprehensive Survey was that it rapidly covered a huge area of Arabia and gave insights into the kind of variability existing in the Middle Palaeolithic record.

Examining the reports on the Comprehensive Survey, it is clear that there were substantially different uses of terminology being applied. In addition there has been a significant evolution in lithic analyses since this 1970's. For instance, Zarins *et al.* (1979) describe 'discoidal cores' as being the dominant core type in their study area. However, some of the figures appear to depict what would today be regarded as recurrent centripetal Levallois cores. Indeed the prevalence or otherwise of Levallois technology in Arabia has long been debated (Petraglia and Alsharekh 2003). From the Comprehensive Survey it is clear that Levallois technology is found across Arabia, but it did not seem to be as consistently important as in, say, the Levantine Middle Palaeolithic, or the East African MSA. Beyond terminological differences, the Survey did seem to suggest real regional variation, but little real detail on this can be extracted from the data available.

Most collections were dominated by unretouched and 'simple' flakes and varying proportions of blades. Given the traditional typological focus on retouched pieces it is not surprising that investigators gave some attention to determining the dominant 'tool' types in their survey area. For Zarins *et al.* (1979) various forms of scrapers were dominant. The following year Zarins *et al.* (1980) noted, in particular, the relative prevalence of side scrapers in their collection. The most important of all were denticulates, which made up around 10% of 'tools'. At 217-42 scrapers make up around 10% of the collection, with endscrapers the most common (Zarins *et al.* 1981). Another characteristic of this site was the presence of fairly large 'choppers'. Whalen *et al.* (1981) found that sidescrapers were the most common tool type, followed by endscapers. Rarer types reported in varying amounts by surveyors include burins, borers and notches. Particular types seemed to vary in occurrence, with, for instance, points identified in some areas (e.g. Zarins *et al.* 1981), but not in others (Zarins *et al.* 1980; Whalen *et al.* 1981).

The Comprehensive Survey demonstrated the widespread presence of bifacial (façonnage) technology at various Middle Palaeolithic sites in Saudi Arabia. It is repeated that bifaces are apparently all but unknown in the Levantine Middle Palaeolithic (e.g. Armitage *et al.*, 2011). Claims

to the contrary is not convincing, such as evidence from the base of the Middle Palaeolithic at Tabun which probably reflects excavation using spits in a complex sedimentary sequence conflating the early Middle Palaeolithic and the late Lower Palaeolithic. Zarins *et al.* (1980) described sites with bifaces as belonging to the 'Mousterian of Acheulean Tradition' (see also Zarins *et al.* 1981; Whalen *et al.* 1981). A more fitting comparison is to the Middle Stone Age of proximal Africa, rather than a French industry.

While these advances were being in made in Saudi Arabia some progress was also being made in southern Arabia. De Hayle des Hermens (1976) reported the discovery of Middle Palaeolithic sites near Sana'a and Marib in Yemen. As with the earlier findings of Garbini (1970), these sites demonstrated that northern Yemen had a rich Middle Palaeolithic record. Over the coming years, little progress would be made in Saudi Arabia, despite the promising start of the Comprehensive Survey, and research focussed on southern Arabia.

**2.6) The 'transitional phase' of Arabian Palaeolithic Archaeology**

Despite a long civil war a number of projects were conducted in Yemen in the 1980's and 1990's (for more detailed background information on the history of archaeological investigations in southern Arabia see Rose 2006; Crassard 2007, 2008). Examples of fieldwork conducted include the identification of a number of Middle Palaeolithic sites in the then North Yemen, although little information is available on these findings (de Maigret 1984, 1985, 1986). In Yemen's Hadramawt region a CNRS project identified Middle Palaeolithic sites demonstrating a number of reduction strategies (Inizan and Ortlieb 1987). Levallois cores included those for flakes, blades and points. Some of the latter cores, as shown in Figure 2.11, clearly represent examples of Nubian-like cores (the Nubian concept is discussed more fully on page 46). Bifaces were also apparently identified in these assemblages, which is of interest as the Dhofar Nubian assemblages discussed later in the chapter have absolutely no façonnage component (Rose *et al.* 2011; Usik *et al.* in press). Norman Whalen also conducted surveys in south-western Yemen and identified yet more Middle Palaeolithic sites (Whalen and Pease 1991; Whalen and Pease 1997). As another reflection of

typological and terminological issues, Crassard (2009) points out that the 'polyhedrons' and 'discoids' illustrated in Whalen and Schatte (1997) are actually recurrent centripetal Levallois cores.

In southern Yemen a joint Soviet-Yemeni project resulted in the identification of multiple Middle Palaeolithic sites (Amirkhanov 1987, 1991, 1994, 2006). Unfortunately much of the publication of this project is only available in Russian and in problematic. For instance, Crassard (2009) re-examined the collections and observed that many appear to be natural geofacts. Many of the sites reported as being 'Upper Palaeolithic' appear to be compatible with a Middle Palaeolithic designation. Amirkhanov (1994) suggests that in the area studied the "universal technological features" of Middle Palaeolithic assemblages (see Figure 2.12) included Levallois technology, denticulate and bifacial components, and the presence of 'Upper Palaeolithic' like forms. Faceting was generally minimal.

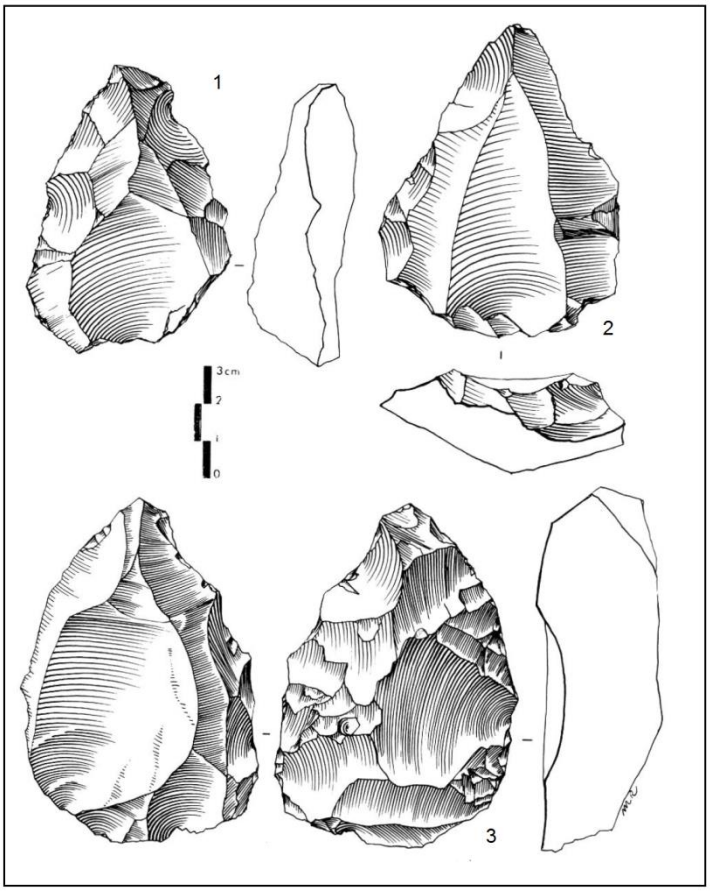



Figure 2.11. Illustration of Nubian-like Levallois cores from Yemen (modified from Inizan and Ortlieb 1987)

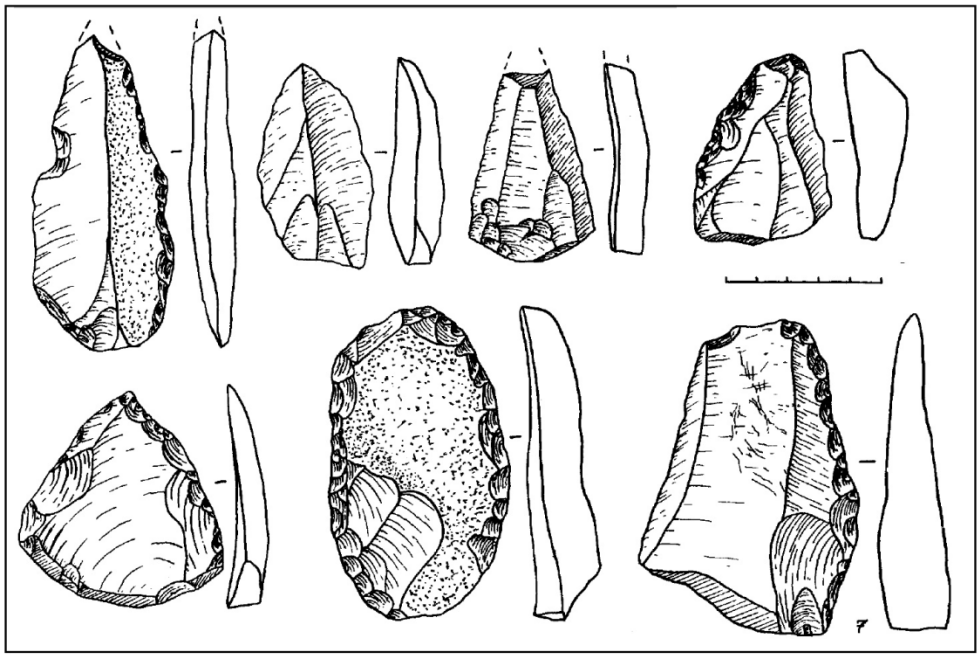


Figure 2.12. Selected lithics from Al-Gabr 1, Hadramawt (modified from Amirkhanov 1994).

An interesting site was identified by McClure (1994) at Bani Khatmah on the south-western edge of the Rub' al Khali. The collection is dominated by large tanged points and scrapers, with other types including bifacial foliates (examples of which are shown in Figure 2.13). Retouch is typically on the dorsal surface, although in many cases the bulb of percussion has been removed. Cores and production debitage which would illuminate the process of production are absent. McClure tentatively suggests the possibility of affinities with the Aterian, otherwise seemingly only found west of the Nile (for previous suggestions in Arabia see also Sordinas 1978). While coming from the surface, McClure (1994) suggested the material correlated with a hypothesised wet phase at around 20-35 ka. While now known to be incorrectly dated, McClure's attempts to correlate archaeological and palaeoenvironmental evidence are nevertheless significant. The material from Bani Khatmah is sometimes cited as evidence for the Aterian in Arabia and hence "the most clear and convincing evidence for eastwards dispersals of African humans into SW Asia" (e.g. Beyin 2006). This is a premature conclusion based on superficial features of a surface assemblage. The assemblage was recently reanalysed by Scerri (2012), who convincingly suggests that the Aterian-like features of the assemblage reflect convergent evolution from Holocene industries. Similarities to the Aterian are superficial and do not stand up to comparative technological analyses

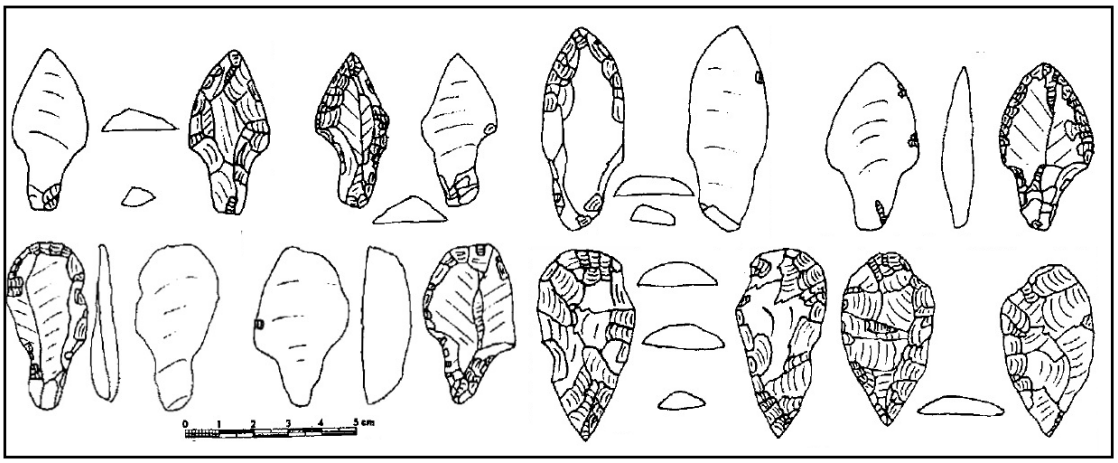


Figure 2.13. Illustrations of selected lithics from Bani Khatmah, Saudi Arabia. Top row: tanged points. Bottom row: tanged scrapers and bifacial foliates. (Modified from McClure 1994).

Sally McBrearty (1993, 1999) analysed surface lithic assemblages from the UAE. Although in most cases attributable to the Holocene, an exception was found at Jebel Barakah, where McBrearty, an experienced Africanist archaeologist, stated that on the lithics "nothing in their technical execution or state of patination would exclude them from the…Middle Stone Age" (1999, 383). Wahida and colleagues (2009) report more recent work at Jebel Barakah. They broadly repeat the observations of McBrearty, but also suggest that one core can be regarded as Nubian. This piece is broadly Nubian like, but it is a single specimen and on technological grounds Rose *et al.* (2011) criticise the description of it as Nubian. Most of the assemblage is dominated by centripetal reduction (see Figure 2.14). Wahida *et al.* (2009) report a high ratio of cores at the Jebel Barakah localities, which they suggest indicates their role as a raw material source.

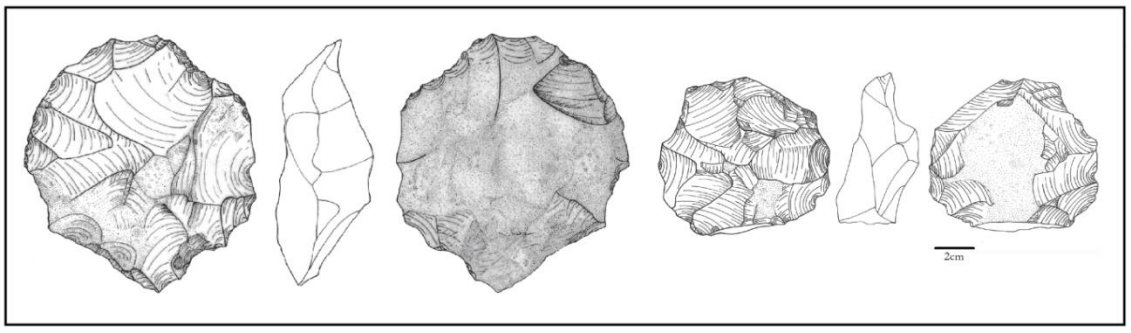


Figure 2.14. Illustrations of cores from Jebel Barakah, UAE. These can be described as recurrent centripetal Levallois cores. Modified from Wadiha *et al.* (2009).

Jeffrey Rose (2004a,b; 2006; 2007a,b) has conducted multiple surveys in the ad-Dakhiliyah (NE) and Dhofar (SW) regions of Oman. Middle Palaeolithic-like sites were found in surface contexts,

with selected assemblages subsequently being analysed in detail. Rose defined three new 'industries' (*sensu lato*) from his discoveries (see table 2.1). Rose (2006, 333) stated that this schema is advanced to "put forth a testable model, instigate debate, and generate interest in the Pleistocene of South Arabia".

Rose suggested that the Leptolithic dated to broadly MIS 6-5 and characterised by blade production, and lacked evidence for a bifacial component. This type of industry seems to be common in Oman, with a core technology typified by the removal of unidirectional-parallel blades from lineal cores, whilst there are also some bidirectional cores and simple blade cores. More recent evidence suggests that the Leptolithic is probably considerably younger, as will be discussed below.

| *Date* | *Techno-typological unit* | *Site* | *Reduction Strategies* | *Potential Regional Affinities* |
|---|---|---|---|---|
| Upper Pleistocene (OIS 3) | **Khasfian** | SH22-SH23 | soft hammer bifacial foliates made on plaquettes, flakes, and blades; centripetal cores | Late MSA of the Horn [Somaliland Stillbay]<br>Early LSA of the Horn [Somaliland Magosian] |
| | | T27.II? | large, flat, sub-triangular bifacial preforms | |
| Late Middle/ Early Upper Pleistocene (OIS 6-5) | **Nejd Leptolithic** | T21 | uni-parallel blades; cores on flakes (possibly mixed) | |
| | | T27.I? | flat cores with supplementary lateral and distal platforms | MP/UP of Rajastan, India<br>Early Hargeisan, Somalia |
| | | T29 | blades from flat, lineal working surface, uni-convergent and uni-parallel scar patterns | |
| Middle Pleistocene (OIS 9-6) | **Sibakhan** | A7-A10 | blades from naturally elongated working surface(s), uni-convergent and uni-parallel scar patterns; hard hammer flat bifacial handaxes | Koimilot Locus 2, Kenya<br>Mugharan Complex, Levant<br>K'One Locality 5, Ethiopia |
| | | A14 | blades from naturally elongated working surface(s), uni-convergent and uni-parallel scar patterns | |

Table 2.1. Rose's proposed scheme for Pleistocene Oman (Rose 2007a)

Rose proposed that the 'Khasfian' belongs to MIS 3. Rose argues that combination of small bifacial foliates – in which he follows earlier discoveries by others such as Pullar (1974) and Biagi (1994) – and some centripetal Levallois cores points towards population connections with East Africa. However, as originally defined (Rose 2006) the industry is built on a small amount of material from the single site of Bir Khasfa, although he does stress potential connections with similar assemblages in southern Arabia.

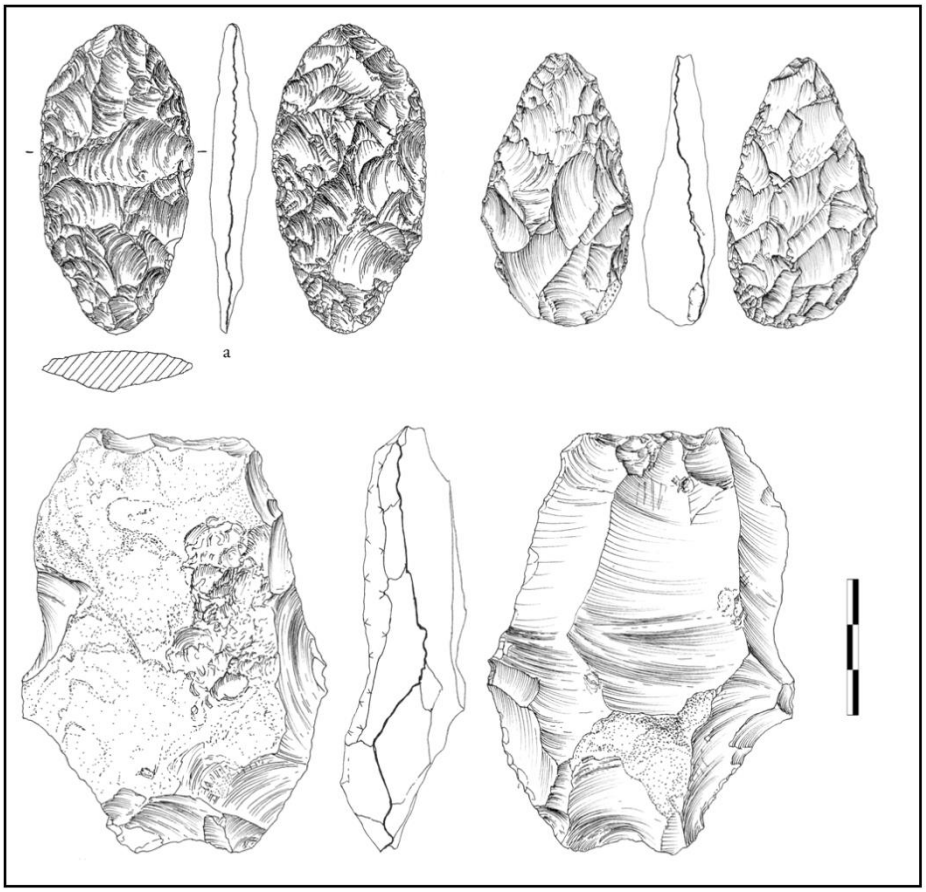



Figure 2.15. Illustrations of selected Palaeolithic artefacts from Oman. Top, 'Khasfian' bifacial foliates from SH22-23, Oman. Bottom, 'Leptolithic' core, T27, Oman. (Modified from Rose 2007a).

In the Huqf region of southeastern Oman the Central Oman Paleolithic Survey (COPS) has identified hundreds of archaeological sites (Jagher 2009; Jagher and Pümpin 2010; Jagher *et al.* 2011). Adopting a rather different, and probably, more objective approach, in comparison to most previous workers, sites identified by COPS were not assigned to a specific cultural phase. A more open system was employed, where assemblages were described according to the basic morphology of the lithics identified (e.g. 'heavy blades', 'light blades', 'small bifacials', etc).

During surveys conducted from 2007 to 2009 a total of 278 localities were identified with lithic assemblages believed to date to the Pleistocene. The research carried out by COPS demonstrates the benefits of adopting a spatially broad approach, in contrast to projects focussing on a single locality. As with earlier surveys, COPS identified a plethora of 'factory' sites, occurring next to most good exposures of flint. A key observation of this project relates to the development of understanding of the palimpsest effect. It is generally assumed that surface sites will often consist of

material from occupations of different time periods. In fact the COPS project has shown this to be less of a problem than might be thought. A majority (56%) of sites with lithic artefacts are characterised by one type of diagnostic artefacts (i.e. they are not obviously palimpsests). Of the sites (35%) with two diagnostic elements 62% are made up of the combination of heavy bifacial pieces and heavy blades. When it is considered that many sites produced simple debitage not attributable to any diagnostic category, the rarity of truly mixed sites is clear. In addition, at many sites extensive refitting is possible.

As the COPS survey has addressed only surface scatters, chronological attributions are problematic. Jagher emphasises a relatively early age for assemblages characterised by heavy blades and bifacial elements on geomorphological grounds as at some sites extensive gullying of sites has taken place, which he feels is too extensive to have occurred during the Holocene Wet Phase and so may reflect MIS 5e or an earlier pluvial. Heavy blades are both common and distinctive in the Huqf area. They are relatively standardised in shape, have little curvature for blades of this length (typically 8-12 centimetres) and unidirectional reduction seems to have seen little platform preparation nor maintenance of core volume. Other than bifaces other 'tool' types are extremely rare. Levallois like pieces are represented, but within a range of variability. Assemblages characterised by lighter blades are comparable to those assigned by Rose to the Leptolithic (Rose 2006). To Jagher the Huqf discoveries demonstrate a long lived and distinctive human occupation of southern Arabia. Some particular characteristics occur in many assemblages, including the prevalence of simple blade technology, little evidence for Levallois technology and sparse retouch.

In the United Arab Emirates survey work by the PADMAC unit has identified a number of surface assemblages believed to be of Middle Palaeolithic age (Scott-Jackson *et al.* 2009). In some cases, as discussed below, assemblages demonstrate similarities to Jebel Faya Assemblage C and the Jebel Barakah material previously discussed (centripetal Levallois and bifacial reduction). Other assemblages, namely those assigned to the 'B1' group, have a rather different character. Their key features include limited faceting and a reduction strategy focussed on the production of blades using a hard hammer. There is little to no evidence for bifacial or Levallois reduction. This again

sounds analogous to 'Leptolithic' assemblages, and perhaps extends their distribution to the north of Oman.

In the Hadramawt region of Yemen a number of Middle Palaeolithic sites were identified by the Roots of Agriculture in Southern Arabia Project (RASA) and French Archaeological Mission in Jawf-Hadramawt (HDOR). Rémy Crassard has conducted detailed technological analyses of the discoveries, focussing on variations in core technology (Crassard 2007, 2008, 2009; Crassard and Thiébaut 2011) (see Figure 2.16.). Levallois point production is of interest as it appears to be more geographically constricted than Levallois flake production (Crassard and Thiébaut 2011).

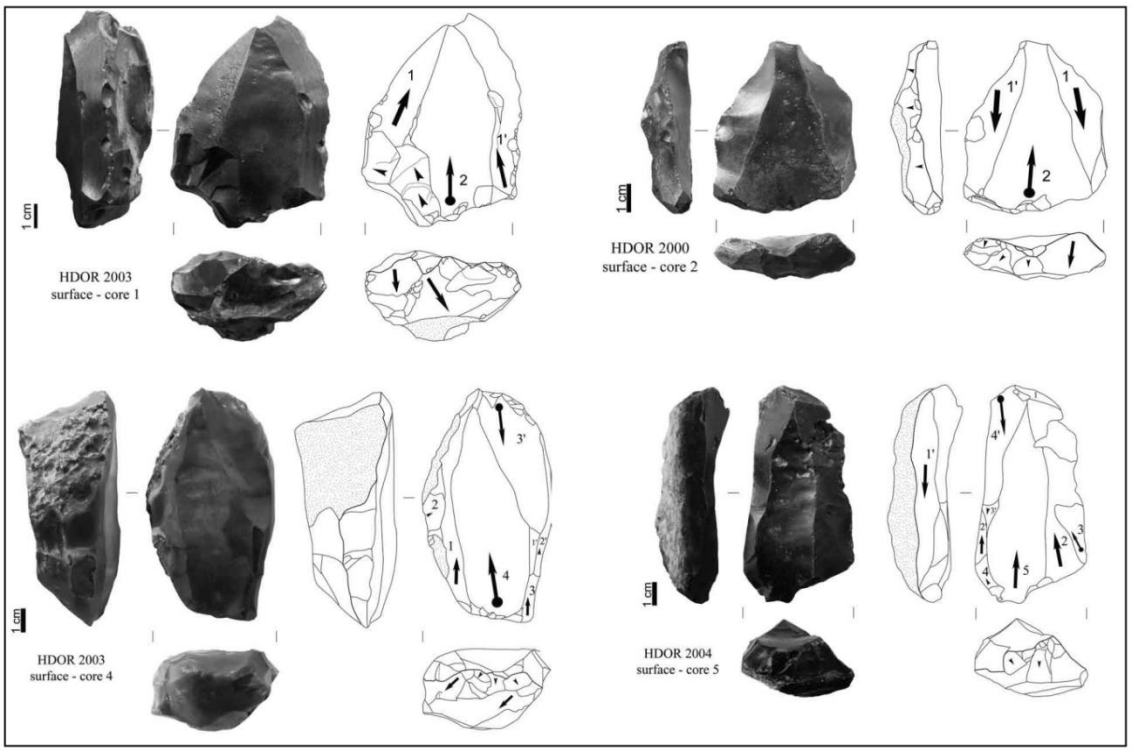



Figure 2.16. Photographs and illustrations of different methods of point production from Hadramawt, Yemen. Clockwise from top left, 1) scheme 'B1', "classical point", 2) 'B3' opposed unipolar, 3) & 4) 'B5', bidirectional preparation (modified from Crassard and Thiébaut 2011).

A key factor which emerges from Crassard's analysis is the diversity of core technology in the Hadramawt. Following the methodology of Boëda (1994) cores are assigned by Crassard to a

number of methods, or 'modalities', which are seen as "equivalent to the knapper's Levallois conceptualisation" (Crassard 2009). From the core morphologies and chronology of removals Crassard emphasises the contrast with the limited information which traditional typological approaches provide.

Crassard (e.g. 2009, 166) suggests that, in a broad sense Levallois point production in the Hadramawt shares more with Levantine traditions than with those of East or North Africa, but that the possibility of significant autochthonous developments must not be ignored. Also, some of the cores clearly resemble Nubian cores. Likewise, further work is needed to differentiate culturally significant methods from 'opportunistic' maintenance of core volume and to increase sample sizes for the different 'methods'. That most cores have similar size dimensions (Crassard and Thiébaut 2011, Figure 13) irrespective of reduction scheme could be taken as evidence for opportunistic reduction until the core was difficult to work. Further support for this may come from the fact that all (although n=4) of the Levallois points themselves are characterised by 'traditional' Levallois unipolar convergent preparation.

**2.7) Jebel Faya, United Arab Emirates**

The publication of the excavations at the FAY-NE1 (Jebel Faya) rockshelter, located just west of the Hajar Mountains, UAE, gave Arabia its first published stratified Middle Palaeolithic site (Armitage *et al.* 2011).

As shown in Figure 2.17, the published information on Jebel Faya concerns the top three Palaeolithic assemblages, which are here all regarded as Middle Palaeolithic. The presence of an underlying assemblage is possibly significant in evaluating the character of the site, as the authors interpret Assemblage C - associated with OSL dates of 95± 13 ka (a minimum age), 123±10 ka and 127±16 ka, although in the Supporting Online Material Armitage *et al.* [2011] suggest the latter date may be problematic, as demonstrating a dispersal of 'modern humans' from Africa, with the overlying Assemblage B (undated, but on stratigraphic grounds between 90 and 40 ka) and Assemblage A (OSL ages of 40.2±3.0 ka and 38.6±3.1 ka) interpreted as evidence for a continuous

regional occupation after this original dispersal. Clearly, the presence of an immediately underlying Assemblage D and possibly an additional assemblage potentially complicates this scenario. It may be that Assemblage C represents an autochthonous development, for instance.

Assemblage C, dating to MIS 5, although with a considerable difference between the OSL dates as stated above, demonstrates an interesting package of technological characteristics. Of immediate importance is its demonstration, previously strongly suggested by the numerous discoveries at surface sites discussed above, that bifaces were present in the Upper Pleistocene Middle Palaeolithic of Arabia. This is a crucial characteristic of the assemblage, and is used in combination with the nature of the Levallois technology by the discoverers to suggest that it reflects a dispersal of modern humans from northeast Africa around the transition from MIS 6 to MIS 5. The bifaces consist of both rather crude 'hand axes', which are interpreted by their discoverers as 'preforms', and finer bifacial foliates. Although no information is given on how many of such types are present. Indeed quantitative information on the assemblage is very sparse overall. Aside from this bifacial, façonnage component a number of core and flake reduction strategies are present. These include Levallois, volumetric blade and 'simple parallel' methods (Armitage *et al.* 2011). Retouched forms are classified typologically as end and side scrapers and denticulates.

The excavators were unable to date the overlying Assemblage B due to the absence of pockets of sand suitable for OSL dating. On stratigraphic grounds it dates to between 90 and 40 thousand years ago, and perhaps correlates with MIS 5a or the short wet phase at ~55ka (early MIS 3). In contrast to assemblage C, bifacial technology is absent. Similarly, Levallois technology is seemingly not represented apart from some convergent flakes which could be called Levallois points. Assemblage B is characterised by a variety of reduction strategies, primarily producing flake proportioned blanks. These strategies include radial and Kombewa methods. A variety of retouched forms are present, including scrapers, denticulates and burins.

Assemblage A, the top Palaeolithic assemblage, demonstrated securely for the first time the presence of hominin populations in Arabia in MIS 3. Like B, Assemblage A is characterised by a focus on flake production. Kombewa and radial cores are also present in this assemblage, but

orthogonal multiplatform cores are the most important core form present. The latter demonstrate a consistent reduction strategy, where the striking platforms, which saw little preparation, were changed as different surfaces were flaked. All of the raw material used in Assemblage A is locally acquired. Similar types of retouched piece are present as in Assemblage B. Again, bifacial and Levallois technology are apparently absent and artefacts are typically small. From the structure of Assemblage B and A, which the authors argue have no known comparisons in surrounding regions, a reasonable suggestion based on published evidence, it is claimed that they demonstrate a regional, autochthonous trajectory descending from the population associated with Assemblage C.

More information on the Middle Palaeolithic of Jebel Faya is awaited, and it is hoped this will address many of the open questions. The hypothesis that the site demonstrates a dispersal from Africa in early MIS 5, followed by a continuous regional occupation until at least MIS 3 needs to be tested. In the absence of fossil evidence it is not impossible that a species other than *Homo sapiens* was responsible for at least some of the assemblages (Petraglia 2011). It is also possible that the site represents three separate dispersal episodes. The discovery of surface assemblages in the same area similar to Assemblage C (e.g. McBrearty 1993, 1999; Scott-Jackson *et al.* 2009; Wahida *et al.* 2009) indicates the kind of correlation between excavated and surface assemblages which will allow progress in the study of the Middle Palaeolithic.

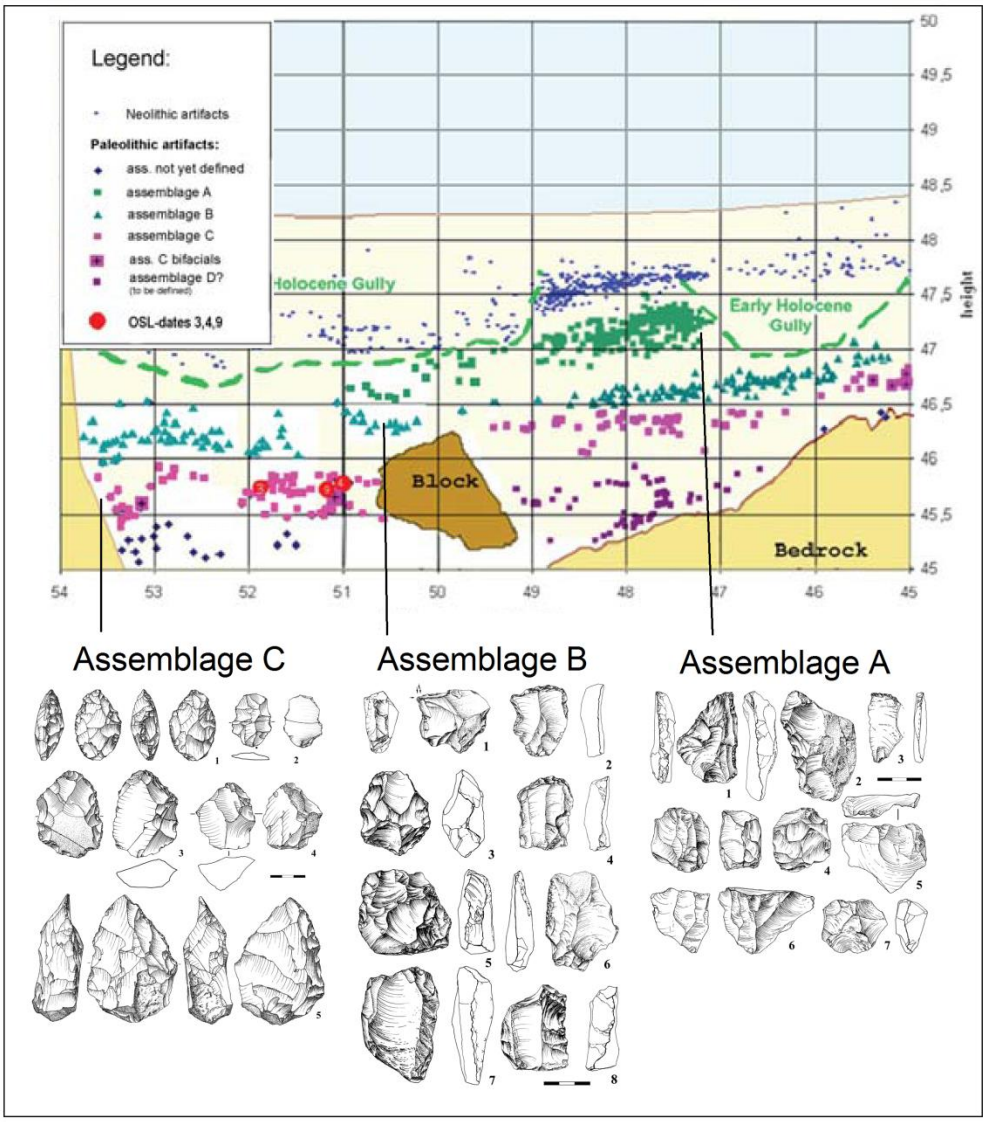



Figure 2.17. The stratigraphy at Jebel Faya (United Arab Emirates) and selected artefacts from the three published Palaeolithic assemblages (modified from Armitage *et al.* 2011).

## 2.8) The 'Nubian Complex' of Dhofar, Oman

Recent research by members of the Dhofar Archaeology Project between 2010 and 2012 led to the discovery of 260 sites in southwest Oman which the discoverers assign to the 'Nubian Complex', which is otherwise an essentially northeast African industry (Rose *et al.* 2011; Usik *et al.* in press). Previously, isolated examples of Nubian-like cores had been identified in Arabia (e.g. Inizan and Ortlieb 1987; Crassard 2009), but the new discoveries were distinguished by their density and apparent technological homogeneity (examples are shown in Figure 2.18). This homogeneity applies

at the broad level of them being dominated by Nubian technology. Within this category, some interesting diversity is beginning to be observed (Usik *et al.* in press).

Sites are typically associated with palaeoriver/stream channels on the Dhofar plateau, and often closely correlated with chert exposures, which are widespread in Dhofar and often of excellent quality. All but one of the sites – which is discussed below – entirely consist of surface scatters. Their technological homogeneity and presence of refits at some sites, however, suggests at least in many cases they belong to restricted chronological contexts.

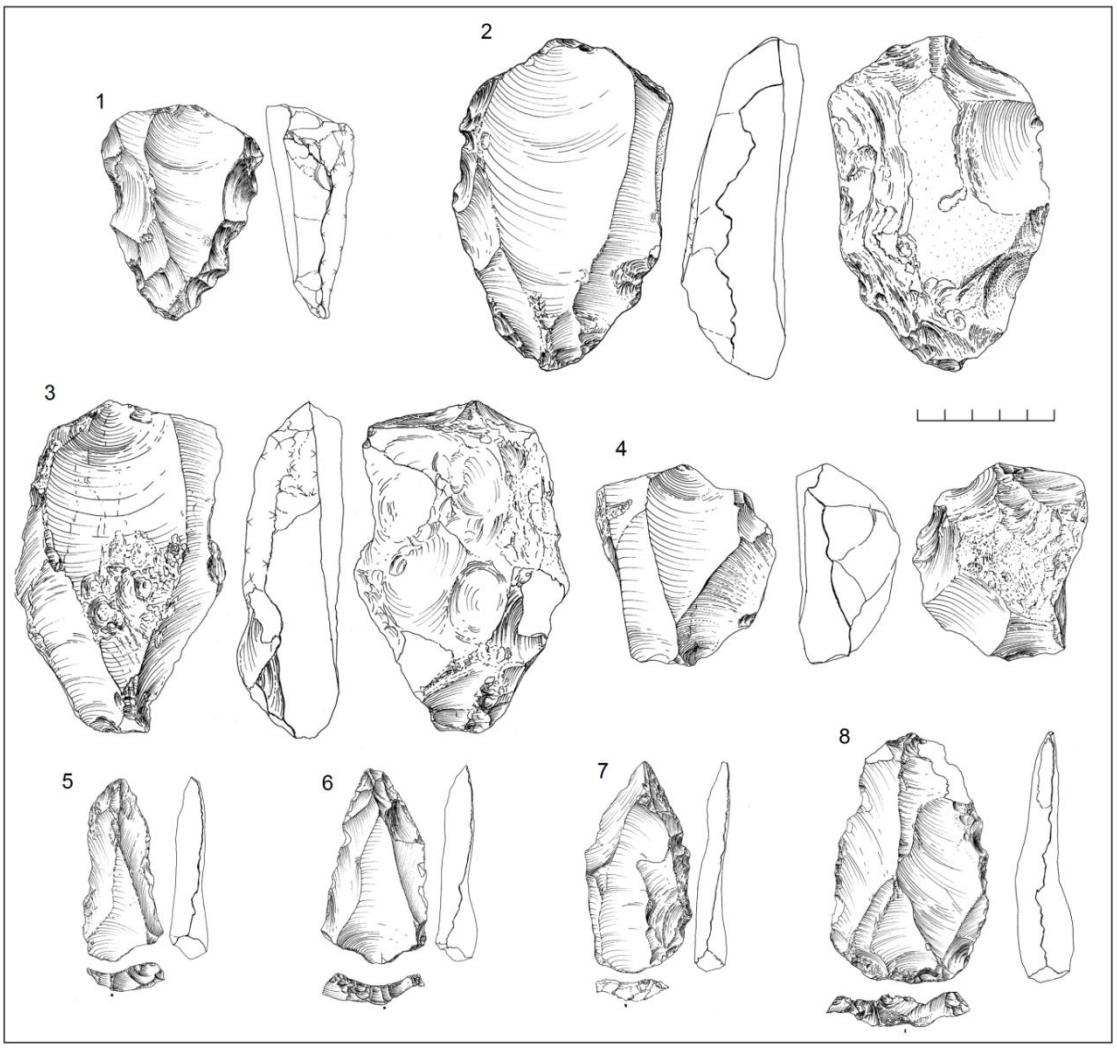



Figure 2.18. Illustrations of selected artefacts from Aybut al Auwal, Dhofar (modified from Rose *et al.* 2011). 1) Type 2 Nubian core, 2-4) Type 1 Nubian core, 5-8) Levallois points.

At the site of Aybut al Auwal, a random collection of artefacts was made from a terrace above a stream channel where chert outcropped. An excavation in fluvial sediments here discovered ~12 lithics *in situ*, including a characteristic Type 1 Nubian core. Other artefacts associated with the sediments were de-silicified in a similar manner to those found buried. OSL estimates on the artefact bearing 'unit 3' produced age estimates of 106±9 ka and 107±9ka (Rose *et al.* 2011). As the context is fluvial, this age, within error ranges of the start of the start of MIS 5c is therefore a minimal age, but it is unclear by how much.

The distinctive feature of the Nubian Complex as defined in North Africa relates to characteristic core preparation, leading to what are defined as Nubian cores and the typically pointed preferential blanks struck from them (see e.g. Guichard & Guichard 1965; Marks 1968a; Van Peer 1998; Van Peer and Vermeersch 2007; Rose *et al.* 2011; Usik *et al.* in press). Nubian cores are characterised by their approximately triangular shape and preparatory removals to create a sharply angled median distal ridge, in addition to the lateral and distal convexities characteristic of Levallois technology. The distal ridge can be formed by removals from the distal end of the core (Type 1 Nubian core), or from the lateral margins (Type 2), or by a combination of both. The flexibility of the preparatory gestures can be seen as a reflection of the different ways in which a median distal ridge can be prepared. Whilst the Type 2 method is present in the Dhofar assemblages, it is far less common than the Type 1 (Rose *et al.* 2011). In fact, the Dhofar assemblages have considerably higher proportions of Nubian cores (particularly Type 1) than Nubian sites in northeast Africa. Other core types are present in small numbers. A relatively small number of blanks were retouched into a variety of 'tool' types, mostly 'sidescrapers', but overall there is little retouch in these assemblages, which are dominated by unretouched flakes and blades, cores and Nubian Levallois points. No bifaces were identified at any of the Dhofar Nubian sites.

These findings are significant as they represent the first discovery of assemblages resembling a specific African industry, and therefore have considerable implications for elucidating dispersal processes. While it is possible that they represent an independent invention, the similarities between

African and southern Arabian technology are certainly striking. The ~MIS 5c date at Aybut Al Auwal is of interest as in northeast Africa sites dominated by Type 1 Nubian reduction typically – although bearing in mind the small number of dated sites – date to MIS 5a. It is, however, significant that important localities such as the classic Nile Valley Nubian sites (Marks 1968) are undated, so the chronology of this time remains poorly understood.

To Rose *et al.* (2011) the higher proportion of Nubian cores at the Dhofar sites compared to those in Africa reflects adaptation to the environment of southern Arabia. More specifically, they suggest that in contrast to the situation in North Africa, or at least the elements of this which we know most about, where populations may have been relatively tethered to the River Nile, in Oman they were more mobile and therefore focussed their reduction processes on producing points to carry away for hunting. This is a reasonable hypothesis. In terms of how the Nubian-bearing populations arrived in Dhofar, Rose *et al.* (2011) strongly support a Bab al Mandab crossing. How much the distribution of Nubian sites (see for example Rose *et al.* 2011, figure 1) supports this contention is debateable. Despite isolated examples in Somalia and Ethiopia, the African Nubian Complex is essentially a northeast African industry. Arguably, a 'northern' route is perhaps as likely as a southern route, if Nubian technology truly does reflect population dispersal. Crassard and Hilbert (submitted) have recently identified an assemblage near Al-Kharj, south of Riyadh in central Saudi Arabia, which features a large number of Nubian cores similar to those seen further south.

What evidence exists on the chronological and technological trajectories of the Arabian Nubian? Aside from Aybut al Auwal none of the assemblages are chronometrically dated. Based on the Aybut al Auwal dates, the chronology of the Nubian Complex in NE Africa and the environmental characteristics of Arabia, it seems likely that the 'classic' Arabian Nubian dates to MIS 5. Rose *et al.* (2011) and Usik *et al.* (in press) discuss a number of assemblages which they associate as the 'Mudayyan Industry'. On technological grounds these can be distinguished by the increased representation of bidirectional cores, and a flattening of core surfaces can be observed. The cores are small compared to those of the classic Nubian. Mudayyan assemblages are less patinated than classic Nubian assemblages, and at several eroding flint sources they are located closer to the source

than are classic Nubian sites indicating that they are younger (figure 19 of Usik *et al.* in press) shows a particular clear example of the latter). On such grounds then the Mudayyan probably dates to between late MIS 5 and MIS 3.

The geomorphological relative chronology described above can be continued to contextualise the 'Leptolithic' assemblages, which are widespread in Dhofar and indeed across much of southern Arabia. These are frequently located even closer to the raw material sources than the Mudayyan and are even less patinated. Building on previous analyses (e.g. Rose 2006), Hilbert *et al.* (2012) provide the first detailed discussed of the 'Nejd Leptolithic Tradition'. The basic features of this are the production of blades from narrow single platform cores with flat debitage surfaces and limited platform preparation, in conjunction with a façonnage component. New OSL dates for 3 Leptolithic sites produced estimates of 14-7 ka, the terminal Pleistocene and early Holocene (Hilbert *et al.* 2012). It, however, remains unclear how much earlier these assemblages extend. While there appears to be a basically similar approach to initial reduction in blade-based assemblages across southern Arabia, there is in fact a considerable typological diversity and much more research is needed to characterise and interpret these assemblages.

**2.9) The stratified sites of Wadi Surdud, Yemen**

Stratified Middle Palaeolithic sites have been identified in the Wadi Surdud, Western Yemen (Delagnes *et al.* 2012; in press). The most important site is Shi'bat Dihya 1 (SD1). Here an excavation over 21m$^2$ uncovered a single extremely dense layer of artefacts, nowhere more than 15cm thick. The context and condition of the assemblage suggests that it represents a short lived occupation, which was rapidly covered by alluvial sediments. Just under 30,000 artefacts were excavated, with 5,488 having a maximum dimension of over 20mm. The occupation is well dated by OSL to ~55ka, correlating with the short early MIS 3 wet phase discussed earlier. This is considerably younger than initial estimates of 80/70 ka (Delagnes *et al.* 2008; Macchiarelli 2008). Almost 100 faunal remains were recovered, although largely in a fragmentary condition. Of those

identifiable taxonomically, 12% can be assigned to Bovidae, 9% to Equidae, 9% to Suidae, and 3% to Hystricidae (Delagnes *et al.* 2012). Of particular interest is a complete left M3 molar, assigned to *Equus* sp. cf. *E. hemionus*, which, following Reading *et al.* (2001), Delagnes *et al.* (2012) cite as a "taxon characteristic of arid steppe environments". Another indicator of the aridity of the environment at the time of occupation is the presence of calcrete and gypsum precipitates throughout the sedimentary sequence, which indicates high levels of evaporation. These suggest that although correlating with the brief wet phase at 55ka, at the time of occupation the environment around SD1 was at least semi-arid.

Raw materials for knapping at SD1 were acquired locally from alluvial sediments. The predominant (92%) raw material is rhyolite. Cobbles of this of desirable morphologies, requiring little preparation, were selected for reduction. Other raw materials were used in smaller amounts, and according to Delagnes *et al.* (2012) there is some evidence that particular raw materials were selected for specific tasks (e.g. basalt for heavy 'choppers'). Of interest from the perspectives of systematics and technology, is the discussion by Delagnes *et al.* (2012) of the relationship between the limited preparation of platforms and the physical properties of rhyolite as a raw material. Rhyolite has reasonable properties of conchoidal fracture, but it needs to be struck forcibly. Delagnes *et al.* (2012, 457) suggest that this property explains the lack of faceting. Clearly more research is needed on this theme, as such points are possibly extremely important in understand lithic technology and need to be factored into attribute-based analyses of technological variation. At a minimum, such observations demonstrate the need for raw material factors to be understood before we can firmly understand dispersals through lithic variation.

Through detailed analysis and refitting, Delagnes *et al.* (2012) offer considerable insights into the different reduction processes, or *chaînes opératoire*s, at SD1. Although the refitting exercise was on a fairly small scale, focussing on particularly identifiable variants of rhyolite, Delagnes *et al.* (in press) were able to refit 2.7% of all rhyolite pieces. In terms of blanks, the characteristic types found in the assemblage are blades and points such as those shown in Figure 2.19.

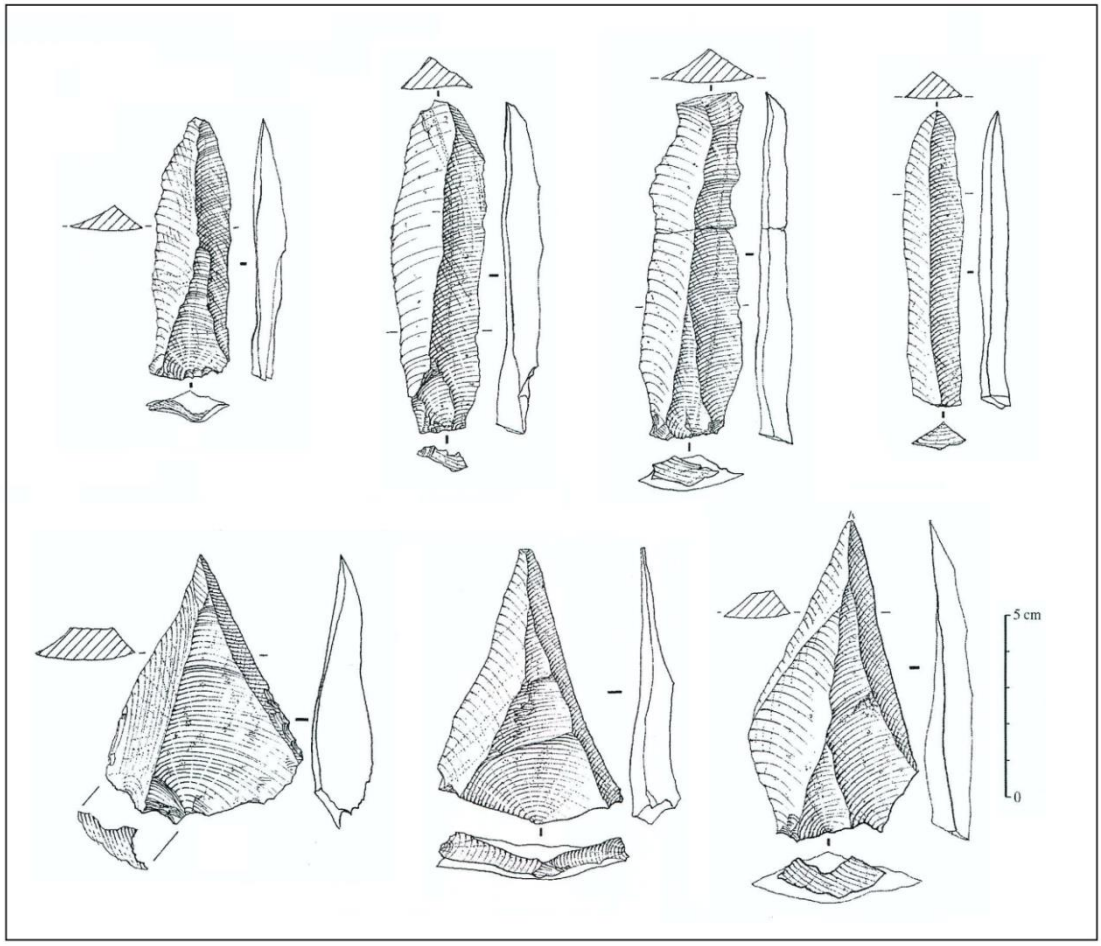


Figure 2.19. Illustrations of selected lithics from Shi'bat Dihya 1 (Wardi Surdud, Yemen) (Modified from Delagnes *et al.* 2012). Top row: blades. Bottom row: points.

Although volumetrically Levallois-like cores and blanks are present in the SD1 assemblage, they are rare. In this sense it does not seem, to this author at least, to have been the result of a specific, intentional *chaîne opératoire*. The primary *chaîne opératoire*, Delagnes *et al.* (2012) convincingly demonstrate, is a flexible reduction strategy where rhyolite was reduced using a hard hammer, with little preparation or maintenance of platforms and flaking surfaces, to produce a variety of unstandardized blades and points. Reduction was primarily unidirectional, with pointed removals resulting from the prior unidirectional-convergent shaping of the debitage surface. This cannot be classified as Levallois, not merely because of the lack of platform preparation, but because in a volumetric sense the refits suggest debitage surfaces were not characterised by lateral and distal convexity. Blade production, using the terminology of Delagnes (2000), can be characterised as following 'semi-rotating' and 'frontal' modes. The refits make clear that both points and blades were produced during the reduction of the same block, as different volumetric and arris-guided

opportunities appeared, and there was little standardization to the process. This impression is reinforced by the more or less equal representation of blades and points in the assemblage. Very little of the assemblage is retouched (n=25), and where present retouch was apparently not carried out in any kind of standardized way (Delagnes *et al.* 2012).

Other stratified sites are located in the Wadi Surdud. Shi'bit Dihya 2 (SD2) is situated close to SD1. Although not extensively excavated, it has produced an assemblage of 1,336 lithics from a single horizon. As at SD1, there is little evidence for Levallois technology. However, neither is the assemblage much like SD1. There are few points or blades at SD-2, which is instead characterised by "thick and quadrangular" blanks produced by unifacial centripetal reduction of basalt, with little standardisation (Delagnes *et al.* 2012). There is even less platform preparation than at SD1, in that platforms are typically cortical. It should, however, be noted that where rhyolite was used as a raw material, the artefacts appear at least broadly similar to those of SD1. OSL dates for SD2 suggest it is slightly younger than SD1, with estimates centring on ~50-55 ka.

The MIS 3 dates for the human occupation of the Wadi Surdud are seen by the discoverers as demonstrating an at least fairly long lived human occupation in the area, which in this arid setting, they claim, "significantly nuances the environmental determinism" apparently present in most models (Delagnes *et al.* 2012, 469). However, given the close correlation of the Wadi Surdud sites and the early MIS 3 wet phase, it is arguably, conversely, the case that the discoveries actually reinforces argument premised on 'environmental determinism'.

The lithic assemblages of Wadi Surdud appear to represent an autochthonous development, and lack clear similarities with assemblages from surrounding regions. The discoveries are significant as they highlight the typo-technological diversity of the Arabian Middle Palaeolithic, and the diversity of reduction schemes present. The broadly similar technological features of SD1 and the 'Leptolithic' assemblages found to the east can be noted. In both cases elongated blanks are produced from the narrow face of cores with relatively simple platform preparation. As the dated examples of the Leptolithic, as previously discussed, date to the Terminal Pleistocene there is some 40,000 years between them and the Wadi Surdud sites. Might it be the case that Middle Palaeolithic

occupation of Arabia contracted into a refugium in Yemen, where it developed the distinctive technological characteristics discussed above, before spreading across southern Arabia with pluvial episodes? Such a scenario clearly needs to be tested. If true, this idea presents some interesting perspectives on the evolution of lithic technology. We might see the distinctive aspects of technology at SD1 as representing both demographic factors, i.e. a small population cut off from contact with other groups, and raw material factors. It is possible that the lack of faceting seen in Leptolithic assemblages across southern Arabia reflect the fact that elaborate platform preparation was difficult on the rhyolite raw material used at sites like SD1. When populations re-expanded did they continue with the reduction techniques of their ancestors, even when they moved to areas with raw material which could be faceted? Alternatively, of course, it could simply be that SD-1 and the Leptolithic merely share superficial features because both represent convergent evolution. Shared ancestory is of course more convincingly demonstrated by the presence of derived features, in contrast to shared primitive features.

**2.10) Discussion.**

As the numerous research projects outlined in this chapter have demonstrated, Arabia has a rich Middle Palaeolithic record. Spatial variation is rooted in the study of hundreds of surface assemblages, giving insights into the distribution of sites in the landscape and the range of typo-technological variability, while the last five years have seen the publication of stratified sites and chronological and environmental information. As shown in Figure 2.20, Middle Palaeolithic sites are known across Arabia, in a variety of environmental settings. Their apparent absence in many areas of sandy deserts suggest a geomorphological issue of site visibility. Many more sites have been discovered than are shown on this figure, but they could not be plotted since precise locational information was not provided by the discoverers in their publications

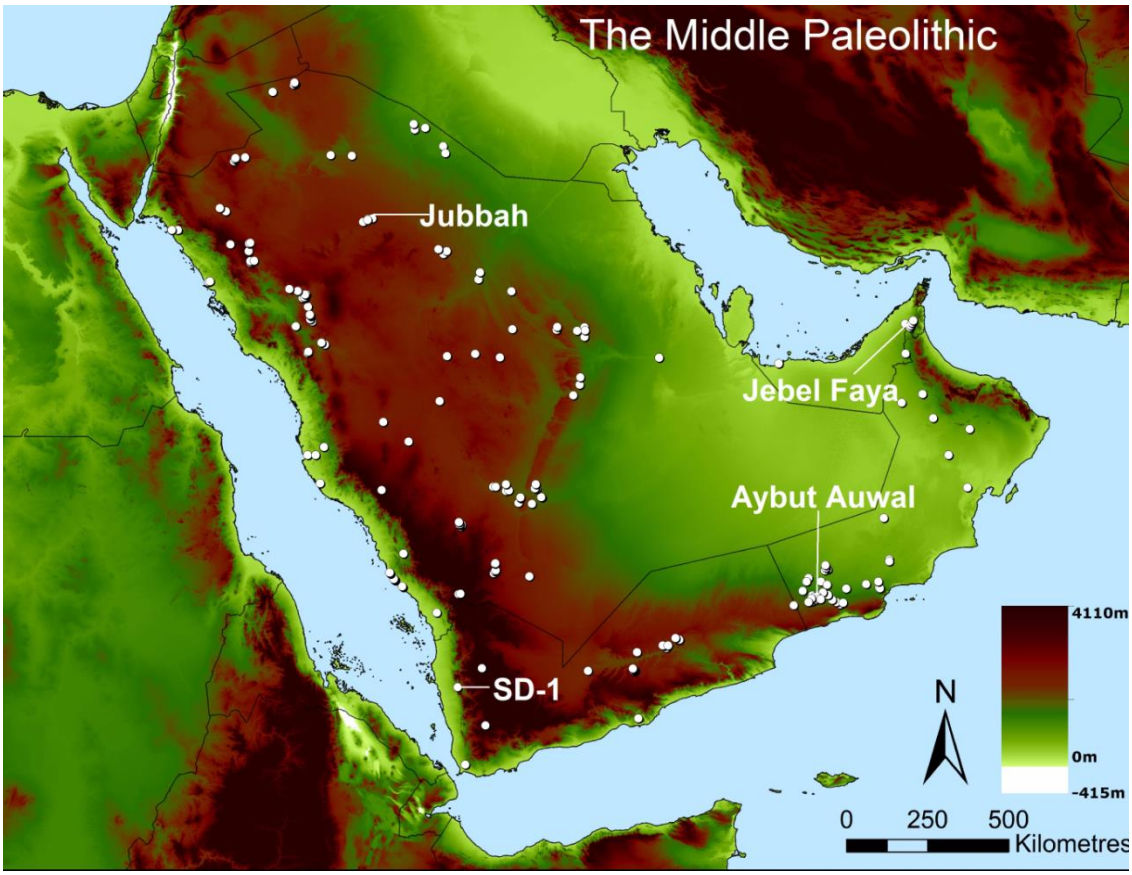


Figure 2.20. Map of key Middle Palaeolithic sites of Arabia (modified from Groucutt and Petraglia 2012).

The small number of systematic surveys conducted and stratified sites excavated in Arabia confirm that the study of the Arabian Middle Palaeolithic remains in its infancy. It is significant that with each site excavated there has been a different chronology of occupation, different forms of technology and different implications for dispersal and adaptation. In this context it is important to appreciate the lessons which have emerged from the discoveries of the last decade. These emphasise that stratified Middle Palaeolithic sites are present in Arabia. At Jebel Faya the decision to excavate *in front* of the (collapsed) rockshelter was a critical choice. In the case of the stratified sites of Wadi Surdud, the discoveries were made due to a deliberate strategy of targeting an area between the heavily eroded mountains to the east and the coastal plain with young sediments to the west. Focussing on the foothills of the mountains brought rewards. The findings of the COPS (e.g. Jagher 2009) and by Rose and colleagues (Rose *et al.* 2001; Usik *et al.* 2011) demonstrates the density of Middle Palaeolithic sites which can be identified by applying systematic survey techniques. In both cases the presence of extensive refits and assemblages with considerable technological

homogeneity demonstrate that surface assemblages can be extremely informative and that the assumed nature of the 'palimpsest problem' has perhaps been exaggerated.

While much remains to be clarified, we are now in a position to examine some characteristics and the spatial and temporal variability of Arabian Middle Palaeolithic assemblages. The presence of bifaces in many Arabian assemblages can be taken as suggesting an orientation of the Arabian early Upper Pleistocene Middle Palaeolithic towards Africa, although this is not mutually exclusive with dispersals from other areas. The fact that bifaces date to many periods of prehistory almost means that care must be taken in assigning a Middle Palaeolithic chronology. Such an attribution reflects the size and technological features of the bifaces, the character of the associating assemblages and levels of weathering and patination. Bifaces were recognised in the earliest reported discovery of Middle Palaeolithic assemblages in 1927 (Field 1960), they are found across Arabia, being widespread from Oman (e.g. Rose 2006) to the most northern areas of Saudi Arabia visited by the Comprehensive Survey (Gilmore *et al.* 1982). And finally they were found in the first stratified Middle Palaeolithic site to be published in Arabia (Armitage *et al.* 2011). Given the paucity of quantified information on Arabian findings available, at this point descriptions of the Arabian Middle Palaeolithic are necessarily primarily qualitative in nature. This is not an ideal situation, but it permits the formation of hypotheses which can be tested by further research. Terminological and methodological problems further hamper comparative analyses. Levallois technology, for instance, is certainly widely present in Arabia, but variably so, and the literature suggests it was less significant than in the Levantine MP or African MSA.

It is beginning to be possible to define some elements of spatial and temporal variability. Spatially, for instance, we can differentiate between Nubian assemblages in Dhofar, 'Leptolithic' assemblages in Oman and the UAE and assemblages combining centripetal Levallois and bifacial reduction in the UAE. Absolute ages for sites in southern Arabia date to MIS 5 (Aybut al Auwal, Jebel Faya Assemblage C) and MIS 3 (Jebel Faya assemblage A (and B?), SD1, SD2). In addition it is possible to make some more relative comments on the chronology of the Arabian Middle Palaeolithic. There is evidence for pre-MIS 5 assemblages at a number of sites. These include below assemblage

C at Jebel Faya, and perhaps at Jebel Sanoora where the assemblage seems to be a mix of two assemblages, one Nubian (MIS 5?) and one dominated by blades and more heavily weathered and patinated (Amitage *et al.* 2011; Rose *et al.* 2011). Zarins *et al.* (1980) noted that in southwestern Saudi Arabia, Middle Palaeolithic assemblages with bifaces were significantly less patinated than those without bifaces. Patina is a problematic 'dating' technique, but the dramatic difference in this example may be significant. Leptolithic occurrences are dated to the terminal Pleistocene (Rose and Usik 2009; Hilbert *et al.* 2012), while it remains unclear if and how these relate to the MIS 3 occupation of Yemen, where a broadly similar technology is present. In other cases, chronology is more thoroughly relative.

Given the above evidence, what inferences can be made on dispersals processes? The key factor which has emerged in recent years is that stratified assemblages suggest population connections between southern Arabia and east to northeast Africa in MIS 5 (Armitage *et al.* 2011; Rose *et al.* 2011). This correlates with the broad wet phases which characterised MIS 5. Evidence is currently lacking, from either stratified or surface contexts, for post-MIS 5 dispersals from Africa, as for instance predicted by Mellars (2006a,b). Likewise, evidence for 'Upper Palaeolithic'-like sites which might suggest connections with the Levant is very limited (see Maher 2009). A generous interpretation might suggest that sites such as Faw Well represent brief dispersals from the Levant in MIS 3 (Edens 2001). But much is problematic about these surface sites. The overall picture then is of dispersals into Arabia in MIS 5, and not clearly afterwards until the early Holocene, which was also the next extended wet phase in Arabia.

The second key emerging feature of the Arabian Middle Palaeolithic concerns adaptive or autochthonous developments. In spatial terms this is best known from 'Leptolithic' like industries in Oman (in particular) and the UAE. Although the chronology of this industry is poorly understood, MIS 3 has been suggested and this seems the most likely at present. Possible connections to the southern Arabian Leptolithic have been discussed above. At Jebel Faya we see rather different forms of autochthonous MIS 3 technology with assemblage A and the undated assemblage B. In no cases do identified MIS 3 assemblages offer evidence of dispersals to

neighbouring regions. The picture is more one of fragmentation into Arabian refugial areas and autochthonous developments. Shared features between these assemblages can be regarded as 'synapomorphic' in a broad sense, and include little or no Levallois technology, platform preparation and retouch. It is interesting that where chronometrically dated these MIS 3 assemblages correlate with short wet phases. It is hypothesised that this demonstrates the expansion of populations which contracted into small refugia in southern Arabia in MIS 4. It is perhaps possible to see the roots of adaptation to Arabian conditions in MIS 5. At present this is most clear in the Nubian Complex sites of Dhofar, where Nubian point cores are considerably more proportionally abundant than in north African Nubian sites, and is reasonably suggested by Rose *et al.* (2011) as suggesting behavioural differences stemming from the specific environmental characteristics of southern Arabia. With the 'Mudayyan (Usik *et al.* in press) we may be witnessing a period of experimentation in lithic technology, from which came the 'Leptolithic'. This narrative stands in stark contrast to Arabia being a conduit for dispersals from Africa or elsewhere in MIS 4 or 3.

It is, of course, possible that discoveries will be made in Arabia which will fundamentally challenge this narrative of MIS 5 dispersals followed by MIS 4/3 autochthonous adaptation. The discovery of Neanderthal fossils, or of a Howiesons Poort-like site dating to MIS 4/3 in southern Arabia, for instance, would both necessitate a fundamental re-evaluation of Upper Pleistocene demographic processes. Pending such findings, the emerging picture, as shown in Figure 2.21, correlates archaeological, environmental and faunal evidence and can identify key hypotheses which need to be tested.

From the preceding discussion it is suggested that the most fruitful avenues for progress in Arabia relate to two particular key themes: firstly, the further interpretation of MIS 5 population connections between Arabia and surrounding areas and, secondly, the clarification of MIS 4/3 demographic and adaptive processes in Arabia.

There is also a spatial dimension to these questions. To clarify dispersals, research should target the areas in proximity to hypothesised source areas. On the other hand, understandings of

autochthonous developments will best be clarified by focussing on likely refugial areas of southern Arabia.

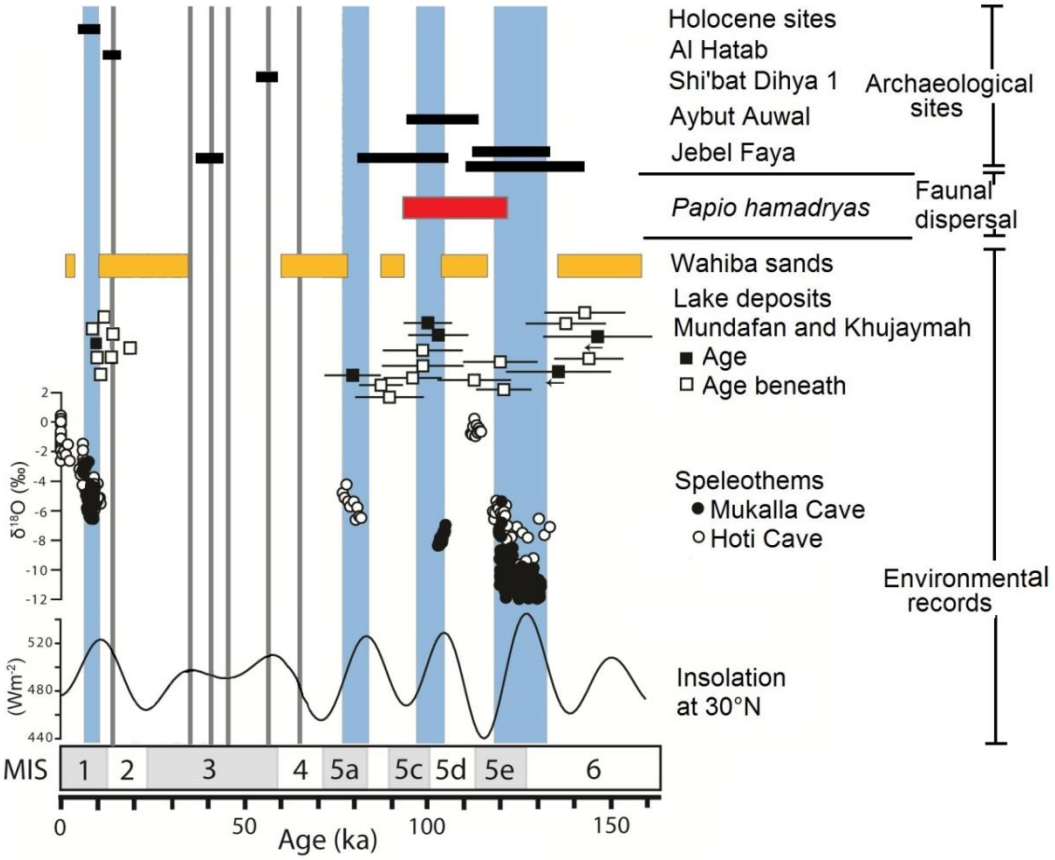



Figure 2.21. Summary of archaeological, environmental and faunal records for Upper Pleistocene and Holocene Arabia. Thick blue lines represent extended wet periods, thin grey lines are short wet periods. (Modified from Groucutt and Petraglia 2012). Environmental records and structure modified from Rosenberg *et al.* (2011), for other sources of information see this chapter.

A key problem is that at present we know little on how fast material cultures would change in an Upper Pleistocene Arabian context. For instance, SD1 and SD2 in Wadi Surdud are separated by only a few thousand years, but have rather different technology (Delagnes *et al.* 2012). From this flows a need for interpretive caution in creating a dichotomy between 'dispersal related' and 'autochthonous' characteristics. The significant point is the need to think about the kind of lithic technologies, and other forms of archaeological evidence, we would predict to develop in Arabian conditions from different ancestral populations. This requires a 'theoretical' orientation rather than an 'empiricist' perspective. This is to stress the need to transcend the simplistic notion that complex

biogeographical phenomena such as dispersal can be explained satisfactorily be merely stating that items of material culture 'look like' those in a hypothesised source area.

Beyond the usual exhortations of the Palaeolithic archaeologist for 'more surveys, more excavations', it is possible to use the evidence outlined in this chapter to highlight key targets for future research. In terms of illuminating dispersals into Arabia the crucial areas are those proximal to the Bab al Mandab, currently a difficult area in which to work due to on-going political instability, and northern Saudi Arabia. The latter is a critical area for study in that it is here that we may hope to distinguish between dispersals from the Sinai Peninsula and those from the Levant. In contrast, most recent research in Arabia has focussed on southern Arabia. The chronological period of key interest is MIS 5. In particular, MIS 5a emerges as pivotal, because, as shown in Figure 2.21, it was only with the discoveries at Jubbah (Petraglia *et al.* 2011), reported more fully in this thesis, that this phase now has dated archaeological evidence. MIS 5a was perhaps the final key climatic window for inter-regional dispersals in the Upper Pleistocene, and additionally one within the error ranges of genetic estimates for the dispersal of hominin populations from Africa into Asia (whether advocates of such methods will continue to make such claims in the light of recent publications such as those of Scally and Durbin [2012] remains to be seen). The key discoveries needed from this spatial and temporal context are stratified Middle Palaeolithic assemblages. These are likely to be related to specific localities, such as rockshelters and palaeolake margins and these areas should be targeted by archaeologists in Arabia. From discoveries in such environments, quantified and comparative lithic analyses can firmly cast light on interregional relationships and hence on the dispersal of hominin populations into Arabia.

## Chapter 3: On Middle Palaeolithic lithic variability

> The production of a concomitant set of artefacts constitutes the transmission of information…A child brought up amongst motor-cars and skyscrapers is differently informed to another child born amongst stone axes and pig hunts.
>
> - D.L. Clarke (1968, 86)

> The fundamental problem of each science is the establishment of the identity of its phenomena. That the problem still awaits its solution, and that the science of culture still lacks any real criteria of identification…will hardly be disputed by anyone acquainted with the controversies of anthropology.
>
> - B. Malinowski (1960, 69-70)

### 3.1) Introduction

In many situations lithic artefacts are the only source of information on the behaviour of Middle Palaeolithic hominins. In virtually all situations they are by far the most prevalent, constituting the "hand of cards" dealt to Palaeolithic archaeologists (Hovers 2009, 156). Aside from their prevalence, their importance rests on the significant behavioural information they contain. A vast literature now exists on lithic analysis in general (see e.g. Bordes 1961, Odell 2003; Andrefsky 2005, 2008; Lycett and Chauhan 2010), and on the Middle Palaeolithic in particular (e.g. Dibble and Mellars 1992; Dibble and Bar-Yosef 1995; Kuhn 1995; Mellars 1996; Hovers 2009). This chapter seeks to engage in the long running debate on the character and causes of lithic technological variability in the Middle Palaeolithic, seeking to clarify evidence on the dispersal of hominin populations. Middle Palaeolithic variability is a major topic and it is impossible to give a systematic review in the space available. The aim then is to highlight some fundamental points with which to guide subsequent chapters.

From insights into the mechanics of knapping and experimental reduction (e.g. Amick and Mauldin 1989; Coterell and Kamminga 1990; Pelcin 1997; Eren *et al.* 2008) to Clive Gamble's (2007) concept of lithics as "material metaphors", the field of lithic analysis is an area of lively debate. However, as outlined by Holdaway and Douglass (2012, 103) it is significant that a number of key debates in lithic analysis have continued for decades and not progressed towards adequate resolution. The examples they cite include the style versus function dichotomy (the 'Bordes-Binford debate'), the emic versus etic debate, and disagreements on concepts such as 'curation'. That so many such

debates remain unresolved suggests that the methods which have been employed are problematic or we are asking the wrong sort of questions. The key areas of focus include sources of variability, units/scale of analysis, and how is similarity and difference between these units measured and, finally, given the above, inferences on dispersal processes.

### 3.2) Pessimism and optimism in the study of Middle Palaeolithic variability

Despite the prevalence and importance of lithic artefacts, it is possible to detect frequent notes of pessimism on lithics. In part this may have a subtle 'psychological' aspect, contrasting 'pieces of rock' (lithics) to visually evocative, yet rare and usually fragmentary, fossil finds and rapidly developing, and modern sounding, genetic analyses. Pessimism in relation to the goals of this thesis also reflects, it is suggested, an overreaction against 'culture-historical' research traditions of the last century.

John Shea (2011, 48) provides one example of the apparent pessimism in some quarters about lithic analysis, stating that:

> Lately, when I read or listen to papers about Paleolithic stone tools, I find my interest wandering, I know I am not alone in this.

He continues that at times it seems that lithic analyses are "purposefully designed" to make the questions asked "irrelevant to larger questions about human origins research" (*ibid*). Shea makes valid criticisms of recent lithic analyses, including the significant role of intuition and anecdote rather than the formulation of testable hypotheses and the mismatch between questions asked and analytical methodologies. Shea (2011, 51) argues that lithic 'industries' covering broad spatial and temporal periods, are "unlikely to correspond to actual self-conscious groups of humans" (*ibid*). However, it may still be the case that lithic data reflects cultural entities, be it self-conscious or otherwise.

Clark and Riel-Salvatore (2006, 32) offer another key example. They strongly argue against the 'European' perspectives, where apparently:

> Lurking just beneath the surface is the tacit assumption that the stone tools represent the remains of quasi-historical, stylistic microtraditions, transmitted from one generation to the next through the medium of culture.

Their over-focus on retouched artefacts – indeed a dubious category to understand cultural factors, and one which has been under attack for over forty years – is supplemented by a more generally pessimistic perspective on lithics in general. They (*ibid,* 36) assert that there is a "minimal and generalized learned behavioral component to chipped stone artefact form", almost totally outweighed by factors such as raw material and site function. The basis for this view is that the "time-scale distributions" of hypothesised cultural units "exceed by orders of magntitude" not just any "actual" social entity which could explain their formation, but even any "imaginable social entity" (Clark and Riel-Salvatore 2006, 37).

Shea and Clark argue against 'cultural' interpretations in favour of an 'ecological' paradigm. Of course, in the last analysis, evolutionary and ecological context is of fundamental importance. To state this is merely to reaffirm 'materialist' philosophy. But how do ecological factors influence human behaviour? With the above arguments comes the implication that 'ecological' factors essentially *directly* influence material culture and behaviour. In contrast, the present author would highlight the *indirect* influence of such factors, which are filtered through human cognition and culture.

Recent reflections of pessimism aside, there exists a more general 'common sense' view that the Middle Palaeolithic was essentially a period of stasis. If true, a lack of meaningful variability in the Middle Palaeolithic seriously compromises attempts to use variation to understand dispersals. The example of the apparent homogeneity of the Levantine Middle Palaeolithic is often cited. The inference is that if we cannot even distinguish the lithic assemblages associated with two different hominin species who occupied this small area, then lithics in general can tell us little and we should rely on alternative analytical techniques. The assertion of homogeneity can either be taken in this way, or rather interpreted in terms of an inadequate methodology having being applied (e.g. Shea 1991, 7). At a broad level, we would expect the material culture of two closely related hominin species occupying a similar environment to be similar, but this does not mean indistinguishable. The DNA in all living things is made up just four nucleobases, and everything which ever appeared

on a computer screen is made up of a series of 1's and 0's. Yet in neither case would we say that products were the same because of their narrow foundations. If archaeologists spent less time trying to fit assemblages into the three stage 'Tabun sequence' and more conducting detailed analyses of particular assemblages (e.g. Hovers 2009) then our view of variability in the Levant might be much more developed. Likewise claims from elsewhere, for example Europe, that there are "no notable changes" in the Middle Palaeolithic, and that where minor change is visible, it probably reflects "ephemeral, specific, local adaptive reactions to climatic fluctuations" (Otte 1992, 45) equally is interpreted here as a reflection of methodology more than reality.

In recent years there has been something of a rehabilitation of the importance of the Middle Palaeolithic. For many, perhaps most, scholars the Middle Palaeolithic now corresponds with the anatomical origin of our species, the development of 'modern behaviour' and the dispersal of our species into Asia. The recognition of various regional trajectories within the Middle Palaeolithic has done much to end the perception of monotony (e.g. papers in Hovers and Kuhn 2006; Camps and Chauhan 2009). It is unfortunate that conceptions of Middle Palaeolithic variability remain framed in terms of 'transitions', often towards the 'Upper Palaeolithic'. This thesis has little to say on the spatially and temporally specific Upper Palaeolithic, the emphasis on which merely reflects the contingent origins of Palaeolithic archaeology in Europe and traditional notions of inevitable 'progress'.

### 3.3) Units of analysis in the study of Middle Palaeolithic variability

If for now we assume, and these points will be reinforced through the rest of the chapter, that a) there is variability within the Middle Palaeolithic, b) there is a 'cultural' element to this variability, then we need to think clearly about the units/scale of our analyses, and the processes which determine the character of these units.

At one extreme we might see the 'industry' (or technocomplex), typically defined either by basic technological features (e.g. prepared cores) or by *fossiles directeurs* (e.g. bifaces and 'backed knives' for

the Mousterian of Acheulean tradition in France) – as our units of analysis. Such an approach only gives coarse insights and is not conducive to comparative analyses. The example of Beyin's (2006, 22) claims on the 'Aterian' in Arabia were cited in the previous chapter (*contra* Scerri 2012).

The widely recognised problems with the traditional *fossiles directeurs* approach, prominent in early conceptions of Middle Palaeolithic variability (e.g. de Mortillet 1883, Peyrony 1921; Breuil and Kozlowski 1932) include its focus on selected, typically retouched, individual artefacts. The specifics of the typological approach, particularly as developed by François Bordes, are discussed below. Here the focus is on some more general points. Critically such an approach represents a significant collapsing of information, as varying features are compressed into a single idealised 'type'. The problem is exacerbated by a traditional over-focus on retouched lithics. Other factors aside, the apparent paucity of retouched artefacts in the Arabian Middle Palaeolithic makes this focus problematic. Where they are present in large numbers, variation in retouched pieces largely reflects function and raw material factors it can be hypothesised.

One factor associated with the rise of *chaîne opératoire* analyses is the rise of perspectives which treat individual *chaîne opératoires* (or 'reduction sequences' and other broadly synonymous terms) as the basic units of analysis. This approach has both strengths and weaknesses. Whilst attempts to combine *chaîne opératoire* analyses with quantification have been attempted (e.g. Geneste 1985), on the whole comparability has not been a central concern for this school. Given the relatively unsystematic basis of the *chaîne opératoire* approach, which often focusses on 'diagnostic' pieces, it is unclear how representative analyses in such an approach are of variation within an assemblage, let alone between assemblages (compare e.g. Boëda 1988; Dibble 1995). How do we compare two assemblages with, say, 'recurrent unidirectional' Levallois reduction? The position taken in this thesis, and elaborated upon below, is that while the *chaîne opératoire* approach has brought a much needed dynamism to lithic analyses, and provides elegant insights into hominin behaviour in particular spatial and temporal contexts, its lack of quantification is a serious concern.

The proposed alternative to the possible units of analyses discussed above is to focus on variation in attributes within an assemblage. Aside from being more amenable to quantification than *chaîne*

*opératoire* approaches, such an approach also finds support in ethnographic accounts which are difficult to reconcile with typological perspectives focussing on individual lithics as the unit of analysis. For example, White (1967, 409) states that:

> New Guineans do not seem to regard a flaked stone tool as a functional whole…they use a piece of stone for a particular task if particular features of it makes it suitable for the work in hand…the need to be appropriate to the work imposes only broad limitations on the shape, size and other features of tools…several edges may serve successively as a core, hammer, scraper and knife, provided it has a suitable edge.

The most appropriate unit of analysis then is the *whole assemblage* – which can, whilst recognising the philosophical nature of doing so, be broken down into cores, debitage and retouched pieces – which is seen as a *constellation of attribute states*. Aside from maximising the amount of information, this approach provides an objective and quantifiable foundation for comparative studies, and does not make assumptions on hypothesised 'intentionality' and the like (see also e.g. Munday 1976; Chazan 1992).

The concept of the assemblage is not without its problems; in many cases an assemblage comes from a large surface scatter, or the finds from a trench sampling larger distribution of a site. The term 'assemblage' is here used in the sense of Clarke (1968, 489):

> An associated set of contemporary artefact-types. To be distinguished from the loose physical or geographical aggregate.

The issue of contemporaneity is always a problem in Palaeolithic archaeology, but as will be discussed below the crucial point is that it is a relative concept, and the significance of this depends on the research questions. Many of the great Palaeolithic sites, such as Shanidar, Tabun and Mumba, contain long archaeological sequences in complicated stratigraphic contexts. In such cases the nearest we can get to an assemblage is an often arbitrary level or spit. This is not seen as a fundamental problem. As, unless proven otherwise, it is realistic to assume that Middle Palaeolithic assemblage are almost always palimpsests. The use of the assemblage is a way to 'average out' this source of variability. Bailey (2007, 198) suggests that palimpsests are a "universal feature of the material world", let alone of ancient archaeological contexts. Even in cases which appear to represent a narrow range of occupations, such as Tor Faraj, Jordan, the picture appears to be rather complex (e.g. Henry 2003, 2012). Here three 'living floors', defined primarily by hearths, each seem

to be associated with several occupations. The relatively successful refitting of 8% of the lithics (Demidenko and Usik 2003), excluding debris, might have been even higher were it not for extensive recycling of lithics in this raw material poor area. We have no simple way of knowing if the hominins who 'recycled' material by using flakes as cores, for example, were the same as those who brought material to the site in the first place. The 'palimpsest problem' is always one of scale.

In general, despite glimpses of 'high definition archaeology' (Gowlett 1997), the archaeological record reflects repeated occupations of particular localities. The application of various techniques to study hypothesised 'living floors' can reveal that they actually represent re-deposited assemblages (e.g. Dibble *et al.* 1997). The reality of the generality of this point can be taken in pessimistic terms, as for example Binford (1981) interprets Schiffer (1976). The impact of the palimpsest depends on what kinds of questions we are interested in asking. It represents a problem if we follow the prevalent "ethnographic paradigm" in archaeology (see e.g. Vaquero 2008).

It is understandable, particularly within the post-modernist project, that archaeologists have an interest in attempting to understanding individual hominin behaviour (e.g. Gamble and Porr 2005), a reflection of Roe's (1980: 107) aspiration to see "precise moments in the past". These are unlikely to ever be more than interesting oddities; ways to supplement and humanise a narrative, but never enough to form the backbone of archaeological accounts. The general falsity of the 'Pompeii premise' has long been recognised (e.g Binford 1981). To Binford this recognition was critical in determining his focus on 'cultural systems' rather than attempting to understand archaeological assemblages in a timeframe comparable to that of ethnography (e.g. Binford 1981, 197). This is perhaps a lesson which is inadequately appreciated by advocates of the *chaîne opératoire* approach, which originated in ethnographic research (Leroi-Gourhan 1964). Given the palimpsest character of most Middle Palaeolithic assemblages it may even be difficult to talk about broad scale behavioural factors , such as site function and mobility strategies, as one assemblage may contain extremely different versions of these. If long lived cultural traditions can be shown to exist within lithic technology, then palimpsests are not automatically such a problem for the understanding of dispersals. In fact, it can be argued that by averaging out variation caused by factors such as the

work of novice knappers, a palimpsest is, in moderation, helpful in understanding 'big picture' perspectives on cultural variation.

This perspective on assemblages and the typically palimpsest nature of Middle Palaeolithic contexts is also significant for understanding the surface assemblages which are widespread in Arabia and elsewhere in the mid-latitude desert belt. To many scholars such assemblages are of little value. For instance, Tixier (1967) rejected any evidence from the surface in developing his Aterian typology. Yet virtually all archaeological material starts its post-knapping and use life on the surface, while some of it is perhaps mixed with other material and subsequently buried. The denigration of surface material arguably reflects, in part, the contingent origins of Palaeolithic archaeology in the specific conditions of Western Europe. McNabb (2012), for instance, discusses the way in which the surface origin of most 'eoliths' was used in the arguments against their artefactual status. Care, however, always needs to be taken in moving from specific examples to general outlooks and methodologies.

A number of workers rightly emphasise the importance of Middle Palaeolithic surface assemblages (e.g. Hawkins 2001, 113; Olszewski *et al.* 2010; Rose *et al.* 2011; Usik *et al.* in press). There is nothing inherently more homogenous about buried than surface assemblages. In fact the reverse may often be the case. In particular, surface assemblages with uniform patination, structural integrity ('knapping scatters'), refits and uniform technology provide assemblages as 'good' as many from stratified contexts. Excavated assemblages have the benefits of providing minimum ages for occupation and allowing palaeoenvironmental situation at this minimum age. Once surface material can be anchored into regional chronologies by the presence of a few excavated sites, then their assemblages can be of great use for lithic analyses. Clearly, excavated material is of great importance, but in the environments of the mid-latitude arid belt, dominated by erosional geomorphological processes, it is a mistake to simply write off the surface record. More than this, the surface record has its specific benefits, such as great visibility in the landscape.

In the view advanced in this thesis, ethnography is primarily of use in a 'negative' rather than 'positive' way, in that it can constrain hypotheses and provide broad frames of reference. Holdaway

and Douglass (2012) provide a particular important paper, pertinently named "A Twenty-First Century Archaeology of Stone Artefacts". The examples cited below, all from Australia, are discussed in this paper. The key point for the present argument is the *social* and *contextualised* character of knapping demonstrated by ethnographic accounts. We must compare these with common archaeological notions such as 'desired end products'. Aside from often being untestable, these conceptions are, perhaps, overly *individualistic*.

Binford (1986) discusses how between knapping episodes, people other than the knappers would come and remove lithics from the "arc of debris flakes". In fact, virtually all of the debitage was therefore removed. Binford (1986) also observed one knapper replace another in working a core. This is hardly surprising given the social context of real knapping, rather than modern 'scientific' experiments, but how can we square 'intentional' reduction when multiple people are involved in reducing raw material? Many accounts describe lithics being collected long after initial knapping acts took place (e.g. Tindale 1965; Hayden 1979, 168). Hiscock (2004: 74) provides a wonderful account of two knappers – Slippery Morton and Billy Dempset – who worked as a team. While one of them knapped in a kneeling position the other collected the flakes which fell behind the first man – not seen to the knapper – and decided which should be collected. Thirty five of the best flakes were kept and later a few of these – those which happened to be at the top of a box – were selected for hafting.

### 3.4) Typology

Typology, defined by Adams and Adams (1991, 370) as a "kind of classification, one made specifically for the sorting of entities into mutually exclusive categories," has played a significant role in discussions of Middle Palaeolithic variability (e.g. Bordes 1961; Tixier 1967; Mehlman 1989; Debenath and Dibble 1994). Typology can be applied at multiple levels, from the attribute, to the artefact and even to the 'technical gesture' of the *chaîne opératoire*.

The typological scheme of François Bordes (1961; see also Debenath and Dibble 1994) has been particularly influential. He defined types primarily according to the morphology of retouched pieces from French sites, although some were also defined by manufacturing techniques and others by the presence of *fossiles directeurs* (e.g. bifaces in the Mousterian of Acheulean Tradition). Bordes typology reflects the French Middle Palaeolithic record, where he identified five particular facies which he regarded as distinct cultural groups (e.g. Bordes 1961, 1968; Bordes and de Soneville Bordes 1970). Many more recent analyses uphold the basic character of the patterning he identified, even if they don't agree on the cause of this variability (e.g. Moyer and Rolland 2001).

Despite Bordes (1961, 3) claim that his typology could be applied to geographic areas beyond France, a number of problems have been raised where this has been been attempted. In the African Middle Stone Age, for instance, the prevalence of points over 'scrapers', *contra* the French record, means Bordes typology, over a third of which consists of forms of 'scrapers', downplays a considerable amount of variation. This aside, scrapers, a considerable amount of whose variability can probably be explained by resharpening (e.g. Dibble 1987), do not provide a reliable cornerstone for any typological system. The case of the Aterian provides another pertinent example of the problems of typology (Hawkins 2001; Scerri in press). In Bordes scheme all 'tanged' pieces are classified in just two types (57 and 58), irrespective of the character of the lithic aside from the tang. Tixier (1967) tried to address the problem, but perhaps went too far in the other direction, created an overly specific typology which overstates the role of tanged pieces in the Aterian (Hawkins 2001; Scerri in press).

The value of typology ultimately depends on what ones wishes to achieve using it. As Dibble *et al.* (1999) point out, the ambiguities in a typological scheme like that of Bordes can provide a useful starting point for training new archaeologists. The key role for typology is in aiding discussion between colleagues and as a broad means of description. It arguably has considerably less analytical power. Along with the typology of Bordes (1961), broad scale, descriptive schemes, such as the mode systems of Clark (1969) and Shea (2012), are of some use in a broad, descriptive sense, but do little to aid detailed analysis. With such schemes great care needs to be taken to avoid the almost

magnetic pull towards progressivism. While there are issues with purely, or overly, typological schemes, some kind of typology is still necessary (e.g. Monnier 2009). It is an often overlooked point that in both 'American' and 'French' approaches a considerable typological approach remains – in terms of discreet 'stages' of reduction in the former and overall *chaîne opératoires* in the latter. In both cases these reflect the problem with transcending typology when the dynamic nature of lithic reduction is contrasted with the static lithic artefacts studied by modern scholars.

Typologies do not need to apply only to single complete artefacts, as has been traditional in European Palaeolithic archaeology, perhaps as a result of a philosophical focus on the individual. Figure 3.1 demonstrates an example of a typological scheme which can be applied for an attribute, that for notching developed by Picin *et al.* (2011). Picin and colleagues use this typology to define 3 types of notched 'tools' and 8 'denticulates', but this extension of the typology of notches to the scale of individual artefacts is not inherent in their typology. The typology of notching on lithics can be recorded as one attribute alongside many.

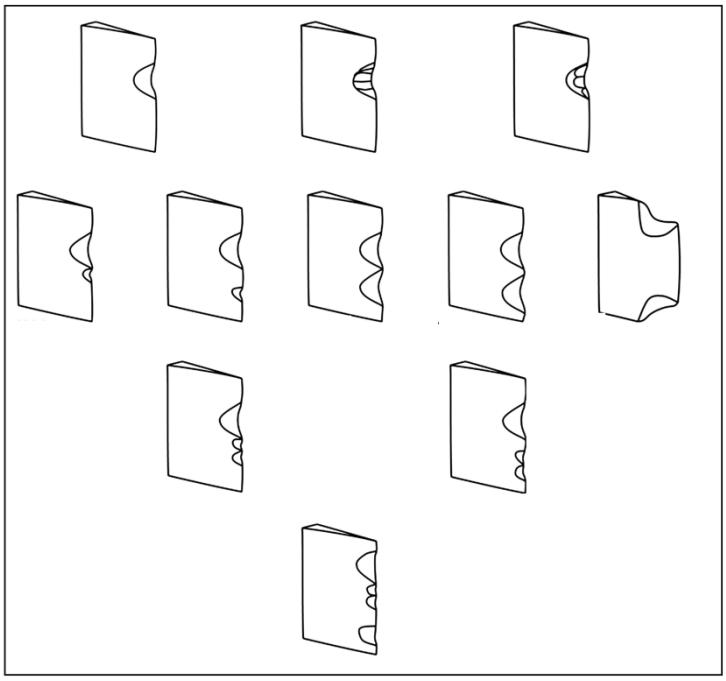


Figure 3.1. An example of typology at the level of the attribute. Picin *et al.*'s (2011) typology for notches and denticulates. Although these authors use the character of notches to define notched and denticulated tool types, their typology need not be extended to the level of the whole piece, but can instead be described as an attribute.

### 3.5) Challenges to culture history

With the development of Bordesian systematics it appeared that all archaeologists had to do was 'fill in the gaps' and we would have a clear understanding of the Middle Palaeolithic world. We would soon have a cultural map of the Palaeolithic. Bordes ideas, however, were quickly attacked from a variety of perspectives. The first significant critique was particularly associated with American architect of the 'New Archaeology', Lewis Binford (Binford and Binford 1966, 1969; Binford 1973, 1983, see also Freeman e.g. 1978, 1992). The essence of Binfords' claims were that because, he argued, most lithics in the Middle Palaeolithic were used expediently, assemblages gave a good reflection of the activities carried out at in a particular spatial and temporal context (e.g. Binford 1983, 66). Despite this, he agreed with the *character* of Bordes typology, and the emic reality of the types to Middle Palaeolithic hominins, he just disagreed on the *meaning* of variation between sites. The key problem with Binford's account is that it remains unclear what Middle Palaeolithic lithics were used for. In the cases where we think we do know, thanks to residue and use wear studies discussed below, the key point is the lack of simple correlation between form and function. In addition, Binford's assumption that a sudden shift occurred with the origin of the Upper Palaeolithic, before which lithics were used expediently is "pure hypothesis and speculation" (Mellars 1996; 322). Binford's suggestions then may reflect a factor to be considered in understanding Middle Palaeolithic variability, but not an overarching and unifying framework (*contra* Freeman 1992).

Although functional arguments are unlikely to provide a consistent explanation of Middle Palaeolithic variability, it does not mean that they are not important. Figure 3.2 compares the prevalence of 'extractive' versus 'maintenance' employed units (EU's) for lithics from the Levantine Middle Palaeolithic (see Shea 1991 for details). The interesting point of Figure 3.2 is the major difference between 'type C' assemblages on the one hand and B and D on the other. Such results indicate that different forms of assemblages were used in different ways, stressing the role of functional variation. Yet the fact that phase D and B assemblages were apparently *used* in similar ways, but that they *manufactured* in different ways, suggests that the influence of function on

assemblage composition is indirect, i.e. it is filtered through culture. The important paper by Delagnes and Rendu (2011) on the French Middle Palaeolithic, using archaeofaunal rather than use-wear data as a proxy for function, appears to demonstrate a similar picture of alternative cultural responses to similar environmental situations.

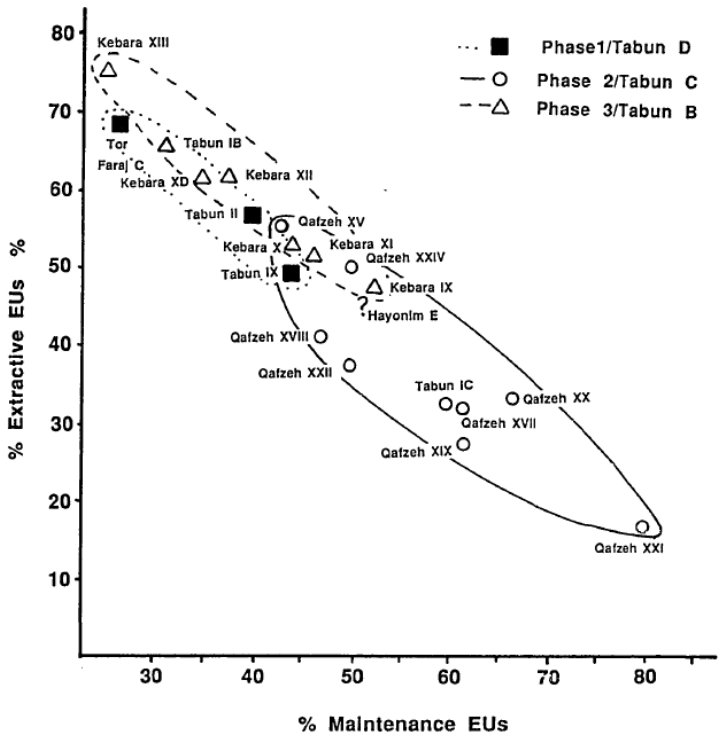



Figure 3.2. Functional patterning in the Levantine Middle Palaeolithic (from Shea (1991, 433).

A perhaps more fundamental challenge to Bordes' typology came in a series of publications by Harold Dibble (in particular) and Nicolas Rolland (e.g. Rolland 1977; 1981; 1988a, b, 1990; Dibble 1984a, b, 1987a, b, 1988a, b; 1987; 1989, 1991a, b; Rolland and Dibble 1990; Dibble and Roland 1992). The 'resharpening model' they developed – a continuation of the notion of the Frison Effect (Frison 1968) - is one reflection of a growth of analyses focussed on lithic reduction as a *process*, rather than the study of individual artefacts. Whereas Binford and Bordes had agreed on the essentially emic (i.e. reflecting conscious decisions on the part of the knapper and the clear imposition of a desired morphology) character of Middle Palaeolithic lithics, Dibble suggested that Middle Palaeolithic variability was heavily etic (see also Spaulding 1953, 1954 *contra* Ford 1954).

Secondly, it was suggested that the various types of 'scraper', and by extension other forms of retouched lithics, did not reflect distinct categories at all, emic or otherwise, but rather stages in the process of reduction. The extent of retouch was driven by factors such as raw material constraints and the nature of occupation, in the latter case linking in to environmental conditions.

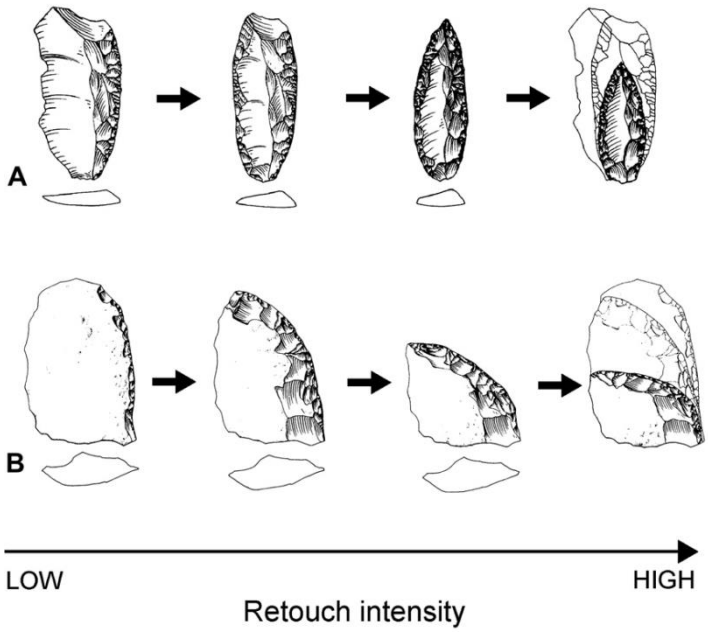



Figure 3.3. Two examples of the effect of increased reduction on artefact morphology (see Dibble 1987a) (modified from Brumm *et al.* 2011).

Clearly, retouch does alter artefact morphology, and therefore in a sense Dibble and Rolland make a valid point. Additionally, it is indeed unlikely that hominins, be they in France or Arabia, had a 'mental template' of the more than 20 types of scraper in Bordes' (1961) scheme, for instance. The key point is to question whether or not the 'reduction model' provides a fundamental mechanism affecting the variability of Middle Palaeolithic assemblages. Particular objections can be made. For instance, at the French Middle Palaeolithic site of Combe Capelle, it is strange that a heavily retouched assemblage is found immediately next to a large and obvious source of high quality raw material (Peyrony 1943). Middle Palaeolithic hominins retouched for multiple reasons, which can in simple terms either be to resharpen an edge or conversely to define the shape of a lithic. It must also be recognised that retouch is uncommon in many Middle Palaeolithic assemblages, particularly in Arabia it seems (see chapter 2), so any focus on retouch cannot offer an overall conceptual model for Middle Palaeolithic variability. Ethnographic studies demonstrate that unretouched flakes

were both widely used and, in fact, often preferred to retouched pieces (e.g. Holdaway and Douglass 2012). Many elements of variability reflect differences in initial reduction strategy, between say the Quina Mousterian and other facies with high proportions of Levallois reduction, a point always made by Bordes (1961, 1981). Such distinctions have nothing to do with retouch intensity.

The comments above on typology and on Dibble's perspectives should not be taken as a critique of the importance of understanding retouch. On the contrary, it is argued that both typology such as that of Bordes and the resharpening model present oversimplification of the character of retouch. The meaning of varying levels of retouch. being high in the Middle Palaeolithic of the Zagros Mountains (see e.g. Lindly 1997) for instance, and detailed analyses of varying forms and locations of retouch on blanks, are significant for interpreting Middle Palaeolithic variability. To understand these themes we need a methodology which objectively compares retouched pieces, rather than attempting to squeeze them into typological boxes.

The role of raw material characteristics on Middle Palaeolithic variability has been addressed by a number of researchers (e.g. Tavoso 1984; Dibble 1985, 1991a; Barton 1988; Geneste 1988a, b; Dibble and Rolland 1992; Bietti and Grimaldi 1995; Grimaldi and Lemorini 1995), while others address the relationship between raw material factors and lithic technology more generally (e.g. Bar-Yosef 1991; Monet-White and Holen 1991; Andrefsky 1995; papers in Adams and Blades 2009; Braun *et al.* 2009).

Raw material factors are typically cited in the context of limiting factors. Klein (2009, 500) for instance suggesting that Middle Palaeolithic/Middle Stone Age variability relates primarily to the "size or flaking qualities" of raw materials and reflecting his assertion that lithic technology of this period was "remarkably uniform through time and space". Fish (1981) suggested that in some European and Middle Eastern assemblages he studied the Levallois technique was only applied in areas where raw material in a large enough form was available. Likewise it is claimed that Levallois reduction is difficult to conduct on material such as quartz and quartzite (e.g. Rolland and Dibble 1990), but this claim is contradicted by a variety of evidences, including those in this thesis. The

bipolar technique is popularly regarded as a technique related to raw material preservation (e.g. Shott 1989; Andrefsky 2006, 153). This is not unproblematic. For example, at Mumba Cave in Tanzania there is a gradual increase in bipolar cores towards the top of the Palaeolithic sequence, although raw material always seems to have been plentiful in the surrounding area (Marks and Conard 2008). The influence of raw material on artefact form is more nuanced than is often portrayed. Van Peer (1993, 137), for instance, emphasises the character of the raw material in terms of suitability for platform preparation, a point discussed in the last chapter in relation to Delagnes *et al.*'s (2012) suggestion that a lack of platform preparation at SD1 in Yemen reflects the physical properties of the rhyolite used.

In fact in many cases where raw material limitations are cited there are complications to any simplistic narratives. In North Africa, for instance, Van Peer (1991) suggests as might be expected a general relationship between the size of nodules and precores and the size of resultant cores and blanks. However, he highlights a notable exception to this with the relatively large cores at Beit Allam being associated with flakes of the smallest mean size for all of his Egyptian sites. Likewise, at Nazlad Khater 1 and 2, two sites in very close proximity with the same raw material source, cores and flakes were of very different sizes. Examples of there not being a simplistic correlation between raw material form and resultant products are widespread in both spatial and temporal terms. There are numerous examples of sophisticated knapping techniques being conducted with poor quality raw material (e.g. Mellars 1992, 35). Interesting examples of prepared core technology being conducted on poor quality raw materials include Pontnewydd Cave, Wales (Aldhouse-Green 1995) and Tsagaan Aguin, Mongolia (Brantingham *et al.* 2000). Clarkson (2010) suggests that while raw material might be influencing core morphology in the Howieson's Poort, 'cultural' style may be a more significant factor. The complicated role of raw material is highlighted by Kuhn's (1995) study of the Middle Palaeolithic of Italy. Kuhn highlights that hominins employed different reduction strategies for the different forms of raw material packages they *chose* to utilise. Kuhn also emphasises that in some situations raw material with a naturally 'Levallois-like' character were selected, 'predetermination' therefore taking the form of raw material selection rather than preparatory knapping.

Environmental changes have also been highlighted as major factor in influencing assemblage variability (e.g. Rolland 1977, 1981, 1988a; Rolland and Dibble 1990). Again it can be argued that such an influence has to be understood in a way which reflects its being filtered through hominin cultural factors. There is no doubt that environmental changes are of great importance in understanding the Middle Palaeolithic, but we must avoid simplistic climatic determination. Given the broadly repetitive nature of the glacial-interglacial cycle in the Middle and Upper Pleistocene one must wonder why agriculture, for instance, appeared in MIS 1 and not MIS 5. Parallel arguments can be made for any major development in hominin evolution. Climate provides context, but not direct explanation. Aside from the considerable role of contingency in the evolutionary process (e.g. Gould 2002), the critical factor is that hominins responded to environmental change by making *choices*. Aside from this factor, environmental change critically effects technology by its influence on demography as carrying capacity of particular environments changes. The role of demography will be discussed below.

Delagnes and Rendu (2011) provide a recent example of the way in which the role of environmental change can be understood, in this case in France, but their arguments have a universal logic. Assemblages dated to MIS 7 and 5 are dominated by Levallois technologies which they argue do not seem to be designed for highly mobile/seasonal subsistence strategies (but see Eren and Lycett 2012 for an alternative perspective on Levallois technology). With post MIS 5 climatic deterioration the presence of the Quina and 'discoidal-denticulate' variants could be interpreted in an environmentally deterministic fashion (but they could also be seen as the result of dispersals, as discussed by Mellars, 1992). Delagnes and Rendu (2011), however, interpret these post MIS-5 assemblages as reflecting an increase in mobility and a concordant change in lithic technology, such as a focus on lithics with high potential for retouch. The critical aspect of their argument is that Quina and 'discoidal-denticulate' industries represent *different* responses to analogous environmental circumstances. In the case of areas such as Levant the role of environmental variation in changes to lithic technology is hard to understand, as major climatic changes appear, at least broadly, to correlate with different hominin in species dispersing into the area (e.g. Shea 2008).

Another factor which has been related to assemblage variability is the demographic structure of Palaeolithic societies (e.g. Shennan 2000; Petraglia *et al.* 2009). The demographic structure of Palaeolithic populations reflects a dialectic of ecological circumstances and hominin behaviour. For instance, it has recently been suggested that factors such as the origin of projectile technology, as apparently demonstrated by small lithic points, will have played a dramatic role in changing hominin demography (e.g. Shea and Sisk 2010; see also Brooks *et al.* 2006). However, did demographic increase in part lead to, or at least catalyse, such developments, or conversely did the development of elements like projectile technology lead to demographic growth? The difficulty in distinguishing between these two hypotheses means we must situate debates in terms of the multi-faceted debate on the character and causes of lithic variability, and in terms of behavioural ecological concepts, which are discussed later in this chapter. The demographic structure of a population has many forms, including population size, structure, dynamics, density, fertility, mortality and dispersal (Chamberlain 2006). Dispersals are primarily a facet of demography, and in this sense the foundations of hominin dispersals are similar to those in other biological entities (see e.g. Clobert *et al.* 2001, 2012; Finlayson 2004). Different forms of dispersal will have different implications for the archaeological record. A gradual and broad expansion can be expected to correlate with a spread of similar material culture to the source area. In contrast 'jump dispersals' where expanding populations are filtered through environmental features such as riparian 'corridors' may mean a strong 'founder affect'. This may, for instance, explain the absence of bifacial technology in the Levantine Middle Palaeolithic assemblages associated with *Homo sapiens* which, most scholars suggest, dispersed from African populations, with long traditions of façonnage technology.

Demographic factors then are likely to have played a significant role in determining the character of Middle Palaeolithic assemblages, but as with previous factors they do so in a way which was filtered through both human behaviour and particular environmental characteristics of different landscapes. Behavioural ecology provides an increasingly widely recognised context for lithic variation. This development, however, has perhaps come at the expense of downplaying 'cultural' factors.

### 3.6) Technology

Along with the growth of 'behavioural ecological' perspectives, there has been a significant growth of 'technological' perspectives. Supplemented by notions such as Dibble's re-sharpening model, this is the primary manifestation of the turn towards dynamic rather than static conceptions of lithic technology. In a broad sense we can say that if typology focusses on what was made, technology addresses how it was made. Tixier *et al.* (1980, 8 – cited and translated by Bar-Yosef and Van Peer 2009) state that:

> Technology is not typology. It takes into account the entire lithic material without preferentially isolating what we choose arbitrarily to call "tools". It places each item in the sequence of technical actions beginning (after its conception and prior contemplation) with the raw material and ending with the abandonment, the "death" of the tool assemblage. Even when fragmented into thousands of microliths and "debris," a lithic assemblage always form a coherent whole bound together by a methodical scheme.

Technological perspectives can be divided into 'French' and 'American' schools, although both perhaps share more than is often admitted (e.g. Andrefsky 2008; Tostevin 2011). The effects of what can be seen as the 'technological revolution' are profound. This has filtered through to the 'textbook level'. Klein (2009, 485), for instance, makes the technological point that identifying "similarities in the initial reduction sequence" provides a better way to "reconstruct cultural relationships" than does the typology of retouched lithics. Fundamentally such interpretations reflect the idea that typology, particularly of retouched tools, is more sensitive to specific local conditions (e.g. function) that technology, which is arguably inherently more culturally transmitted and conservative (e.g. Bar-Yosef and Meignen 1992).

The primarily French approach to technological research is labelled the *chaîne opératoire* school (e.g. Leroi-Gourhan 1964; Tixier 1978, 1979; Lemmonier 1986, 1992; Boëda *et al.* 1990; Sellet 1993; Soressi and Geneste 2011). The *chaîne opératoire* perspective developed from ethnographic research (Leroi-Gourhan 1964), a genesis reflected in its conception of *chaîne opératoires* of lithic reduction as something tangible in the minds of the knappers, a thoroughly emic conception. This perspective sits alongside the idea of the *chaine opératoire* as an

analytical approach or conceptual framework. At a basic level this reflects a way of exploring lithic reduction through perceiving a number of stages (acquisition of raw materials, production, shaping/retouching, utilization, and discard).

From the perspective of this thesis there are a number of problems with the *chaîne opératoire* approach. Audouze (1999, 167) stresses that a key aspect in the development of this school was the perspective held by most of its founders of the "autonomy of the technical realm and its quasi-biological development". Lithic reduction was, it can be argued, abstracted from its social context. This is reflected in the notion of the emic and 'intentional' character of reduction, which aside from being untestable contradicts considerable ethnographic evidence previously discussed in this chapter. In terms of methodology the *chaîne opératoire* approach can be criticised in that it remains essentially descriptive and not explanatory as such (e.g. Monigal 2002, 113). Many accounts are indeed "thickly descriptive" (Shea 2011, 52). Bar-Yosef and Van Peer (2009) offer an important critique of the *chaîne opératoire* approach, warning against a "technological typology" which the approach engenders. Soressi and Geneste (2011) outline some of the contingent factors which came with the birth of the *chaîne opératoire* approach as a "rebellion" against Bordesian typological approaches. These include a rejection of formal quantification and a 'whole assemblage' perspective which are in fact the primary problems with the *chaîne opératoire* approach.

The positivist or inductivist basis of *chaîne opératoire* research means that there is typically relatively little interest in testing hypotheses. A telling example concerns the differing interpretations of Level IIA of the French site of Biarch Saint-Vaast. Boëda (1988) claimed that unidirectional and bidirectional Levallois *chaîne opératoires* were present and that only one approach was applied to a single core, never both. However when Dibble (1995) conducted a quantified attribute analysis of the assemblage he demonstrated strong correlations between, firstly, scar patterns and percentages of cortex and, secondly, length of blank and dorsal scar pattern. Given this, it is more parsimonious to assume that unidirectional and

bidirectional reduction were flexibly applied as part of the same reduction sequence. There has been little response to Dibble's (1995) paper by *chaîne opératoire* enthusiasts.

Despite these issues there is much of value to the *chaîne opératoire* approach, primarily its highlighting of the dynamic nature of lithic reduction. There is nothing to stop such an approach being combined with a more quantified method (e.g. Tostevin 2003a,b; in press). The idea of the *chaîne opératoire* being able to demonstrate that a "sequence of technical gestures…were passed down from one generation to the next" (Bar-Yosef and Meignen 1992) articulates with the premise of this thesis, that lithic technology reflects cultural information which can clarify Middle Palaeolithic dispersals. Yet the *chaîne opératoire* method as traditionally applied is not well designed for comparative analysis, which is critical to understand issues such as adaptation and dispersal. Instead interpretations are focussed on understand particular individual assemblages, as well as the frequent and probably dubious inference that the *chaîne opératoire* will allow us to "read" the minds of the prehistoric artisans (Bar-Yosef and Meignen 1992, 178). This reflects what Tostevin (2011, 355) refers to as the "tyranny of the emic goal in *chaîne opératoire* middle-level theory".

Changing conceptions of Levallois technology provide an interesting example of the evolving focus of lithic studies from typological to technological perspectives. Original definitions were typological and focussed on Levallois blanks (e.g. de Mortillet 1883; Oakley 1956, 49-51). More recently, and rooted in the ideas of Bordes (e.g. 1961, 16), the work of scholars such as Eric Boëda (e.g. 1995) has led to a new technological and volumetric understanding of Levallois technology, particularly focussed on cores. Much debate has concerned the definitions and significance of Levallois technology and a primary feature of Dibble and Bar-Yosef's (1995) *The Definition and Interpretation of Levallois Technology* is a failure to agree on either the definition or interpretation of Levallois technology. One is reminded of the differing way in which Darwin (1859) struggled to define 'species'. The boundaries of Levallois are to some blurred and to others tightly defined. To some, 'Levallois' and 'discoidal' reduction, for instance, are by essence different forms of reduction (Boëda 1993),

while to others the dichotomy is rather less blunt (e.g. papers in Peresani 2003). Where variation is quantified it has been observed that core type appears to vary with size, and other attributes such as the percentage of cortex (e.g. Haslam *et al.* 2012). As previously discussed, in the assemblage studied by Kuhn (1995) lateral and distal convexity of cores was determined by selection of raw material naturally possessing this character rather than this convexity being achieved by knapping. These cores are therefore not Levallois *sensu* Boëda (e.g. 1995).

In the preface of their book, Bar-Yosef and Dibble (1995, ix) contrast the 'opportunism' of other reduction strategies with the 'predetermination' of blank morphology in Levallois reduction (see also Bordes 1980). It is however unclear that a black and white distinction can be made between Levallois and non-Levallois blanks in this regard. Others have suggested that evidence for the use of particular blanks may offer an objective way to study desired flakes (Baumler 1988), while others point out that thinking about the pieces *missing* from refits may offer useful insights (Marks 1988). There is a considerable problem of equifinality, which cannot be addressed without extensive refitting. Hence the phenomenon of biface thinning flakes which are typologically Levallois flakes (Boëda 1995, 44). Likewise typologically Levallois points can be produced by non-Levallois reduction (Marks and Volkman 1983). Van Peer (1992, 5) states rather bluntly:

> There is a problem with Levallois. We cannot seem to arrive at a coherent recognition of Levallois blanks…Stated in very simple terms, the problem appears to be that nobody seems to know anymore what Levallois technology precisely is.

In this context it is suggested that quantification is the way to understand what exactly we mean by terms like Levallois. One example of a quantified experimental study is Eren and Lycett (2012).

Alongside the development of the *chaîne opératoire* approach, the primarily American 'organization of technology' approach has sought to address many similar factors, growing from an analogous dissatisfaction with overly typological perspectives (e.g. Binford 1973, 1977; Torrence 1983; Shott 1986; Nelson 1991; Andrefsky 2006, 2009; Shott and Nelson 2009; Tostevin 2011). In the organization of technology approach there is a far more explicit appeal to high-level theory, in the

form of behavioural ecology, than in *chaîne opératoire* research which has focussed on middle-level theory. A large literature exists on the ecological context and behavioural strategies which will influence lithic variability, a particularly useful summary being given by Clarkson (2007, 9-25) while the papers in Andrefsky (2009) reflect applications of the organization of technology approach (see also Hovers 2009). Some important aspects of the organization of technology approach are discussed below, although space prevents a thorough discussion. As Clarkson (2007, 22) argues, the substantive and cross-cutting literature on this topic makes evaluation and application somewhat difficult. He argues that Kuhn's (1995) concept of 'provisioning' provides a useful heuristic which brings together many overlapping concepts. Kuhn distinguishes between the idea of provisioning an individual and provisioning a place. This dichotomy brings together many of the concepts briefly discussed below and provides a significant theoretical foundation for this thesis. Specific features of Middle Palaeolithic assemblages can be correlated with predictions made by Kuhn's model. For example, he predicts that in contexts focussed on provisioning individuals assemblages will reflect increased transportability and maintainability of lithics.

The concept of 'optimality' is central to accounts seeking to contextualise lithic variability within ecological situation and subsistence strategies. Concepts within Optimal Foraging Theory include diet breadth, patch choice and time allocation, central place foraging and field processing, resource depression and patch choice, and mobility patterns (Clarkson 2007). Three particularly pertinent concepts which have repeatedly been highlighted concern curation, risk, and mobility. These concepts are associated with explicit predictions on the character on lithic variability.

The concept of 'curation' has been regularly cited since it was introduced by Binford (1973, 1977). Binford did not define clearly the concept in his initial publication, and subsequently a proliferation of differing interpretations of the idea developed (e.g. Bamforth 1986, Parry and Kelly 1987; Odell 1996; Andrefsky 2006; Shott and Ballenger 2007). Indeed such was the diversification of interpretation that Nash (1996) argued that the term should not be used and it lacked clear definition (but see e.g. Andrefsky 2009, 8).

The notion of risk developed from Torrence's (1983) concept of 'time-stress', from where she moved towards a notion of risk avoidance and its effects on material culture (Torrence 1989, 2000). Collard *et al.* (2005) conducted a comparative study of 20 modern hunter gatherer societies and suggest that risk appears to be the major factor determining variability in subsistence related technology. The downside to their study is that their sample of modern societies is biased towards modern coastal societies of the northern hemisphere, but it still demonstrates the importance of risk avoidance.

The idea of variations in 'mobility strategy' is that nomadic hunter gatherers will change the frequency and distance of their movements across the landscape in relation to differences in resource availability (a useful summary is given in Adler 2002; see in particular Binford 1973, 1977; Marks and Friedel 1977; Kuhn 1995). The example of the heavily retouched Middle Palaeolithic industries of the Zagros Mountains are a situation in which a seasonal mobility strategy bringing hunter gatherers into an area poor in lithic raw materials is associated with specific technological features, primarily the heavy retouch of flakes. Attempts to understand mobility strategies through data other than lithics (e.g. Lieberman 1993a, 1998; Lieberman and Shea 1994) have faced methodological problems (e.g. Stutz 2002).

### 3.7) New techniques of lithic analysis

Alongside the lively debates discussed above which have characterised lithic studies, a considerable diversification and advancement of analytical methods and procedures has occurred. These primarily relate to three categories: firstly refitting studies, secondly use-wear and residue analysis and, finally, the quantification of lithic variability.

Refitting studies (e.g. Cels and De Pauw 1886; Leroi-Gourhan and Brézillon 1966, 1972; Van Noten *et al.* 1978) have been applied successfully in a number of Middle Palaeolithic contexts (e.g. Volman 1981, 1989; Demidenko and Usik 2003; Adler and Conard 2005; Rose *et al.* 2011; Usik *et al.* in press). Where applied refitting offers significant insights into hominin behaviour in particular spatial and temporal contexts. In many contexts, however, refitting is difficult at Middle Palaeolithic sites, which are frequently palimpsests of varying magnitude, and refitting is considerably easier

with certain raw materials than with others. Caution must also be taken, in moving from the inferences of the refits to the 'intentions' of the knappers, as refits may represent the actions of multiple individuals (see Larson and Ingbar 1992), perhaps over broad timescales. The notion that refitting allows modern researchers "into the mind of the maker" (Demidenko and Usik 2003) is at least commonly implied in lithics studies and is problematic.

The final and key issue with refitting concerns the issue of comparability. While methods to depict fairly complex sequences of refits have been developed (e.g. Van Peer *et al.* 2010), little attention has been given to developing techniques to compare refitting sequences. Some hints in that direction indicate that elements of comparability are possible (e.g. Figure 6 in Bar-Yosef and Van Peer 2009, 115). Pending considerable developments in comparability we face the situation where fascinating insights into particularly assemblages can only loosely be correlated with other assemblages. As with *chaîne opératoire* analyses then, refitting studies as currently constructed are not well designed to articulate with themes such as dispersals. The final issue with refitting is the procedure of leaving refitted constellations glued together. This may give something interesting to look at, but also prevents easy subsequent analysis of the individual pieces.

Alongside developments in refitting studies, a number of advances have been made in residue, and particularly, use-wear studies, beginning with the work of Semenov (1964). Examples of important studies include those of Shea (1991) and Rots *et al.* (2011). The issue with use-wear and residue analyses is the uneven distribution of suitable material for their application. This reflects both differential preservation of evidence with different raw materials and other factors such as the role of taphonomy and context (e.g. surface versus stratified assemblages). The key development these studies have brought is the demonstration of the absence of a simple correlation between form and function. Lithics of various morphologies were used for various tasks in the past, as ethnographic studies have demonstrated they are in the modern world. While such studies provide fascinating insights into particular spatial and temporal contexts, and some frequently cited generalities, such as the frequent assertion that notches and denticulates primarily reflect woodworking (e.g. Klein 2009, 496), their general lack of applicability means they cannot be used at present to compare

assemblages systematically. Where comparison is possible it relates primarily to function, which is not a primary topic of this thesis.

A most exciting development in lithic analyses relates to the rapid progression of quantitative methods of analyses, which are often used alongside sophisticated techniques for gathering data. Clarkson *et al.* (2006, 132) provide a by-no means comprehensive list of over thirty recent papers which reflect a growth in quantitative methods of lithic analysis, and state that:

> Quantitative analysis offers an alternative to the ambiguity and regionality of conventional typology, and provides results that lend themselves to inter-assemblage comparison while also being amenable to many different kinds of statistical analysis.

One significant category concerns quantified ways to illuminate lithic retouch (e.g. Hiscock and Tabrett 2010). The specific methods employed in this thesis, primarily after Kuhn (1990) and Clarkson (2002), will be described in the following chapter. Here it suffices to highlight the significance of the development of quantified techniques to measure retouch, but also to highlight the suggestion by Hiscock and Tabrett (2010) that they remain 'under theorised'. Attention has focussed on methodology, not on what results actually tell us. In addition many assemblages have few retouched artefacts, and even fewer complete retouched pieces, so quantifying retouch is a useful part of an analysis, but will not be a primary element of most questions.

A critical development concerns advances in geometric morphometric analyses, which allow the three dimensional character of lithics to be compared in contrast to traditional approaches which focus on orthogonal measurements. Geometric morphometric analyses have been slow to develop in lithic studies, in part because of the issue of defining 'landmarks'. A variety of approaches have been developed which include the use of '3D digitisers', such as Miscoscribes (e.g. Clarkson 2006, 2010; Clarkson *et al.* 2012; Petraglia *et al.* 2007), laser scanners (e.g. Lin *et al.* 2010; Shott and Trail 2011; Bretzke and Conard 2012), Crossbeam Coordinate Calipers (Lycett *et al.* 2006, 2010), and micro-CT (Abel *et al.* 2011). The rapid development of geometric morphometric analyses has been labelled a "revolution" (Lycett and Chauhan 2010).

The major strength of these techniques is that they allow objective comparisons between the shapes of lithic artefacts, but there are downsides. Many of the pieces of equipment needed are expensive,

although they are decreasing rapidly in price they are still beyond the reach of many who would be interested in their use. Many of these techniques are also time consuming, and at present analysis of an entire reasonably sized assemblage would take a considerable length of time. Another factor of concern relates to the proliferation of approaches. It often seems that every lithic analyst using geometric morphometric analysis has their own unique method. This is a bad situation for replicability and testing. Finally, it is critical to remember that the results of multivariate analyses will not speak for themselves, but must be interpreted.

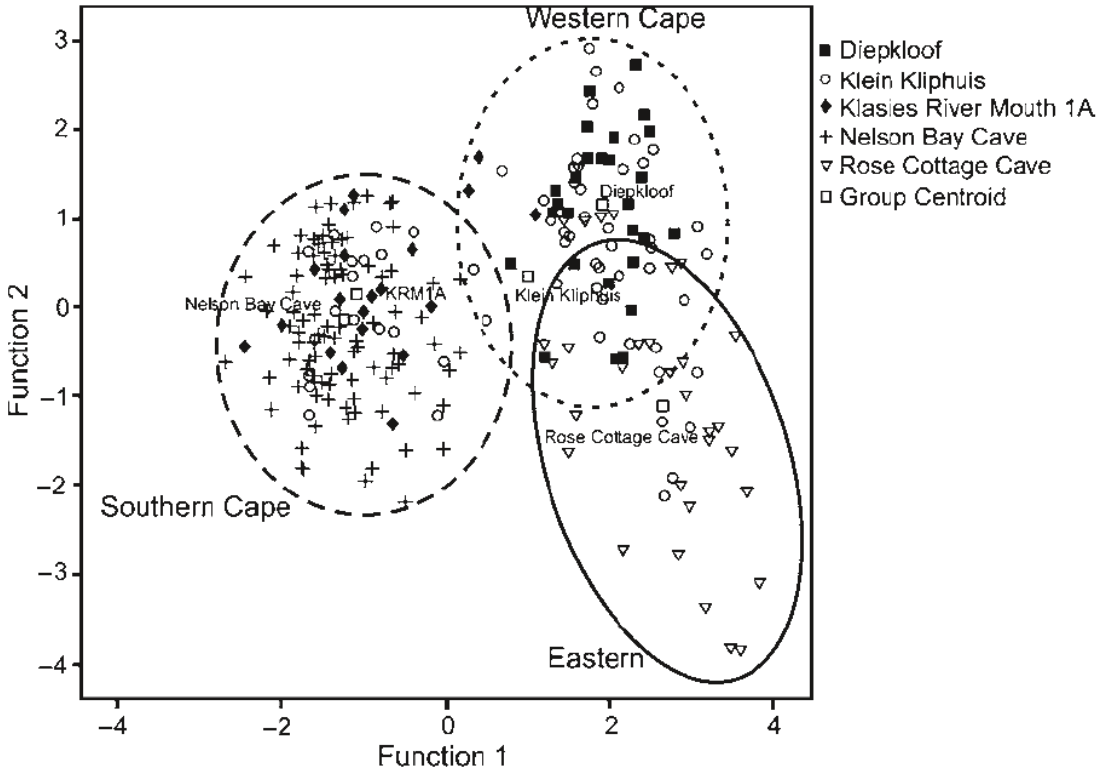



Figure 3.4. Discriminant function analysis Howiesons Poort core variability. Data from five sites in South Africa, demonstrating clear regional variability (Clarkson 2010).

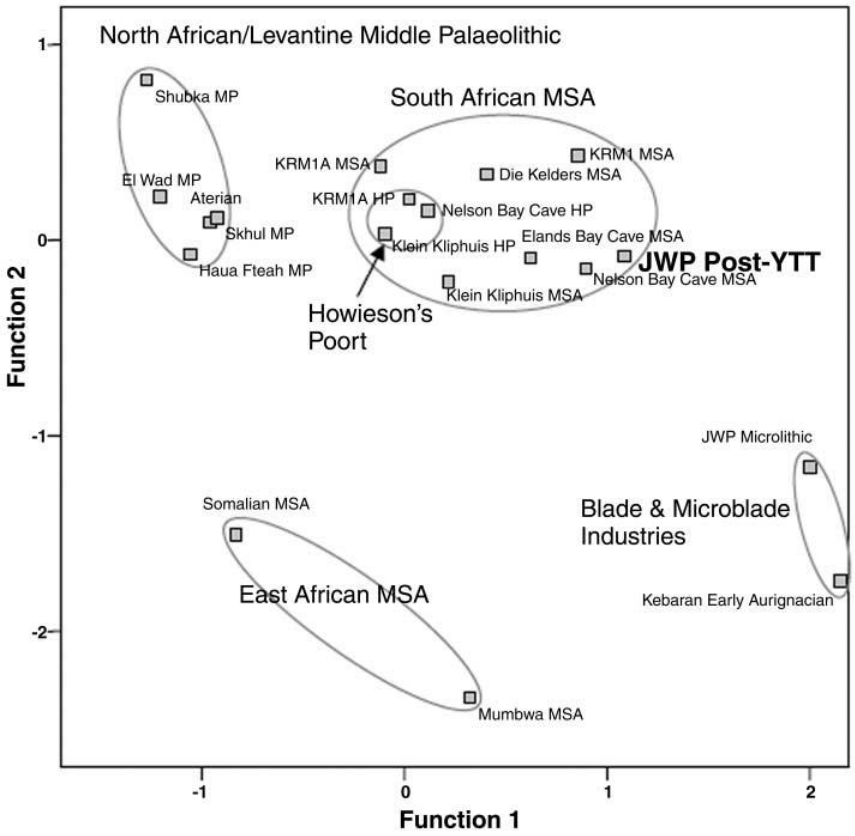



Figure 3.5. Discriminant function analysis of Upper Pleistocene cores (from Petraglia *et al.* 2007).

Figure 3.6 shows Van Peer's (1991) principal components analysis of Levallois flake attributes from across North Africa. In this case, and with the previous examples in Figures 3.4 and 3.5, we must ask what is causing the patterning visible. It appears that it can be found at a variety of scales, from assemblages of a single country (Figure 3.4), to a region (Figure 3.6), to an intercontinental scale (Figure 3.5). Clarkson (2010) quantifies variability in core morphology in the Howiesons Poort and shows that variability does not seem to primarily reflect raw material factors, the patterning he demonstrates (Figure 3.4) appears to be most parsimoniously explained by cultural variation. A variety of other statistical approaches have recently been applied, such as the use of elliptical Fourier coefficients to understand the relationship between shape and size (Iovita 2008), COPLOT analyses (Hovers and Raveh 2000; Hovers 2009) and cluster analysis (e.g. Hauck 2011). The key point to emerge from these various approaches is the demonstration of spatial and temporal

grouping in lithic variability, which do not seem to be driven primarily by factors such as raw material variability, which are clearly important in understanding lithic variability.

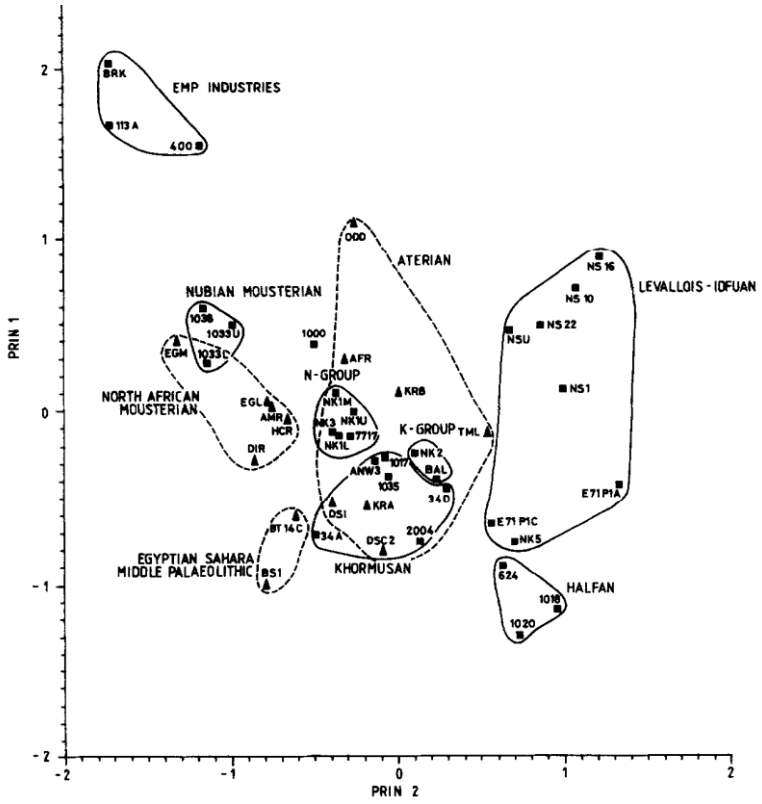



Figure 3.6. – Principal components analysis of Levallois flake variability in the North African Middle Palaeolithic (Van Peer 1991, 132).

### 3.8) Discussion

All too often a single factor, be it 'function' or 'ecology', for example, is venerated as the overwhelmingly important factor in determining Middle Palaeolithic technological variability. From the preceding discussion the various factors affecting variability are seen as causing changes in assemblage composition and character through time and space, but in doing so many scholars overlook the considerable continuity which characterises elements of the Middle Palaeolithic record. Given the social context of lithic technology, irrespective of the position taken on questions such as whether language is needed for the transmission of sophisticated technology, it seems hard to avoid the explanation that 'culture' is a central factor in determining the character of lithic assemblages. This is what explains the existence of clear spatial and temporal 'technocomplexes'.

Culture must be separated from 'culture-history'. This thesis seeks to address what Middle Palaeolithic hominins did, not what they thought they were doing. The key factor concerns our methodology as lithic analysts in how we measure variation. There is a growing consensus that individual artefact 'types' are not a productive avenue. Instead culturally specific reduction schemes are highlighted by numerous researchers. It is unfortunate that relatively little attention has been given by ethnographers and experimental knappers to the process of *learning* (e.g. Shennan and Steele 1999; Davidson and McGrew 2005, 87). Limited insights – such as Wiessner's (1983) study where 49 out of her 55 !Kung informants stated they learned the craft of arrowmaking from their fathers or other close relatives – demonstrate the social context of technology.

The idea that 'cultural' means 'identity conscious' (e.g. Rolland and Dibble 1990; Clark and Riel-Salvatore 2006) is a connection which needs to be broken. Ethnographic accounts, e.g. Wiessner (1983) demonstrate culturally specific patterns in material culture, in this case arrowheads, which were not deliberately imposed by the makers. A lively literature on cultural transmission in material culture has developed (see the examples cited by Lycett and Chauhan 2010, O'Brien and Lyman 2000, 2003; Mace *et al.* 2005; Lipo *et al.* 2006; O'Brien 2008; Shennan 2000, 2009; Mesoudi *et al.* 2004, 2006). Without some kind of cultural role, albeit one interacting with various elements of the environmental realm, how do we explain the idiosyncratic features of the archaeological record? Why are bifaces not, or hardly ever, present in the Levantine Middle Palaeolithic? Why is the Nubian technique of core preparation found in a certain spatial and temporal situation and not others? This recognition of the "strangely idiosyncratic" features of the Middle Palaeolithic record is not new (e.g Mellars 1992, 40). This recognition has extended from Europe to other areas, such as the African Middle Stone Age with its regional variation in point form (e.g. Clark 1984, McBrearty and Brooks 2000) and as Clarkson (e.g. 2010) shows, in core technology. Scerri (in press) shows from a number of lines of evidence that lithic variation in North Africa appears to demonstrate MSA population structure. Examples where a cultural role has been highlighted are both numerous and occur across time and space in the Middle Palaeolithic world (e.g. Delagnes and Meignen 2006; Marks and Chabai 2006; Hovers 2009; Picin *et al.* 2011, 717-718).

Given the above discussion, there should be optimism on the ability of lithic variability to aid in the interpretation of hominin dispersals. Two critical factors which need to be considered are 'levels of theory' and 'methodology'. It is common to divide theory into low, middle and high levels (e.g. Trigger 1989; Thomas 1998). Low level can be regarded as "empirical research with generalisations" (Klein 1977: 2). Middle level theory, analogous to Binford's Middle Range Theory, typically seeks to use arguments from theory, ethnography and experimental knapping to understand patterns of hominin behaviour in the archaeological record. High-level theory reflects broad intellectual paradigms. It is arguably the case that, considering the symbiotic relationship between levels of theory, archaeologists have overemphasized the middle level of theory. In the *chaîne opératoire* school, for instance, there was an implicit ban on exploring the epistemology of the method introduced by Leroi-Gourhan (see e.g. Audouze 1999). As a result, advances in *chaîne opératoire* studies have focussed on *how* to conduct analyses, not *why*. The changing position of dispersals - *contra* 'evolution' from one form to another in the same area, in the study of the Palaeolithic has greatly affected studies of lithic variability. Most Palaeolithic archaeologists acknowledge that dispersals are an important element in structuring the Palaeolithic record, yet building methodologies which will help us to understand dispersals, using lithics which are by far the most common form of archaeological find, remain poorly developed.

It has been argued throughout this chapter that to understand dispersals we need to consider firstly units of analysis and, secondly, comparability between units. It is unfortunate that despite a huge effort by a large number of scholars, understanding of lithic variation remains constrained by incompatible methods and results.

Exploring an example from 'low-level' theory, the number of scars on a lithic, which is often regarded as a measure of reduction intensity, it should have been possible for lithic analysts to have long ago agreed a common way to measure this, but the literature reveals a sadly different picture. Hovers (2009) records the number of scars which are more than 5 mm long, as does Baumler (1987), Monigal (2002) and Kelly (1996). Clarkson (2007) records scars over 15mm in length, as does Beyin (2009). Jones (2007) records scars which are more than 1/3 the length of the piece.

Andrefsky (2005, 106) uses an ordinal system from 0 (completely cortical) to 3 (more than 2 scars). Armagan (2003, 271) also uses an ordinal system, but it is a different to Andrefsky's, although she does add the specification that she only counts scars if they are longer than 2mm. Mackay (2009, 266) uses three different systems to record the number of scars on cores, those longer than 15mm, those >20% the length of the core, and those more than 50%. In other cases more philosophical considerations are employed, Van Peer (1992, 11) for instance counting scars which "contributed to the actual core morphology".

In many cases no explicit definition of the number of scars is provided. As a consequence it is impossible to compare the number of scars between assemblages on published information. This is not intended as a criticism of individual scholars, but rather a call for the need to recognise that there is clearly a methodological problem. Figure 3.7 shows the effect these different ways of recording the number of scars has using the example of cores from the site of TH 59 (Dhofar, Oman). When recording scars more than >1/3 the length of the core, the mean average number of scars is 3.24. When scars are 5mm are recorded this increases to 12.87.

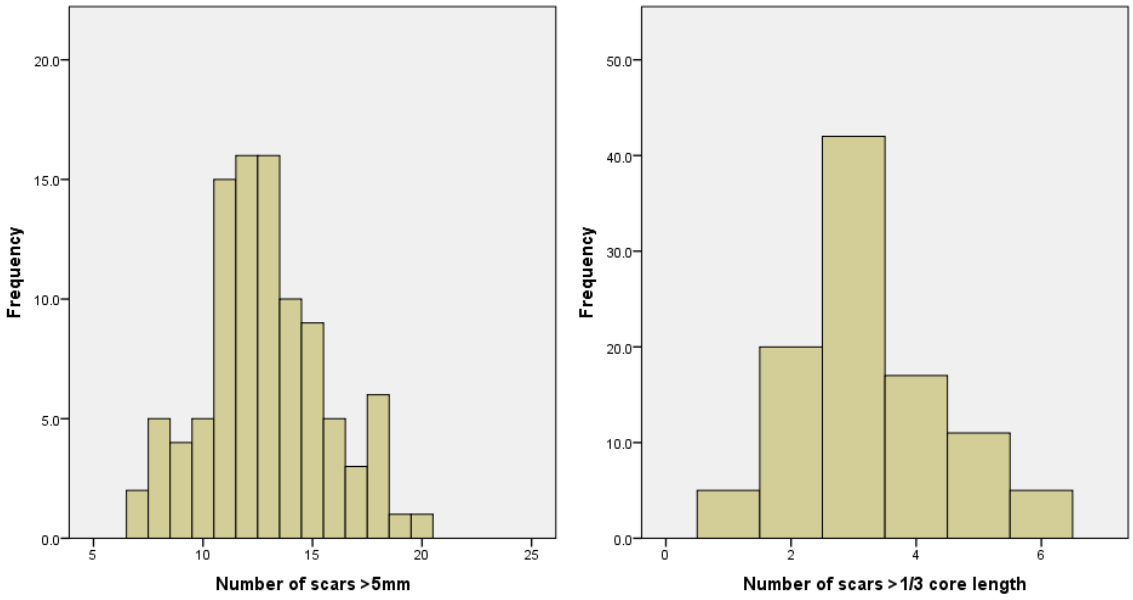



Figure 3.7. Histograms comparing methods of recording the number of scars (data from cores from TH 59, Dhofar, recorded by the author).

In general the absence of standardisation in measurements and recording appears to merely reflect a lack of consideration that it is important. In other cases, however, it is defended. Eren (2011) for instance argues that "we do not need more methodological and measurement standardization". He says so because, correctly, he argues the information gathered should reflect the particular question being asked. Yet this should not be incongruous with recording standardized measurements as well as more specific information for a particular study. In the absence of standardised recordings we find attempts to undertake comparative analyses such that of Vermeersch (2001) facing insurmountable difficulties. Vermeersch (2001) tried to compare North African and Levantine assemblages. He concluded that different methodologies and terminologies made this impossible. In terms of core types alone he records 34 different types used by different authors. It is indicative of the lack of progress in developing methods of comparative analysisthat Vermeersch (2001) is forced to argue that comparing illustrations – which always show selected 'attractive' artefacts from an assemblage – may be an important way to compare assemblages. It is inconceivable that astronomers would compare planets by looking at drawings of the planets, or historians study the English Civil War by comparing portraits of Charles I and Oliver Cromwell.

Given the incompatibility of most data available in the literature, to cast light on the Middle Palaeolithic of Arabia and the role of hominin dispersals it is necessary to conduct an inter-regional analysis of lithic assemblages. Here it is necessary to introduce and justify the approach adopted. The use of attribute analyses is designed to reduce subjectivity in analyses, as they are inherently quantitative. Some form of typology is necessary, although this plays a primarily descriptive and not analytical role. The division of assemblages into cores, debitage and retouched components is a philosophical decision and is not unproblematic, as the example of the phenomenon of 'cores on flakes' demonstrates. Given criticisms of attributes by scholars such as Ahler (1989) it is vital to explain in detail not merely what will be recorded, by why and how this addresses the questions of this thesis. Aside from recording an extensive array of attributes, it is necessary to interpret them. While criticisms of the lack of quantification and comparability have been made in this chapter, we need to avoid the opposite risk which is that quantitative analyses produce mainly "numbers rather than understanding" (Isaac 1984: 44). Consequently aside from rooting methods in terms of precise

questions and hypotheses, interpretation must be carried out in an objective manner, which is best achieved through the use of multivariate statistics. The habit of scholars recording detailed measurements and merely reporting average values, and perhaps standard deviations, represents a huge loss of information. Attributes and metrics are used to define the reduction processes of assemblages, which are interpreted through the context of the assemblage, the resulting synthesis therefore representing an overview of the organization of technology in particular spatial and temporal contexts.

There will long remain certain problems and ambiguities in the study of lithic analyses. These primarily relate to the fact that lithics were merely one element, albeit a very important one, of Palaeolithic material culture. There also remains the fact that the role of factors such 'symbolism' in lithic technology are likely to remain unclear. Wherever we can recognise something in the Palaeolithic as 'symbolic' it is almost by definition more appropriately seen as 'iconic' or 'indexical', as symbolism relates to shared *abstract* concepts. These difficulties must be recognised, but they do not prevent us from advancing the overdue quantitative comparison of lithic assemblages to generate hypotheses on the dispersal of hominin populations which can be tested by interdisciplinary research.

# Chapter 4. Sites and samples

## 4.1) Introduction

This chapter introduces and describes the lithic assemblages used in this study. The methodology by which they will be analysed in outlined in the following chapter.

The samples used can be divided into two groups. As Chapter 2 outlined, interior and northern Saudi Arabia is a poorly understood area, yet one critical to debates on Upper Pleistocene hominin dispersals. Consequently, the first part of the chapter describes the results of fieldwork conducted by an interdisciplinary team including the author at Jubbah, Saudi Arabia. The later part of the chapter describes assemblages from Oman, Iran, Tor Faraj, Sudan, Ethiopia and further sites in Saudi Arabia. These latter assemblages consist of museum collections, and in the case of 123-b (Oman) the recent discoveries of the Dhofar Archaeology Project. Figure 4.1 shows the locations of the sites used in this study, while the basic typological structure is presented in Table 4.1.

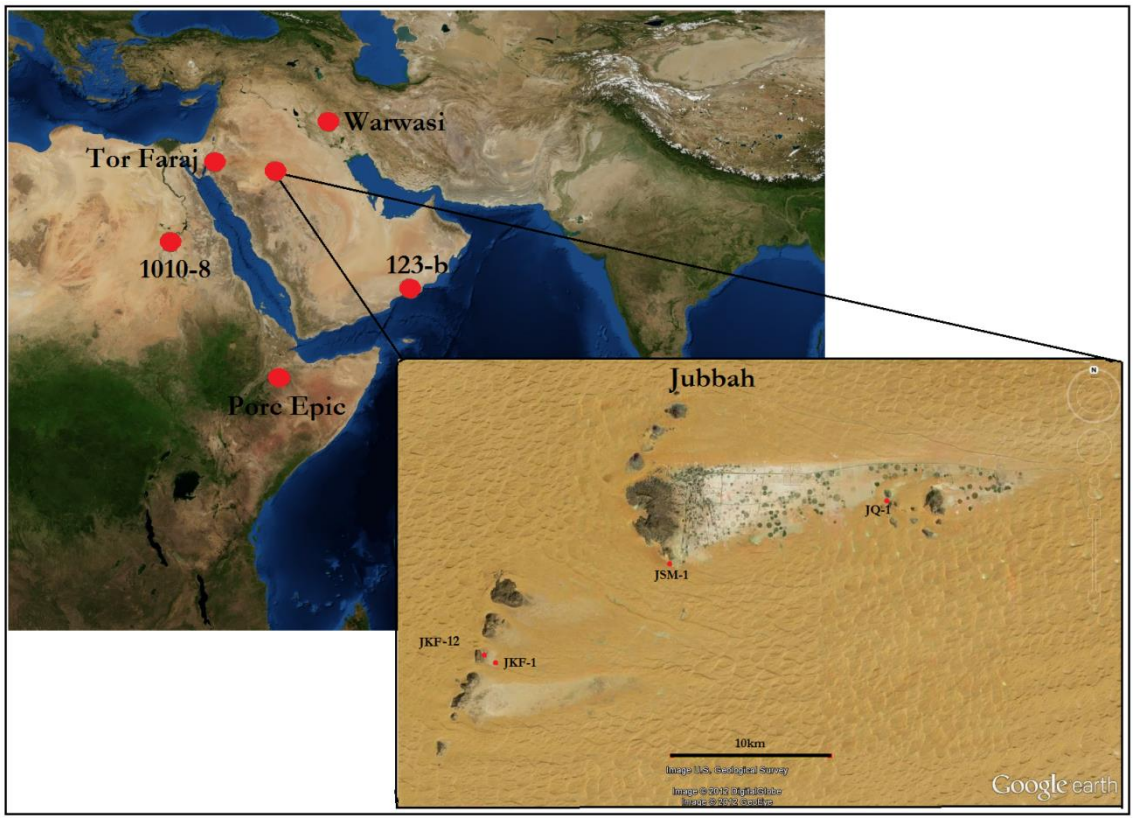



Figure 4.1. Locations of primary sites used in study, inset shows sites around Jubbah.

In some cases very little research has been conducted on the assemblages used, as, for instance, with the recently discovered site of 123-b in Oman (Rose *et al.* 2011), while in other cases, such as Porc Epic, Ethiopia, a number of scholars have contributed to debates on the character of the assemblages (as discussed later in this chapter).

| **site** | **country** | **~ age (MIS)** | **cores** | **blanks** | **chunks/chips** | **retouched** | **total** |
|---|---|---|---|---|---|---|---|
| JQ-1 lower | Saudi Arabia | Mixed | 39 | 276 | 68 | 21 | 404 |
| *JQ-1* upper | Saudi Arabia | ~75 ka (5a | 9 | 79 | 16 | 10 | 114 |
| *JQ-1* MIS 7 | Saudi Arabia | ~220 ka (7) | | 13 | 15 | | 28 |
| *JSM-1* | Saudi Arabia | MIS 5e/5c | 10 | 51 | 23 | 4 | 88 |
| *JKF-1* | Saudi Arabia | ~87ka (5a) | 99 | 815 | 298 | 10 | 1222 |
| *JKF-12* | Saudi Arabia | Unknown | 10 | 83 | 2 | 1 | 96 |
| *Porc Epic layer C* | Ethiopia | ~70-100 ka (5a) | 52 | 149 | 2 | 27 | 230 |
| *Porc Epic layer E*$^{+}$ | Ethiopia | ~70-199 ka (5a) | 41 | 164 | 9 | 52 | 266 |
| *1010-8** | Sudan | MIS 5a? | 12 | 114 | | 25 | 151 |
| Bir Sahara 1$^{+}$ | Egypt | 105 ka (5c) | | 204 | 89 | | 293 |
| *Tor Faraj, floor 1*$^{+}$ | Jordan | 55 ka (3) | 57 | 495 | 55 | 62 | 669 |
| *Warwasi NNOO* | Iran | MIS 3? | 54 | 387 | 123 | 36 | 600 |
| *Warwasi WW XX* | Iran | MIS 3? | 45 | 298 | 42 | 79 | 464 |
| *Mudayy As Sodh (TH 123-b) ** | Oman | MIS 5 | 125 | 283 | 2 | 25 | 435 |
| 201-60* | Saudi Arabia | Unknown | 9 | | | | 9 |
| 201-61* | Saudi Arabia | Unknown | 9 | | | | 9 |
| 210-165* | Saudi Arabia | Unknown | 8 | | | | 8 |
| 216-205* | Saudi Arabia | Unknown | 8 | | | | 8 |
| 217-42* | Saudi Arabia | Unknown | 6 | | | | 6 |
| 210-232* | Saudi Arabia | Unknown | 6 | | | | 6 |
| **total** | | | 599 | 3411 | 744 | 352 | 5106 |

Table 4.1. Basic information on the assemblages used in this study. Assemblages in italics are those which are employed in systematic, comparative analyses. See text below for more details. $^{+}$ representative sample, i.e. random sample of debitage, * - less representative sample.

### 4.2) Jubbah, northern Saudi Arabia

As the review of knowledge of the Arabian Middle Palaeolithic in Chapter 2 showed, recent developments in research have been focussed on southern Arabia. To understand dispersals into Arabia and demographic and other processes within Arabia, it was argued that interior and particularly northern Arabia was a critical and understudied area. For this reason two seasons of fieldwork were undertaken at the palaeolake of Jubbah in northern Saudi Arabia (see also Petraglia *et al.* 2011; 2012).

### 4.3) Jubbah background

Jubbah (or Jubba) is the name given to a traditionally small, although fast growing, village around 28.030 N, 40.940 E in the An Nafud desert, Ha'il province, northern Saudi Arabia. It is located some fifty kilometres into the An Nafud desert, whose name meaning 'the dunes', is an accurate indicator of the geography. Several large jebels (sandstone eminences) blocked the flow of sand and led to the formation of at least one palaeolake. The major palaeolake today stretches to the east of the village of Jubbah, while a further area to the southwest contained at least one further palaeolake which seems to have been considerably shallower than the main basin. The main Jubbah palaeolake measures at least twenty kilometres (east to west) and four kilometres wide (north to south), although the full extent of the lake is concealed by aeolian sand and so the precise dimensions of the lake are unclear. The major jebels which allowed the formation of the lake, particularly Jebel Umm Sanman just west of the village of Jubbah, consist of 'Saq' sandstone at their base and 'Tabuk' sandstone towards their peaks (Bramkamp *et al.* 1963). Although no water is present on the surface today, the author was told of flooding 25 years ago in which the whole population of Jubbah had to be temporarily relocated to Ha'il. Water is currently pumped up from deep wells, causing a rapid lowering of the water table.

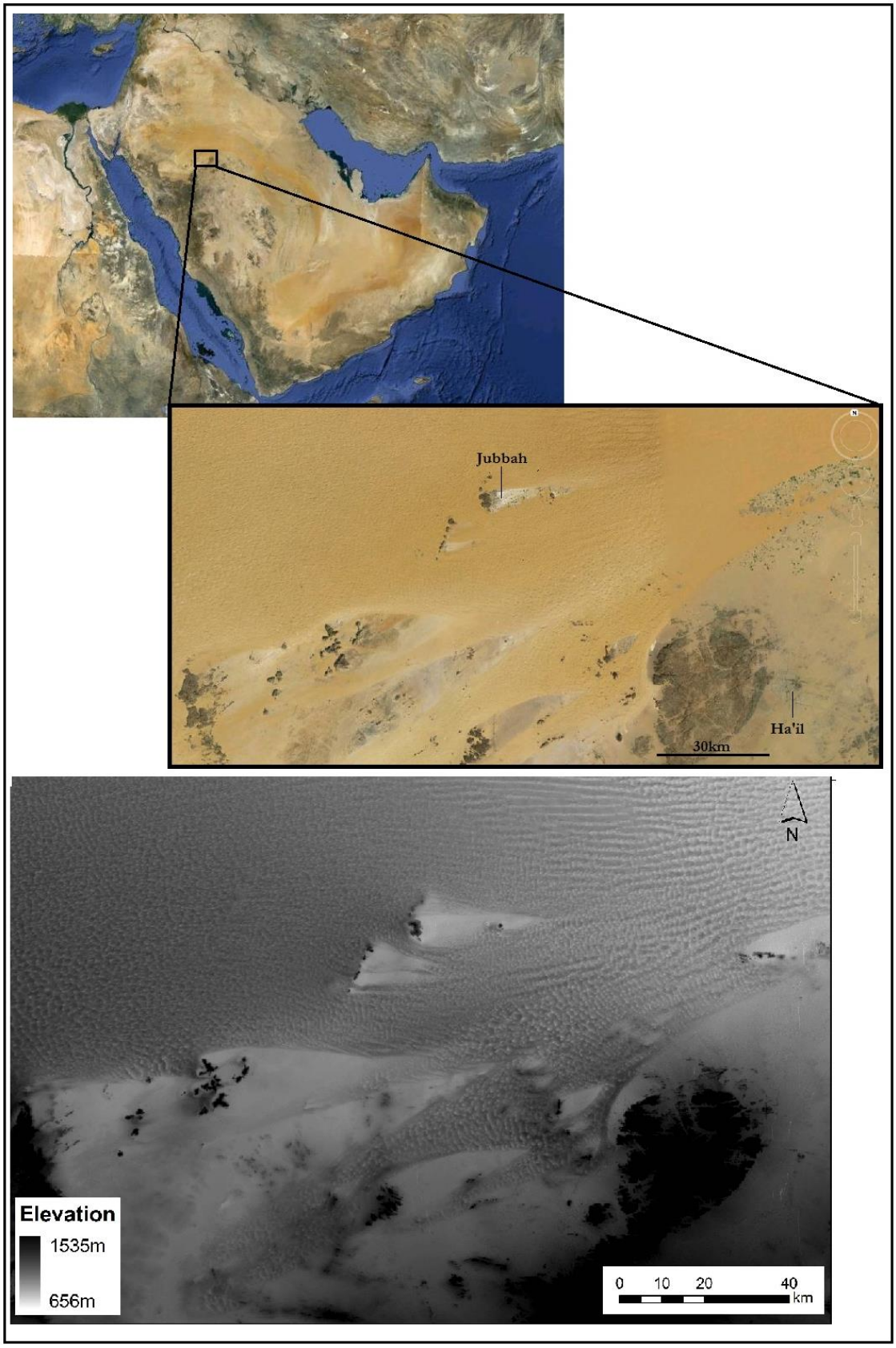



Figure 4.2. The location of Jubbah in northern Arabia. Top two satellite images courtesy of Google Earth. DEM courtesy of Dr. Richard Jennings.

**4.4) Previous archaeological research at Jubbah**

As an oasis and famous rock art locality (see Figure 4.3), Jubbah has long attracted visitors. Among the earliest recorded western explorers was Anne Blunt, the granddaughter of Lord Byron. In 1879 she passed through Jubbah, recognising the evidence for an ancient palaeolake. The geography and spectacular rock art led her to comment "Jubbah is one of the most curious places in the world, and to my mind one of the most beautiful". Since then a number of studies have addressed the rock art at Jubbah (e.g. Khan 1993).



Figure 4.3. A tracing of rock art from Jubbah. A 'rain deity?' (Modified from Khan 1993).

Modern investigations of the archaeological record at Jubbah developed with the Comprehensive Survey of the Kingdom, as described in Chapter 2. Adams *et al.* (1977) and Parr *et al.* (1978) rapidly visited Jubbah during the survey and gave initial reports of archaeological sites. More detailed work was undertaken by Andrew Garrard and colleagues (1981). This team spent less than a week at Jubbah, and their focus was not on the Palaeolithic. Most of their trip focussed on the environs of Jebel Umm Sanman, with a short trip to the easternmost jebel (Garrard, personal communication). Aside from rock art, sites reported by Garrard *et al.* (1981) were assigned on typological grounds to

the Neolithic and Middle Palaeolithic. Sites attributed to the latter, the 'Levallois-Mousterian' in the discoverers terms, were labelled 201-25a, 201-25b, and perhaps most importantly, a potential 'quarry' site near the summit of Jebel Umm Sanman (201-26a). Lithics at these sites were described as being manufactured using ferruginous sandstone and quartzite. No typologically Upper- or Epi-Palaeolithic sites were identified, with the Middle Palaeolithic seemingly being followed by a hiatus and then a Neolithic-Chalcolithic occupation.

In addition to these archaeological discoveries Garrard *et al.* (1981) conducted the first stratigraphic study at Jubbah. They describe seven major stratigraphic units, the differing sediments reflecting a repeated oscillation between humidity and aridity, with the highest and lowest units consisting of an organic rich palaeosol and a thick clay respectively (Figure 4.5). Between these humid related sediments are a range of sediment types, including evaporates and possible diatomites. More than twenty four metres of this sequence lies below a radiocarbon date of 25,630±430 BP (Q-3117), although the issues with such radiocarbon dates as raised in Chapter Two must be remembered.

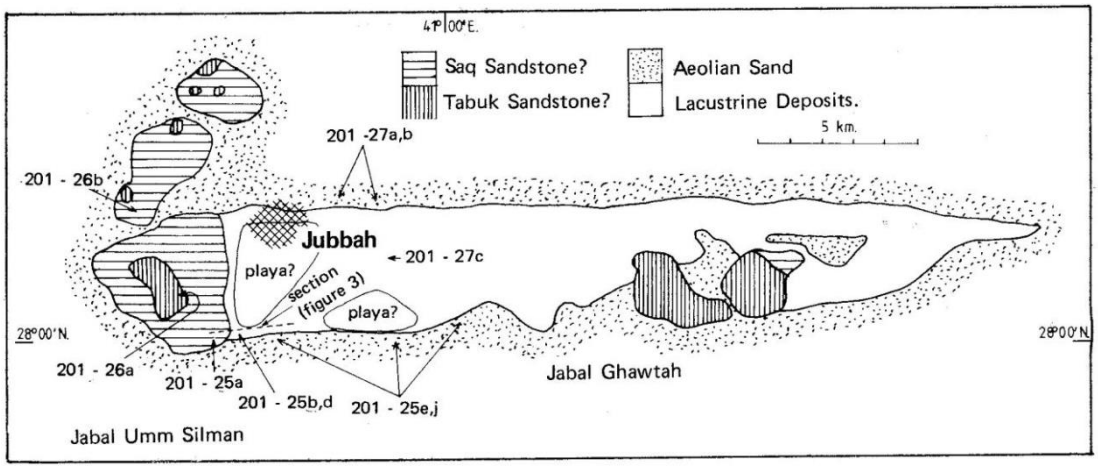


Figure 4.4. Archaeological sites identified at Jubbah in the late 1970's (modified from Garrard *et al.* 1981).

These preliminary observations of Jubbah revealed it to be a key locality for further research. The presence of thick lacustrine deposits may mean the preservation of *in situ* archaeological material, as well as the probability that ancient lakes were a significant aspect of Middle Palaeolithic hominins landscape and therefore somewhere more likely to preserve archaeological material than other areas. The presence of lacustrine deposits also allows for the chronometric dating and environmental contextualisation of hominin occupation. The depth of the sequence at Jubbah is

unique for a known palaeolake in northern Arabia, although a number of other Upper Pleistocene palaeolakes have been identified in northern Saudi Arabia (e.g. Whitney *et al.* 1983; Schultz and Whitney 1986).

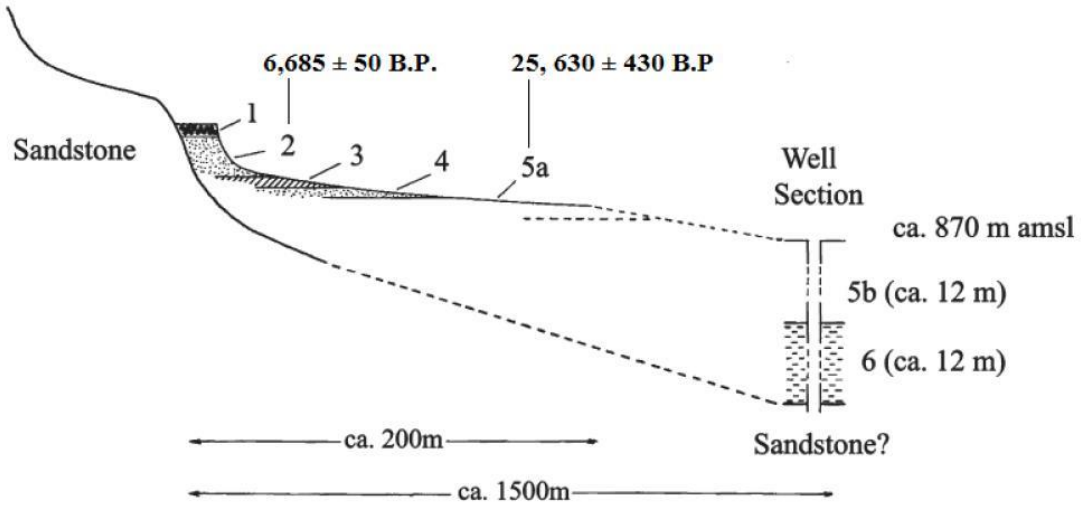



Figure 4.5. Garrard *et al.*'s summary of the sedimentary sequence at Jubbah (modified from Garrard *et al.* 1981).

The location of Jubbah in northern Arabia renders it in important in understanding the dispersal of hominin populations. Situated in a position where populations from the north might have passed, whether they had moved from Africa across the Sinai Peninsula or south from the Levant. In addition Jubbah's position near the highlands which extend down the whole western side of Arabia mean it could have been reached by populations moving from the south. The terrestrial position of Jubbah, more than 500km from the coast, gives it the potential to offer insights terrestrial dispersal routes, in contrast to fashionable 'coastal dispersal' hypotheses (e.g. Stringer 2000; Marean 2010), which rest on very limited evidence.

The above factors led to an interdisciplinary team, including the author, conducting fieldwork at Jubbah. Prior to this, no research on the Palaeolithic had been conducted here since the 1970's. The results of fieldwork conducted in 2010 and 2011 are discussed below (see also Petraglia *et al.* 2011; 2012).

### 4.5) Fieldwork results

Fieldwork was conducted at Jubbah in March 2010 and January 2011. The aims and discoveries of the interdisciplinary team were wide ranging, including surveys for rock art (Jennings *et al.* in press) through to research on the Palaeolithic. This thesis exclusively addresses the Middle Palaeolithic element, which was found to be very widespread at Jubbah.

Typologically Middle Palaeolithic lithics were observed at a number of localities at Jubbah (see Figure 4.6). In most cases these 'sites' consist of small scatters of debitage. Greater information comes from three excavated sites (JQ-1, JSM-1, JKF-1) and one surface area, JKF-12, which appears to have been the area from which raw materials were acquired for JKF-1. In addition a number of bifaces were identified on the surface in a lag deposit at 27°57'35.5, 40°49'31.3. This is the only locality at Jubbah to have so far produced bifaces in any number. These crude bifaces may either belong to the Middle Palaeolithic, or conceivably to an earlier period. Given the lack of possibility for *in situ* archaeology in the immediate area in which these bifaces were discovered in 2010, the locality was not revisited in 2011 when attention was focussed on excavation of the most promising sites. Information presented below focusses on JKF-12, JKF-1, JSM-1 and JQ-1.

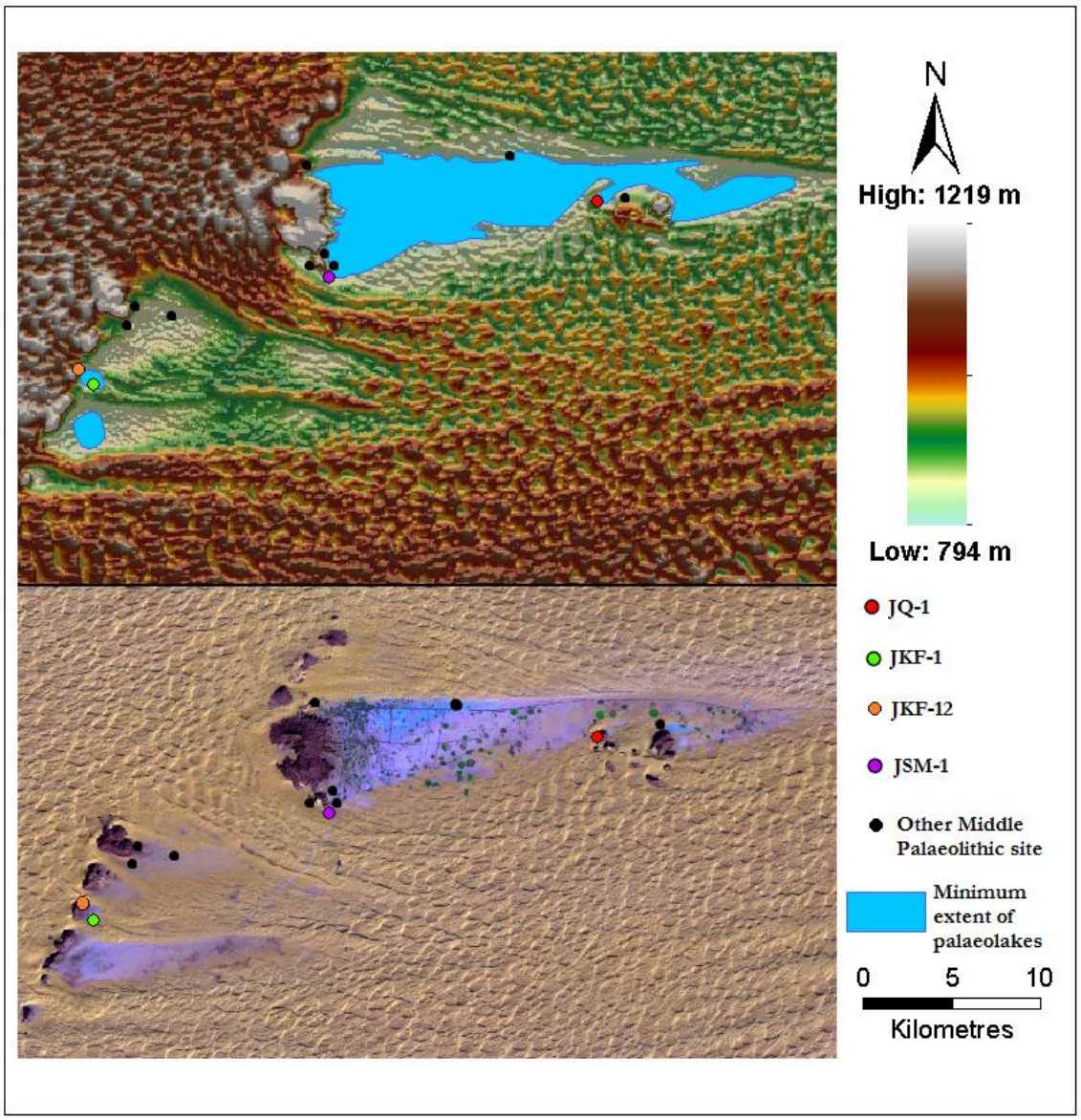



Figure 4.6. Digital elevation model and satellite image of Jubbah Palaeolake showing Middle Palaeolithic localities. Modified from Petraglia *et al.* (2012).



Figure 4.7. Images of important features in the Jubbah area. Clockwise from top left: (1) Rockshelter on SW side of Jebel Umm Sanman (photo by M. Petraglia), (2) Colluvial surface beneath a jebel containing Palaeolithic artefacts including bifaces, north of Jebel Katefeh, (3) putative palaeolake basin eroded to bedrock, north of Jebel Katefeh, (4). Stratigraphic section south of Jubbah village.

### 4.6) Jebel Qattar 1 (JQ-1)

JQ-1 (28°00'53.20 N, 41°03'35.94) was first identified in 2010, with further work conducted at the site in 2011. The sedimentary sequence at JQ-1 consists of a series of stratified units (Figure 4.8), alternating between aeolian sand units, indicating arid conditions, and palaeosols and calcretes associated with wetter conditions. A variety of proxies, including loss on ignition and phytolith analysis, correlate with the sediment types and OSL ages and associate the evidence for humid conditions with interglacial periods. More information of the stratigraphic sequence is provided in Petraglia *et al.* (2011; 2012). All OSL dating was performed by Richard Roberts (University of Wollongong) and sedimentary analysis by Adrian Parker (Oxford Brookes University).

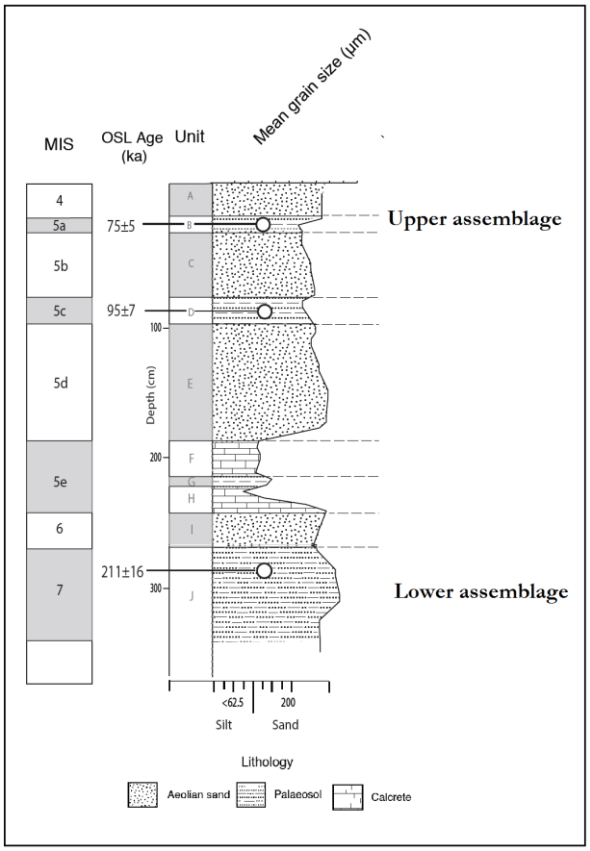



Figure 4.8. Stratigraphic log and archaeological associations at JQ-1. From Petraglia *et al.* (2012).

Firstly, the Upper Assemblage is found on the surface of Unit B (the 75 ka palaeosol), which is exposed as a terrace-like surface (see top photo in Figure 4.10), and on the surface immediately beneath this palaeosol. The artefacts are relatively fresh and are hypothesised to have eroded from the palaeosol. The palaeosol is not continuous beneath the dune, but several flakes were recovered

from a thin layer of orange/grey silty sand making the contact of the 5a palaeosol and the overlying sands. The upper assemblage (n=114) forms the comparative sample for JQ-1 used in this thesis.

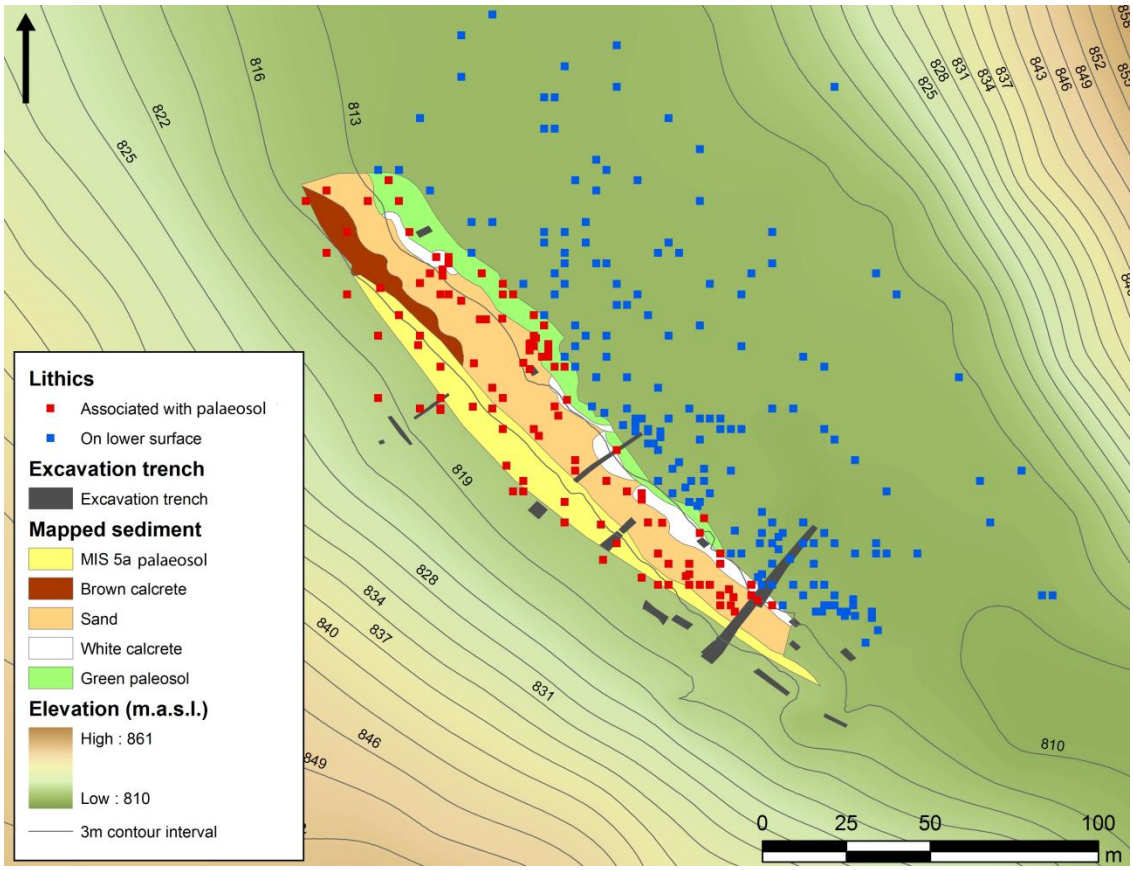



Figure 4.9. JQ-1 topographic survey, location of trenches and location of artefacts on the surface. It should be noted that much of the Upper Assemblage, associated with the MIS 5 palaeosol, was collected in 2010 and the locational information recorded using GPS. The plotted distribution then reflects the error range of this method (modified from Petraglia *et al.* 2012).

The second assemblage comes from the lower area of the site. Most of the assemblage is Middle Palaeolithic in character, but includes some younger artefacts. It is hypothesised that much of the assemblage has been washed down from the upper assemblage, but this is unclear so the upper assemblage is retained as a separate group, which although small is more likely to be chronologically homogenous. A total of 404 artefacts were collected from the lower area, consistsing of debitage (n=344), cores (n=39) and retouched pieces (n=21). The Middle Palaeolithic component is heavily Levallois and features similar characteristics to the upper assemblage. In addition, however, a large number of simple quartz pieces are present, which could be of almost any age, and flint is well represented. An example of the latter is the Neolithic arrowhead shown in Figure 4.12. Because the collection represents a mix of at least two episodes of occupation it has not been analysed in detail.




Figure 4.10. Scenes during excavation at JQ-1. Top = excavation of the interface between the MIS 5a palaeosol and the overlying (MIS 4?) aeolian dune sand (photograph M. Petraglia). Bottom = an example of the stratigraphy at the site (trench 2).

The final assemblage, termed here the Lower Assemblage, was excavated from the MIS 7 unit. The assemblage is very low density, with just 28 pieces of debitage recovered from several trenches. These, however, were found at a consistent stratigraphic position (see Figure 4.8). Due to the small size of the assemblage it is not included in the detailed comparative analysis of this thesis. Further fieldwork is planned to expand the sample size. The assemblage is dominated by flakes and chips/chunks. Most are in a fresh condition. Raw materials consist of quartzite (50%), quartz (18%), rhyolite (7%) and several flint like materials (25%). Most are very small flakes. Two pieces appear to show the use of Levallois technology. One, in particular, is a large and thick Levallois flake which has a faceted platform and was centripetally prepared. Unlike the other pieces this example is rather weathered.

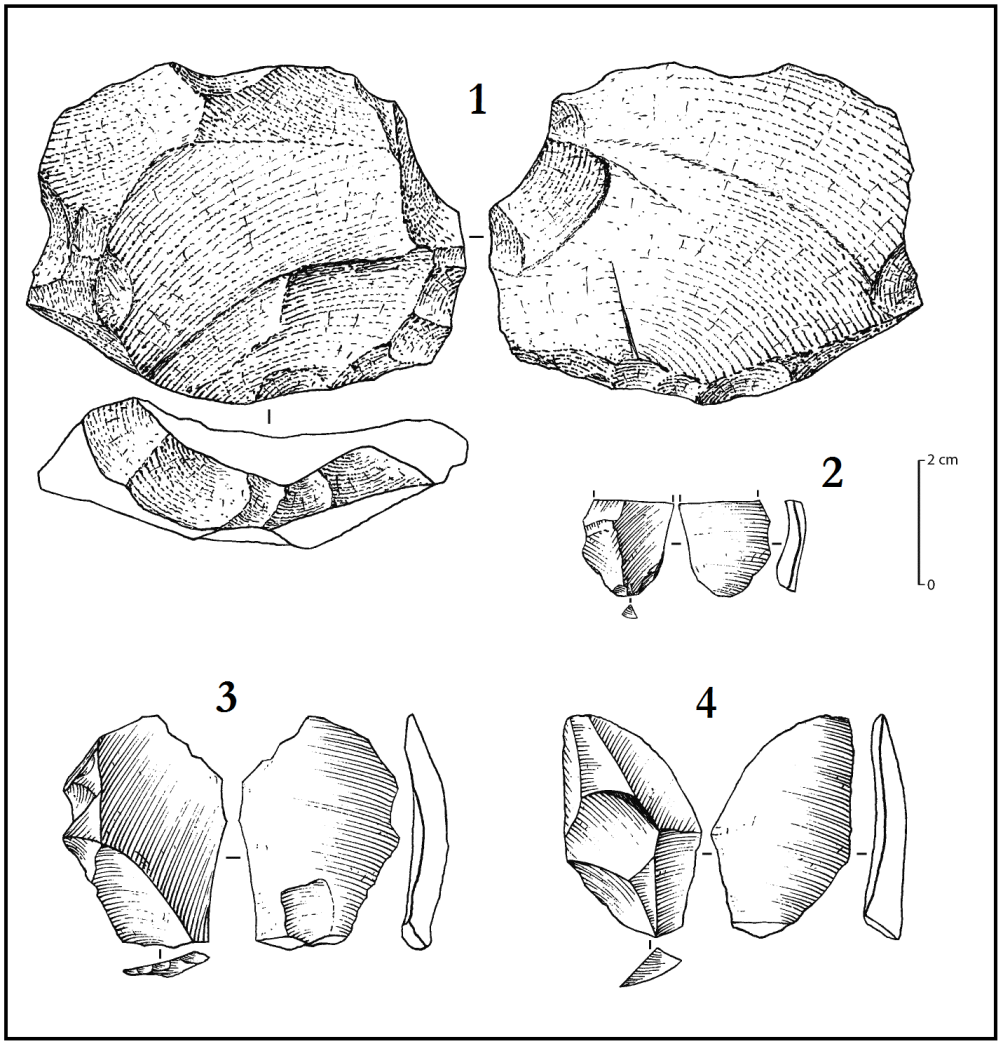



Figure 4.11. Illustrations of Flakes from the MIS 7 'Lower assemblage' at JQ-1. 1 = Levallois flake with faceted platform and centripetal preparation, 2-4 = 'normal flakes'. Illustrations by R. Crassard (modified from Petraglia *et al.* 2012).

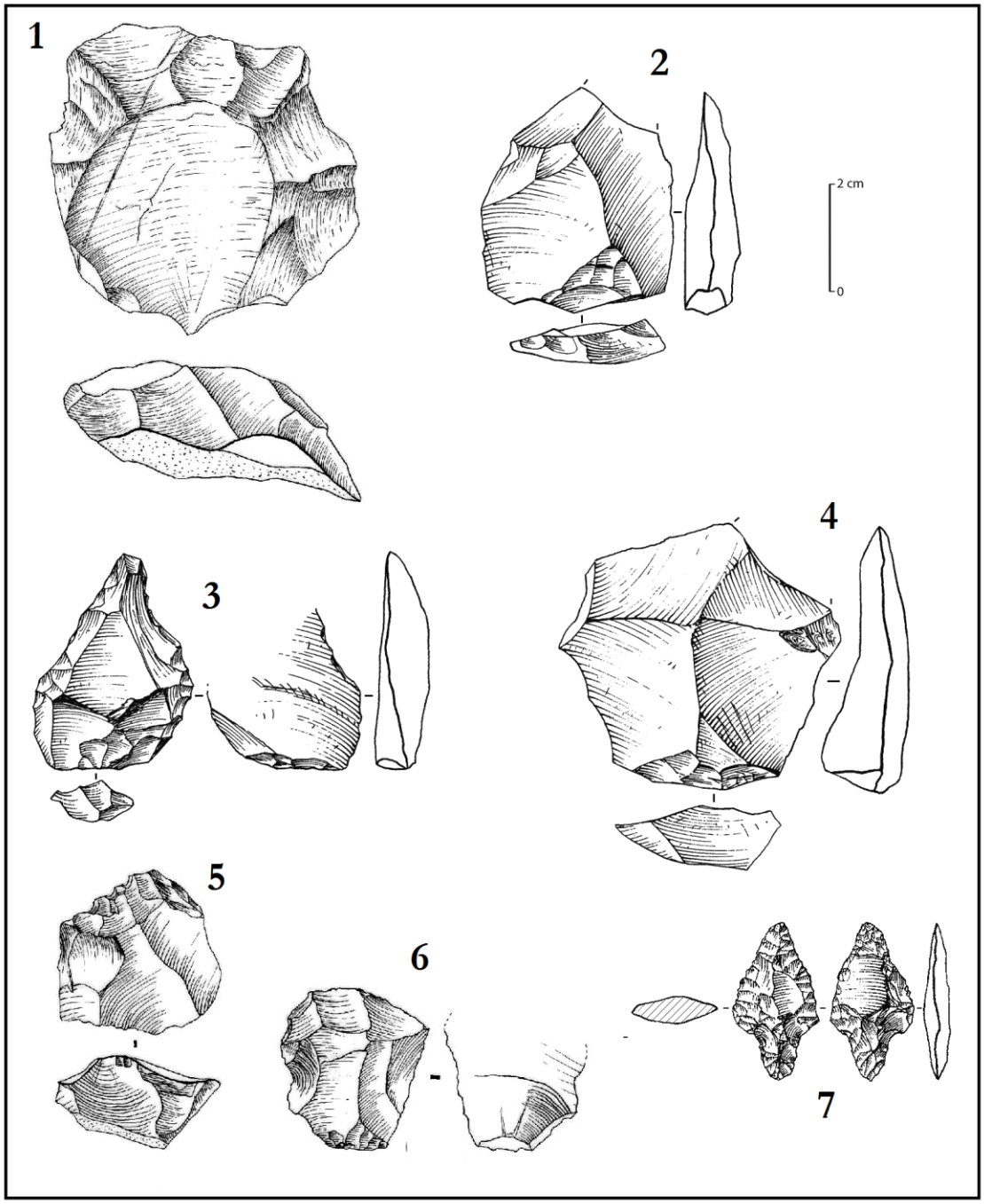



Figure 4.12. Ilustrations of Lithic artefacts from the lower surface area at JQ-1. Note mix of lithics of Middle Palaeolithic character (1-6) with a Neolithic arrowhead (7). 1 – preferential Levallois core with centripetal preparation, 2,4 – Levallois flakes, 3,5,6 – retouched flakes, 6 is notched, 7 – Neolithic flint arrowhead. Illustrations by R. Crassard (from Petraglia *et al.* 2011, 2012 and unpublished).

### 4.7) Raw material survey around Jebel Qattar and Jebel Gattar

A survey of raw material sources around Jebel Qattar and the neighbouring Jebel Gattar was conducted. This revealed that there are few sources of good quality material in the vicinity of JQ-1.

At the neighbouring 'JQ-A' and 'JQ-B' (JQ-A is 1 in Figure 4.13*)* two seams of low quality quartzitic sandstone were identified. Below them are a large number of fragments of the rock, but these are almost all small in size. The rock appears to naturally fracture into very small pieces.

Slightly to the north of this two localities were labelled JQ-D (2 in Figure 4.13, 28°00'50.0, 41°03'49.5) and JQ-E (28°00'51.3, 41°03'51.1). In both these cases two horizontally bedded seams of ferruginous quartzite were identified. Both are thin (~3-4 cm), but appear to be of relatively high quality. Both of these seams appear to have been knapped.

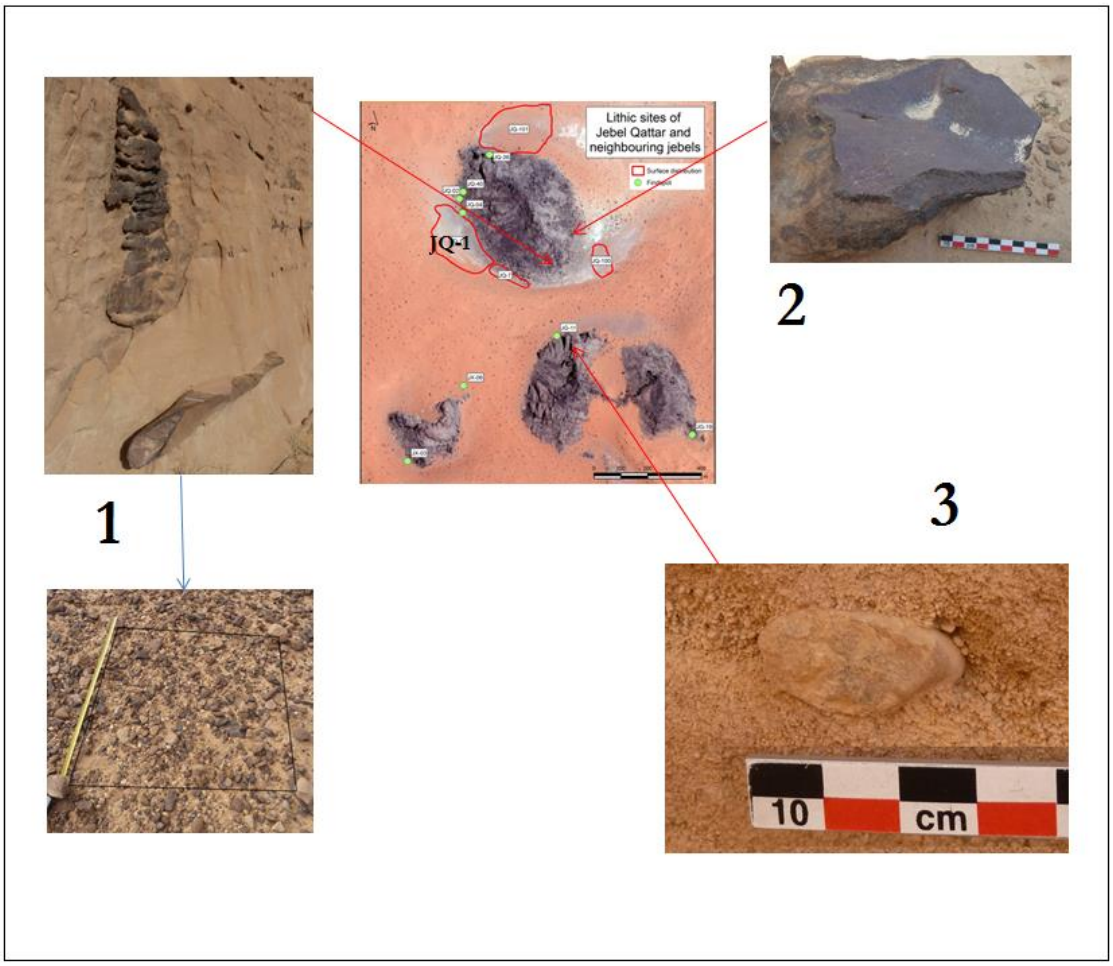



Figure 4.13. Key examples of raw material sources close to JQ-1. The raw material survey demonstrated that there are few good sources of raw material in the area of Jebel Qattar and Jebel Gattar.

In several places, such as 3 in Figure 4.13, pieces of quartz embedded in bedrock showed evidence of having being knapped. Typically these pieces are located beneath overhangs, so their breakage cannot be explained by something like falling rock. An interesting case was observed at 'JG-A' at the base of Jebel Gattar (28°00'42.9, 41°03'50.6). Here in the bedrock at the base of the jebel numerous small pieces of quartz, almost all less than 1cm in visible maximum dimension, are *in situ* in sandstone bedrock. The presence of many large holes around them may indicate where larger pieces of quartz had previously been present. If this is an accurate interpretation this would have been the closest observed source of reasonable sized quartz to JQ-1.

Additional sources of raw material in the past included quartzite boulders which fell from high up Jebel Qattar, which could not be reached for survey due its almost vertical sides, and from quartz pebbles which were likely widespread. Overall, however, the evidence clearly suggests relatively limited raw material availability in the vicinity of JQ-1. That several small and fairly low quality sources of raw material show signs of knapping indicates that they played a role in lithic reduction, but it is of course impossible to know when this took place.

### 4.8) Jebel Umm Sanman 1 (JSM-1)

The site of JSM-1 is located at the south-eastern corner of Jebel Umm Sanman (27°58'34.83 N, 40°55'28.28 E). A low density distribution of artefacts was identified on the surface of the site in 2010.

In the 2011 season two test units both 1 x 1 metres were excavated. Beneath a thin (<10cm) layer of aeolian sand and recent colluvium (stratum A) some 50-60cm centimetres of sediment were excavated before bedrock was reached. Two strata were identified. Stratum B consists of pink-grey sediment with Stratum C is more of a pale yellowish grey, containing weathered fragments of bedrock. Lithic artefacts were found throughout Stratum B and C with no obvious patterning or variation in density.

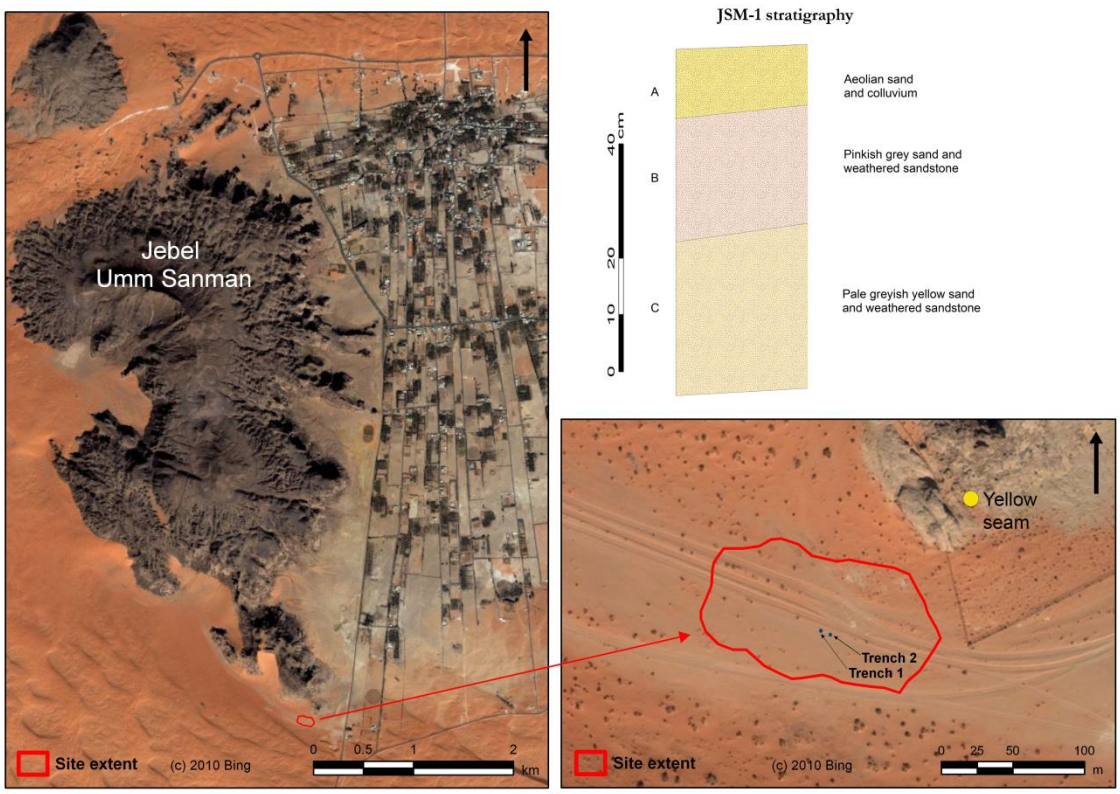



Figure 4.14. Location and stratigraphy of Jebel Umm Sanman 1 (modified from Petraglia *et al.* 2012).

Two sediment samples were taken for OSL dating (for more information see Petraglia *et al.* 2012). The first from 20cm beneath the surface (Stratum B, JSM1-OSL1) and the second from 42cm below the surface (Stratum C, JSM1-OSL2). A very low proportion of grains were suitable for OSL (~1%) and $D_e$ values were widely spread with high over-dispersion values. This is presumed to reflect the shallow depth of the sediments. In both samples two populations of grains are present. For Stratum B these yielded burial ages of 96± 9 ka and 42 ± 9 ka (a majority belonging to the former). For Stratum C burial age estimates are 140 ± 14 ka and 61 ± 8 ka. It is hypothesised that in each case the younger dates reflect intrusive grains from root action and bioturbation. Considering the colluvial context of the site it is hypothesised that the assemblage reflects a single phase of occupation corresponding to the early part of MIS 5.

Almost the entire lithic assemblage is manufactured on a fine grained yellow rock, which can be described as siliceous quartzite. A seam of this material was identified close to the site (see Figure 4.14). This rock type was not observed anywhere else in the Jubbah area.

**4.9) Jebel Katefeh 1 (JKF-1)**

JKF-1 (27°55'18.64 N, 40°48'18.14 E) was also first identified in 2010 and subsequently excavated in 2011. The site forms a notable mesa at the edge of a depression, some 800 metres east of Jebel Katefeh. Stratigraphically the site can be described as a mesa of aeolian sediments overlain by lacustrine sediments, with a single archaeological horizon between these units, and an upper calcrete deposit. Figures 4.16 and 4.17 show the stratigraphy of the site, further information is provided in Petraglia *et al.* (2012).

Almost 1000 artefacts on the surface, of a consistent Middle Palaeolithic character, were systematically piece plotted with a total station and collected for analysis. The artefacts begin around halfway up the mound and are spread downwards from this point. A trench was excavated from the top of the mound downwards and a single archaeological horizon (Stratum H) was intercepted which corresponds stratigraphically with the distribution of lithics on the surface. The surface and excavated material is therefore treated as a single assemblage in this study.

A number of OSL samples were taken (see Petraglia *et al.* 2012). As with JSM-1 the results appear to be affected by intrusive grains and the samples have two populations of grains in them. The results for samples from the artefact bearing Stratum H are, firstly (JKF1-OSL4) 87 ± 6 ka and 49 ± 5 ka and, secondly (JKF1-OSL3), 86 ± 11 ka and 53 ± 6 ka. The fact that, as with JSM-1, the younger population of grains correlates with MIS 3 is taken as indicating an increase in precipitation at this time leading to an increase in plant and animal activity. Bioturbation was observed at JKF-1 so the younger grains are hypothesised to be intrusive and the date of the human occupation to be ~87 ka.

Most of the raw material at JKF-1 consists of quartzite, which is hypothesised to largely come from the site of JKF-12 discussed below, and of quartz which was probably widely available as typically small pebbles having eroded from the bedrock.

Given the localised distribution of artefacts, the homogenous nature of the technology and the narrow distribution of lithics in stratum H, JKF-1 is interpreted as demonstrating a fairly short-lived

occupation. Initial studies have demonstrated the presence of refits and further refitting is planned once the excavation area has been extended.



Figure 4.15. Images of JKF-1 during excavation. Clockwise, 1) Initiation of excavation (photo M. Petraglia), 2) Excavator points to *in situ* artefact in stratum H (photo. M. Petraglia), 3.) trench late in excavation (photo R. Crassard).

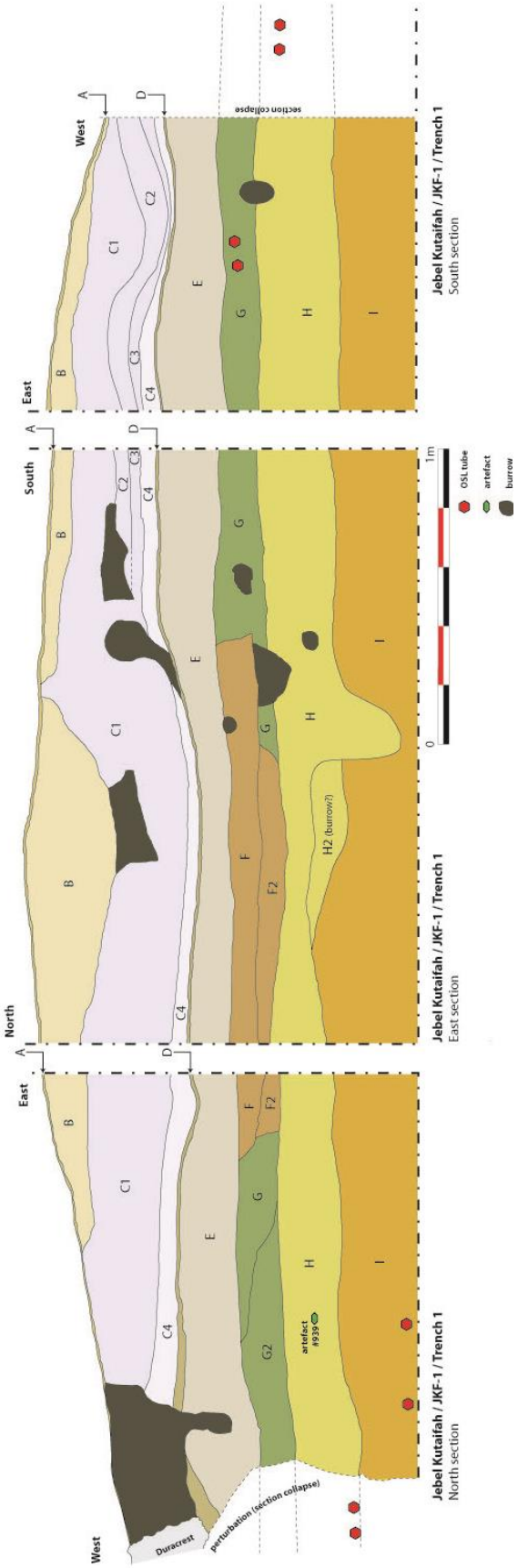



Figure 4.16. JKF-1 section diagram (modified from Petraglia *et al.* 2012).

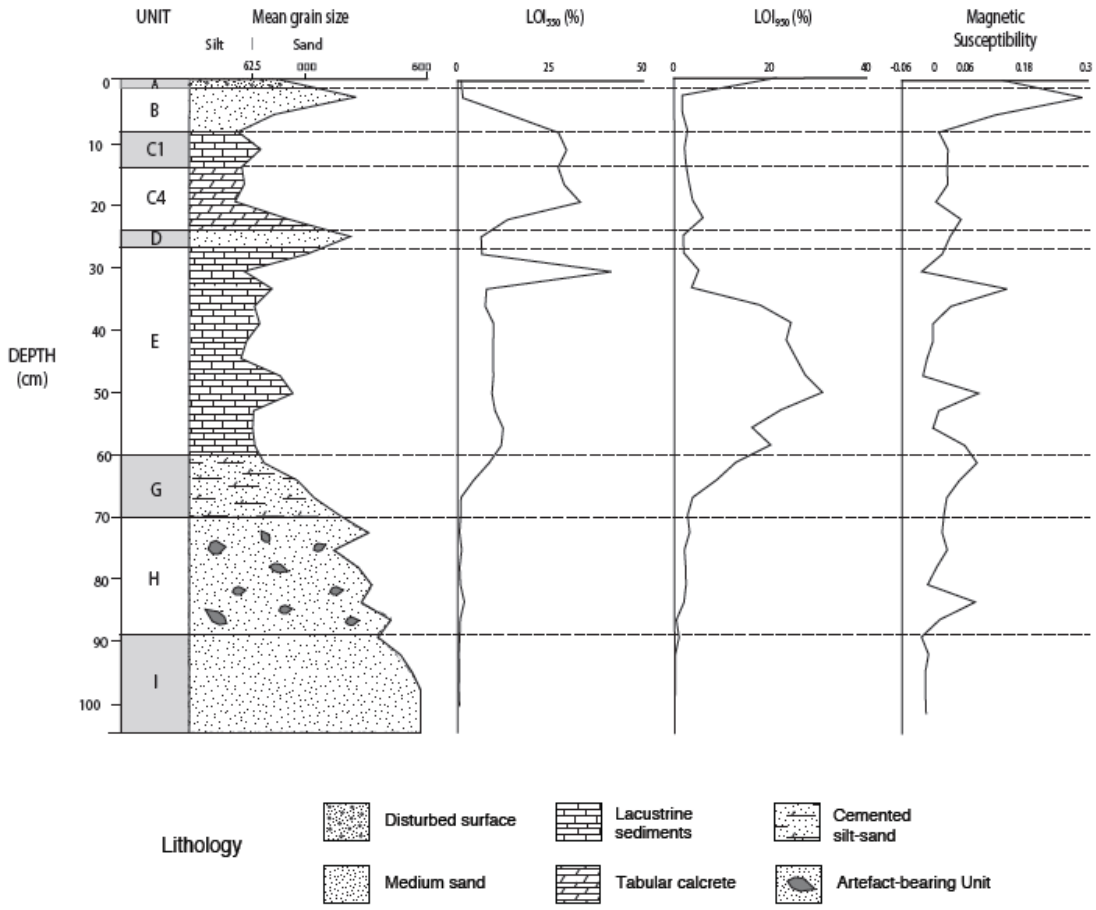



Figure 4.17. Stratigraphic log of JKF-1. Note position of the archaeological unit (Stratum H), modified from Petraglia *et al.* (2012).

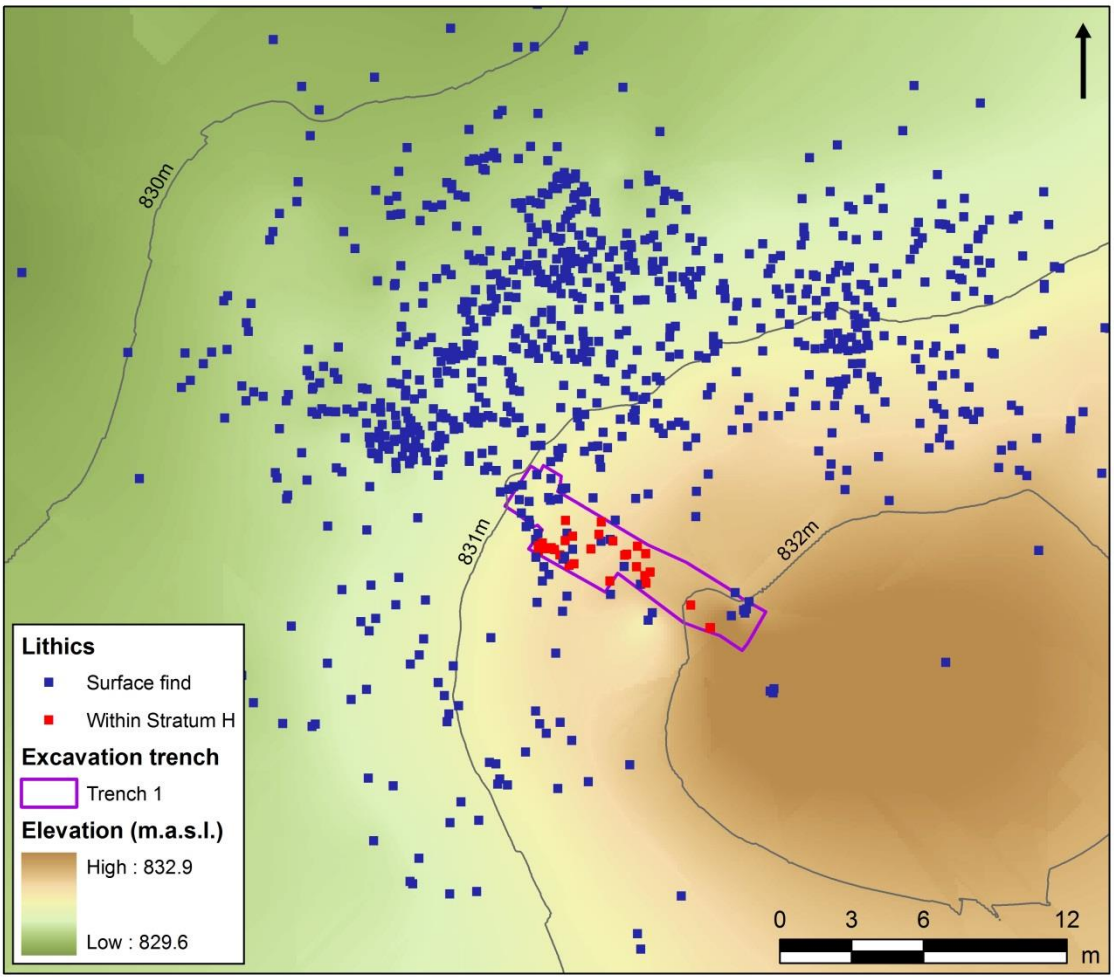



Figure 4.18. Topographic survey of JKF-1 and position of trench 1. From Petraglia *et al.* (2012).

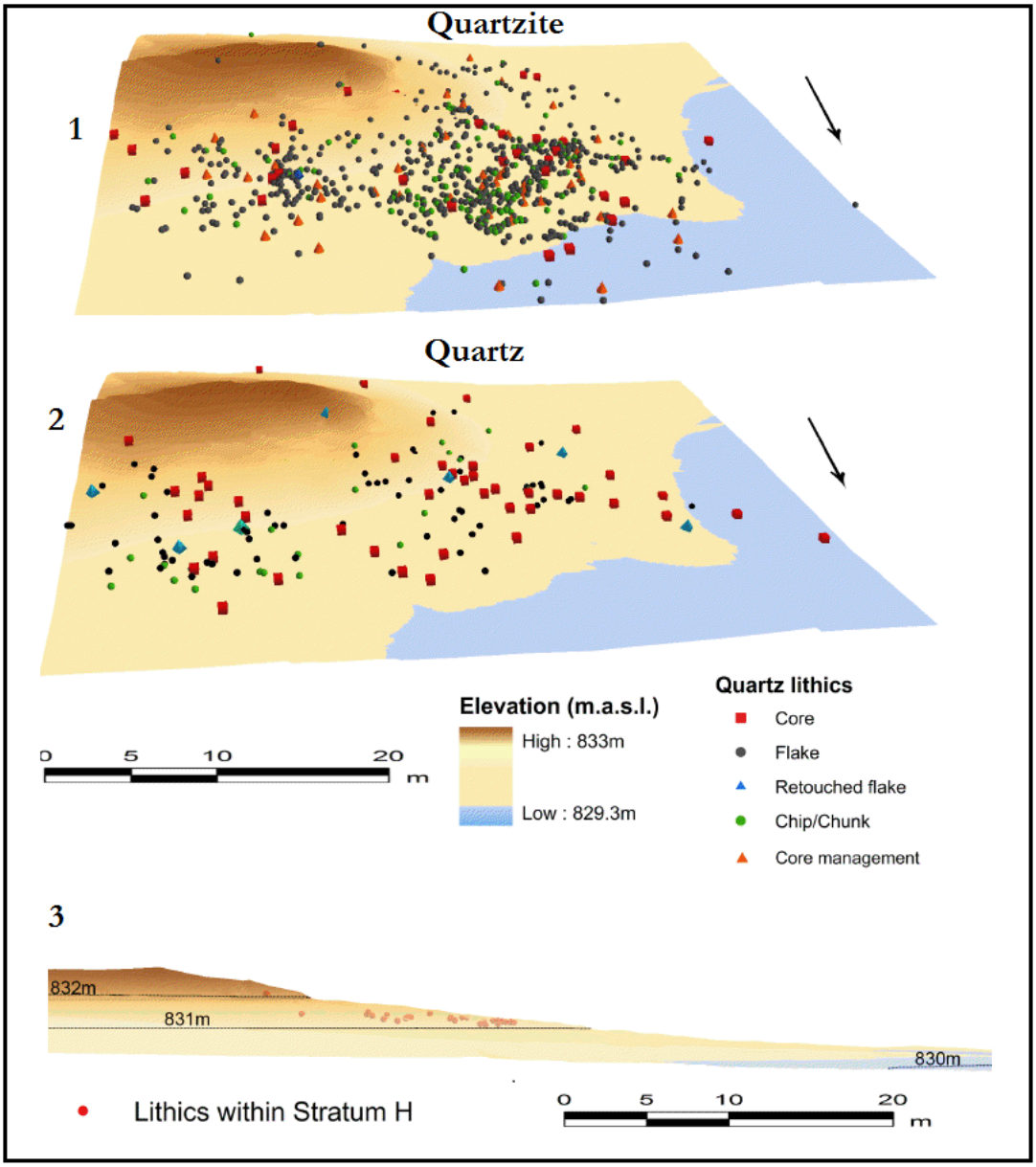



Figure 4.19. Distribution of artefacts at JKF-1 (figure courtesy of Dr. Richard Jennings). Note that in bottom plot, all artefacts occupy a narrow vertical range of stratum H. Only one lithic was found higher, perhaps reflecting burrowing.

### 4.10 Jebel Katefeh- 12 (JKF-12)

The final site from Jubbah to be analysed in detail is that of JKF-12. The site is located at the base of Jebel Katefeh (27°55'15.1 N, 40°48'05.9 E), some 800 metres west of JKF-1. The site is a surface collection of material interpreted as a raw material procurement area. A broad seam of reasonable quality quartzite is present (see Figure 4.20). A large amount of knapped lithic material was identified. A sample was collected by walking two transects through the site and collecting all knapped material encountered. This appears to have given a reasonably representative sample of the technology present. The assemblage appears homogenous and is hypothesised to be temporally related to the JKF-1 assemblage, although of course this must remain a hypothesis.



Figure 4.20. Photograph of the site of JKF-12. Note the large exposure of quartzite. This is very similar to the dominant raw material at JKF-1 (Photograph M. Petraglia).

### 4.11 Porc Epic, Ethiopia

Porc Epic is located close to the modern city of Dire Dawa, Ethiopia. Originally excavated in 1929 (Teilhard de Chardin 1930) and 1933 (Breuil *et al.* 1951), a pioneering project for the East African Middle Stone Age, it was subsequently re-excavated in 1974 (Clark and Williamson 1984) and extensively by Clark in 1975-76, although little has been published on the results of the latter work. Porc Epic, often described as a 'typical MSA' site (e.g. Clark 1988), here forms the sub-Saharan MSA sample for this study. As shown in Figure 4.21, the site is less than 400 kilometres from southern Arabia. The lithic material has been extensively studied by Pleurdeau (2003, 2004, 2005).

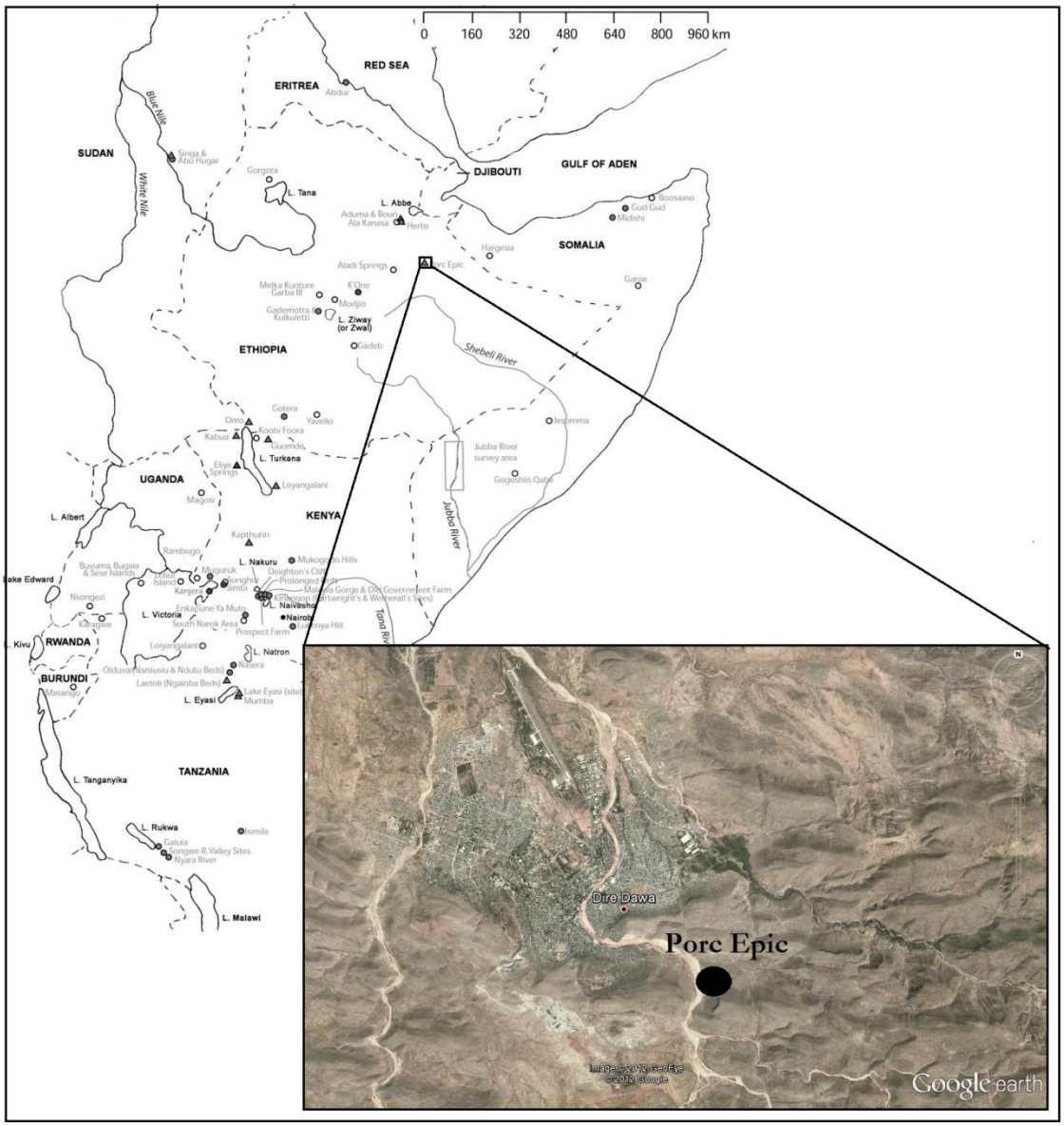



Figure 4.21. The location of Porc Epic in the context of the East African Middle Stone Age. Triangles and circles represent MSA sites (adapted from Basell 2008 inset figure, courtesy of Google Earth).

Figure 4.22 shows the plan of the cave and a stratigraphic profile along the 6 metre long trench excavated by Clark and Williamson (1984). The stratigraphy of the excavations from the early twentieth century is not clear, but the Harris matrix produced by Pleurdeau (2005, 181) for the more recent excavations shows the basic correspondence between the major stratigraphic units of the site. The material employed in the present study comes from the 1933 excavations. While imprecise information is available on the stratigraphy of these excavations, some significant points can be made. In 1998 a French team led by De Lumley revisited the site to examine the stratigraphy and obtain samples for absolute dating. They did not observe evidence for strong bioturbation (Pleurdeau 2005). In addition the Middle Stone Age assemblage was capped by a calcitic flowstone, except where this had been eroded near the entrance of the cave. The 1933 excavations proceeded by arbitrary 10cm spits. Given the above factors, it is reasonable to believe that each spit is therefore a relatively good sample. This will be addressed below by comparing Pleurdeau's summaries of the 1933 material and that of 3 squares from the 1974 excavation.

A lack of good chronological control has plagued the Middle Stone Age of East Africa, despite its central importance for the origin and dispersal of *Homo sapiens*. Porc Epic is no exception to this, as an examination of the literature suggests. For instance, Rose (2006) suggests that the site probably dates to MIS 5, with Pleurdeau (2005) also suggesting a minimum age of ~70ka, while Basell (2008) suggests it is either MIS 5 or MIS 4. Assefa prefers MIS 4 (Assefa 2002), or younger (Assefa 2006). A Late Pleistocene date for the Middle Stone Age of Porc Epic was suggested on the grounds of the character of faunal remains, although these had not at the time been studied in detail (e.g. Breuil *et al.* 1951; Vallois 1951; Howell 1978; Clark 1982). In the later twentieth century both chronometric age estimates and the results of detailed faunal analysis became available.

Efforts to date the MSA deposits have been made by radiocarbon dating and obsidian hydration. The former, represented by 3 samples of gastropod shell from depths of 170cm (Beta e 193517), 190cm (Beta e 193516) and 280cm (Beta e 193518) produced ages of 33,700±300, 35,600±250 and >43,000 respectively (Assefa 2006, 54). Although these are in the correct stratigraphic order, and are taken by Assefa as indicating that the site dates "generally to the Last Glaciation" (*ibid*), it is felt

by the present author that these dates are not reliable. These ages are near the limit for reliable radiocarbon dating, and no indication is given of the application of modern standards of pretreatment. The dates would be incongruous with other sources of information on the site, and on the regional Middle Stone Age.

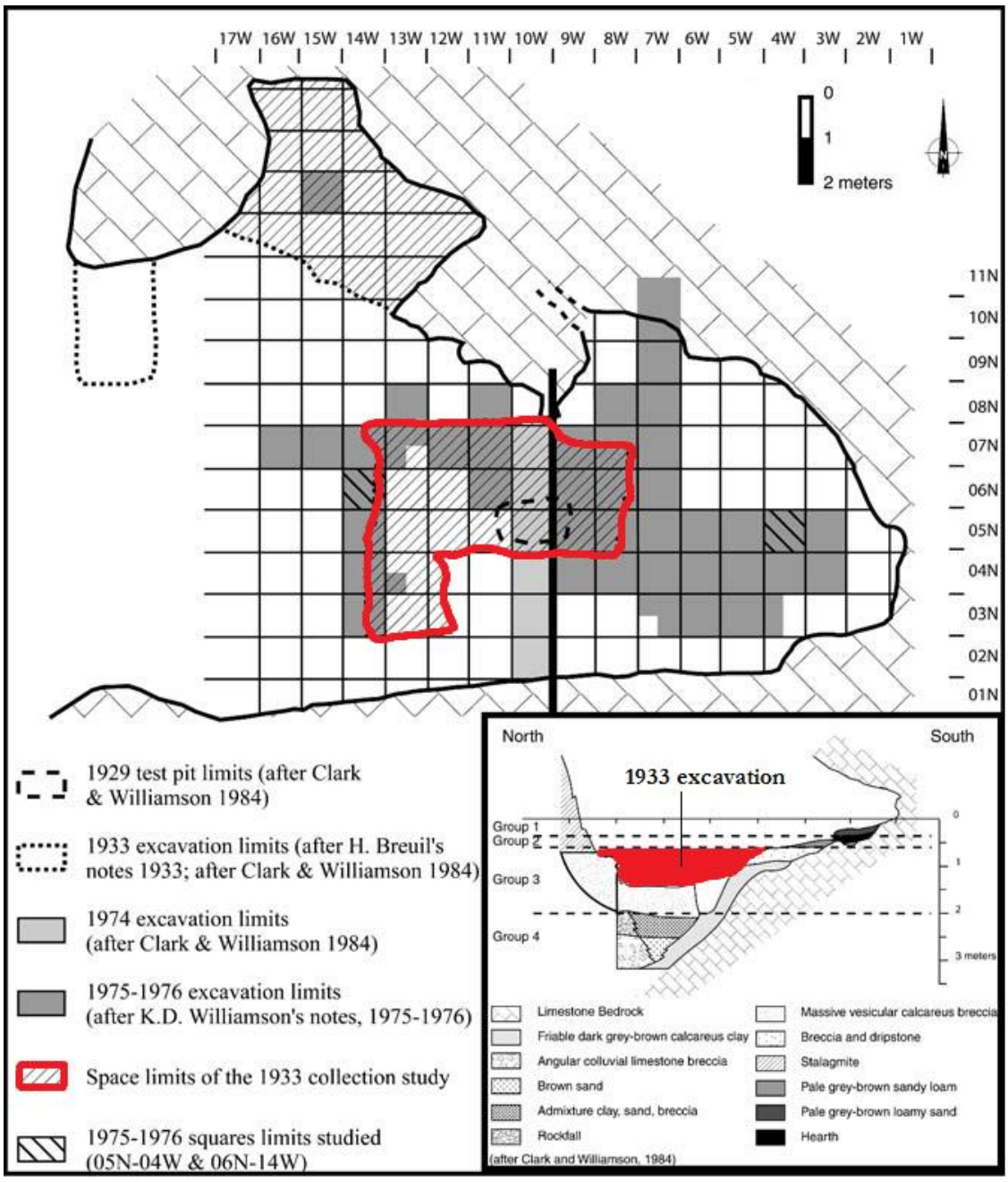



Figure 4.22. Plan of excavations and synthetic stratigraphic section at Porc Epic (modified from Clark and Williamson 1984 and Pleurdeau 2005).

The more commonly cited chronometric age estimates for Porc Epic take the form of obsidian hydration dates (Michels and Marean 1984). Three estimates were made from MSA artefacts from

the 1933 excavations, although no information is available on their exact stratigraphic provenance. The samples produced age estimates of 61,202 ka +/- 958 yrs, 61,640 ka +/- 1083 yrs, 77, 565 ka +/- 1575 yrs (Michels and Marean 1984). Critically, these estimates are temperature dependent, and the authors used the modern local temperatures for their calculations. As they acknowledge, given the generally lower global temperatures for tens of thousands of years before the Holocene, these ages are almost certainly underestimates (Michels and Marean 1984; Clark 1988). They note that "preliminary calculations would put the true age of the specimens 20,000 years earlier than the dates listed above" (*ibid*, 68). If we take this as a rough guide, then the obsidian hydration results can be taken as indicating the 1933 material, at the top of the Middle Stone Age deposits, dates to ~70-100 ka. This date around the end of MIS 5 would fit with other dated Middle Stone Age assemblages in East Africa (e.g. Yellen *et al.* 2005), although, of course, the only definite inference is that caution is needed, as are more absolute age estimates. Three recent radiocarbon estimates ranging from 34 to > 43 ka are reported by Assefa (2006). These are from shell and as the dates are from towards the earlier limits of radiocarbon they may be problematic.

Given the ambiguity of the obsidian hydration results, many issues with this technique have been raised, we can turn to other sources of evidence for support. Porc Epic has the largest recorded faunal assemblage for an East African Middle Stone Age site (Assefa 2002, 2006). Given the situation of the cave, either reached by a long scramble up a steep and loose slope or by climbing down a cliff, as well as the body parts represented and forms of surface modification, it appears that hominins were the main agents responsible for the accumulation of the faunal remains at the site. The kind of fauna found at the site can indicate the regional environmental setting during its occupation. Although Porc Epic demonstrates some contradictory patterns, with for example the presence of Grevy's Zebra perhaps indicating drier conditions than at present, it is notable that a number of species present indicate wetter conditions than those found in the area today (Assefa 2002; 2006, e.g. 112). The key taxa include buffalo and reduncines, both of which are dependent on perennial water sources. As a result Assefa (2002, 115), takes their presence as indicating that it must have been "much wetter" during the time of occupation. Today the rivers near Porc Epic are only seasonally active. While it may be possible that reduced temperatures in MIS 4 meant less

evaporation and therefore a greater availability of water. This might be taken as supporting an MIS 5 age for the Middle Stone Age occupation of the site.

The suggestion that no major changes appears to occur through the lithic sequence (Clark and Williamson 1984; Clark 1988; Pleurdeau 2004, 2005) might indicate a relatively short duration for the occupation of the site, perhaps at the level of a marine isotope stage. On the other hand the relative stability of lithic technology has been argued to be a common feature of the East African MSA (e.g. Wendorf and Schild 1974).

The lithic material from Porc Epic is stored in Paris (n= 4909 from the 1933 excavations) and Addis Ababa (1970's excavations). In the latter case, a huge amount of material awaits detailed study. The sample used for this study comes from the 1933 excavations. Pleurdeau (2004, 2005) studied all of the 1933 assemblage and 3 squares of the 1975/76 excavations. The latter were conducted to modern standards, with, for instance, sieving being applied. A simplified breakdown of the categories given by Pleurdeau (2005) is given in Table 4.2.

| **Simplified category** | **08N-07W** | **05N-04W** | **06N-14W** | **1933 excavation** |
|---|---|---|---|---|
| *flakes* | 1109 (40%) | 429 (40%) | 795 (19%) | 1308 (32%) |
| *blades/microblades* | 298 (11%) | 193 (18%) | 309 (7%) | 824 (20%) |
| *points* | 25 (1%) | 39 (4%) | 41 | 189 (5%) |
| *debitage products <20mm* | 431 (15%) | 234 (22%) | 1516 (37%) | 453 (11%) |
| *cores* | 67 (2%) | 42 (4%) | 10 | 207 (5%) |
| *'waste'* | 734 (26%) | 28 (3%) | 1291 (31%) | 414 (10%) |
| *scrapers* | 35 (1%) | 22 (2%) | 15 | 144 (3%) |
| *denticulates* | 10 | 3 | 2 | 17 |
| *notches* | 1 | 3 | 0 | 38 |
| *end-scrapers* | 5 | 1 | 1 | 8 |
| *backed tools* | 0 | 1 | 3 | 25 |
| *retouched points* | 11 | 36 (3%) | 22 | 354 (9%) |
| *other retouched* | 12 | 17 (2%) | 7 | 129 (3%) |
| *Misc.* | 46 (2%) | 14 (1%) | 104 (3%) | 6 |
| ***Total*** | 2784 | 1062 | 4121 | 4116 |

Table 4.2. Typological breakdown of Porc Epic samples studied by Pleurdeau (2005). 3 squares from 1975/6 excavations compared to results of 1933 excavations. (number of lithics and % of total for square in brackets).

The major categories – i.e. those making up more than 1% of each sample – are shown in graphical format in Figure 4.23. The proportions of major artefact categories appear to show that the 1933 excavation material is fairly representative. The fact that ~75% of the 1933 collection consists of unretouched debitage indicates the excavation was not strongly selective. There appears to be some bias towards larger material (i.e. cores) and against smaller material (i.e. debitage less than 20mm in maximum dimension) in the 1933 assemblage, but not particularly dramatically so. In the categories of 'flakes' and 'waste' the 1933 material falls *within* the variability seen between the 1975/76 squares.

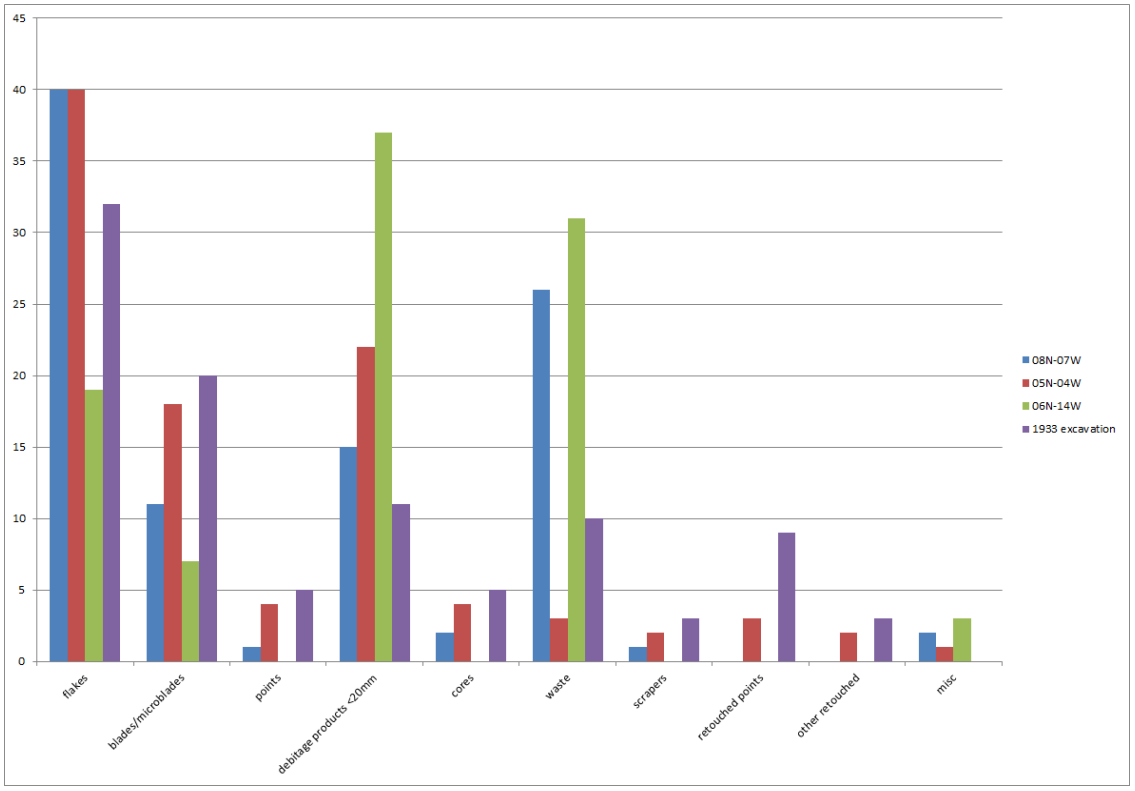



Figure 4.23. Comparison of the percentages of major categories (>1%) of lithic artefacts at Porc Epic (data from Pleurdeau 2005)

Figure 4.24 compares the proportions of points and retouched lithics. To compensate for the large differences in artefact density, each category is shown as a percentage of the "tools" for that sample. As with the previous figure, this appears to show that the 1933 assemblage is reasonably representative. Retouched points, a visually obvious and aesthetically pleasing category are over represented, but in the case of points, scrapers and denticulates the 1933 material again falls within the variability of the 1970s excavations. While the excavation of the 1933 spoil heap revealed a large

amount of material, this does not appear to have been particularly selectively biased. Clark and Williamson (1984) found this material matched the proportions produced by their own excavations.

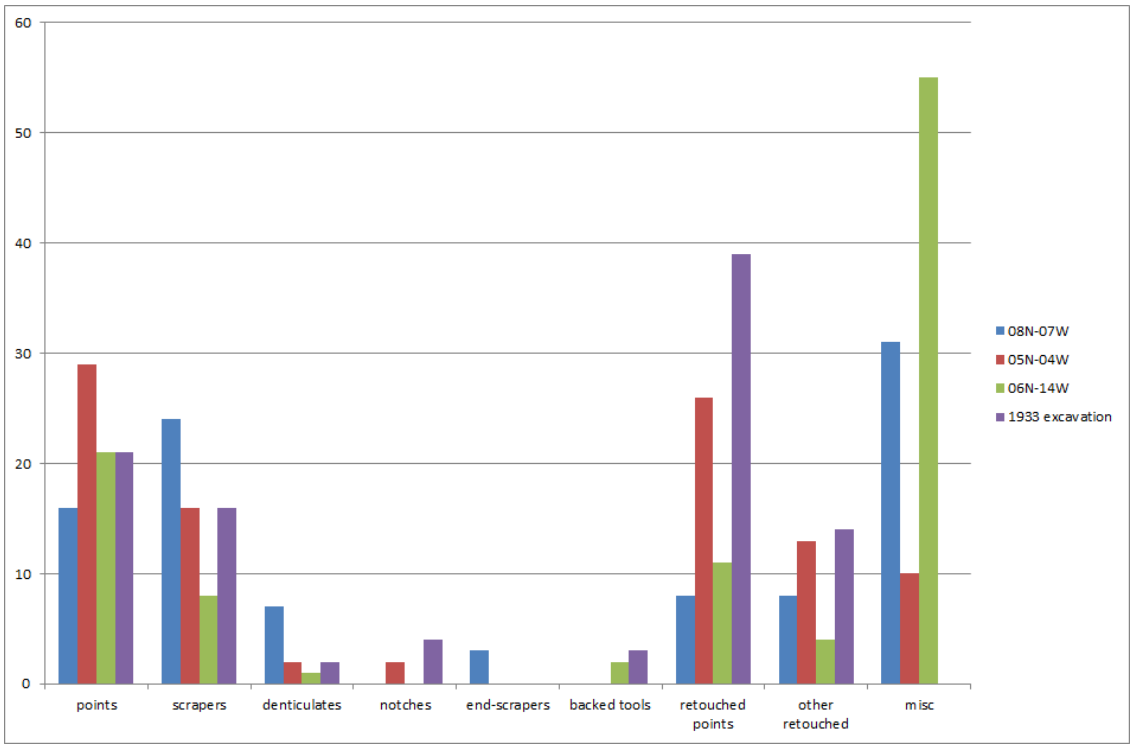



Figure 4.24. Comparison of points and retouched lithics for 3 squares of 1975/76 and 1933 excavations of Porc Epic (data from Pleurdeau 2005). Percentage are of the total points + retouched for that square/category.

Clark and Williamson (1984) report of their 1974 excavation of a 6 x 1 metre test trench at Porc Epic. They found raw materials to consist of around 80% chert, which occurs locally, 8% basalt, 5.5% obsidian, 2% quartz and small amounst of 'oolitic cemented sandstone', limestone and quartzite. They did not observe any obvious trends in changes to raw material use through time, with the possible exception of quartz, most of which was found in one small area. Likewise, they did not observe evidence for technological change through time. For instance, point lengths remained constant. On the other hand, a weak trend towards a reduction in width/length for points may be observed, but this was based upon a small sample size.

Pleurdeau (2004) found raw materials to occur in somewhat different proportions to that reported by Clark and Williamson (1984), with flint at 69%, basalt at 17%, obsidian (8%) and sandstone/quartzite (3%). The complexity of the raw material economy is demonstrated by the

presence of at least ten varieties of flint at the site (Pleurdeau 2005). Based on the lack of cortex in the assemblage, Pleurdeau suggests that most raw material was decortified elsewhere.

To Pleurdeau (2003, 2004, 2005) there are four main *chaîne opératoires* present in the MSA at Porc Epic, which are present throughout the sequence. The most common is Levallois-like. The second '*schéma opératoire'* reflects discoidal-like reduction. The third scheme is somewhere between Levallois and volumetric-blade reduction. In the upper levels of the stratigraphy, cores demonstrate something similar to the Halfan method found in the Nile Valley (Marks 1968a). The final scheme is more strictly blade/microblade.

In terms of the retouched component, Pleurdeau highlights that it is well represented (at 17% of his sample), but covers a restricted range of types. Points are particularly important. Pleurdeau follows Perlès (1974) typological scheme for points, employing twenty categories. Such a scheme faces the problems of all typological schemes (see chapter 3). Points occur in a variety of shapes (Pleurdeau 2004, 170). For unifacial points these are oval (18%), triangular (22%) and elongated triangular (19%). Bifacial points are oval (44%), triangular (17%) and elongated triangular (22%). Indeterminate point types are 75% triangular and 25% 'strangled'. It is also significant that small 'backed' pieces are present throughout the MSA sequence.

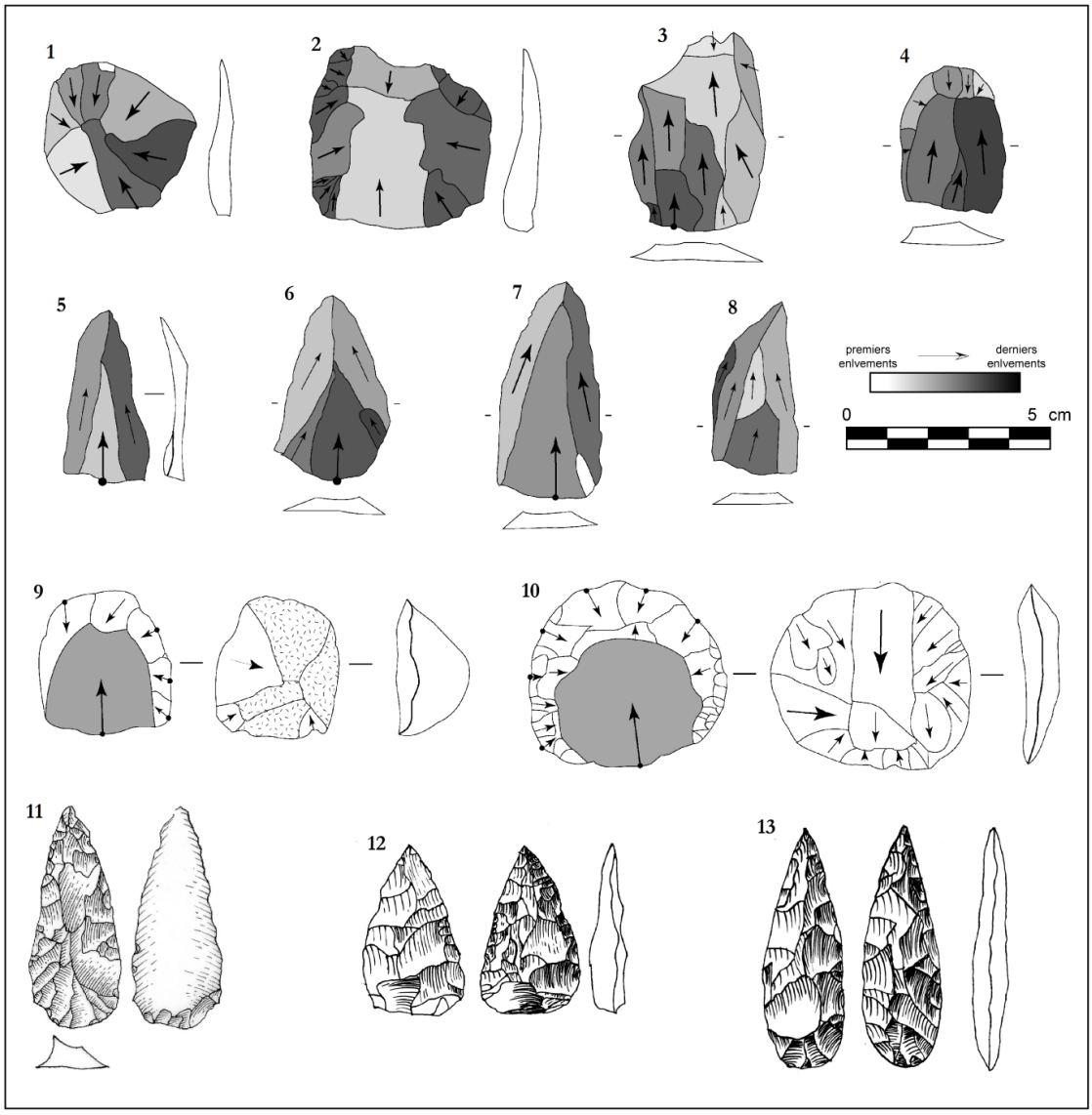



Figure 4.25. Illustrations of selected lithics from Porc Epic (modified from Pleurdeau 2004). 1-2 = preferential Levallois flakes, 3-4 = Levallois flakes from a recurrent method, 5-8 = Levallois points, 9-10 = Levallois cores with centripetal preparation and preferential removal, 11-13 = retouched points.

Space prevents a thorough discussion of the context of Porc Epic in the East African Middle Stone Age but the reader is directed towards Clark (1988), McBrearty and Brooks (2000), Yellen *et al.* (2005) and Shea (2008). The spatial and temporal variability of the MSA remains poorly understood, but it appears that Porc Epic is a broadly typical example of the later MSA.

For the present thesis two layers were chosen: C (0.20 to 0.30 metres depth) and E (0.45 to 0.60 metres). All lithic material from C was analysed, while all cores, retouched pieces and a random sample of debitage from E were studied. An important factor in making this choice was that these assemblages have relatively large numbers of lithics compared to other layers.

**4.12) 1010-8, Sudan**

The site of 1010-8 in located in northern Sudan, some 9 km south of the border with Egypt and 10km east of the River Nile. It occurs in an area with a rich Palaeolithic archaeological record, primarily recovered by the Combined Prehistoric Expedition in response to the flooding of the area due to the construction of a dam at Aswan in southern Egypt (papers in Wendorf 1968). As shown in Figure 4.26, 1010-8 is found in proximity to a number of other important Middle Palaeolithic sites.

1010-8 consists of an assemblage of lithics located on the narrow 'finger' of an inselberg. This particular site was chosen for the present study as this position on a narrow spit of the inselberg, measuring less than 8 by 4 metres in size, bounded by cliffs on three sides, which suggested to the discovers "almost entirely ruled out any mixing of assemblages" (Marks 1968a, 216). The lithics densely covered the site and were initially collected from a $2m^2$ area, with a subsequent area of $4m^2$ then collected for 'tools'. The lithics were collected from the surface and in a 'light tan surficial layer' up to 4cm deep (*ibid*). This latter factor explains the well preserved state of the assemblage. All artefacts were produced from a fine grained ferruginous quartzite, which was available immediately next to the collection area (see inset to Figure 4.26).

| **Type** | **Number** |
|---|---|
| Flakes | 175 |
| Chips/debris/waste flakes | 99 |
| Levallois cores (non-Nubian) | 8 |
| Nubian type 1 cores | 2 |
| Other cores | 7 |
| Levallois flakes | 28 |
| Levallois points | 1 |
| Pseudo-Levallois points | 2 |
| Side-scrapers | 22 |
| End-scrapers | 13 |
| Burins | 3 |
| Borers | 10 |
| Truncated pieces | 13 |
| Notches/denticulates | 39 |
| Other 'tools' | 31 |

Table 4.3. Typological structure of 1010-8, after Marks (1968a).

Table 4.3 gives a simplified description of the typology of the assemblage (Marks 1968a). The most common core type, aside from 'unidentifiable', are Levallois flake cores. Other types present are

described as two Nubian type 1 cores. Retouched blanks are common, particularly various types of 'side-scrapers' and forms of notched lithic. To Marks this suggested that 1010-8 was a 'living area', and not primarily a workshop/raw material procurement area (Marks 1968a, 284).

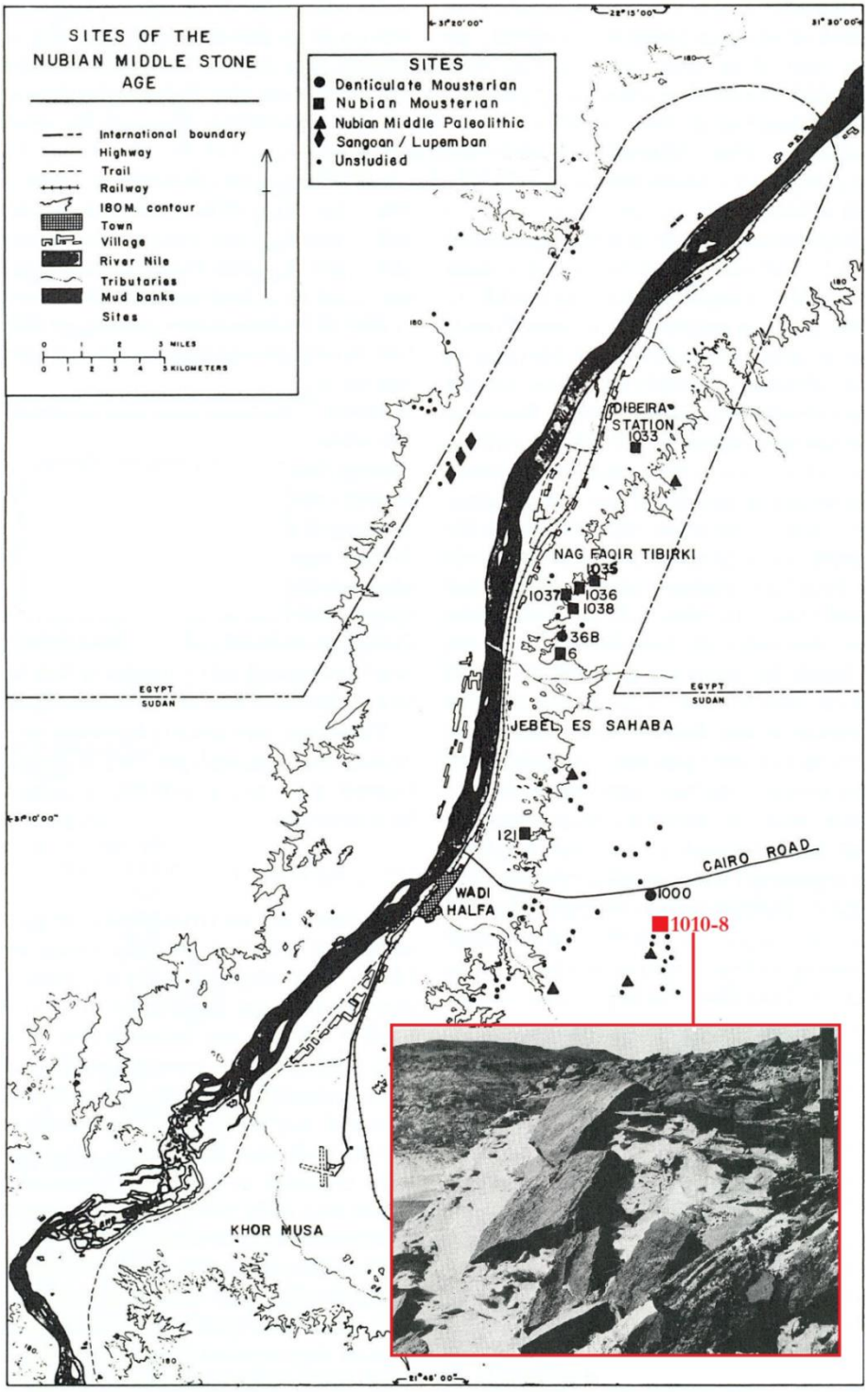



Figure 4.26. The location of 1010-8 near the Nile at the border between Egypt and Sudan. Inset shows naturally occurring slabs of ferruginous quartzite at 1010-8, the material used to manufacture the assemblage (modified from Marks 1968a).

To situate 1010-8 within other Middle Palaeolithic ('Mousterian') sites in the immediate area, a number of indices were compiled from Marks (1968a). There are shown in Table 4.4 and Figure 4.27. Criticisms of these Bordesian indices can be made, but they are helpful to give an overview into the approximate typological and technological variability of the various assemblages and therefore to assess how typical 1010-8 is.

| | Site | Levallois Index (IL) | Index of Faceting (IF) | Restricted Faceting Index(Ifs) | Blade Index (Ilame) | Side scraper Index (IR) | Biface Index (IB) |
|---|---|---|---|---|---|---|---|
| **Denticulate Mousterian** | ***1000*** | 14.3 | 49.7 | 27.3 | 13.9 | 6 | 0 |
| | ***36B*** | 11.6 | 33.6 | 20.6 | 11.6 | 13.3 | 0 |
| **Nubian Mousterian Type A** | ***1010-8*** | 25.4 | 30.8 | 21.8 | 3.5 | 12.7 | 0 |
| | ***1035*** | 21.7 | 69.3 | 38.6 | 7.8 | 10.1 | 0 |
| | ***1036*** | 4.9 | 52.6 | 25.6 | 3.2 | 21.6 | 0 |
| | ***1037*** | 11.6 | 43 | 15.4 | 6 | 19.8 | 0 |
| | ***1038*** | 18.7 | 54.1 | 30.1 | 11 | 13.2 | 0 |
| | ***1033U*** | 7 | 46.8 | 17.9 | 9.5 | 11.2 | 0 |
| | ***1033L*** | 8.3 | 43.7 | 15.2 | 12.7 | 8 | 0 |
| **Nubian Mousterian Type B** | ***6*** | 6.3 | 44.1 | 32.8 | 10.5 | 16.3 | 3.3 |
| | ***121*** | 7.9 | 38.9 | 22.9 | 6.9 | 17.3 | 0.7 |

Table 4.4. Technological and typological indices of 1010-8 and nearby Middle Palaeolithic sites (after Marks 1968a).

As Table 4.4 and figure 4.27 show, 1010-8 has a similar structure to other assemblages in the area. Although it has the lowest Index of Faceting of all the sites, much of this is made up of dihedral platforms, so for the Restricted Index of Faceting 1010-8 is about midway in the range of variability. In terms of the typological indices, 1010-8 again falls at about midway. In as far as can be seen from these indices then, 1010-8 is a typical site for this region and therefore it makes a good sample. It is apparently rather more 'Levallois' than some of the other sites, but not dramatically and it is unclear what this might mean.

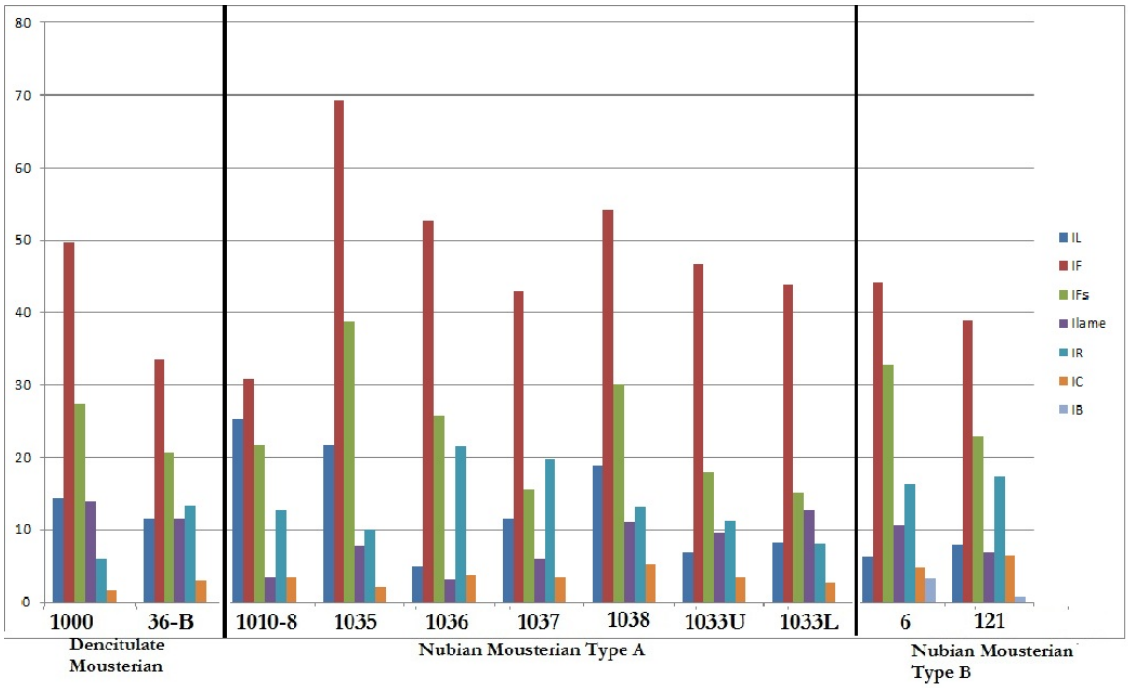



Figure 4.27. Technological and typological indices of 1010-8 and nearby Middle Palaeolithic sites (after Marks 1968a).

As with the typological and technological indices above, Table 4.5 and Figure 4.28 below show that there are both similarities and differences in the core technology of these Nubian Complex assemblages. Overall, they are dominated by Levallois cores of various forms. In most cases 1010-8 falls in the mid-range for core types. The exceptions are its high percentages of para-Levallois and Nubian type 1 cores, but with such small sample sizes this may not be significant. Likewise, in other areas of variability, such as size of blanks and retouched bool, 1010-8 falls within at around the midpoint of variability (Marks 1968a, 294-295).

| Site | Levallois blade | Levallois Flake | Levallois point | Para Levallois | Nubian Type 1 | Nubian Type 2 | Marginal | Discoidal |
|---|---|---|---|---|---|---|---|---|
| **1033L** | 10.1 | 53.1 | 5.0 | 1.3 | 0.0 | 0.0 | 12.6 | 3.8 |
| **1033U** | 7.5 | 37.5 | 1.5 | 3.0 | 0.0 | 0.0 | 21.0 | 6.0 |
| **1035** | 1.4 | 38.4 | 2.9 | 5.0 | 21.0 | 2.1 | 2.1 | 3.6 |
| **1038** | 4.8 | 25.1 | 1.5 | 21.8 | 21.8 | 1.5 | 3.0 | 3.0 |
| **1010-8** | 5.9 | 29.4 | 0.0 | 11.7 | 11.7 | 0.0 | 5.9 | 0.0 |
| **1036** | 0.0 | 31.4 | 2.2 | 6.6 | 0.0 | 0.0 | 17.7 | 17.7 |
| **1037** | 0.0 | 25.0 | 2.8 | 5.6 | 2.8 | 0.0 | 11.1 | 8.3 |

Table 4.5. Percentages of different core types in Nubian Mousterian A type sites (from Marks 1968a).

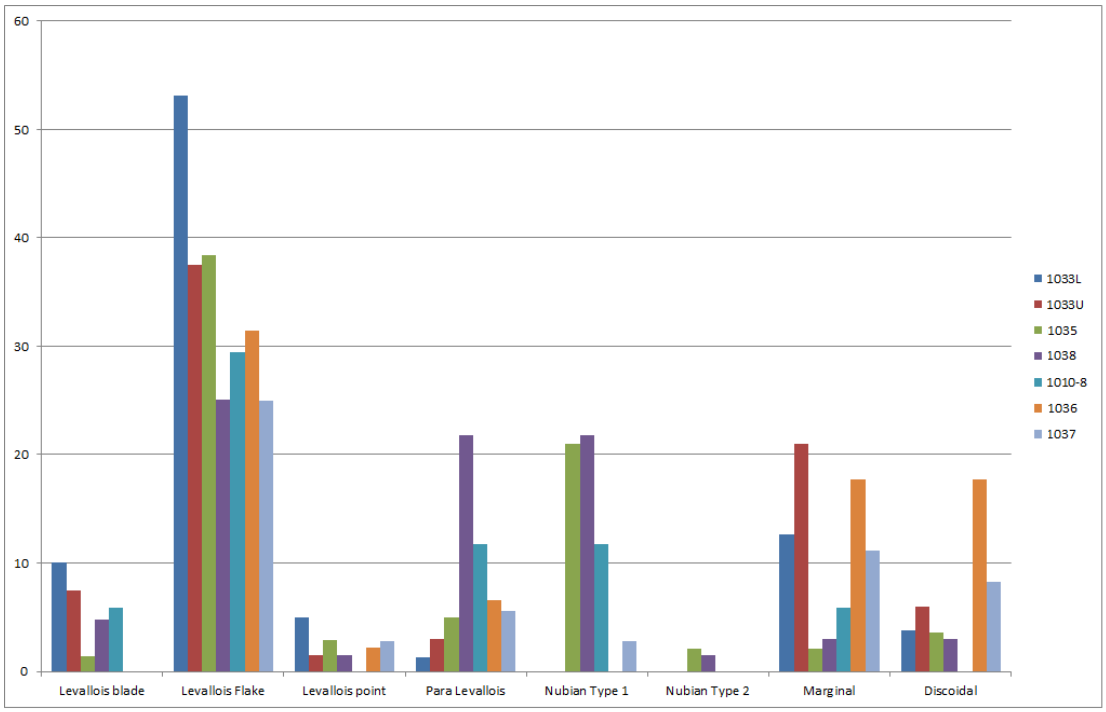



Figure 4.28. Graph of percentages of core types in selected Middle Palaeolithic assemblages on the border of Sudan and Egypt (data from Marks 1968a).

1010-8 was initially assigned to the 'Nubian Mousterian type A' (Marks 1968a), but as more has become known on the Palaeolithic of Northeast Africa the assemblage can be assigned to the wider 'Nubian Complex' (e.g. Van Peer 1998; Rose *et al.* 2011). The Nubian Complex primarily corresponds with MIS 5, apparently developing from the Lupemban in the later Middle Pleistocene (Van Peer *et al.* 2003) and, in one view, subsequently giving rise to a variety of industries including the Aterian and Khormusan (e.g. Van Peer 1998; Van Peer and Veermeersch 2007; see also Marks 1968a,b). The Nubian complex has been defined by varying technological criteria, but following the original definition by Guichard and Guichard (1965), and more recent work (e.g. Rose *et al.* 2011; Usik *et al.* in press), the presence of distinctive Nubian cores is central. The Nubian Technique, as it is here is labelled, represents a form of Levallois dorsal surface preparation where a sharply angled median distal ridge is created, presumably, as is often emphasised, to create pointed removals. Although most scholars emphasise the character of Nubian core technology is a form of Levallois point reduction, this has been challenged by, for instance, Chiotti *et al.* (2009) and Olszewski *et al.* (2010) who argue that, *contra* e.g. Guichard and Guichard (1965), Van Peer (1991, 1998), Rose *et al.* (2011), that the 'pointiness' of Nubian blanks has been overemphasised. Kleindienst (2006) challenges the concept of the 'Nubian Complex' more widely.

The chronology of the Nubian Complex is poorly understood, and at present extrapolations for a vast region of northeast Africa are made from a very small number of dated sites. As with most sites, 1010-8 is not dated chronometrically and comes from the surface and a superficial sedimentary layer. We can hypothesise a relative age for the assemblage by reference to elsewhere. From the small number of dated Nubian assemblages it has been argued that there is an early and a late Nubian Complex (e.g. Hill 1993; Van Peer *et al.* 2003, 2010; Vermeersch 2010)

The early (MIS 5e) Nubian Complex has a bifacial component and in terms of specifically Nubian Levallois cores there is a dominance of the Type 2 method. The late (MIS 5a) Nubian complex lacks bifacial technology, and Type 1 Nubian cores predominate. As 1010-8 lacks bifacial technology and features Type 1, but not Type 2, Nubian cores we can hypothesise that it dates to late in MIS 5, presumably MIS 5a.

There remains some confusion on what exactly is meant by the term 'Nubian Complex', as the reaction of, for instance, Garcea (1998, 2001), Schild (1998) and Kleindienst (2000, 2003, 2006) to the ideas of Van Peer (e.g. 1998, 2001; Van Peer and Vermeersch 2000) demonstrate. Kleindienst (2006, 22), for instance, outlines the changing and seemingly inconsistent definitions of the Nubian complex (e.g. Van Peer 1998 *contra* Van Peer and Vermeersch 2000). As with other spatial and temporal contexts for the Middle Palaeolithic, the position taken here is that the character and usefulness of the 'Nubian Complex' as an analytical device can be tested through quantification of lithic data.

The author's intention was to sample the whole of the 1010-8 assemblage described in Marks (1968) but many of the reported blanks could not be located, having probably been left in Sudan. However, it is felt that the material studied constitutes a sample of acceptable quality for the purposes of this thesis.

**4.13) Tor Faraj, Jordan**

The site of Tor Faraj is a rockshelter in southern Jordan, excavated by a team led by Donald Henry in the 1990's (e.g. Henry 2003; 2012; Henry *et al.* 1996). The site is located at ~1000 metres above sea level in sandstone uplands between Aqaba and Ma'an, and is one of the most southerly sites referred to the 'Levantine Middle Palaeolithic'. It should be noted that the site is located just outside the modern edge of the southern limit of the Mediterranean woodland zone (see e.g. Shea 2007, figure 19.1).

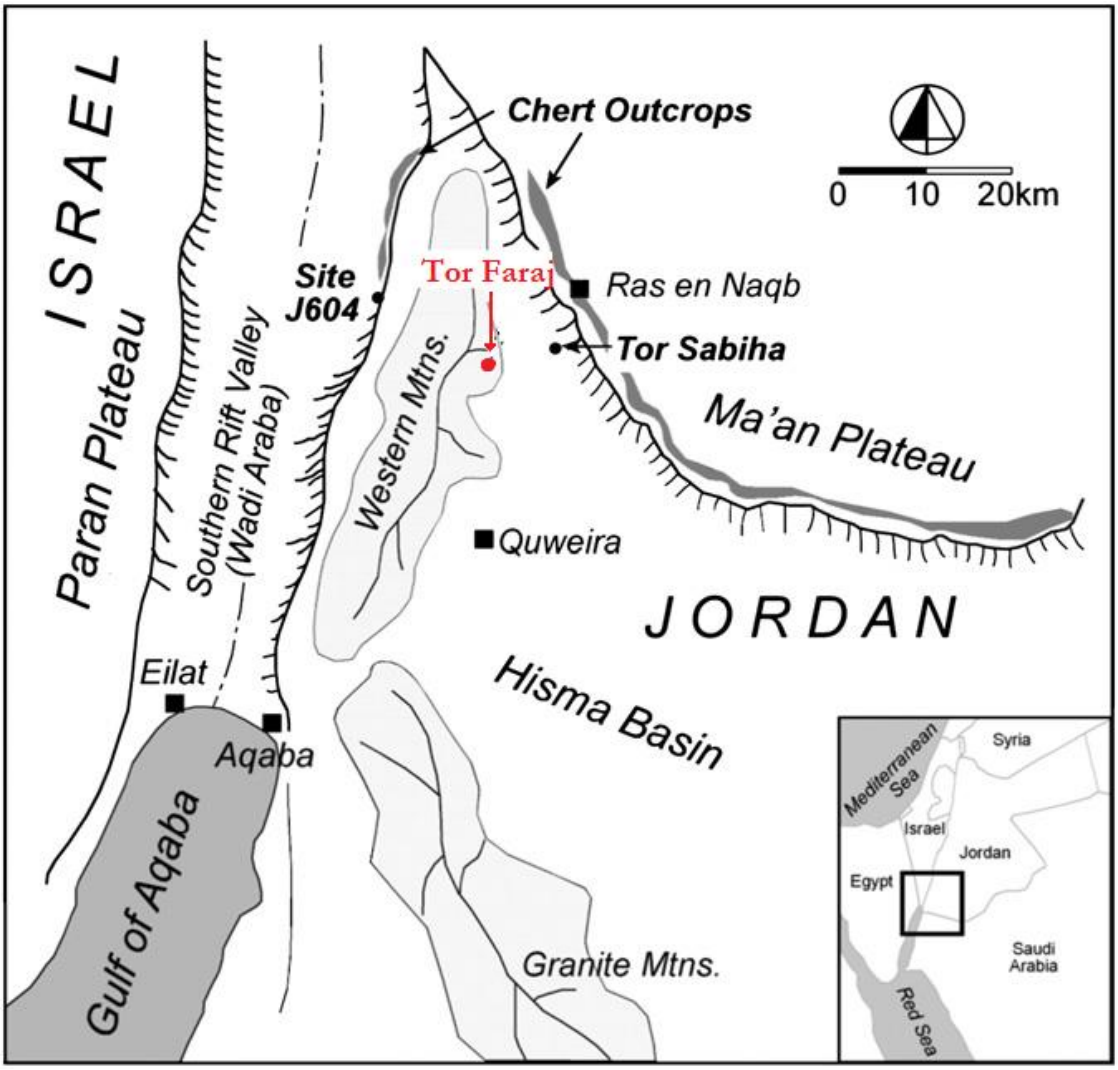



Fig 4.29. The location of Tor Faraj in southern Jordan (after Henry 2012)

The excellent preservation and spatial integrity of Tor Faraj (e.g. Henry 2012) reflects the process of sediment accumulation at the site. The repeated collapses of the brow of the rock shelter created a barrier behind which aeolian sand accumulated in nearly horizontal levels (see Figure 4.30), rapidly covering and preserving the hearths, lithics and other archaeological evidence of the site. In

addition there is good microbotanical evidence from the site, indicating the presence of a wide number of plant species, including the oldest evidence for the use of date palms in the world (Rosen 2003). The excellent excavation procedures employed combined with this geomorphological context mean the lithic assemblage from Tor Faraj has an unusually high resolution for a Middle Palaeolithic site, and here the term 'living floor' can perhaps reasonably be applied (Hietala 2003; Henry 2012). More details of the stratigraphy are provided by Henry (2003, 2012), who suggests the existence of a number of 'activity' areas (e.g. 'bedding area', 'bone and antler work', 'dump', etc.).

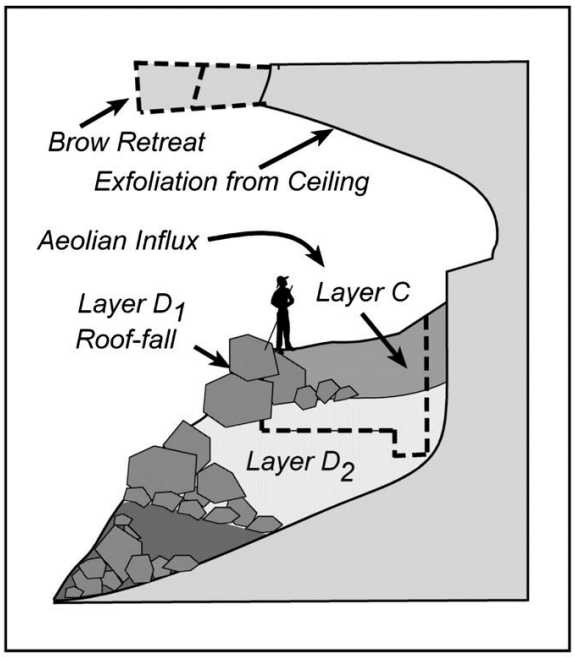



Figure 4.30. The general stratigraphy of Tor Faraj (from Henry 2012).

Amino-acid racemization (Henry and Miller 1992), uranium series (Henry 1995c) and thermoluminescence (Vallad, pers. com 1990, cited by Henry 2003) dating of layer C at Tor Faraj have produced age estimates of 49-69 ka, in line with other Late Levantine Middle Palaeolithic sites such as Kebara and Amud. The results put the occupation of Tor Faraj in MIS 3 or 4. Some of the age estimates for Tor Faraj are considered more reliable than others. Henry (2003, 2012) argues, based on an average of the estimates, for an age of approximately 55 ka. This is congruous with the early MIS 3 wet phase discussed in Chapter 2, and a parsimonious estimate for the extension of hominin populations from the Levant into this typically arid zone.

Henry (e.g. 1994, 2003) associates the occupation of Tor Faraj with a transhumant mobility strategy of Neanderthals, with the site being occupied in a residential fashion over the winter, while sites such as Tor Sabiha reflect summer occupations. Given a lack of fossil evidence at Tor Faraj, whether the assemblage was produced by Neanderthals or 'modern humans' is not clear. Given the lack of evidence for post MIS-5 *Homo sapiens* in the Levant until the Upper Palaeolithic, and, conversely, the evidence for Neanderthals in MIS 4 and 3 (e.g. Shea 2008), it is parsimonious to associate Tor Faraj with Neanderthals, but this must for now be seen as a working hypothesis. Part of the problem is that points (convergent blanks) tend, irrespective of the biological population of the manufacturers, to be more abundant in the more arid interior areas of the Levant than the coastal/oak woodland area of the East Mediterranean. If Tor Faraj does represent Neanderthals, then it is the most southern known example of their range in southwest Asia.

In terms of lithic technology, reduction was focussed on the production of Levallois points from cores with well faceted striking platforms and typically unidirectional-convergent, although also bidirectional, preparatory scars (Demidenko and Usik 2003; Henry 2003). The other notable feature of the site is the level of 'recycling', as demonstrated by numerous 'cores on flakes' ('truncated-faceted' pieces) (*ibid*). This latter behaviour can perhaps be explained by the distance (~20km) of the site from the main raw material sources. The naturally convex raw material lent itself to a procedure of limited preparation before the production of points was initiated (*ibid*). Due to the presence of many blade proportioned blanks and the relative prevalence of bidirectional preparation, Henry (1995a,b,c) initially assigned the site to the 'D-type', or early, Levantine Middle Palaeolithic. However, the detailed attribute analysis and refitting of the assemblage has revealed the similarities to the Later Middle Palaeolithic seen as sites such as Kebara (e.g. Bar-Yosef *et al.* 1992). The chronological estimates discussed above are also similar to those for sites like Kebara. For further information on the Levantine Middle Palaeolithic see, for instance, Shea (2003).

| Type | Floor one (number) | Floor two (number) |
|---|---|---|
| *Retouched Levallois point* | 7 (4%) | 16 (6%) |
| *Unretouched Levallois point* | 43 (26%) | 34 (13%) |
| *Side-scraper* | 4 (2%) | 9 (3%) |
| *End-scraper* | 3 (2%) | 2 (1%) |
| *Burin* | 18 (11%) | 36 (14%) |
| *Truncated piece* | 2 (1%) | 3 (1%) |
| *Notch* | 6 (4%) | 25 (10%) |
| *Denticulate* | 3 (2%) | 7 (3%) |
| *Retouched piece* | 74 (45%) | 120 (46%) |
| *Varia* | 6 (3%) | 7 (3%) |
| **Tool subtotal** | 166 | 259 |
| *Core* | 32 (3%) | 27 (2%) |
| *Primary debitage element* | 119 (11%) | 201 (12%) |
| *Core trimming element* | 38 (4%) | 38 (2%) |
| *Blade* | 213 (20%) | 295 (18%) |
| *Flake* | 488 (46%) | 819 (50%) |
| *Levallois flake* | 96 (9%) | 140 (9%) |
| *Levallois blade* | 32 (3%) | 46 (3%) |
| *Burin spall* | 12 (1%) | 24 (1%) |
| *Truncated-faceted piece* | 27 (3%) | 54 (3%) |
| **Debitage subtotal** | 1057 | 1644 |
| *Chips* | 3531 (88%) | 5771 (94%) |
| *chunks* | 501 (12%) | 357 (6%) |
| **Debris subtotal** | 4032 | 6128 |
| **Grand total** | 5255 | 8031 |

Table 4.6. The typological composition of the Tor Faraj assemblages (From Henry 2003, 64). Percentages are out of the total for each group ('tools', 'debitage' and 'debris').

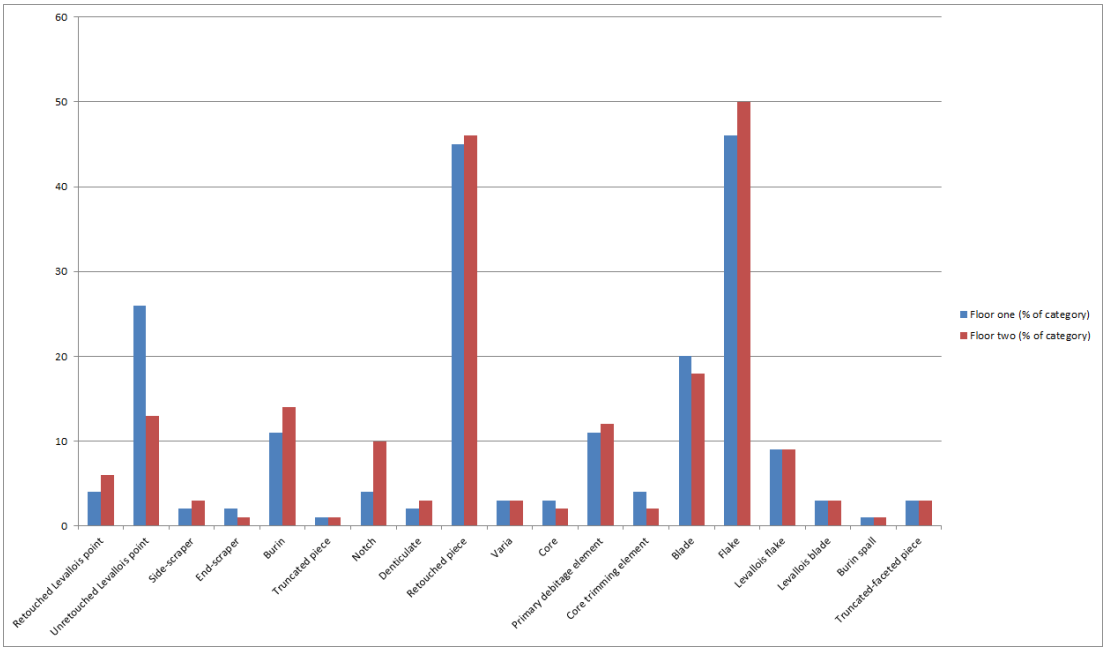



Figure 4.31. Graph comparing the typology of Floor one and Floor two at Tor Faraj. Based on data in Table 4.6, each category is given as a percentage of its group (as assigned by Henry (2003), i.e. 'tools', 'debitage' including cores, and debris).

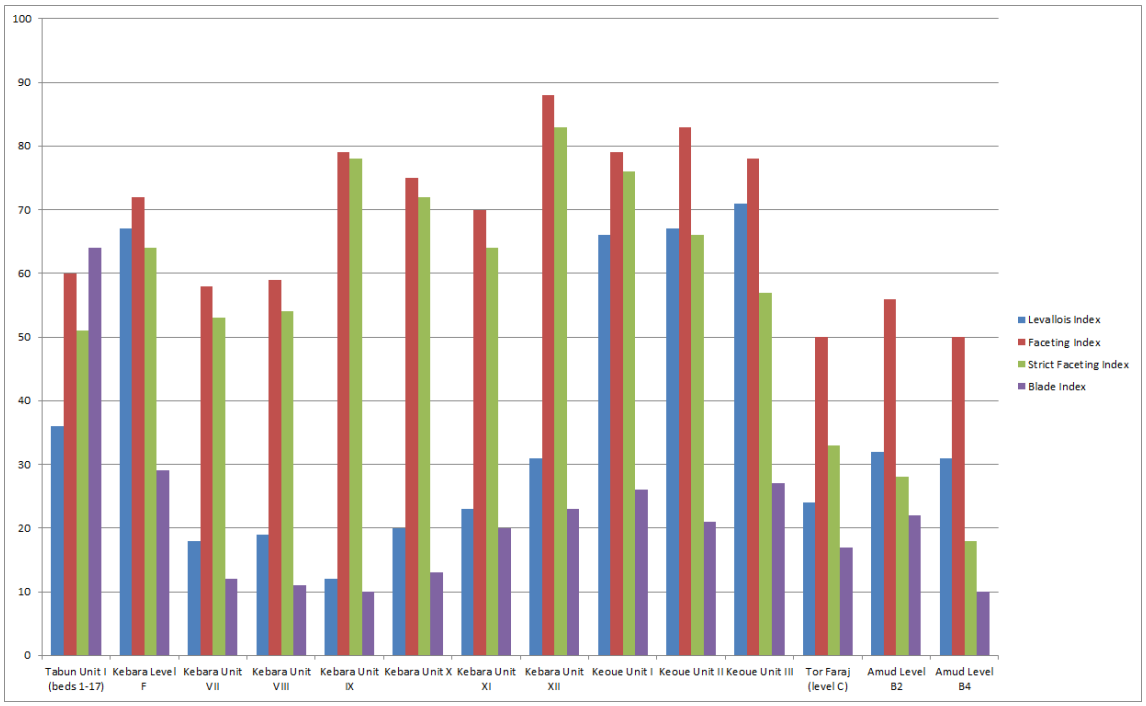


Figure 4.32. Comparison of basic technological indices for Levantine Late Middle Palaeolithic assemblages (data from Jelinek 1982; Meignen and Bar-Yosef 1989; Nishiaki and Copeland 1992; Hovers 1998; Henry 2003).

### 4.14) Warwasi, Iran

Warwasi is a rockshelter located in the Tang-i-Knesht Valley of western Iran (~ 34.4 N, 47.15 E), excavated by Bruce Howe as part of the Iraqi-Jarmo project (Braidwood 1960; Braidwood *et al.* 1960, 1961; Braidwood and Howe 1960). Since the collection was transferred to the University of Pennsylvania the Middle Palaeolithic material has been analysed by several workers (e.g. Skinner 1965; Dibble and Holdaway 1990; Dibble and Holdaway 1993; Lindly 1997; Adler 2002). As a relatively well excavated Palaeolithic site, it is one of the most important in Iran (see also e.g. Nasab 2011). Although not all lithic material uncovered during the excavation was kept, the large sample of artefacts makes it one a key site for the region (e.g. Lindly 1997).

The site was excavated by the opening of a single trench covering a horizontal area of 2 by 8 metres, and extending to a depth of 5.6 metres. Sieving was employed, so the collection of lithic material was relatively complete, in contrast to other sites such as Bisitun Cave. It is for this reason that Warwasi was selected for inclusion in this study. The stratigraphy was divided into arbitrary spits, almost all 10cm thick, labelled A to CCC with increasing depth. Beneath more recent assemblages (see Olszewski 1993) is a thick deposit containing Middle Palaeolithic artefacts.

Dibble and Holdaway (1993) grouped the Middle Palaeolithic material into four arbitrary units, as smaller units lacked the sample sizes deemed necessary for a Bordesian typological analysis. As shown in Table 4.7 and Figure 4.34, the only real differences are an apparent decrease in Levallois flakes through time, although of course this may merely reflect changing levels of the retouch of Levallois flakes, and an increase in the 'other category', for Unit D.

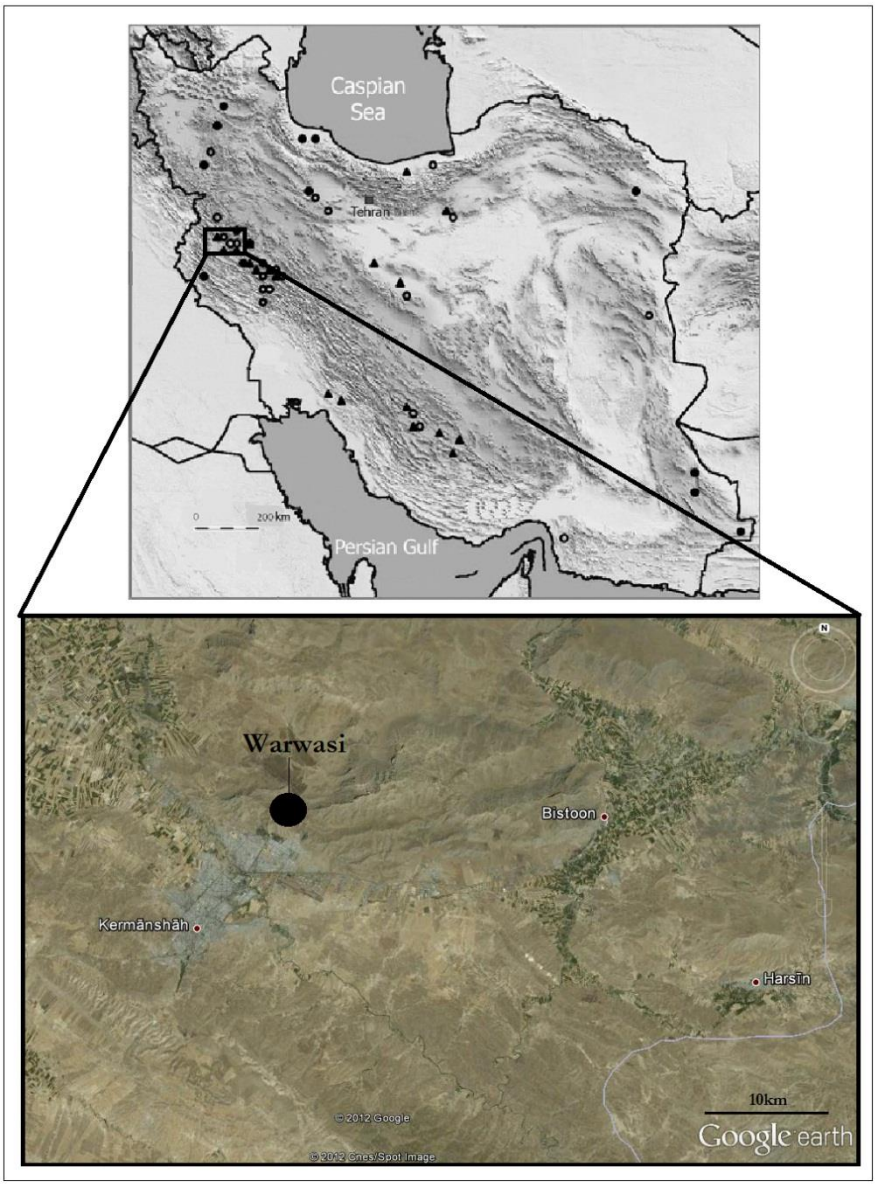



Figure 4.33. The approximate location of Warwasi rockshelter in western Iran. Top map modified from Nasab (2011) – solid circles = Lower Palaeolithic sites, open circles = Middle Palaeolithic sites, triangles = Upper Palaeolithic sites. Bottom image courtesy of Google Earth.

| Simplified type | Unit A (WW-CCC) (% of tools) | Unit B (SS-VV) (% of tools) | Unit C (NN-RR) (% of tools) | Unit D (JJ-MM) (% of tools) |
|---|---|---|---|---|
| Levallois flakes | 38 (20%) | 21 (7%) | 5 (2%) | 5 (3%) |
| Levallois points | 2 (1%) | 2 (0.5%) | 1 | 2 (1%) |
| Pseudo-Levallois points | 0 | 0 | 1 | 2 (1%) |
| Mousterian points | 6 (3%) | 17 (5%) | 15 (5%) | 7 (4%) |
| Side-scrapers | 89 (47%) | 190 (60%) | 148 (51%) | 67 (41%) |
| End-scrapers | 1 | 3 (1%) | 3 (1%) | 3 (2%) |
| Convergent scrapers | 16 (8%) | 16 (5%) | 15 (5%) | 10 (6%) |
| Other scrapers | 2 (1%) | 5 (2%) | 3 (1%) | 8 (5%) |
| Burins | 6 (3%) | 8 (3%) | 10 (3%) | 7 (4%) |
| Naturally backed knives | 4 (2%) | 1 | 7 (2%) | 7 (4%) |
| Truncated flakes/blades | 4 (2%) | 6 (2%) | 10 (3%) | 1 |
| Truncated faceted pieces | 0 | 10 (3%) | 10 (3%) | 3 (2%) |
| Notches and denticulates | 21 (11%) | 36 (11%) | 33 (11%) | 20 (12%) |
| Other | 2 (1%) | 4 (1%) | 18 (6%) | 20 (12%) |
| **Total 'tools'** | **191** | **319** | **289** | **162** |

Table 4.7. Typological structure of the Warwasi units defined by Dibble and Holdaway (1993).

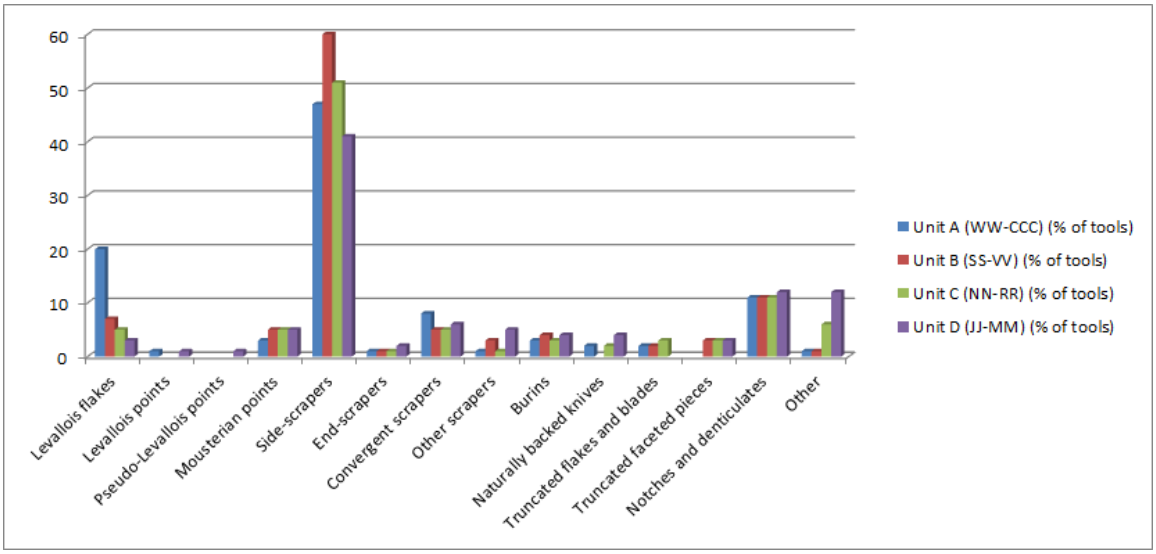



Figure 4.34. Percentage of each Bordesian type out of total tool composition for each unit for Warwasi. Data from Dibble and Holdaway (1993).

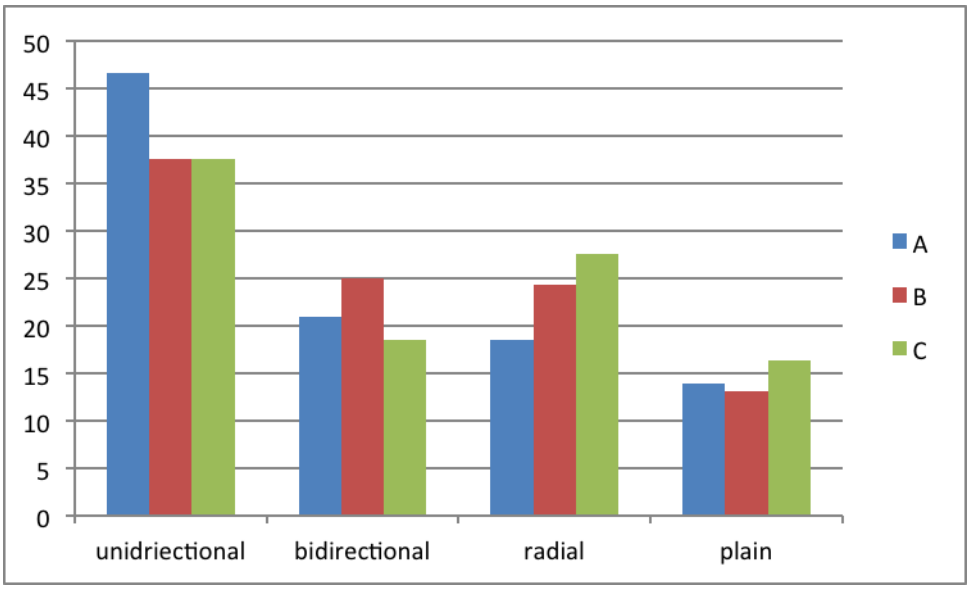


Figure 4.35. Scar patterns for units A-C of Warwasi (data from Dibble and Holdaway 1993, information for layer D unavailable). The proportion of radial scar patters increases with younger age.

Dibble and Holdaway (1993, 77) highlight some important technological features of the Warwasi material. These include the presence of 'truncated-faceted' pieces and the presence of 'burin spalls', which show the removal of a previously retouched edge, which may reflect a method of resharpening. They also note the total absence of *Chapeau du Gendarme* platforms. Such observations are of importance as they indicate that there are real and significant technological differences between assemblages such as Warwasi and those from assemblages in areas such as the Levant with high levels of *Chapeau du Gendarme* platforms. The particular characteristics of the Zagros Middle Palaeolithic cannot merely be explained by retouch intensity.

Dibble and Holdaway (1993) highlight some important technological characteristics, but it is hard to tease out the significant data as their results are provided in typical Bordesian fashion. Their technological indices (*ibid* 89) include indications of increased levels of Levallois technology in the younger deposits, as well as increased faceting and laminarity. When these factors, however, are compressed down to a single value for a unit already representing several spits, it is difficult to observe fine grained change through the sequence.

Little faunal material was preserved or recorded in the Middle Palaeolithic levels of Warwasi. Taxa represented include *Equus hemionus* (Onager), *Capra aegagrus* (Goat), *Sus scrofa* (wild boar) and *Hyaena sp.* (Turnbull 1975, cited by Dibble and Holdaway 1993). A variety of environmental

reconstructions are possible based on this small sample of fauna but the presence of *E. hemionus* and *C. aegagrus* indicate at least relatively arid conditions. As noted in Chapter 2, *E. Hemionus* is present at SD-1 in Yemen, in the context of fairly arid conditions of MIS 3. These species, as well as *Suc scrofa*, are typically Palaearctic species. *Hyaena* are found across a wide range and are not particularly diagnostic. Absolute dates are not currently available for the Middle Palaeolithic occupation of Warwasi. It is here hypothesised, in the context of both the Zagros and wider regional setting, the environmental setting and the faunal composition previously described, that the site was occupied by Neanderthals during wet phases of MIS 3. This is in accordance with previous estimates of the site's chronology. For instance, Adler (2002, 346) suggests an age of MIS 3 or 4. Here, the latter is thought to be unlikely given the altitude and mountainous setting of the site.

The lithic assemblages from Warwasi share many similarities with those from other sites of the Zagros Middle Palaeolithic, such as Bisitun Cave (Dibble 1984b) and several other sites (e.g. Skinner 1965, Akazawa 1975). In contrast to the claims made by Skinner (1965), there is clearly a significant Levallois component in many of these assemblages. Skinner's claim to the contrary merely emphasise the definitional problems of 'Levallois' previously discussed, in this case because for Skinner (1965) Levallois implies centripetal preparation of the debitage surface. In the case of Warwasi, Skinner (1965, 196) claimed that there was "no Levallois technique". A number of studies have viewed sites such as Warwasi as being occupied for short periods, correlating with the summer months (Dibble and Holdaway 1993; Lindly 1997; Adler 2002). To Lindly (1997, 298) it is this seasonal character, with its implications for different use of raw material and intensity of site occupation, "almost exclusively", which gives the sites of the Zagros Mountain a different character to those of areas such as the Levant.

In fact, as Dibble and Holdaway (1993, 78) discuss, there is a large variability in the representation of Levallois technology at the Zagros sites, but it is hard to separate genuine rarity from different standards of observation. A distinctive feature of the Zagros Middle Palaeolithic assemblages relates to the high levels of retouch (e.g. Olszewski and Dibble 1993; Lindly 1997). Figure 4.36 shows

some characteristic elements of the Zagros Middle Palaeolithic, Levallois blanks characterised by unidirectional and bidirectional dorsal scar patterns, heavily retouched convergent scrapers/points, and truncated faceted pieces (cores on flakes), here from the site of Bisitun.

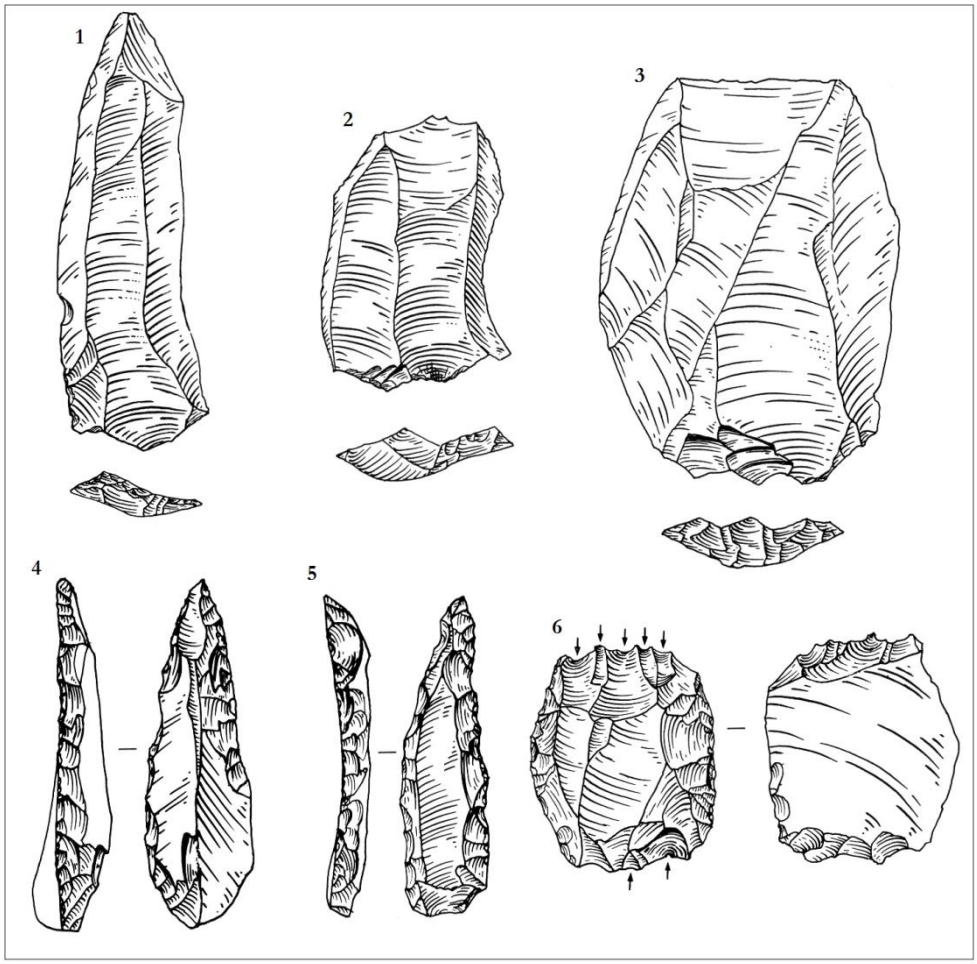



Figure 4.36. Illustrations of selected Middle Palaeolithic artefacts from Bisitun Cave, Zagros Mountains, Iran (modified from Dibble 1984). 1 – Levallois blade, 2-3 – Levallois flakes, 4-5 – 'convergent scrapers', 6 – 'truncated faceted' piece.

For the present study the following layers were analysed (with increasing depth): NN, OO, WW, XX. These were chosen as each single spit (~10cm thick) has a rather small sample size, so here two neighbouring spits were combined. NNOO comes from quite high in the sequence and WWXX, lower in the sequence. The full lithic materials available for each layer were analysed.

**4.15) Mudayy as Sodh (TH 123-b)**

The recent discovery of a large number of sites assigned to the 'Nubian Complex' in Dhofar, Oman was introduced in Chapter two. In the present study the site of Mudayy as Sodh (TH 123-b) was chosen for analysis. This assemblage was selected because the other major sites discussed by Rose *et al.* (2011) were not collected systematically, or were more heavily weathered than 123-b.

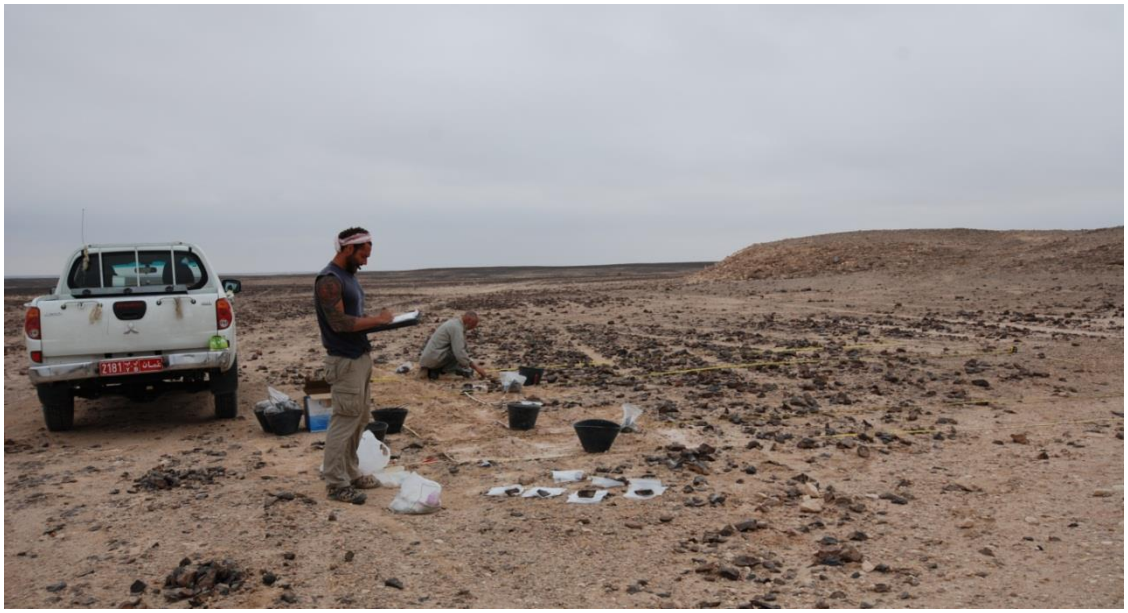


Figure 4.37. Photograph of Mudayy as Sodh (TH 123-b) during collection. Photograph courtesy of Jeffrey Rose.

123b-b is located on a plateau above the village of Mudayy. Various lithic scatters were observed in the area, with the assemblage coming from a systematic collection of 64m$^2$ (an 8x8 metre square). The assemblage is described (Rose *et al.* 2011) as consisting of 965 lithics, made up of 804 pieces of debitage (83.3% of the total), 92 cores (9.5%), and 69 (7.2%) 'tools', including unretouched Levallois blanks. Rose *et al.* (2011) describe most cores as Nubian, particularly Type 1. A variety of types of blanks are present, including many with cortex. A variety of retouched forms are present.

The date of ~107 ka at Aybut Al Auwal (Rose *et al.* 2011), a minimal date given the fluvial context, suggests an age of at least MIS 5 c, and perhaps MIS 5e. 123-b is hypothesised to be of a similar age. This is of course a large generalisation to make from a single dated context. However, this scenario is also parsimonious on palaeoenvironmental grounds.



Figure 4.38. Photograph of Mudayy as Sodh (Th 123-b) after collection. Photo courtesy of Jeffrey Rose.

For the present study all cores and retouched artefacts were studied, while a sample of the debitage was taken. After an initial rapid analysis of all the material, it was clear that some squares had produced more debitage than others. Consequently all debitage from the following squares was analysed: F4, F5, F6, G4, G5, G6, H4, H5, H6. In addition some initial material which was collected from the site before the grid was established, marked SM (surface material) were included as these included important pieces such as Levallois points.

**Supplementary lithic material**

Additional information was collected from the following sites in order to address particular questions and to provide additional information for specific concerns. This forms a secondary focus for the thesis, so less attention is given here to this material. Material from Bir Sahara-1 (BS-1, south-western Egypt) was added to increase the debitage sample as an experiment to see the extent to which a site with few cores, but a reasonable sample of debitage, can illuminate the process of reduction. Little data is available for vast areas of Arabia. As an initial attempt to address this, data

from a small number of cores from several sites across Saudi Arabia which were analysed by Prof. Michael Petraglia are used in to offer insights into broad scale core variability across Saudi Arabia.

**4.16) Bir-Sahara 1 (BS-1)**

This site is of spatial (i.e. north East African) and temporal (mid-MIS 5) interest given the aims of this study. Few cores were found and the assemblage is dominated by debitage (Wendorf *et al.* 1993). It appears that cores were brought to the site partially prepared, end products were removed and then the cores and many of the blanks were then subsequently removed. What is then visible is the middle part of the reduction sequence. The aim of sampling this material is to test whether the particular characteristics of the reduction system can be understood given only this partial insight into the process.

The site is located in southwestern Egypt at the palaeolake of Bir Sahara. Excavations in the 1970's uncovered the assemblage, consisting in total of 11,512 artefacts. Wendorf *et al.* (1993) attributed the 70cm vertical spread of the lithics to the action of roots. The occupation is associated with the 'early west lake 2' phase and thermoluminescence and optically stimulated luminescence dates put the occupation at ~105-110 ka (Wendorf *et al.* 1993). The two dating techniques applied at Bir Sahara/Bir Tarfawi have produced rather inconsistent results. The optical dates are the most internally consistent and probably the most accurate. For BS-1 these produced an age of 103.9+9.5/-13.2 ka.

The material from BS1 is stored at the British Museum, London. A random sample was made of the material, most of which is stored in one bag containing thousands of pieces.

**4.17) Saudi Arabian core sample**

As a major focus of this thesis is on material from northern Saudi Arabia at Jubbah, supplemented by material from 123-b (Dhofar) it is desirable to in some way factor in more information from elsewhere in the peninsula, particularly in Saudi Arabia. As Chapter 2 outlined, the limited state of development of Palaeolithic research in Arabia makes this rather difficult.

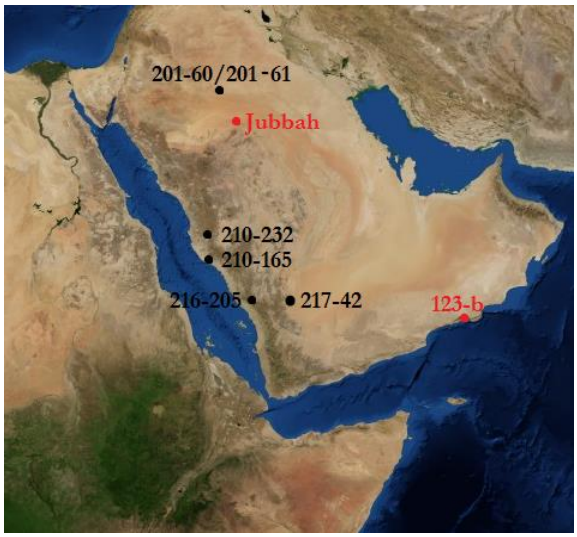



Figure 4.39. The locations of the Arabian core samples used in this study. Core samples are shown in black. Systematically analysed assemblages are shown in red.

Core data collected by Professor Michael Petraglia on the collections of the Comprehensive Survey, stored at the National Museum in Riyadh, Saudi Arabia, will be used to explore possible variation across Saudi Arabia. The sites used give insights into lithic technology in the far north of Arabia (201-60, 201-61), near the western coast (210-165, 216-205), another in western Saudi Arabia (210-232) and finally on the western fringes of the Rub' al Khali (217-42). Given the small sample sizes, the aim with this data is to explore possible broad patterns of variation. For more information on these sites consult Parr *et al.* (1978), Whalen *et al.* (1981) and Zarins *et al.* (1981).

# Chapter 5: Methods for lithic analysis

## 5.1) Introduction

The chapter outlines the methodology of lithic analysis employed in this study. Given some of the criticisms which have been made of attribute analyses (e.g. Sullivan and Rozen 1985; Ahler 1989), an effort is made here to detail not only *what* will be recorded, but precisely *how* and, importantly, *why*. Little will be achieved here by the discussion of topics such as the physics of conchoidal fracture, as a large literature already exists. Nor is the methodology presented intended to be applicable as a universal scheme for lithic analysis. It is a product of both the questions asked and the time and resources available.

Given the lack of consensus on lithic analysis for the Middle Palaeolithic, as discussed in the last chapter, and demonstrated through examples such as the absence of agreement on how to record the number of dorsal scars, there exists no ready-made methodology and interpretative framework which this thesis could employ. The method applied attempts to build on, in particular, the work of Clarkson (e.g. 2007), Hovers (2009) and Scerri (in press), while also reflecting to varying degrees the contributions of Wendorf and Marks (1975), Baumler (1988), Odell (1989), Volkman (1989), Kuhn (1995), Phagan (1985), Ashton and McNabb (1996), Lindly (1997), Adler (2002), Monigal (2002), Tostevin (2003a,b; in press); Pleurdeau (2004); Andrefsky (2005), Rose (2006) and Jones (2007).

It is clearly possible to understand lithic variability from numerous perspectives. In the present thesis attributes and metric states will be analysed using the heuristics of cores (Chapter 6), debitage (in the sense of everything removed from the core by knapping, not 'waste', Chapter 7) and retouched lithics (Chapter 8).

The notion of the assemblage as employed here, essentially following Clarke (1968), is premised on the approximate contemporaneity of clusterings of lithic artefacts. Given this character the absolute discreetness of lithic assemblages is best seen as a "heuristic premise rather than an absolute measure of contemporaneity" (Hovers 2009, 16). As the previous chapter outlined, different elements of assemblage variability reflect different factors. In a broad sense, however, we can make

some general distinctions between, for instance, features which reflect preparation of cores, which can be seen as representing means to an end, and variables such as shape and size of blanks, which are perhaps more likely to present an actual goal of the reduction process (Hovers 2009, 88).

Some points should be made on ways with which this thesis departs from standard conventions. Firstly, because of the difficulties of definition and application of the Levallois concept (e.g. Bar-Yosef and Dibble 1995), the notion of Levallois does not play a prominent role, in contrast to other recent publications (e.g. Hovers 2009). If Levallois is something real and discreet it should be reflected in metric dimensions and attributes. Where Levallois is used, particularly for blanks, it is done so in an inclusive manner.

It has been said that a key difference between the 'behavioral chain' and *chaîne opératoire* approaches is that whereas the latter attempts to see things from the knapper's perspective, the former approaches reduction from the rock's perspective (Odell and Henry 1989: 241). From this perspective, this thesis is very much aligned with the 'behavioral chain' approach.

**5.2) Typology**

The focus of this thesis is on the technological analysis of Middle Palaeolithic assemblages. Nevertheless, some level of typological classification is necessary, aside from typology at the level of the attribute which will be discussed below. The typological scheme adopted here deliberately eschews the elaborate typological approach of scholars such as Bordes (1961), and adopts a minimal type list for individual lithics (see also e.g. Bar-Yosef *et al.* 1992; Kuhn 1995; Villa *et al.* 2005). The implications of this approach include the abandonment of subjective terms like 'atypical'. The type list reflects the typical composition of a general Middle Palaeolithic/Middle Stone Age assemblage. The major typological classes, which are expanded on below, are: cores, debitage, retouched pieces and other (e.g. hammerstones).

**5.3) Cores**

Cores are here defined as lithics which have essentially been used as raw material sources, as demonstrated by the presence of negative flake scars and, typically, the absence of 'positive' flaking features, such as bulbs of percussion. This perspective is, however, problematic from two perspectives. Firstly, the existence of 'cores on flakes' makes any neat dichotomy between cores and removals problematic. Secondly, it is hard to distinguish between cores as a source of flakes and certain 'tool' types, such as 'choppers' and bifaces and indeed there is no *a priori* reason why a mass of rock cannot have played both roles. Debénath and Dibble (1994, 12) suggest that about the only feature consistently present on cores is the existence of a platform and one or more faces from which removals were made.

Cores demonstrate well the typological confusion which has dominated Palaeolithic analyses. Brézillon (1968), for instance, described nearly 50 types of cores. Cores only demonstrate the last phase of reduction, so in the present thesis the notion of elaborate core typologies is eschewed and a simple scheme highlighting major forms of core is used. Cores as we find them have often either been reduced until they were too small to continue, or have been abandoned due to the presence of undesirable characteristics (e.g. prominent aberrant terminations on the debitage surface). Table 5.1 describes the major core types which will be used to describe lithic variability in this thesis.

The morphology of cores offers one of the clearest insights into the reduction process, albeit at the end point of this process. As Baumler (1987, 45) points out, however, most cores are "by-products and therefore waste", while in other cases the core may have been abandoned while retaining reductive potential for a variety of reasons, including the presence of aberrant terminations on the debitage surface. Examples such as the latter may be particular informative.

| Core type | Description/characteristics |
|---|---|
| *Single platform* | Core with a single primary platform, with varying levels of platform preparation. Removals are made onto one (typically) or more surfaces of the core from this platform. The debitage surface is not characterised by lateral and distal convexity, nor is there a distinction between two hierarchically related surfaces and other features associated with Levallois reduction. In this definition many cores previously defined as 'single platform' are perhaps better seen as Levallois (e.g. Singer and Wymer 1982). |
| *Double-platform (bidirectional)* | As single platform, but with two major striking platforms. These are typically on opposite sides of the core. |
| *Multiplatform* | Core with several platforms and no clear hierarchy between platforms and debitage surfaces, the latter featuring scars from several directions. |
| *Discoidal* | *Sensu* Boëda (e.g. 1993). The core is divided into two surfaces, but these are not hierarchically related as with Levallois cores, and both can serve as debitage surfaces. Removals are made at a steep angle compared to the intersection of the two surfaces, whereas with Levallois cores removals are approximately parallel to the plain between the two surfaces. Given the sometimes problematic distinction between Levallois and discoidal cores, Terradas (2003: 24-25) suggestion that discoidal cores are characterised by the meeting of removals at the centre of the core, therefore creating a peak, is another useful criterion for defining a discoidal core. Discoidal cores can be seen as reflecting an economising approach to raw material use (e.g. Slimak 2003). |
| *Radial* | A core with centripetal preparations, but not fully Levallois in volumetric terms, nor dicoidal. Different from multiplatform in that all the removals extend onto one, or perhaps two opposed, faces. Less organised than discoidal cores, lacking the specific characters of such cores discussed above. |
| *Unidirectional Levallois* | This and subsequent Levallois cores are defined by the essential features highlighted by Boëda (e.g. 1995), a core with a clear intersection between two hierarchically related surfaces (one is the striking platform surface, one is the debitage surface) and the lateral and distal convexity of the core. In the present analysis striking platform preparation is not seen as essential to a being described as Levallois, but is usually present. In the case of unidirectional Levallois removals are made from a primary platform onto a debitage surface. This surface has not been primarily prepared by centripetal preparations, and the preparatory removals are not convergent but typically broadly parallel. |
| *Bidirectional Levallois* | As with unidirectional Levallois, but removals onto the debitage surface are made from two, typically opposed, major striking platforms. |
| *Unidirectional convergent Levallois* | Converging preparatory removals from proximal lead to a typically pointed preferential flake. Such types are seen as being common in the Levantine Late Middle Palaeolithic, but also occur in MSA contexts. |
| *Recurrent centripetal Levallois* | Core type with the essential features of Levallois technology, but with several preferential removals, each both predetermined and predetermining, made on the same debitage surface. Some scholars reserve the term Levallois for cores demonstrating a single, or occasionally two, removals (e.g. Usik *et al.*, in press). In the present thesis, however, it is felt that the retention of typically Levallois features on cores demonstrating recurrent flaking is sufficient to distinguish them from more loosely 'radial' cores and from discoidal cores. |
| *Preferential Levallois with centripetal preparation* | 'Classic Levallois' (e.g. Bordes 1988, 95). Typically a single, large preferential removal made from each prepared debitage surface, which has previously been shaped by centripetal removals. The preferential removal is from a primary, and typically prepared, platform. |
| *Nubian* | Nubian cores are typically considered to be a variant of Levallois point cores (see e.g. Guichard and Guichard 1965; Van Peer 1998; Chiotti *et al.* 2009; Rose *et al.* 2011; Usik *et al.* in press). The distinctive characteristic feature of Nubian cores is the presence of a median, distal ridge. Nubian Type 1 cores have been characterised by the presence of bidirectional preparatory removals, whereas Type 2 emphasise removals from the lateral |

| | |
|---|---|
| | margin. As is increasingly recognised this dichotomy is problematic (Chiotti *et al.* 2009; Usik *et al.* in press). In the present thesis the creation of the median distal ridge is defined as the 'Nubian Technique', and the defining character of 'Nubian cores', and where a distinction is made between Type 1 and Type 2 cores it exclusively relates to direction of scars in relation to the ridge. |
| *Blade* | Blade cores are typically characterised by removals from a single striking platform, and are characterised by evidence for the removal of at least two laminar blanks (laminar in a simple morphological sense of a length at least twice the width). A variety of different methods are represented within blade core technology (e.g. Delagnes *et al.* 2000). Volumetrically, blade cores as defined here typically have a more prismatic shape than what could be defined as 'single platform blade cores'. Another distinguishing feature is that the majority of scars on a blade core are of laminar proportions (Jones 2007). |
| *Tested* | Cores with a small number of removals. The precise character varies from one or two removals, perhaps intended merely to test the flaking quality of the core, to seemingly proto-Nubian cores where a median distal ridge is defined, but the core is abandoned before it is shaped and a striking platform prepared. |
| *Amorphous* | Cores which, while complete, cannot be assigned to one of the above schemes. They are typically small and heavily worked and represent a terminal state of reduction. |
| *Core on flake* | Flake (or blade) which has been used as a source of further blanks. Typically focussed on the proximal end of the core, one surface is used to prepare a striking platform and the removals come from the other surface. These can typically only be recognised when removals are made on the ventral surface. |
| *Fragment* | Broken piece which demonstrates the morphological characteristics associated with a core, but does not preserve enough of its mass to be placed into one of the above categories. |

Table 5.1. Typology of core forms.

### 5.4) Debitage typology

Debitage is treated here as meaning all removals made from a core, aside from those which have subsequently been retouched. The term is used interchangeably with 'blank'. The categories of debitage used in this thesis are listed below in Table 5.2.

| Debitage type | Description/characteristics |
|---|---|
| *Flake* | "a portion of rock removed from an objective piece by percussion or pressure" (Andrefsky 2005), with a maximum dimension of more than 20mm. Length is less than twice the width. A complete flake has several identifying features reflecting deliberate, conchoidal fracture – including a striking platform and ventral (inner) and dorsal (outer) surfaces, with a bulb of percussion on the inner surface. Where broken a flake is defined where sufficient of these features are present. |
| *Blade* | As flake, but maximum length (of more than 40mm) is greater than two times maximum width. Typically with approximately parallel margins but here the definition is a simple, morphological one. |
| *Microblade* | As blade but with a maximum length of less than 40mm (after e.g. Clarkson *et al.* 2012) |
| *Point* | A broadly triangular flake or blade with convergent margins creating a pointed distal end. |
| *Core management element* | These are blanks struck from the lateral margins of the core to increase lateral and distal convexity (e.g. Beyries and Boëda 1983). They typically have a plain or dihedral platform, a very diffuse bulb of percussion, a curved profile reflecting the role of the mass of the core and often distal terminations which border on being 'overshot'. One side of core management elements is typically relatively steep, and constituted the former debitage surface of the core. This surface often features several dorsal scars. Opposite this steep side of the blank the other surface slopes more gradually. |
| *Chunk/ fragment* | Pieces which appear to reflect knapping, but lack features such as definable ventral and dorsal surfaces and so cannot clearly be assigned to one of the above categories. |

Table 5.2. Typology of debitage forms.

### 5.5) Retouch typology

In contrast to traditional typological schemes applied to the Middle Palaeolithic, where the retouched component both dominates the typology and is associated with functional names ('scraper', 'burin', etc.) (e.g. Bordes 1961), the present thesis adopts a simple, morphological system. Because it is felt that traditional typological schemes minimise data, the present approach is an inclusive one. Qualitative descriptions of retouch type are avoided for their subjectivity, and replaced by quantitative analytical techniques described later. Retouch is classified in terms of four groups, 1) (normal) 'retouch', 2) notching, 3) burination, 4) backing . In addition, façonnage elements – in the present context essentially bifaces and bifacial foliates – are recognised. The type

of retouch is combined with the morphology of the piece to give the typological description. Examples include 'side retouched flake', 'end retouched blade', 'side retouched and notched flake', 'double side and double end retouched flake'. This is merely intended to allow an overview of the type of retouch present in an assemblage, while the more specific features exist in such a way that a typological approach is seen as being unhelpful.

**5.6) Metrics and attributes**

The typological framework provided above does not form an important element of the analytical aspect of this work, but it does provide descriptive or comparative context. More important is the recording of metric measurements and attribute states.

Attribute analyses can be premised on both qualitative and quantitative information. Monigal (2002) is an example of an application of an attribute study primarily utilising qualitative data. In the present thesis, the focus is on quantitative data as this provides a more objective foundation and is appropriate for comparative and statistical analyses. For instance, rather than assigning a 'shape' to the margins of a blank, the approach of recording width measurements at several positions is adopted. This approach is adopted as it is faster than a fully geometric morphometric approach, but encodes considerably more information than attempting to fit attributes into a smaller number of qualitative categories, with the subjectivity that the latter approach implies. In some cases quantitative techniques were avoided because of the difficulties of achieving accurate measurements. This primarily applies to the recording of platform angles, which are difficult to record accurately (e.g. Odell 1989; Andrefsky 2006, 91). Platform angles are certainly important, but the position adopted here is that hi-tech solutions, such as the use of laser scanning, are needed to understand them accurately.

For each variable to be measured or recorded, the following pages provide information and justification. This discussion assumes some prior knowledge of lithic analysis. If the reader wants

the definition of, say, a feather termination they are referred to a publication such as Andrefsky (2006). All weights were recorded to 0.1 grams using electronic scales. All linear measurements were recorded in millimetres to two decimal places using Mitutoyo digital callipers connected to a computer by USB and input into Microsoft Excel.

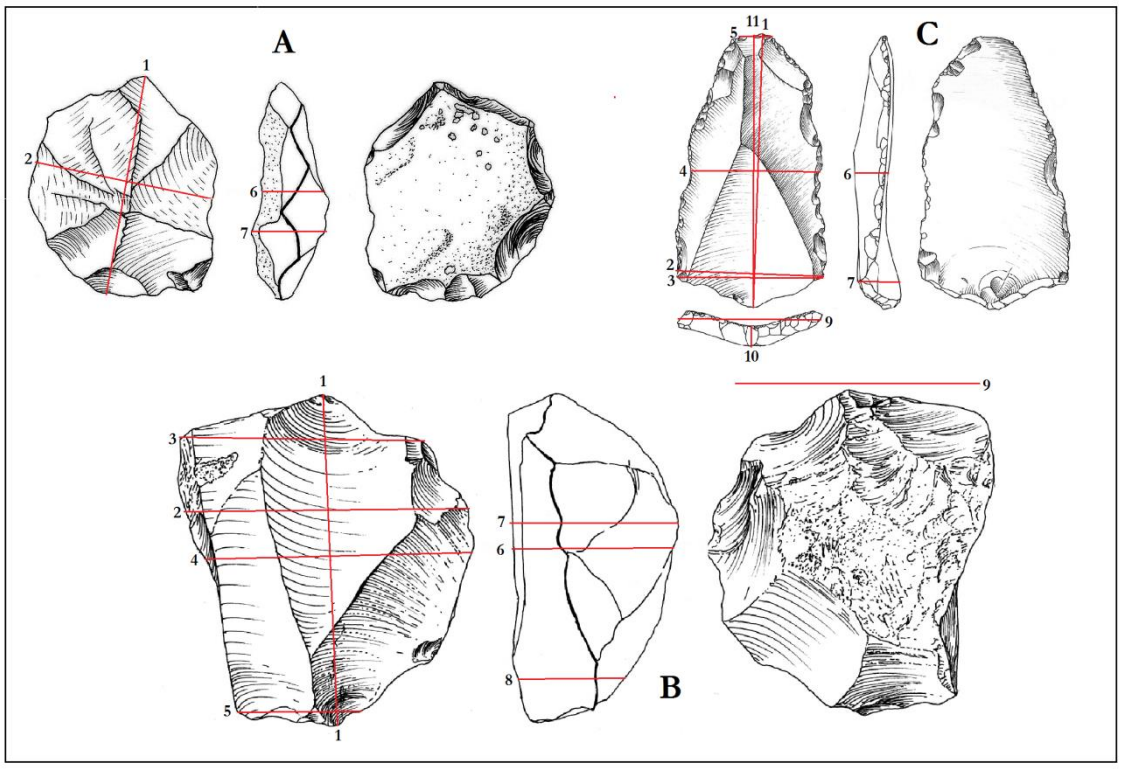



Figure 5.1. Major measurements on cores (A,B), debitage and retouched pieces (C), images not to scale. A – basic measurements for cores which lack a clear directionality (illustration from Petraglia *et al.* 2011), B – basic measurements for cores with a clear directionality, in the form of a primary preferential scar (illustration from Rose *et al.* 2011), C – basic measurements for debitage and retouched artefacts (illustration from Crassard & and Thiébaut 2011). 1 – maximum length, 2 – maximum width, 3 – proximal width, 4 – medial width, 5 – distal width, 6 – thickness at medial, 7 – maximum thickness, 8 – thickness at median distal ridge (for Nubian cores), 9 – platform width, 10 – platform thickness, 11 – axial length.

**5.7) Metrics and attributes recorded for cores**

Cores have formed the centre of some significant recent analyses of Middle Palaeolithic assemblages (e.g. Crassard 2009; Clarkson 2010). There is no doubt that cores provide considerable information, at least on the final phase of reduction. However, it must be borne in mind that a few, final, opportunistic removals may have been made from a core before it was abandoned. It is not hard, if we wish to think about things at an ethnographic scale, to imagine a skilled and respected knapper discarding a core which was subsequently picked up by children and a few poorly controlled flakes removed. For selected examples illustrations will be produced, particularly those demonstrating the chronology of removals, and photographs taken.

| Measurement/attribute | Description/characteristics | Information provided |
|---|---|---|
| *Weight* | Measured to 0.1 grams | Weight gives information on the position of an artefact in the reduction process and on the character of reduction (the distinction between 'preparatory' and 'preferential' removals, for instance).<br>Point at which cores were abandoned/intensity of reduction. |
| *Maximum length* | Maximum length (maximum dimension) is the longest linear length on the core. | Can reconstruct size of the original piece of raw material.<br>Understand how efficient the reduction process was.<br>Understand the point at which core reduction was abandoned.<br>Size indications can help position cores within the reduction schemes of an assemblage, e.g. distinguish a small number of cores which have been abandoned due to factors such as aberrant terminations on the debitage surface. |
| *Maximum width* | The longest dimension at a right angle to maximum length. | |
| *Proximal width* | Width of core at proximal end of the core, in the cases where proximal and distal ends can be defined by the presence of a well formed striking platform, preferential removal etc. The measurement is that which best describes the shape of the proximal end of the core. | |
| *Medial width* | Width of core measured at 50% of length. | |
| *Distal width* | Width of core measured at the distal end. | |
| *Thickness at medial* | Thickness of core measured at a right angle to medial width. | |
| *Maximum thickness* | Thickness of core recorded at the thickest point. | |
| *Thickness as median distal ridge* | Only applies to Nubian cores, vertical distance measured from the mid-point of median distal ridge downwards. | The presence of a 'median distal ridge' has been described as essential feature of the core technology of the Nubian Complex. The creation of the ridge is here defined as the 'Nubian Technique'. This measurement aims to test the extent of 'standardisation' of this attribute. |
| *Number of elongate scars* | The number of scars with a length more than twice the width. | The number of blade proportioned scars can reflect particular reduction techniques. |
| *Last platform width* | Where the last removal can be distinguished, typically a preferential removal, the width of the striking platform is measured. | Provides information on the character of platform preparation for final preferential removal. Platform thickness is not measured here as variable amounts of the platform's thickness will be removed with the blank, whereas the width is preserved on the core. |
| *Last platform type* | Cortical/plain/dihedral/faceted/crushed/indeterminate/combination. | Provides information on platform preparation. |
| *Length of last scar* | Length of last dorsal scar where this can be defined, typically a preferential removal from initiation point or centre of proximal margin of scar to distal termination. | Gives an insight into the point at which cores were abandoned. Can be compared with blank population and provide insights into the removal of blanks from the assemblage. |

| | | |
|---|---|---|
| *Last scar face length* | The length of the face with the last flake scar. | Provides context for last scar length. |
| *Last scar face width* | The maximum width of the face with the last flake scar. | |
| *Termination of last scar* | Feather/hinge/step/outrepassé/indeterminate. | Feather terminated final scars may indicate that the core was abandoned because it became too small for further removals, whereas aberrant terminations can be interpreted as meaning the core was abandoned due to their obstructing the debitage surface. |
| *As above for scar 2, 3.* | If it is possible to see the order of the second and third from last removals, typically of preferential flakes, then the last six categories can be repeated. | |
| *Raw material* | For this study: ferruginous quartzite/sandstone/siliceous sandstone/ flint/ rhyolite/quartz/limestone/obsidian/ indeterminate/other. | Procurement behaviours and mobility strategies. Ethnography points towards cultural factors in determining raw material choices (e.g. Gould 1968). |
| *Patination/weathering* | Light/moderate/heavy. | Provides information on the taphonomic history of the assemblage. May indicate the extent to which the assemblage in a palimpsest. |
| *Edge rounding/condition* | Light/moderate/heavy. | Can indicate rolling and transport of the lithic (Jones 2007). |
| *Edge damage/use* | Yes/no/indeterminate. | Provides information on possible use of the lithic, and on the taphonomic history of the assemblage. May indicate use of 'cores' as 'tools'. |
| *Dorsal cortex* | Estimated percentage of surface area. Can subsequently be classed into groups if so desired. | Point of reduction sequence/raw material. procurement/mobility. In terms of the reduction process, cortical pieces are typically removed early in reduction, giving an insight into how the process changes through the reduction cycle.<br>With cores, cortex shows how much it has been reduced. |
| *Cortex location* | Where the orientation of the core can be defined, for instance with a Levallois core, this can be defined as distal/left lateral etc. If this is not possible it can be possible to assign it to upper/lower surface of core. | Gives insights into the character of reduction. Different reduction schemes will lead to the decortification of the core in different potentially significant ways. |
| *Completeness* | Is the piece complete yes/no. Completeness is regarded as being when any damage to the piece is insufficient to prevent complete measurements and recording of attributes (Debénath and Dibble 1994, 11). | Can give indications into the context of the assemblage and the reasons for its accumulation, as well as the quality of the raw material. |

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|---|---|---|
| *Flaking method* | Levallois/non-Levallois/indeterminate.<br>Levallois defined along the lines of e.g. Van Peer (1992) and, particularly, Boeda (1995). The definition is primarily volumetric and more relaxed than many, i.e. platform preparation and the kind of scar pattern are not important.<br>The key characteristics are a.) the presence of two hierarchically related surfaces (lower is striking platform, upper is debitage surface), b.) lateral and distal convexity existed for last blank/s removed, c.) blanks are removed more or less parallel to the plane between the two surfaces | While qualitative distinctions such as 'Levallois' do not play a substantial role in this thesis, they are still important as they are frequently discussed in the literature. Levallois is difficult to define for debitage, but for cores the picture is more clear. What exactly the presence of Levallois technology means is rather debated (e.g. Delanges and Rendu 2011 *contra* Eren and Lycett 2012). |
| *Platform preparation* | An overall characteristic of the core: Cortical/plain/faceted. | Gives an overview of platform preparation for the whole core, rather than simply for the platform of the final removal. |
| *Number of scars >5mm* | Total number of scars with a maximum length of >5mm | Intensity of reduction/reduction technique. This measure gives an inclusive count of scars. |
| *Number of scars >1/3 length* | Total number of scars with a maximum length of >1/3 the maximum length of the core | As above, but only gives information on major scars. For certain types of cores, such as discoidal, this may give a similar figure to the previous category, while for others it may give very different results. |

Table 5.3. Attributes recorded for cores.

### 5.8) Metrics and attributes recorded for debitage

The character of the reduction process can be understood through a variety of the features recorded for this study. A number of studies have demonstrated that several features – including shape and size variables, cortex percentage and position, and dorsal scar pattern, for instance – vary through the reduction sequence. Such factors allow the dynamic character of core reduction to be understood.

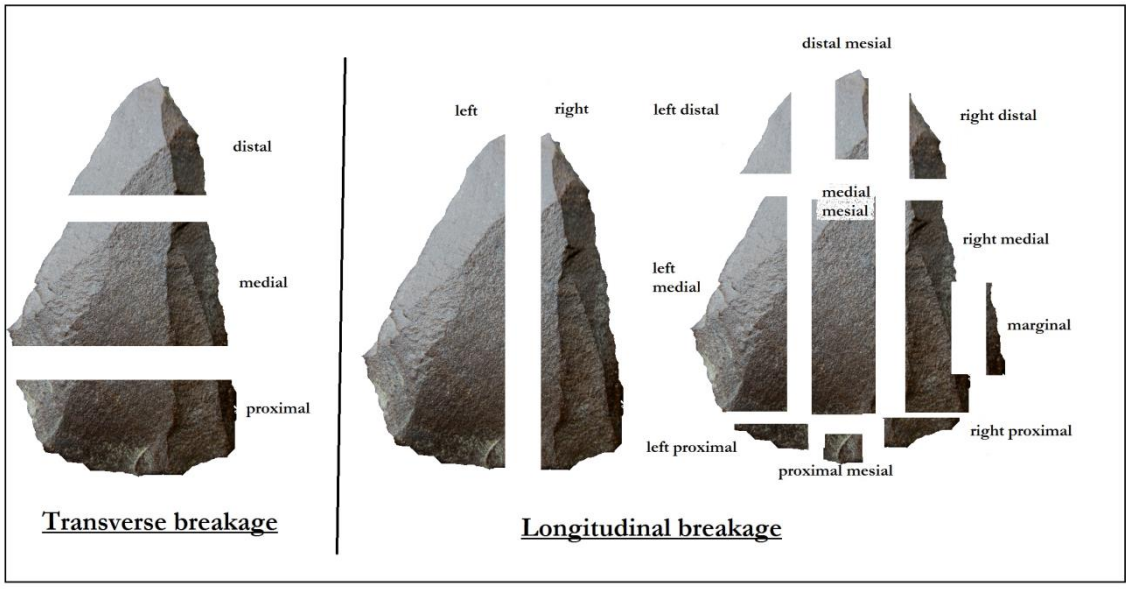



Figure 5.2. Categories of breakage.

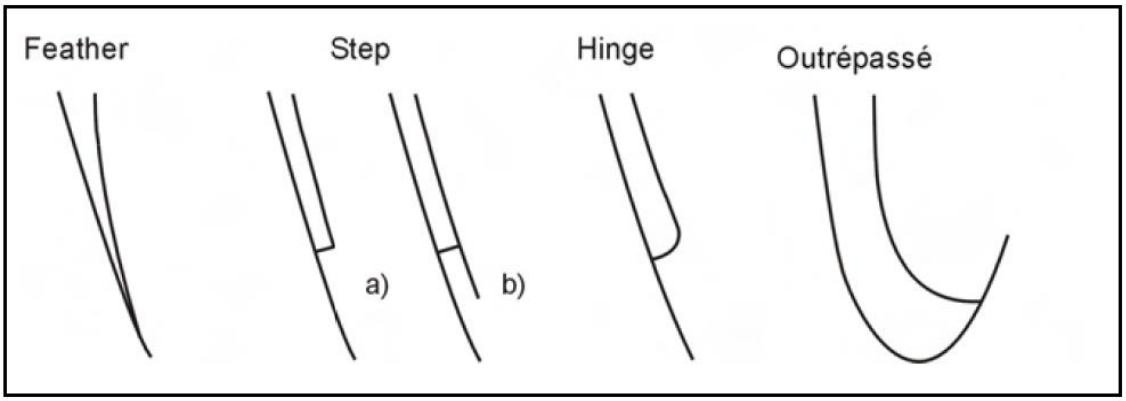



Figure 5.3. Categories of distal termination (modified after Clarkson 2007).

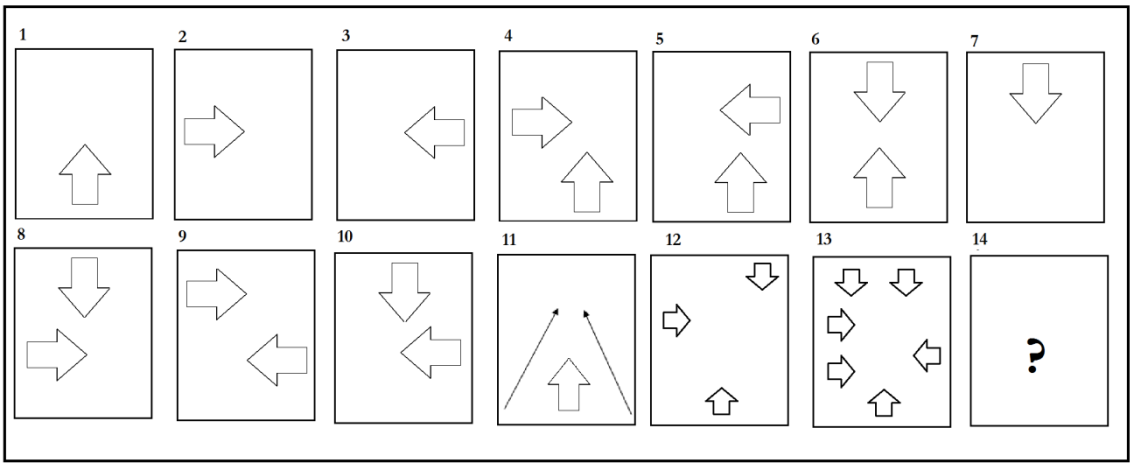



Figure 5.4. The primary dorsal scar patterns for blanks and retouched blanks recognised in this thesis, in cases striking platforms are at the bottom. 1- from proximal, 2- from left, 3 – from right, 4 – from proximal and from left, 5 – from proximal and from right, 6 – bidirectional, 7 – from distal, 8 – from distal and from left, 9 – from right and from left, 10 – from distal and from right, 11 – from proximal congergent, 12 - weakly centripetal, 13 – strongly centripetal, 14 – indeterminate.

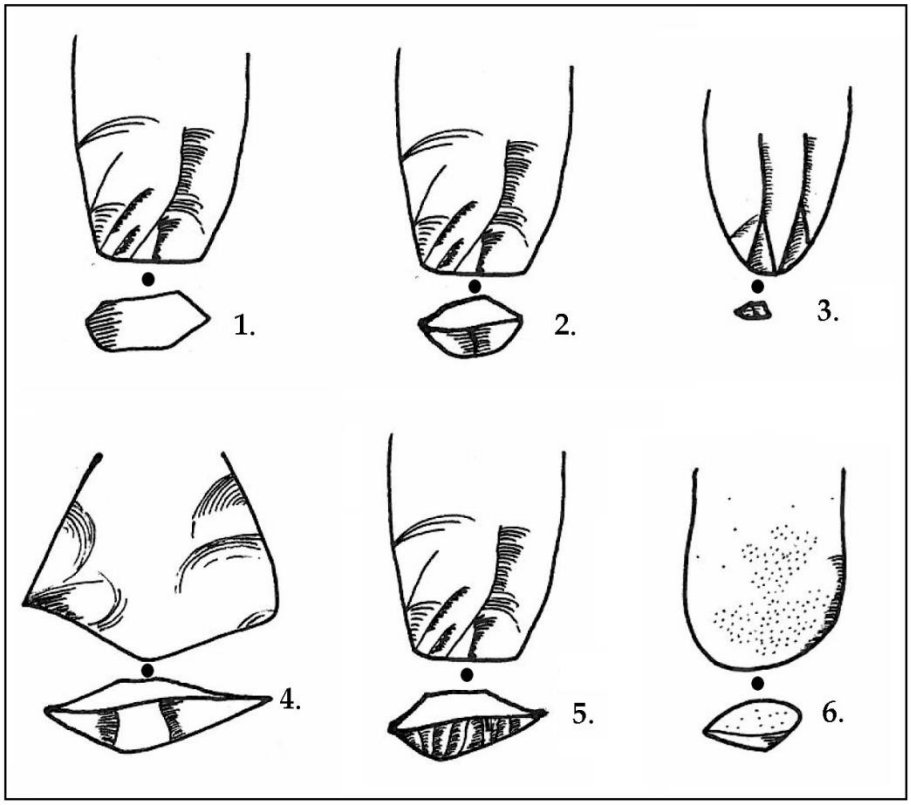



Figure 5.5. Platform types used in this study. 1 = plain, 2 = dihedral, 3 = punctiform, 4-5 = faceted, 6 = cortical (figure courtesy of E. Scerri)

| Measurement/attribute | Description/characteristics | Information provided |
|---|---|---|
| *Weight* | Measured to 0.1 grams. | Indicates position in reduction cycle. Weight of blanks has been regarded as one of the best indicators of this (e.g. Amick and Mauldin 1989; Andrefsky 2005). |
| *Axial length* | Length from initiation point, or central point of striking platform if initiation point is unclear to distal termination. | Size can be related to position in reduction cycle. In general terms, smaller blanks will be produced later in the production cycle.<br>Also may reflect culturally specific behaviours.<br>Can show size of core.<br>Some believe that thickness reflects the kind of hammer used (Crabtree 1972).<br>Dimensions also reflect the knapper's use of the core debitage surface, i.e. elongated pieces reflect the use of longitudinally dispersed arises, whereas shorter, flake, blanks reflect a focus on dispersed arises (Tostevin 2003a,b).<br>Longer blanks reflect larger cores, so it has been argued reduced size reflects greater mobility (Munday 1976). Likewise different reduction strategies producing different sizes of debitage have been relate to mobility strategies (Kuhn 1995).<br>Insights into taphonomic history/character of site occupation, i.e. small debitage/chunks indicate on site knapping.<br>Midpoint thickness has been seen as an indicator of the point in a reduction sequence at which the blank was removed (Speth 1972, 1974). |
| *Maximum length* | Maximum dimension of the piece in any direction. | |
| *Maximum width* | Maximum dimension at a right angle to maximum length. | |
| *Proximal width* | Width at proximal end of piece, if the sides are relatively straight then this will be the same as the striking platform width. If the piece expands immediately after the striking platform then it is measured there if this gives a better description of shape. | |
| *Medial width* | Width at 50% of axial length. | |
| *Distal width* | Width at distal end of piece. | |
| *Maximum thickness* | Maximum thickness at any point. | |
| *Thickness at medial* | Thickness measured as a right angle to medial width. | |
| *Striking platform thickness* | Maximum thickness of the striking platform, between the ventral and dorsal surface. | Striking platform dimensions can provide insights into the stage of the reduction process at which the removal was made (Odell 1989).<br>Size of striking platform can be used to estimate dimensions of blanks if they are broken (e.g. Dibble 1997).<br>Striking platform thickness is determined by the position at which the knapper strikes the core.<br>Typically thicker and less wide platforms correlate with less platform preparation (Phagan 1985). |
| *Striking platform width* | Maximum width of the striking platform. | |
| *Raw material* | For this study: ferruginous quartzite/sandstone/silicious sandstone flint/ rhyolite/quartz/limestone/obsidian/ indeterminate/other | As for cores, while in addition it provides insights into the transport of particular blanks. |
| *Patination/weathering* | Light/moderate/heavy | As for cores. |
| *Edge rounding/condition* | Light/moderate/heavy | Can indicate rolling and transport of the lithic (Jones 2007). |
| *Edge damage/use* | Yes/no/indeterminate | Can provide information on the taphonomic history of the assemblage, as well as providing indications of use. |
| *Dorsal cortex* | Estimated percentage of surface area | Gives information on stage of reduction process, character of raw material used and insights into the size of initial raw material used. |

| | | |
|---|---|---|
| | | It has been suggested as indicating different levels of attention to the core surface, on the premise that flakes with cortex are undesirable (Phagan 1985). However, on at least some occasions cortical flakes were preferentially removed from sites (Douglass *et al.* 2008), perhaps their typically larger size relating to notions of curation. |
| *Cortex location* | All dorsal, platform and all dorsal, both laterals, both laterals and distal, distal, distal and platform, left lateral, left lateral and distal, mesial, patchy, platform, platform and both laterals, platform and left lateral, platform and right lateral, proximal, proximal and distal, right lateral, right lateral and distal | Show's how the core was shaped during the early phase of reduction, information which is not preserved on heavily reduced cores.<br>Particular patterns of cortex location may reveal information on the nature of the reduction process. For instance, the consistent presence of cortex on the left of blanks may indicate that reduction typically proceeded in a clockwise manner. |
| *Completeness* | Yes/no/indeterminate | As for cores. |
| *Transverse breakage* | Proximal/medial/distal/surface | Provides insights into the character of the raw material and reduction techniques. |
| *Longitudinal breakage* | Left/left proximal/left medial/left distal/right/right proximal/right medial/right distal/mesial/ proximal mesial/ medial mesial/distal mesial/marginal. | |
| *Flaking method* | Levallois/non-levallois/indeterminate | In this thesis Levallois is used more for cores. For removals its application is more problematic. Where applied it essentially implies platform preparation, dorsal scar patterning which appears to indicate an attempt to predetermine the shape of the blank, and the blank is relatively thin. |
| *Lipping* | Lipping on dorsal edge of striking platform.<br>Present/absent/indeterminate | May indicate the type of hammer used (Frison 1968; Crabtree 1972), but this has been criticised (Patterson and Sollberger 1978). May be a useful way to, for instance, separate Pleistocene and Holocene assemblages. |
| *Distal termination* | Feather/hinge/step/outrepassé/indeterminate | May provide information on the character of the strike causing the detachment of the blank. Outrepassé terminations provide important information on the distal end of the core and are therefore, along with core management elements, an important way to cast light on core morphology during reduction.<br>Aberrant terminations provide information on either inadequate or excessive force being applied, combined with the angle at which the core was struck, |
| *Number of scars >5mm* | Total number of scars >5mm in length, excluding scars formed after removal of the blank from the core (retouch, damage etc). | The number of scars can be taken as demonstrating position in reduction process (e.g. Clarkson 2007; Hovers 2009), but this has been criticised by e.g. Baumler (1988); Odell (1989); Shott (1994). Different numbers of scars will reflect different approaches to reduction. The use of both of these values gives both insights into total number of scars and the number of large scars. |
| *Number of scars >1/3 length* | Total number of scars with a maximum length of more than 1/3 the length of the piece, excluding scars formed after removal of the blank from the core (retouch, damage etc.) | |
| *Dorsal scar pattern* | From proximal, from distal, from left, from right, from proximal and from left, from proximal and from right, bidirectional, from distal, from distal and from left, from right | Scar patterns reflect particular ways for the knapper to relate to existing aris structure (e.g. Van Peer 1992, 36-38; see also e.g. Baumler 1987; Boëda 1995; Boëda *et al.* 1995) and particular ways of reducing a core. |

| | | |
|---|---|---|
| | and from left, from distal and from right, from proximal convergent, weakly centripetal, strongly centripetal, indeterminate. In most cases the meanings of these are fairly straightforward. Weakly centripetal is applied where three scars are present, struck from different directions. Strongly centripetal is where four or more scars from different directions are present. | Can be related to both reduction strategies as cultural phenomena, and to mobility and subsistence. For instance increased bidirectional flaking has been seen as reflecting decreased mobility, with centripetal equating with increased mobility and convergent often relating to point production, which has been linked to hunting behaviour (e.g. Shea 1991; Bar Yosef *et al.* 1992; Kuhn 1995; Hovers 2009). |
| *Platform morphology* | Cortical/plain/dihedral/faceted/punctiform/crushed/indeterminate | The character of the striking platform provides information the type of hammer used (e.g. Cottrell and Kaminga 1987).<br>Affects dimensions of blank (e.g. Dibble and Whittaker 1981; Dibble and Phagan 1985; Pelcin 1997).<br>Levels of predetermination/planning.<br>For a useful summary of techniques of platform preparation and their effects see Clarkson and O'Connor (2005, 168). |
| *Platform preparation* | Faceting/overhang removal/grinding/none (faceting and overhang removal are distinguished by the orientation of the small scars, faceting scars originate on the dorsal surface and extend onto the platform, while the reverse is true for overhang removal [Clarkson 2004]). | |
| *Number of arises >1/3 length* | Total number of arrises more than 1/3 the length of the core | Information on how knapper related to existing arris structure on the core surface (e.g. Tostevin 2003a,b). |

Table 5.4. Attributes recorded for debitage.

**5.9) Metrics and attributes recorded for retouched pieces**

The final major analytical sector concerns retouched blanks. This reflects two primary concerns. Firstly, were particular kind of blanks selected for retouch, and if so why these and what does this imply for raw material transport and mobility? Secondly, does retouch display culturally specific patterning? In analytical terms this means a focus on firstly what types of blanks were retouched and secondly how they were retouched, primarily relating to the position and invasiveness of retouch.

As Hovers (2009, 107) suggests, about the only element on which Palaeolithic archaeologists agree in relation to the application of retouch is that it reflects "investment beyond the stage of blank production". This notion forms the centre of the analysis of the retouched component of the assemblages studied in this thesis. The equation of retouched artefacts with 'tools', with the implication that blanks were retouched for a specific purpose, is eschewed here, where little attention is given to function. Retouch reflects adaptation of lithics after initial knapping processes, and is therefore of interest because it gives an insight into the dynamic process of lithic production and offers an alternative perspective to cores on the 'end point' of lithic reduction.

More information on the specific techniques of measuring the extent/invasiveness of retouch are outlined after the full list of attributes are outlined. The selection of variables aims, firstly to, describe the morphology of retouched blanks and, secondly, quantify the extent and character of retouch.

For each complete piece a technical diagram was produced, and photographs were taken of selected examples.

The extent and character of retouch was quantified by several means (see Table 5.5). The most significant are Kuhn's (1990) Geometric Index of Unifacial Retouch (GIUR), as shown in Figure 5.6. This records retouch in a 'vertical' manner, i.e. the height of retouch scars in comparison to the highest point of the dorsal surface. Where an edge is retouched along its length, rather than in a small location, three recordings are taken and the GIUR is given as the average. In general a

distinction is not made between 'types' of retouch. The character of retouch is instead quantified using the GIUR and Index of Invasiveness. In addition the length of the margins and the length of retouched margins are measured to give a value for the percentage of margin retouch.

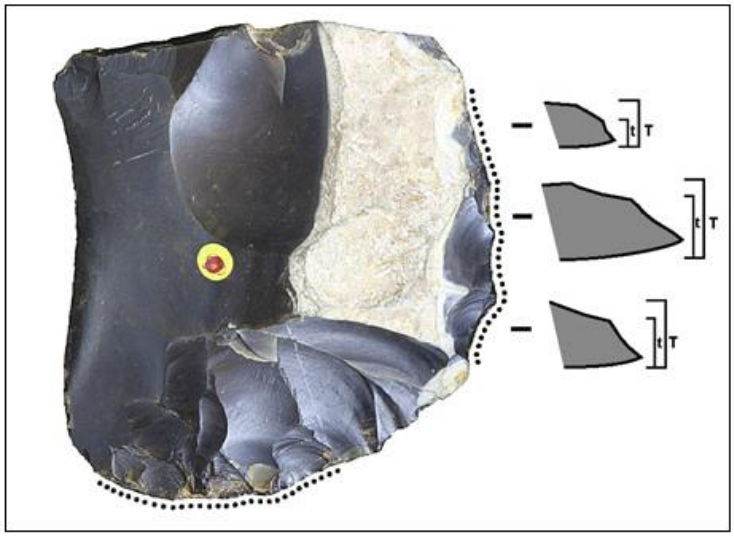



Figure 5.6 . An example of the application of Kuhn's Geometric Index of Unifacial Retouch (from Brumm and McLaren 2011). In examples such as this with a relatively long length of margin retouched, three recordings are taken and a mean average calculated. GIUR = [(t1/T2) + (t2/T2) + (t3/T3)] / 3

The second quantified technique for recording retouch is Clarkson's (2002) Index of Invasiveness. This complements the GIUR, as it describes the extent of retouch coverage in a horizontal sense. Figure 5.7 shows how the Index of Invasiveness is calculated. The grid system employed by Clarkson (Figure 5.7, a.) is also used to describe the position of retouch.

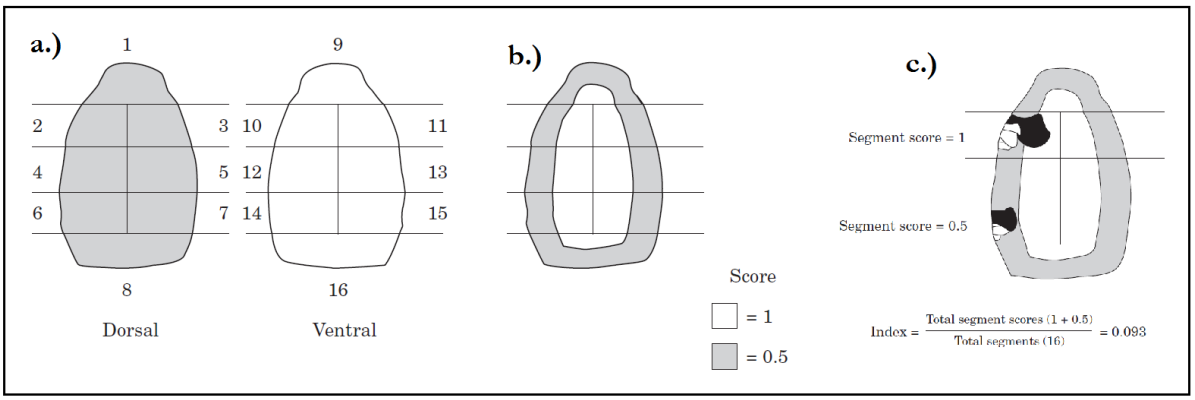



Figure 5.7. Clarkson's Index of Invasiveness (II). A.) Method for dividing artefacts into 16 zones. B.) The distinction between outer zone (grey), where the presence of retouch in each box zone gives a score of 0.5, and inner, white, area which gives a score of 1. C.) An example of the Index of Invasiveness.

The exceptions to this 'retouch' category are 'burination', 'notching' and 'backing'. Burination consists of the removal from an edge, typically the lateral edge, of a 'burin spall' (see e.g. Debénath and Dibble 1994). The removal follows the margin of the flake, and therefore does not belong to either the ventral or the dorsal surface. Care must be taken to distinguish deliberate burination from accidental removals, or from longitudinal fractures, which can create a burin like appearance ('burins de Siret'). A burin removal must therefore be characterised by specific knapping features, such as a negative bulb of percussion. Notching refers to the creation of a concavity on the margins of the blank either by a single blow (a simple notch) or by multiple strikes (a complex burin). Backing refers to a form of retouch where an edge is continuously retouched at a steep (~90°) angle, and therefore blunts rather than resharpens an edge.

| Measurement/attribute | Description/characteristics | Information provided |
|---|---|---|
| *Weight* | Measured to 0.1 grams. | As for debitage and indicates whether blanks of particular weight for selected for retouch. |
| *Axial length* | Measured from initiation point, or central point of striking platform if the initiation point is unclear, to distal termination. | Were particular size and shape blanks selected for retouch? E.g. retouched typically larger than unretouched blanks at Qafzeh (Hovers 2009). This can indicate things like mobility and provisioning strategies, i.e. were hominins preferentially transporting large retouched pieces around the landscape? |
| *Maximum length* | Maximum dimension of the piece in any direction. | |
| *Maximum width* | Maximum dimension at a right angle to maximum length. | |
| *Proximal width* | Width at proximal end of piece, if the sides are relatively straight then this will be the same as the striking platform width. If the piece expands immediately after the striking platform then it is measured there if this gives a better description of shape. | |
| *Medial width* | Width at 50% of axial length. | |
| *Distal width* | Width at distal end of piece. | |
| *Maximum thickness* | Maximum thickness at any point. | |
| *Thickness at medial* | Thickness measured as a right angle to medial width. | |
| *Striking platform thickness* | Maximum thickness of the striking platform, between the ventral and dorsal surface. | Striking platform dimensions relate to blank size, so can help to understand the original size of a retouched blank (e.g. Dibble and Whitaker 1981; Dibble and Pelcin 1995; Dibble 1995). |
| *Striking platform width* | Maximum width of the striking platform. | |
| *Retouched face* | Dorsal/ventral/both. | May reflect a cultural choice over which side is retouched (e.g. Henry 1995). |
| *Length of margins* | Total length of the margins of the piece, measured with a thin string. A random sample checked using measuring function on Photoshop to confirm accuracy. | See 'retouch length' below. |
| *Retouch length* | The length of the margins retouched, recorded as above. | The % of the margins retouched gives another quantified measure of the extent of retouch. |

| | | |
|---|---|---|
| *Geometric Index of Unifacial Retouch (GIUR)* | Three measurements of the GIUR recorded and an average produced, see figure 5.6 giving more information (Kuhn 1992). This only applies to pieces retouched on the dorsal surface. | Quantifies invasiveness of retouch, here primarily in a 'vertical' sense, i.e. how high does the retouch extend compared to the highest point of the dorsal surface. |
| *Index of Invasiveness (I of I)* | Index of Invasiveness calculated for all complete retouched pieces. See Figure 5.7 for more information (Clarkson 2002). | Quantifies invasiveness of retouch, here primarily in a 'horizontal' sense, i.e. what proportion of the dorsal and ventral surfaces were retouched. |
| *Location of retouch* | The location of retouch according to the division of artefacts proposed by Clarkson (2002), as shown in figure 5.6. | Indicates both functional and possibly cultural factors. Offers a more quantified description of the location of retouch than saying 'sidescraper', 'endscraper' etc. |
| *Number of notches* | Total number of notches anywhere on the piece | Quantifies the character and position of notches, providing information on both functional and cultural factors. |
| *Notch type* | Simple (single scar)/complex (multiple scars) | |
| *Picin et al. notch type* | 1Ns (notch simple), 1Nc (notch complex), 1Nm (notch mixed), 1N1n,1N-1n (the difference between the length of notches is bigger than 2mm); 2N, 2-N (the difference between the length of notches is lower than 2mm); 2-N1F (two notches separated by a notch), 1N2n, 1N-2n (the length of one notch is 2mm bigger than the others), Nc (more than three adjacent or separated notches along same edge) (after picin *et al.* 2011). | |
| *Notch location* | Proximal/left lateral/distal/right lateral | |
| *Notch width* | Maximum width of the notch in mm | |
| *Notch depth* | Maximum depth of the notch in mm at a right angle to width | |
| *Number of burin spalls* | Number of spalls struck from piece. | Quantifies the character and position of burination, providing information on both functional and cultural factors. |
| *Burin platform types* | Striking platform type associated with the burination. | |
| *Length of spalls* | Axial length of each spall where they can be recorded. | |
| *Raw material* | For this study: ferruginous quartzite/sandstone/silicious sandstone flint/ rhyolite/quartz/limestone/obsidian/ indeterminate/other. | As for cores and blanks. Provides information on curation/mobility. |

| | | |
|---|---|---|
| *Patination/weathering* | Light/moderate/heavy. | As for cores. |
| *Edge rounding/condition* | Light/moderate/heavy. | As for cores. |
| *Edge damage/use* | Yes/no/indeterminate. | As for debitage. |
| *Dorsal cortex* | Estimated percentage of surface area. | As for blanks, and provides information on the process by which blanks were selected for retouch. |
| *Cortex location* | Platform/all dorsal/proximal/left lateral/right lateral/distal/medial/patchy. | As above. |
| *Completeness* | Yes/no/indeterminate. | As for debitage. |
| *Transverse breakage* | Proximal/medial/distal/surface. | As for debitage. |
| *Longitudinal breakage* | Left/left proximal/left medial/left distal/right/right proximal/right medial/right distal/mesial/ proximal mesial/ medial mesial/distal mesial/marginal. | As for debitage. |
| *Flaking method* | Levallois/non-Levallois/indeterminate. | Were Levallois blanks preferentially selected for retouch? |
| *Lipping* | Lipping on dorsal edge of striking platform. Present/absent/indeterminate. | As for debitage |
| *Distal termination* | Feather/hinge/step/outrepassé/indeterminate. | Indicates whether blanks with particular distal terminations were selected for retouch. |
| *Number of scars >5mm* | Total number of scars >5mm in length. | As for debitage, as well as indicating whether blanks with particular dorsal characteristics were selected for retouch. |
| *Number of scars >1/3 length* | Total number of scars with a maximum length of more than 1/3 the length of the piece. | |
| *Dorsal scar pattern* | From proximal/from left/from right/bidirectional/weakly centripetal/ strongly centripetal/ crested/indeterminate. | As above. |
| *Platform morphology* | Cortical/plain/dihedral/faceted/punctiform/crushed/indeterminate. | As above. |
| *Platform preparation* | Faceting/overhang removal/grinding/none (faceting and overhang removal are distinguished by the orientation of the small scars, faceting scars originate on the dorsal surface and extend onto the platform, while the reverse is true for overhang removal [Clarkson 2004]). | As above. |

| | | |
|---|---|---|
| *Number of arises >1/3 length* | Total number of arises more than 1/3 the length of the core. | As above. |

Table 5.5. Attributes recorded for retouched blanks.

### 5.10) Other forms of lithic artefacts

In addition to the above discussed categories, there are two significant types of lithic for which basic information (raw material, weight, maximum length, maximum width, maximum thickness) will be recorded. These are, firstly, hammerstones and, secondly, manuports. Hammerstones are of interest in that they provide information on the context of the assemblage, indicating it was probably knapped *in situ*, and the size and raw material type of the hammerstones will have an effect on the reduction process. Manuports are of significance for clarifying the movement of raw material around the landscape, which in turn relates to mobility strategies. These 'other' forms of lithic artefacts play little role in this thesis, but their presence should be recorded in lithic analyses as they are important for addressing certain types of question.

### 5.11) Descriptive statistics and indices

A number of basic descriptive statistical techniques will be used to describe the character of the assemblages, consisting of measures of central tendency (mean, median, etc.), dispersion (interquartile range, standard deviation, coefficient of variation) and scatterplots. In addition a number of basic indices will be calculated, offering a quick insight into the character of variability.

| ***Index*** | **Definition/Explanation** | **Information provided** |
|---|---|---|
| *Index of elongation* | = Length/width | Provides a quantitative assessment of two dimensional blank shape, greater values indicating more elongated pieces (e.g. Phagan 1985; Monigal 2002). |
| *Index of flattening* | = width/thickness | Low values indicate relatively massive blanks, while higher values indicate more gracile lithics (e.g. Monigal 2002). As a measure of relative thickness it casts lights on the retouch potential of blanks. |
| *Blank area* | = width x lengh | Overview of the dimensions of the blank.<br>Gives insight into force applied in removing blank (Phagan 1985). |
| *Blank volume* | = width x length x thickness | Summary of size. Can be taken as a measure of how much control the knapper exerted on the reduction process, higher values meaning greater general control (Phagan 1985). Has been claimed to indicate point in the reduction process as it has been argued that variance in blank volume typically decreases as reduction |

| | | |
|---|---|---|
| | | proceeds (Newcomer 1971). |
| *Relative platform size* | = blank area/platform area | Because it is relative to size, this aids comparison between assemblages. It has been argued that it provides information on the accuracy and consistency of the knapper (Johnson 1977). |
| *Index of platform flattening-* | = platform width/platform height | Higher values indicate which are relatively thin. |
| *Index of faceting* | = total number of dihedral and faceted striking platforms x 100) / total number of recognisable platforms | Indicates the frequency of platform preparation, with implications for the 'predetermination' of debitage. |
| *Restricted Index of faceting* | = total number of striking platforms x 100) / total number of recognizable platforms | As above, but only for faceted platforms. |
| *Ilame (blade index)* | (total number of blades x 100) / total number of flakes, blades, and points. | Indicates the role to which the creation of elongated blanks was a goal of reduction in an assemblage. |
| *Flaking surface area* | Length x Width | Gives an approximation of the size of the debitage surface of the core (Monigal 2002). |
| *Core volume* | Length x Width x Thickness | An approximation of the size of the core, indicating conditions of core abandonment and perhaps efficiency of knapping. |
| *Core scar area* | (Length x Width) / dorsal scar count | Gives approximate indication of the number of dorsal scars on the core surface. |

Table 5.6. Examples of indices calculated for assemblages.

**5.12) Multivariate statistics**

The central aim of this thesis is to quantify patterns of variability (similarity and differences) within and between lithic assemblages in Arabia and surrounding areas. This will allow the formulation of hypotheses on the dispersals of hominin population which can guide future research and analyses. The study aims to move beyond the use of simple descriptive statistics will be provided by applying multivariate statistics, which offers insight into factors such as size and shape in terms of the interaction of variables and not simply as univariate.

The primary statistical techniques employed are Correspondence Analysis (for categorical data) and Principle Components Analysis (for continuous data). Where appropriate, testing for significance was conducted using ANOVA. Results of these were grouped using the Tukey Method. The methodology is broadly that of Scerri (in press), which should be consulted for more information. In the present study, however, a more general orientation is taken in terms of comparison of basic

features. In contrast Scerri (in press) more explicitly orientates multivariate analysis around heuristic moments of the reduction process.

Correspondence Analysis (CA) and Principal Components Analysis (PCA) are broadly similar techniques which aim to extract correlations of variables which vary between samples. Both techniques produce components which are orthogonal with the previous dimensions. It is this feature which means each component offers a different insight into the character of reduction, and even if the initial components are dominated by, say, raw material type or size, then subsequent components may offer more behaviourally informative information. The techniques are used here in a rather exploratory manner, as no previous study has applied them to cores, blanks and retouched pieces across an interregional area.

Standard procedures were followed for CA and PCA. The Minitab programme was used for all statistical analysis. All continuous data was normalised using Box-Cox transformations and then standardised. Rather than the reader having to repeatedly refer back to this section the individual questions addressed by the multivariate analyses are presented in each chapter. In the various tables of Correspondence Analysis results important results are in **bold** and very important variables, i.e. those which are strongly driving the component, are **underlined**.

# Chapter 6: Core technology

## 6.1) Introduction

This chapter begins the in depth analysis of the assemblages outlined in Chapter 5. The analysis of cores offers both strengths and weaknesses in the interpretation of lithic technology. The strength is that cores provide a view of a volumetric 'system', and hence insights into factors such as the relationship between blank removals and variation in striking platform preparation. However, this systematic view only reflects the terminal phase of reduction, and this is the major downside to the insights offered by cores. In the view of this author, it is eminently possible, and indeed probable, that fundamental changes in the character of knapping may have been implemented in the later stages of reduction. One example is the conversion of Levallois to discoidal reduction.

Given the systematic, or relational, properties of cores – where we find interactions between, for example, debitage and platform surfaces, or between preparatory and preferential removals – they are arguably more amenable to typological division than the blanks between them, which can be subject to considerable equifinality (e.g. Marks and Volkman 1983; Delagnes *et al.* 2012, figure 9). Core typology is used in this chapter as a heuristic concept relating to the organization of removals from a mass of rock. Qualitative descriptions are given of the different forms of technology and basic descriptive statistics used to analyse the relationship between different core typologies to cast light on reduction trajectories in the assemblages studied. Understanding the different character of these trajectories will offer, it is suggested, important insights into cultural choices made in relation to core reduction. From these foundations a series of multivariate analyses are conducted to quantify attribute variability in core morphology and technological characteristics. In other words, the chapter begins with a focus on intra-assemblage variation, and moves on to inter-assemblage variability.

### 6.2) JKF-1 core technology

A total of 99 cores were recovered from JKF-1, 33 excavated from stratum H and the rest from the surface, clearly relating to the erosion of stratum H. The cores, with the exception of a single rhyolite example, are made from quartz (61) and ferruginous quartzite (37). As shown in Figure 6.1, the cores at JKF-1 almost all demonstrate a close relationship between length and width. Similar relationships are found between other variables, r-squared values for the relationship between weight and length, for instance, are 75.6% for quartz and 73.7% for quartzite.

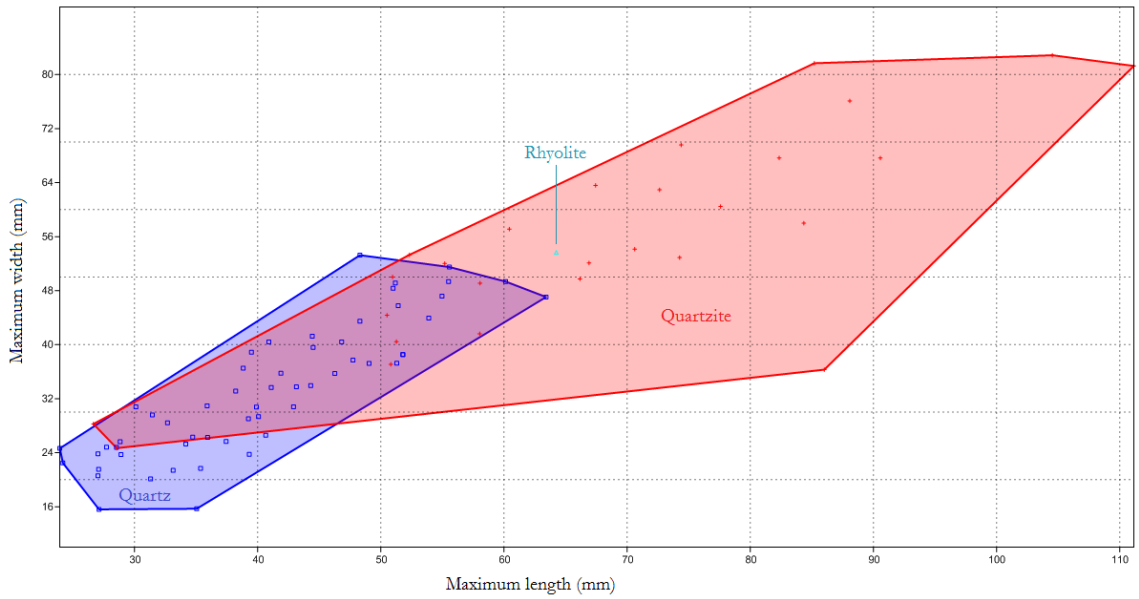



Figure 6.1. Scatterplot of length vs. width for all complete JKF-1 cores.

This close relationship between variables such as length and width, across raw material types, suggests a conscious and deliberate understanding of volumetric relationships on the part of the knappers. Figure 6.2 compares length and width for JKF-1 cores, this time divided by a basic typology. This repeats the point about the systemic organisation of reduction and suggests typology is substantially related to core size. Whether this size reflects reduction intensity or initial raw material package size, then, is the key factor which needs to be addressed to explain such patterns. As Figure 6.2 shows, larger cores at JKF-1 are Levallois, the variability of which will be discussed below, while the small sized cores demonstrate a number of non-Levallois typologies. Discoidal and single platform cores are intermediate in size, while the small types can be classified as multiplatform, bidirectional, radial and amorphous.

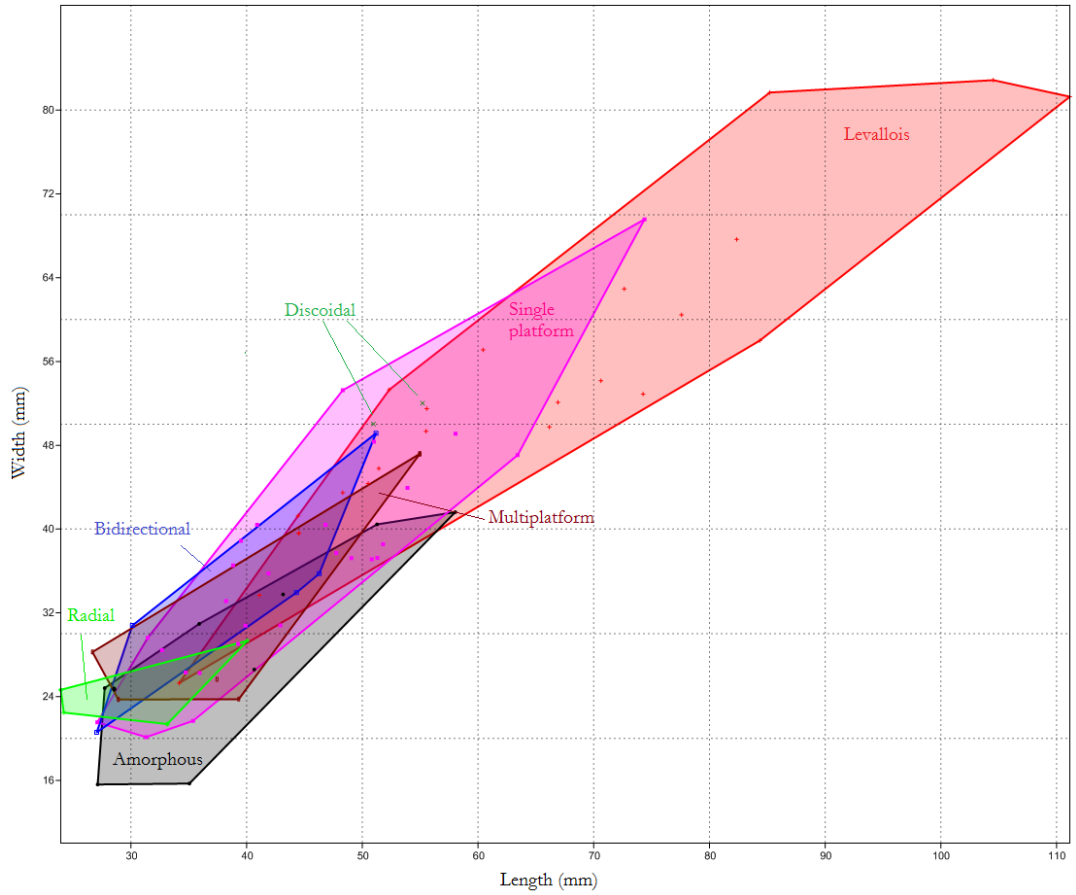



Figure 6.2 Scatterplot of length vs. width for all complete JKF-1 cores arranged by typology

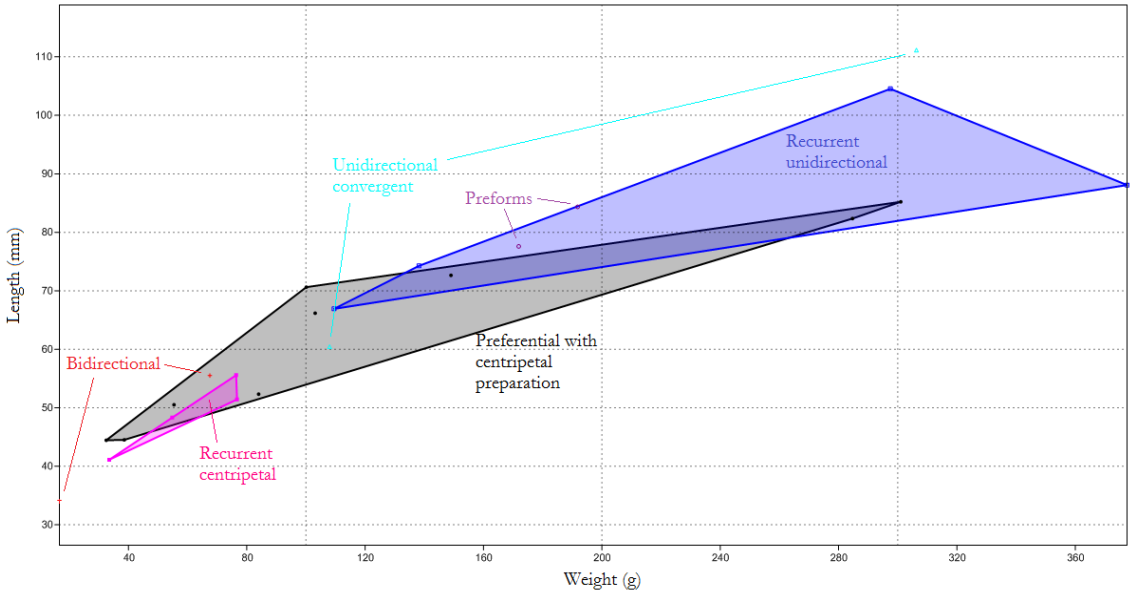



Figure 6.3. Scatterplot of weight vs. length for all complete JKF-1 Levallois cores.

Within Levallois cores, which are here highlighted as they are often suggested to reflect more preparatory investment than more opportunistic cores, a similar relationship between size and

typology exists (Figure 6.3). Clearly, caution is needed given the very small sample sizes. For instance, it is hard to contextualise the position of unidirectional-convergent –Levallois cores. The overall picture seems to be that unidirectional Levallois cores are the largest, grading into preferential cores with centripetal preparation, and finally recurrent centripetal and bidirectional Levallois cores are the smallest.

### 6.3) JKF-1 quartz cores

The majority of the quartz cores are small and demonstrate simple reduction processes, with few removals made from each core. Some, however, demonstrate a more sophisticated, Levallois-like, reduction strategy. A continuum of variability connects these two poles. With this in mind, Table 6.1 presents a typological classification of quartz cores at JKF-1. In terms of raw material variation, a number of types of quartz are present, distinguished by colour and apparent knapping characteristics. The most common is a white quartz with, in relative terms, apparently reasonable knapping qualities.

| **Core type** | **Number** |
|---|---|
| Single platform | 24 |
| amorphous/other | 11 |
| Bidirectional | 5 |
| Radial | 5 |
| Fragment | 4 |
| Multiplatform | 4 |
| Recurrent centripetal Levallois | 4 |
| Bidirectional Levallois | 2 |
| Preferential Levallois with centripetal preparation | 2 |

Table 6.1. Typology of JKF-1 quartz cores.

Figure 6.4 compares the length and width of cores according to this typological division. This suggests that single platform cores, while having a large range of size variability, are, alongside Levallois cores, typically towards the upper range of size variability. Aside from being typically relatively large, Levallois cores demonstrate a narrower range of basic morphological variability, supporting the idea that they demonstrate greater 'design' investment. The smallest cores are radial,

amorphous and multiplatform. These typically have similar size dimensions (30-40mm long, 20-30mm wide), perhaps indicating a threshold at which they were perceived to be too small and were abandoned.

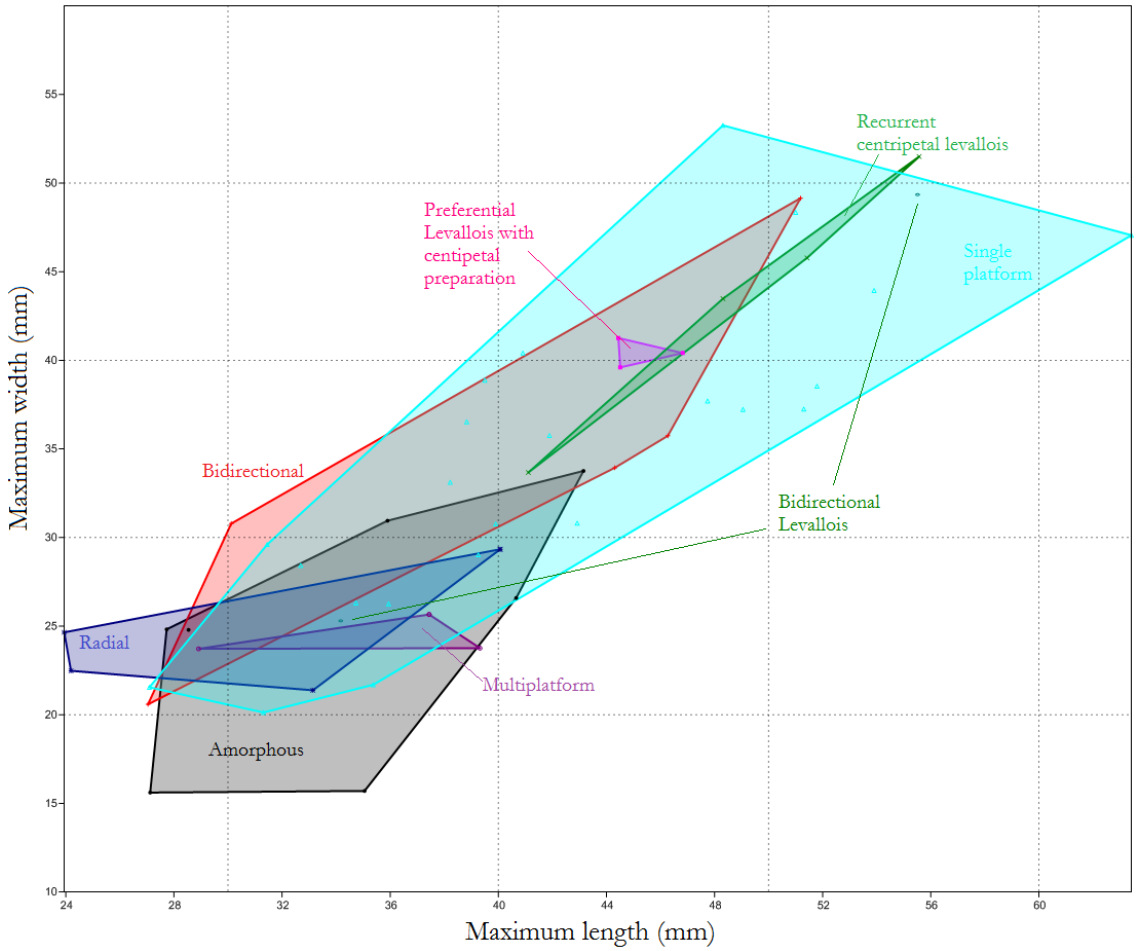



Figure 6.4. Scatterplot of length vs. width for all complete JKF-1 quartz cores arranged by typology.

Some general morphological and technological points can be made on the JKF-1 quartz cores. The form of raw material, rounded pebbles, gives a natural lateral and distal convexity and, therfore, an almost 'Levallois' like morphology without the need for extensive preparatory knapping (see Kuhn 1995 for a similar point elsewhere). This original form appears to be an important influence on the trajectory of reduction. Tables 6.2 and 6.3 present basic descriptive statistics for the quartz cores of JKF1. These are combined with qualitative observations to describe differences between core forms and hence hypotheses on the reduction process.

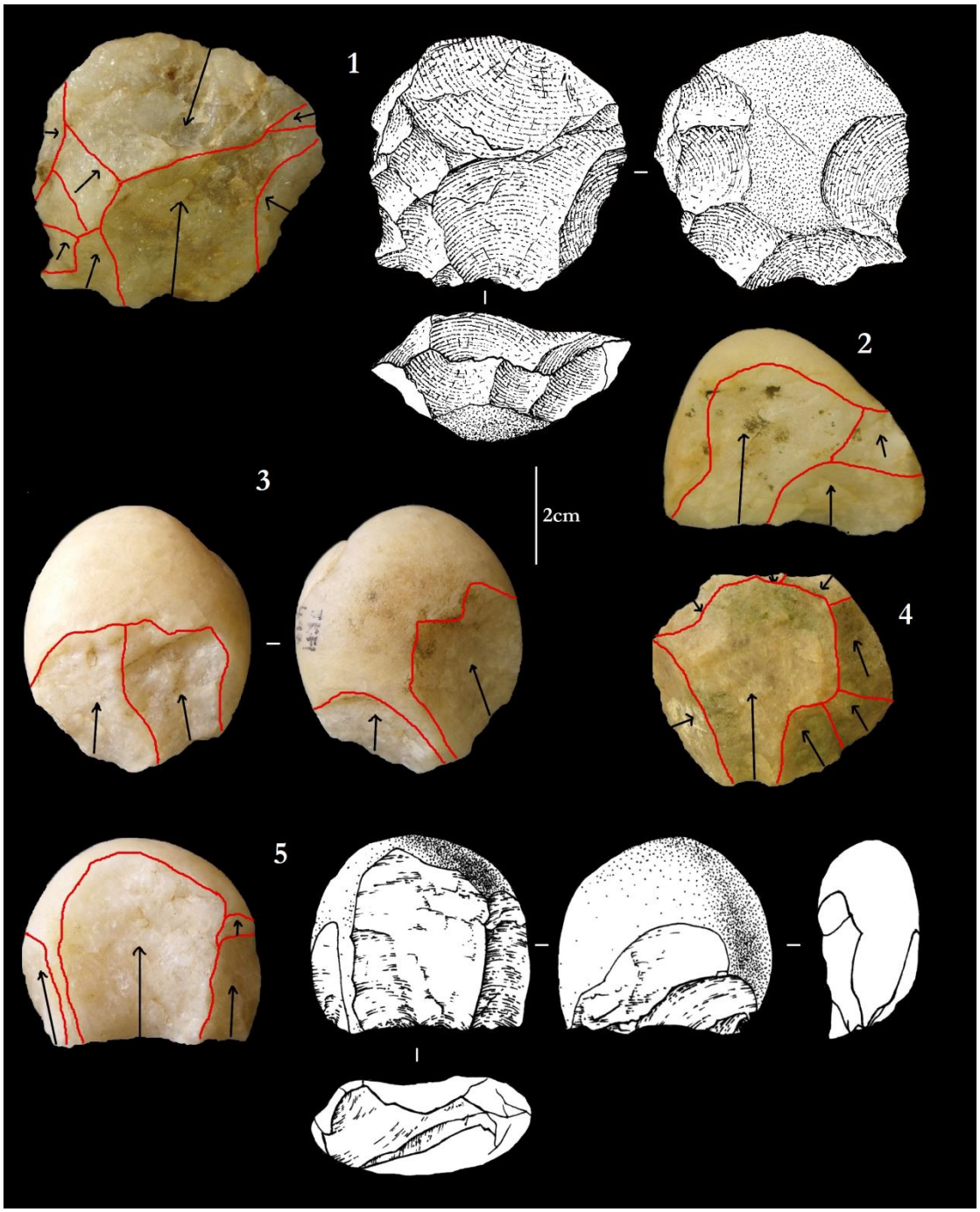


Figure 6.5. Illustrations and photographs of quartz cores from JKF-1. 1 – bidirectional Levallois (illustration by R. Crassard and G. Devilder), 2,5 – single platform (illustration by M. Terrade), 4 – preferential Levallois with centripetal preparation.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 48 | 45 | 48 | 48 | 48 | 48 | 47 | 46 | 21 |
| **Min** | 10 | 2 | 1 | 0 | 6.6 | 23.9 | 20.1 | 10.3 | 14.6 |
| **Max** | 80 | 15 | 8 | 5 | 140.3 | 63.4 | 53.3 | 37.8 | 37.3 |
| **Mean** | 39.8 | 7.1 | 4.5 | 1.3 | 41.1 | 41.2 | 34.4 | 21.9 | 24.7 |
| **Std. error** | 2.9 | 0.5 | 0.2 | 0.2 | 4.5 | 1.3 | 1.4 | 1.0 | 1.4 |
| **Std. dev** | 20.1 | 3.1 | 1.7 | 1.1 | 31.0 | 9.3 | 9.4 | 6.7 | 6.3 |
| **Median** | 35 | 7 | 5 | 1 | | | | | |
| **25 prcntil** | 21.3 | 5 | 3 | 0.25 | 17.6 | 34.3 | 25.7 | 17.5 | 19.8 |
| **75 prcntil** | 50 | 9 | 5 | 2 | 57.8 | 48.3 | 41.3 | 25.5 | 28.4 |
| **Skewness** | 0.5 | 0.5 | 0.2 | 1.2 | 1.4 | 0.1 | 0.3 | 0.5 | 0.3 |
| **Kurtosis** | -0.6 | 0.2 | -0.4 | 1.8 | 2.2 | -0.6 | -1.0 | 0.1 | -0.5 |

Table 6.2. Descriptive statistics of all complete JKF-1 quartz cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Sing. Plat.** | 52.2 | 5.7 | 3.6 | 1.2 | 44.9 | 42.0 | 34.4 | 22.4 | 25.2 |
| **Bidirectional** | 38 | 5.8 | 4.4 | 1.2 | 34.4 | 39.8 | 34.0 | 18.4 | 28.6 |
| **Radial** | 34 | 6.6 | 4.6 | 1 | 20.4 | 33.0 | 25.5 | 15.7 | 22.7 |
| **Multiplatform** | 13.8 | 10.5 | 6 | 1.8 | 43.6 | 40.2 | 30.1 | 23.1 | 14.8 |
| **Recurrent. cent. Lev.** | 26.3 | 11 | 1.4 | 1.5 | 28.2 | 39.4 | 31.7 | 22.3 | 15.0 |
| **Bidi. Lev.** | 20.0 | 9.5 | 5.5 | 2.0 | 42.1 | 44.9 | 37.4 | 23.1 | 17.6 |
| **Pref. Lev. Centrip. Prep.** | 27.5 | 8 | 5 | 1 | 35.6 | 44.5 | 25.2 | 19.8 | 25.3 |

Table 6.3. Descriptive statistics for complete JKF-1 quartz cores grouping by typology.

The most common type, single platform cores, represent the formation of a simple striking platform at one end of the pebbles and the removal of a small number of blanks from the long face of the core. In some cases it appears that a small number of lateral removals were made to exaggerate convexity. Their typically early position in the reduction process is supported by their high levels of cortex – a mean of 52.2%, compared to 39.8% for all quartz cores – and other factors such as small numbers of scars (see Table 6.). Despite the overall simplicity of these cores, even here there is evidence of a clear conceptual hierarchy between the surfaces, with steep removals to produce a striking platform and shallowly inclined removed from the debitage surface.

Despite the above, it can be observed that in some size related factors, the single platform cores are quite similar to other, seemingly more heavily reduced, core types. This may suggest that the more heavily reduced examples were produced on initially larger raw material packages. This suggests that factors such as size alone can be misleading, and need to be situated in terms of indicators of reduction intensity.

Aside from amorphous cores, whose technological features are typically unclear and seem to demonstrate simple and opportunistic removals, the next most common categories are bidirectional and radial cores. Bidirectional are similar to single platform cores, simply with the addition of a small number of removals from the distal end. They concordantly typically have slightly less cortex and more scars. The radial cores continue the trend of having less cortex and more scars and are typically small. Multiplatform cores similarly continue the trend to be heavily, having the lowest mean cortical coverage (13.8%) of all the core types and large numbers of scars. Despite this, multiplatform cores are typically relatively large and perhaps therefore indicate an initially large package size for this type.

Eight cores are classified as Levallois. Other scholars might not agree with this designation, but it is felt here to be justified on volumetric grounds and in terms of the dorsal scar patterns observed. The recurrent centripetal Levallois cores have the lowest mean percentage of cortex and the highest numbers of scars over 5mm of any core type. While these seem to be focussed on extracting large numbers of blanks, bidirectional Levallois cores produce the highest number of blanks over 1/3 the length of the core, emphasising the production of relatively large blanks. Preferential Levallois cores with centripetal preparation are associated, as might be expected, with long final scar lengths.

A final point to be made in relation to JKF-1 quartz cores concerns the evidence for minor 'battering' at one of the core (the distal). This has several possible interpretations. It may reflect the use of quartz pebbles as hammerstones. Alternatively it may represent failed attempts to obtain removals from the distal end of the core. There were unsuccessful because the sloping margins did not give a steep enough angle. The slight battering marks may also indicate the existence of bipolar reduction. Given the small size and physical characteristics of the raw material this is a distinct possibility, although morphological variability does not indicate that it played a major role.

### 6.4) JKF-1 quartzite cores

A total of 37 quartzite cores were recovered from JKF-1. Subtly varying colours and textures of quartzite are present and further study is required to understand this variability. Quartz cores may be more common than quartzite numerically, but in terms of volume of rock, quartzite is far more important. In addition the majority of the debitage is quartzite.

| Core type | Number |
|---|---|
| Amorphous/indeterminate | 7 |
| Preferential Levallois with centripetal preparation | 7 |
| Fragment | 4 |
| Recurrent unidirectional Levallois | 4 |
| Levallois preform/indeterminate | 4 |
| Multiplatform | 3 |
| Single platform core | 3 |
| Discoidal core | 2 |
| Unidirectional convergent Levallois | 2 |
| Recurrent centripetal Levallois | 1 |

Table 6.4. Typology of JKF-1 quartzite cores.

As shown in Table 6.4 the core assemblage is quite diverse typologically. Aside from amorphous cores, Levallois cores dominate the assemblage. As a generalisation (see Table 6.6 and Figure 6.6) Levallois cores, with a broadly unidirectional character, are larger, and discoidal, amorphous, multiplatform, radial, single platform and discoidal cores are smaller.

As shown in Figure 6.6 with the exception of a single multiplatform core, all of the quartzite cores share a closely similar relationship in length and width, as they do in other size variables. This would again suggest a reduction continuum. In fact, it is possible in some cases to see in a single core evidence for the evolution of the cores morphology. The case of the core shown in Figure 6.7 is instructive. Here three scars in the centre appear to preserve evidence for a phase of Levallois unidirectional convergent reduction. Subsequently the core has been radially flaked, somewhat casually, all the way around the circumference.

Faceting of at least primary platforms is common, but not particularly fine. Preferential removals vary in shape, from triangular/convergent to broadly oval (see Figure 6.8) The variable morphology of the cores seems to reflect the flexibility of the knappers, who adapted to variation in raw material form. In cases where knapping has been carried out in a centripetal manner there appears to be a

large number of aberrant terminations, perhaps as a reflection of the fracture qualities of the raw material. In fact as Table 6.6 shows, all core typologies at JKF-1 are characterised by high numbers of aberrant terminations, and this factor must be considered when we seek to understand the character of reduction at the site. Cortex is common on the base of the cores (Tables 6.5 and 6.6).

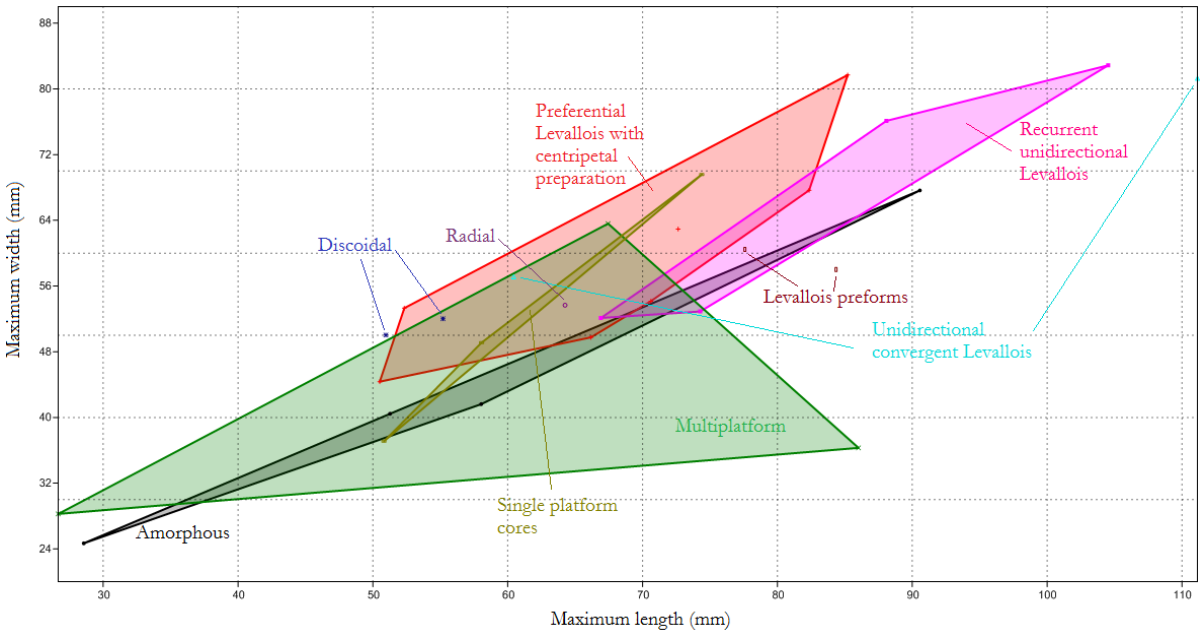



Figure 6.6. Scatterplot of length vs. width for all complete JKF-1 quartzite cores arranged by typology (nb, the single radial core shown is the rhyolite core).

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 25 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 15 |
| **Min** | 0 | 5 | 2 | 1 | 10.8 | 26.7 | 24.7 | 14.4 | 9.8 |
| **Max** | 75 | 23 | 9 | 8 | 377.5 | 111.2 | 82.9 | 54.0 | 73.8 |
| **Mean** | 21.2 | 12.6 | 5.3 | 3.2 | 153.5 | 67.7 | 55.4 | 30.2 | 34.2 |
| **Std. error** | 4.1 | 0.7 | 0.4 | 0.4 | 20.2 | 3.9 | 3.0 | 2.0 | 3.9 |
| **Std. dev** | 20.7 | 3.8 | 1.9 | 2.1 | 102.9 | 19.9 | 15.4 | 10.1 | 15.0 |
| **Median** | 20 | 12 | 5 | 2 | | | | | |
| **25 prcntil** | 0 | 10.8 | 4 | 2 | 80.7 | 52.1 | 47.9 | 23.7 | 24.9 |
| **75 prcntil** | 40 | 15 | 6.3 | 4.3 | 247.1 | 82.9 | 64.6 | 34.2 | 41.1 |
| **Skewness** | 0.6 | 0.3 | 0.2 | 0.9 | 0.6 | 0.0 | 0.0 | 0.7 | 1.0 |
| **Kurtosis** | -0.1 | 1.5 | -0.7 | -0.3 | -0.7 | 0.3 | -0.2 | 0.2 | 2.8 |

Table 6.5. Descriptive statistics of all complete JKF-1 quartzite cores.

Tables 6.6 and 6.6 present descriptive statistics for the quartzite cores. Focussing on the mean figures, a number of sources of evidence support the trajectory from broadly unidirectional Levallois to multiplatform, radial, discoidal and amorphous cores. The position of single platform cores is a little more complex. They are relatively small, but also typically have quite a high

percentage of cortex and relatively few scars. For such reasons they can be interpreted as a separate reduction sequence to that which is represented by Levallois cores in its earlier phases. All of the amorphous cores lack cortex, and are typically very small. When we consider multiplatform and discoidal cores these also have very little cortex, a high number of scars, high numbers of aberrant terminations in the case of the and they are smaller in linear dimensions than Levallois cores. The Levallois cores typically have around 12 or 13 scars over 5mm in length, or 4 or 5 over 1/3 the length of the core, weigh around 200 grams and have 2 or 3 aberrant terminations. They are usually around 70 to 80 mm in length and 60 to 70 mm wide and 30-35 mm thick.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Amorp/indet** | 0 | 7.5 | 5 | 1 | 24.6 | 39.9 | 32.6 | 18.5 | / |
| **Pref. Lev.** | 27.1 | 13.3 | 4.4 | 2.4 | 153.9 | 68.5 | 59.1 | 31.5 | 40.11 |
| **Unidir. Lev.** | 33.3 | 13.5 | 4.8 | 2 | 230.7 | 83.4 | 66.0 | 34.7 | 35.6 |
| **Lev. Preform/indet** | 13.3 | 13.0 | 4.0 | 5.7 | 162.8 | 75.4 | 57.4 | 32.0 | / |
| **Multiplat.** | 0.0 | 15.0 | 8.3 | 5.3 | 179.3 | 60.0 | 42.7 | 30.2 | 21.33 |
| **Sing. Plat.** | 40.0 | 10.7 | 4.7 | 4.3 | 103.5 | 61.1 | 51.9 | 25.7 | 15.54 |
| **Discoidal** | 5.0 | 14.0 | 8.0 | 2.5 | 95.8 | 53.1 | 51.0 | 28.1 | / |
| **Uni. Conv. Lev.** | 35.0 | 11.5 | 5.0 | 3.0 | 207.2 | 85.8 | 69.2 | 34.7 | 26.3 |

Table 6.6. Descriptive statistics for complete JKF-1 quartzite cores grouped by typology.

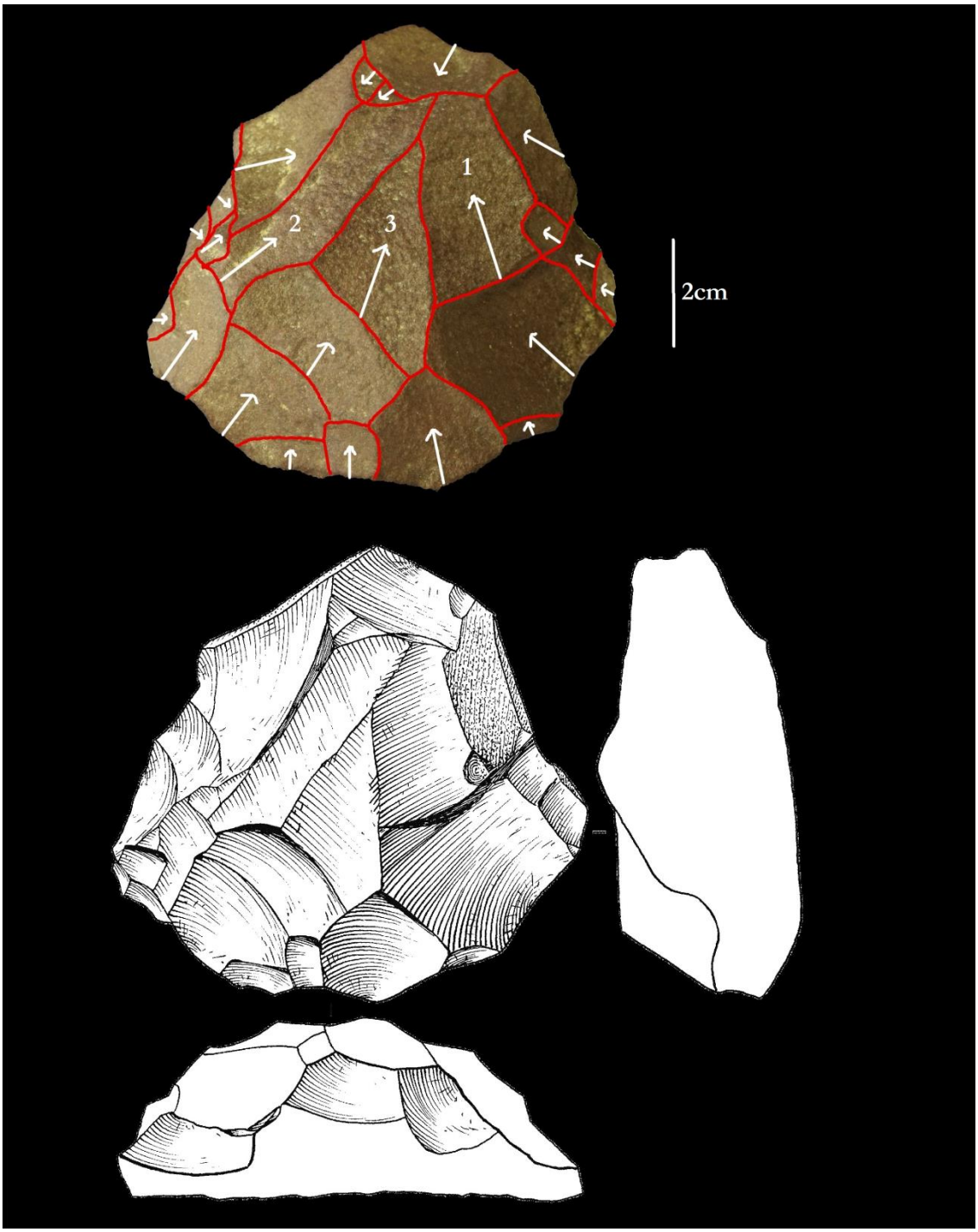


Figure 6.7. Photograph and illustration of multiplatform core from JKF-1. Interpreted as demonstrating an early unidirectional-convergent Levallois phase followed by a more opportunistic series of centripetal removals around the perimeter (illustration R. Crassard and G. Devilder).

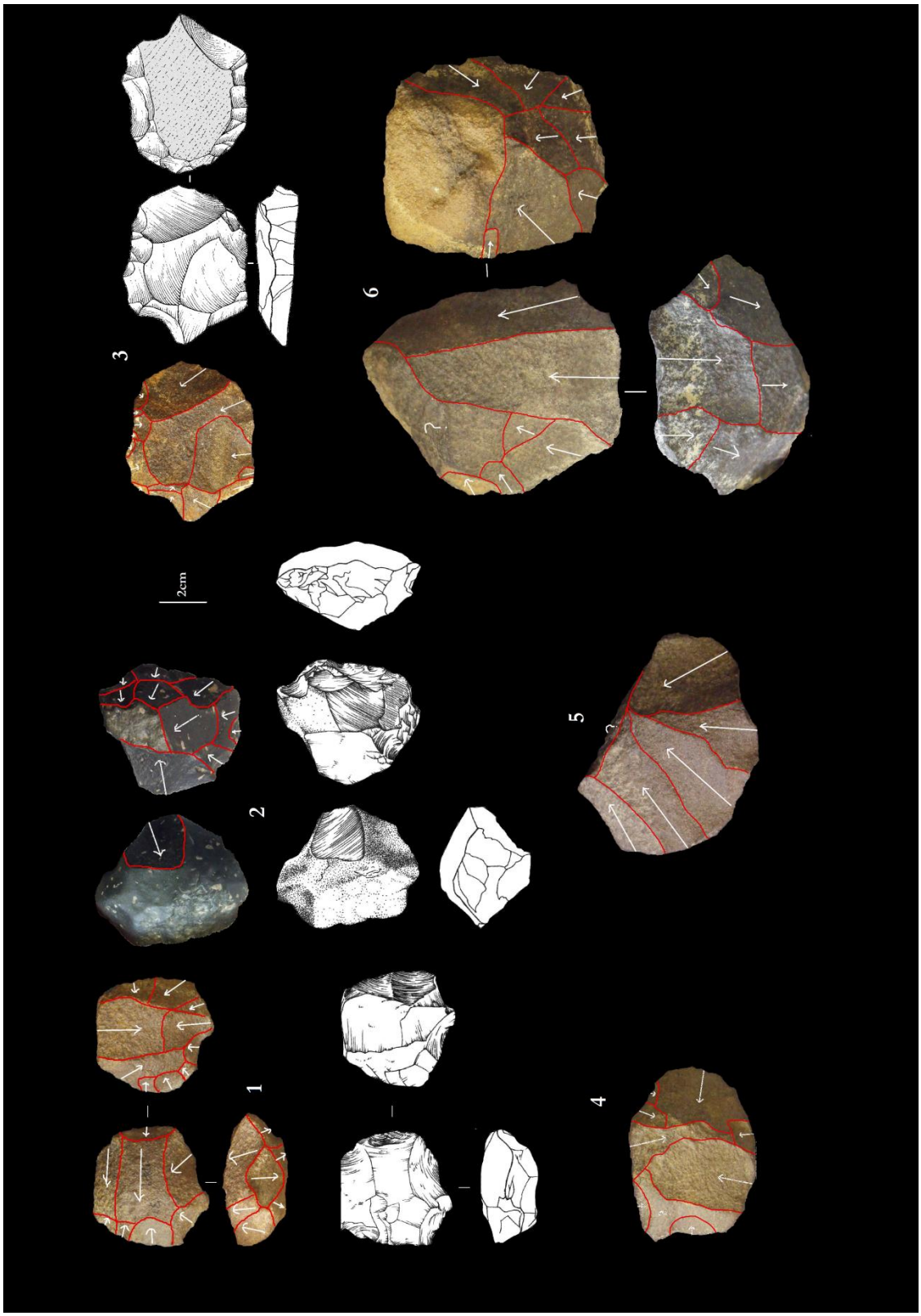


Figure 6.8. Examples of quartzite and rhyolite cores from JKF-1. 2 = rhyolite, all others = quartzite. 1 – discoidal core (illustration M. Terrade), 2 – radial core (illustration M. Terrade), 3 and 4 – preferential Levallois core with centripetal preparation (illustration R. Crassard and G. Devilder), 5 – unidirectional convergent Levallois core.

### 6.5) JKF-12 core technology

A total of eight cores were collected from the transects through JKF-12. A number of very large Levallois cores were also identified here, but were not removed for analysis for logistical reasons. The site appears to be the raw material source for the quartzite at JKF-1, so is of interest from this perspective. All cores are made of quartzite.

| Core type | Number |
|---|---|
| Recurrent unidirectional Levallois | 3 |
| Multiplatform | 2 |
| Unidirectional convergent Levallois | 1 |
| Nubian type 1 like/bidirectional Levallois point core | 1 |
| Preferential Levallois with centripetal preparation | 1 |

Table 6.7. Typology of JKF-12 cores.

Descriptive statistics for JKF-12 cores are presented in Tables 6.8 and 6.9. The technology of the cores is quite diverse, but mostly Levallois. In fact, for the moment we will consider the assemblage with the exception of the multiplatform cores. The larger cores can be classified as unidirectional Levallois, the medium sized as unidirectional convergent Levallois and Nubian type-1 like, and the smallest a single example of a preferential Levallois cores with centripetal preparation.

Despite the small number of cores in the assemblage, two of them make good examples of the important qualitative information which can be gained in such cases. Firstly, is the Nubian like core (number 1 in Figure 6.9). This shows the removal of a triangular preferential blank from a faceted platform, with two preparatory distal-divergent scars. These scars have created a median-distal ridge upon which the preferential removal has terminated, and this is the essence of the Nubian Technique. This is the first reported presence of this technology in northern Arabia. The significance of a single specimen is unclear, and the site will be the examined further in future fieldwork, but is of significance in terms of on-going debate about the Nubian Complex (e.g. Rose *et al.* 2011, Usik *et al.* in press).

The second example relates to one of the 'multiplatform' cores (number 4, Figure 6.9, this could also technically be described as a core on flake). This reveals both the flexibility of the knappers at JKF-12 and considerable insights into the reduction process at the site. The core began as a large

flake, at least 120mm long and 150mm wide. This was centripetally prepared in a clockwise manner and must have been removed from a large core. The flake broke, either when struck or subsequently. After this it was picked up and recognised to be of suitable morphology to act as a core. A preparatory removal was made and a preferential removal struck from what had been the distal end of the flake. A further two removals were made from the corner of the core, both ending in hinge terminations, and it was abandoned.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 |
| **Min** | 0.0 | 5.0 | 3.0 | 1.0 | 128.0 | 67.2 | 51.0 | 33.0 | 46.4 |
| **Max** | 50.0 | 23.0 | 13.0 | 6.0 | 1041.0 | 168.4 | 122.6 | 81.1 | 107.5 |
| **Mean** | 20.6 | 13.9 | 5.5 | 2.6 | 605.5 | 111.6 | 94.3 | 49.3 | 62.8 |
| **Std. error** | 6.7 | 2.3 | 1.2 | 0.6 | 117.4 | 10.7 | 7.9 | 5.7 | 8.7 |
| **Std. dev** | 19.0 | 6.4 | 3.3 | 1.6 | 332.1 | 30.2 | 22.4 | 16.2 | 23.1 |
| **Median** | 15.0 | 13.5 | 5.0 | 2.5 | | | | | |
| **25 prcntil** | 2.5 | 8.8 | 3.0 | 1.3 | 295.5 | 90.2 | 80.0 | 36.8 | 46.6 |
| **75 prcntil** | 38.8 | 20.8 | 6.0 | 3.0 | 953.4 | 125.6 | 110.2 | 59.6 | 80.7 |
| **Skewness** | 0.4 | 0.4 | 2.0 | 1.4 | -0.1 | 0.6 | -0.9 | 1.1 | 1.6 |
| **Kurtosis** | -1.4 | -0.6 | 4.6 | 2.7 | -0.9 | 1.2 | 1.0 | 0.9 | 1.7 |

Table 6.8. Descriptive statistics of all complete JKF-12 cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Rec. uni lev** | 23.3 | 14.0 | 7.0 | 2.0 | 427.8 | 90.5 | 80.7 | 49.2 | 58.6 |
| **Multiplat.** | 25.0 | 13.5 | 5.5 | 4.0 | 892.9 | 147.1 | 104.0 | 58.9 | 51.8 |
| **Uni. Conv. Lev** | 10 | 5 | 3 | 1 | 537.2 | 113.7 | 103.9 | 40.0 | 57.7 |
| **Nubian like.** | 0 | 14 | 6 | 3 | 214.9 | 88.2 | 77.7 | 37.2 | 46.6 |
| **Pref. Lev with centrip. Prep.** | 35 | 23 | 3 | 3 | 1023 | 125.0 | 122.7 | 51.7 | 107.5 |

Table 6.9. Descriptive statistics for complete JKF-12 cores grouped by typology.

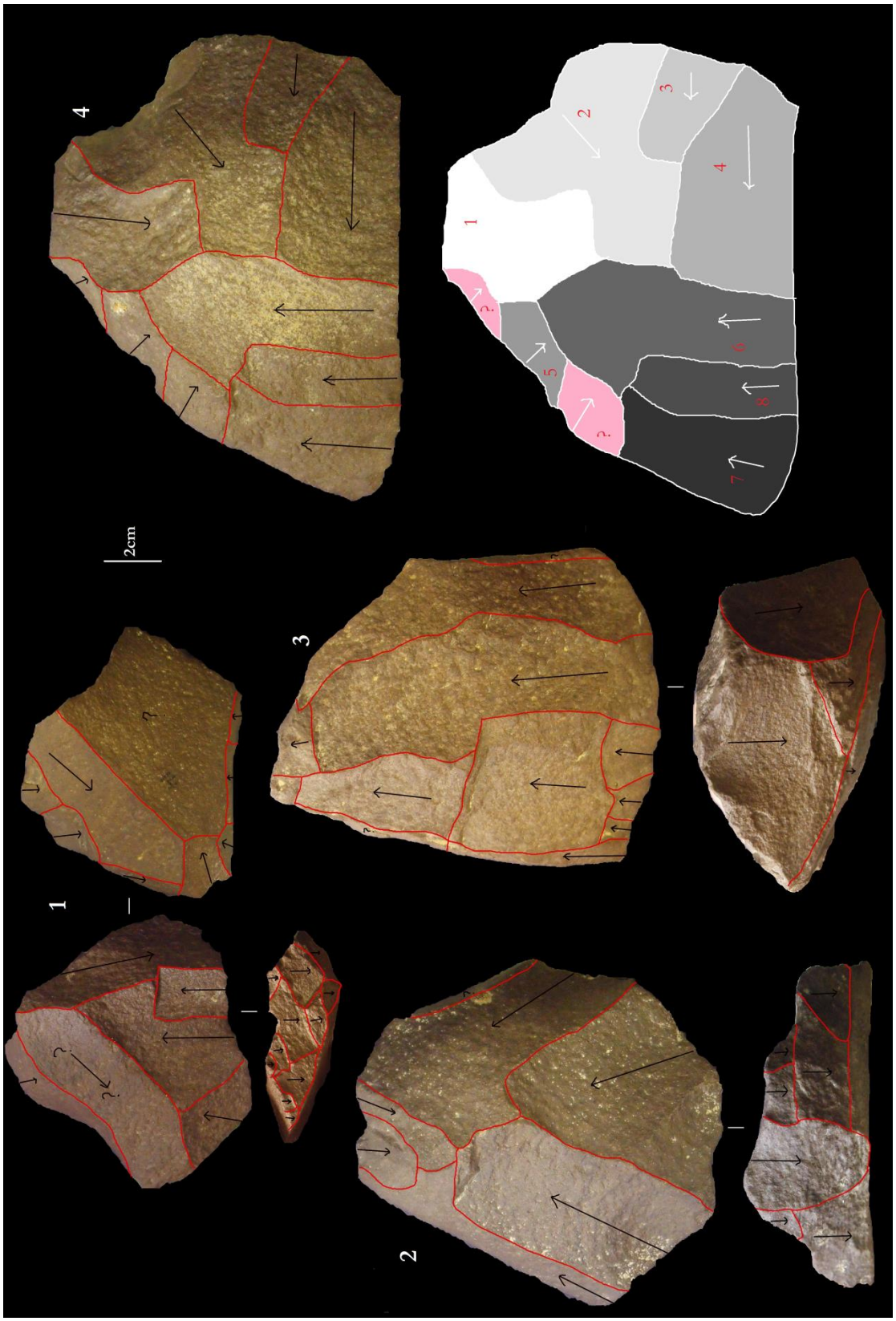


Figure 6.9. Photograph and diacritic illustration of examples of JKF-12 cores. 1 – Nubian Type-1 like core, 2 – unidirectional convergent Levallois core, 3 – unidirectional Levallois core, 4 – multiplatform core (on large flake).

### 6.6) JSM-1 core technology

10 cores were collected from JSM-1, half from the surface and half from excavation. They are treated here as a single assemblage. As discussed earlier, the site is associated with a single narrow seam of fairly fine grained yellow siliceous quartzite-like material, which was not observed anywhere else in the Jubbah area. This is of interest as the narrow thickness of the seam, and hence the resultant cores, suggests it would have been difficult to re-prepare Levallois cores, so a single cycle of reduction may be represented.

| Core Type | Number |
|---|---|
| Preferential Levallois with centripetal preparation | 5 |
| Levallois preform/radial | 3 |
| Fragment/indeterminate | 2 |

Table 6.10. Typology of JSM-1 cores.

The assemblage appears extremely technologically homogenous. With the exception of two fragmentary specimens of indeterminate character, the cores can either be regarded as pre-cores of as struck preferential Levallois cores. Number 2 in Figure 6.10 is a good example of a preform. It appears to have not been struck, nor the 'proximal' end faceted, because, perhaps, the preparatory removals were rather steep and several ended in aberrant terminations. The struck cores (numbers 1,3 and 4 in Figure 6.10) demonstrate a similar morphology to the preforms, but with large preferential removals struck from faceted platforms. The undersides are partly cortical, and the debitage surfaces feature a high number of preparatory scars.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 9 | 6 |
| **Min** | 10 | 6 | 2 | 0 | 41.1 | 53.0 | 40.5 | 15.0 | 20.4 |
| **Max** | 40 | 18 | 7 | 4 | 171.2 | 83.2 | 66.8 | 33.2 | 65.3 |
| **Mean** | 32.9 | 11.9 | 4.7 | 1.3 | 85.6 | 66.4 | 54.1 | 22.6 | 40.2 |

Table 6.11. Descriptive statistics of all complete JSM-1 cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) |
|---|---|---|---|---|---|---|---|---|
| **Pref. Lev core** | 27.5 | 12.5 | 5.5 | 1.3 | 61.9 | 61.6 | 56.1 | 20.2 |
| **Preform** | 40 | 11 | 3.7 | 1.3 | 117.3 | 72.9 | 51.5 | 25.7 |

Table 6.12. Descriptive statistics of all complete JSM-1 cores grouped by typology.

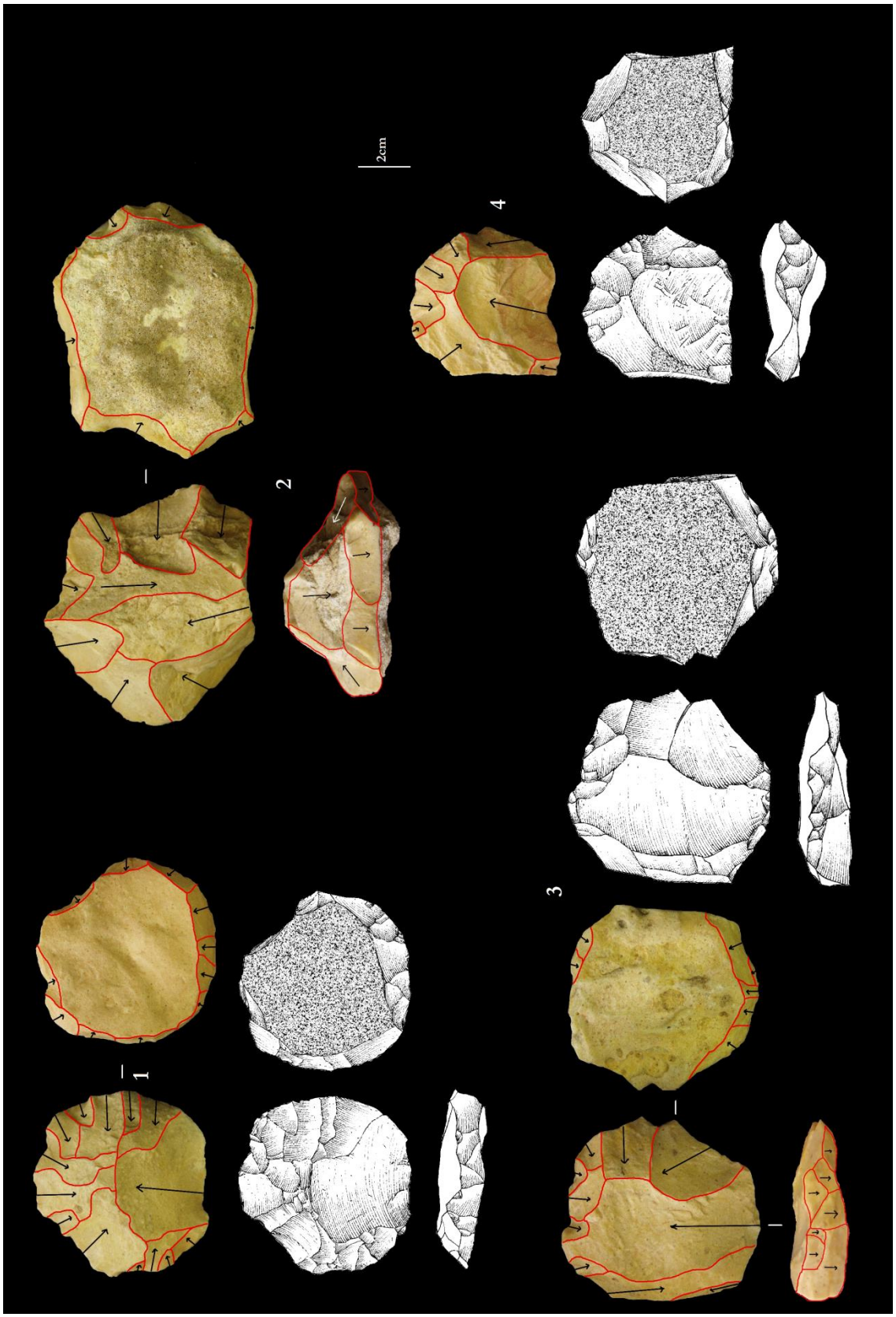


Figure 6.10. Photographs and illustrations of examples of JSM-1 cores. 1, 3, 4 – preferential Levallois cores with centripetal preparation. 2 – Levallois preform (illustrations R. Crassard).

### 6.7) JQ-1 core technology

The final assemblage from Jubbah to be considered in the present work is that of JQ-1. This assemblage includes nine cores. Seven of the nine cores are of quartzite/sandstone, the distinction between these categories in the raw material of this area being rather blurry, and one each of quartz and rhyolite.

The single rhyolite core can be regarded as preferential Levallois, with centripetal preparation. The single quartz core is a simple single platform core similar to examples found at JKF-1. The sandstone/quartzite cores are dominated by centripetal removals, which can be divided in a typological scheme into radial, discoidal, recurrent centripetal Levallois and in one case a Levallois like core with centripetal preparation and a preferential removal. In all cases the cores are small and heavily reduced (exhausted) and so typological divisions may only tell us about the final few removals. All cores are interpreted as being complete.

| Core type | Number |
|---|---|
| Discoidal | 2 |
| Preferential Levallois with centripetal preparation | 2 |
| Recurrent centripetal Levallois | 2 |
| Levallois preform | 1 |
| Radial | 1 |
| Single platform | 1 |

Table 6.13. Typology of JQ-1 cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 2 |
| **Min** | 0 | 8 | 5 | 0 | 25.9 | 37.17 | 31.4 | 17.9 | 29.2 |
| **Max** | 40 | 18 | 9 | 3 | 108.3 | 58.9 | 53.8 | 31.8 | 30.9 |
| **Mean** | 8.9 | 14.3 | 7.1 | 1 | 45.3 | 47.6 | 38.7 | 21.8 | 30.0 |

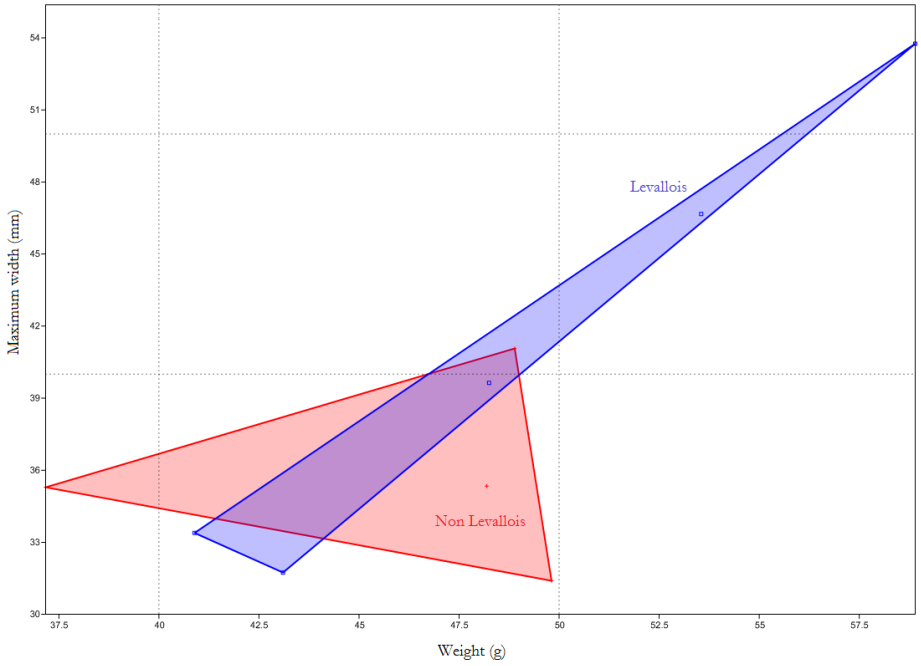
Table 6.14. Descriptive statistics of all complete JQ-1 cores.

The JQ-1 assemblage possesses a certain homogeneity, primarily in terms of the heavily centripetal character of reduction and the small size of the cores. In terms of size and indicators of reduction, there is no obvious indication of typology relating to different moments of a common reduction cycle. This might lead us to suppose a diversification of the precise mode of reduction according to the character of raw material form. For instance, the recurrent centripetal Levallois method perhaps

being favoured on thin pieces of raw material, a reflection of these cores origin in quartzite seams; number 1 in Figure 6.12 is a clear example of this, with the lower surface being entirely cortical. In other cases, where the form of the raw material played less of a role in favouring a hierarchical relationship between surfaces, a more discoidal like core appears to be have resulted. On the other hand Figure 6.11 compares length and weight for non-Levallois and Levallois cores and suggests, with small sample size again acknowledged, that Levallois cores followed a narrow range of variation in terms of these attributes. Non-Levallois cores are more diverse, and perhaps represent a more opportunistic approach to reduction when the core became small.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) |
|---|---|---|---|---|---|---|---|---|
| **Discoidal** | 0 | 15 | 8.5 | 1.5 | 26.7 | 39.0 | 34.3 | 19.9 |
| **Pref. Lev.** | 10 | 16.5 | 6.5 | 0.5 | 49.0 | 49.4 | 36.2 | 24.4 |
| **Rec. Lev.** | 20 | 14 | 8 | 1 | 44.2 | 50.9 | 43.2 | 19.6 |
| **Lev. preform** | 0 | 18 | 7 | 3 | 108.3 | 58.9 | 53.8 | 31.8 |
| **Radial** | 0 | 12 | 5 | 0 | 34 | 48.2 | 35.3 | 17.9 |
| **Sing. Plat.** | 20 | 8 | 6 | 0 | 27 | 43.1 | 31.7 | 19.2 |

Table 6.15. Descriptive statistics for complete JQ-1 cores grouped by typology.




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Figure 6.11. Scatterplot of weight vs. width for all complete JQ-1 cores grouped by Levallois versus non-Levalois typology.

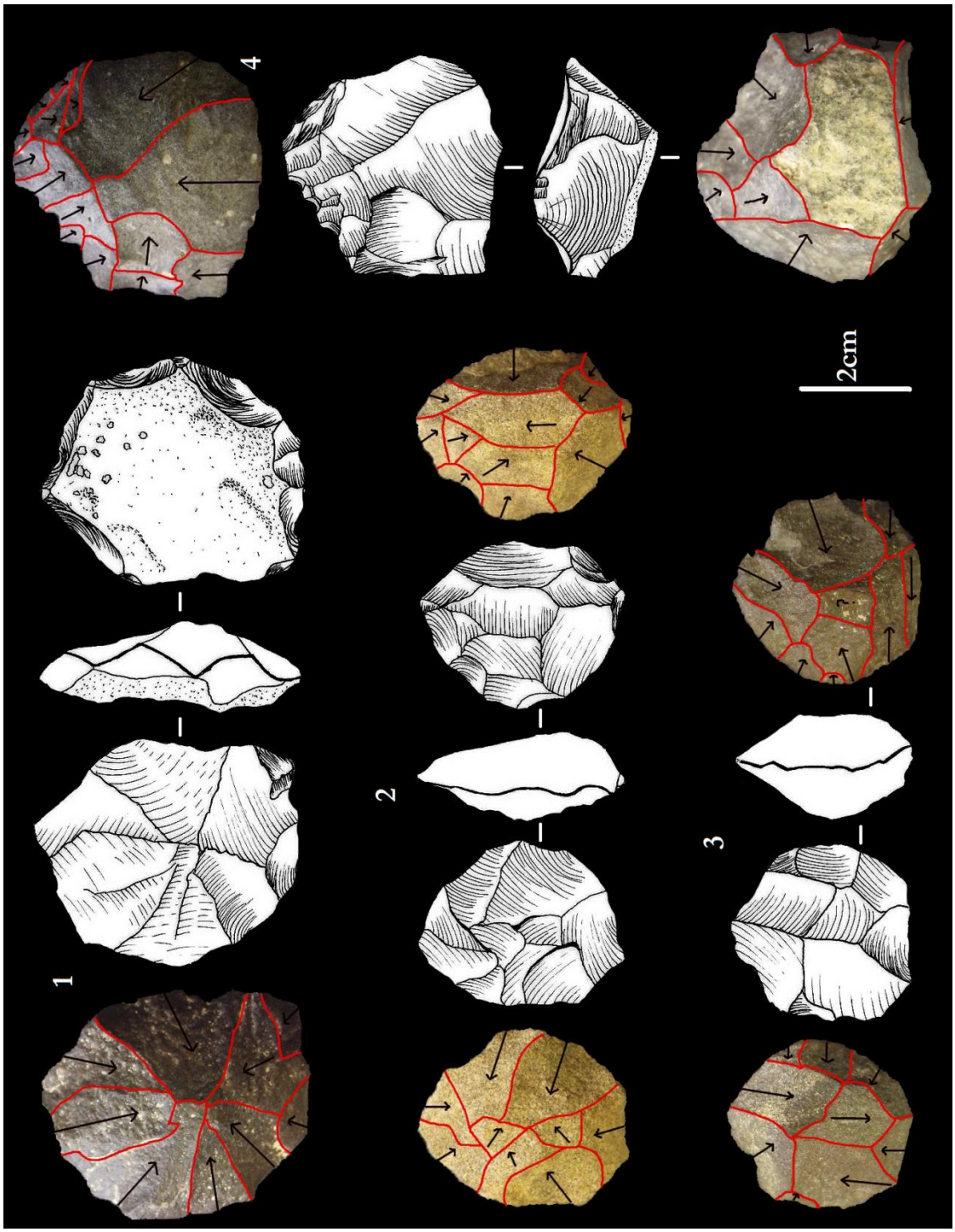


Figure 6.12. Photographs and illustrations of examples of JQ-1 cores. 1, 2 – recurrent centripetal Levallois core, 3 – discoidal core, 4 – preferential Levallois with centripetal preparation (illustrations by R. Crassard)

**6.8) 123-b core technology**

The 125 cores at 123-b, all manufactured on high quality *Mudayy* flint, give a robust insight into the character of reduction at the site. Table 6.16 presents the typological division of the cores. In outline, it is clear that Nubian, and particularly Nubian Type 1, reduction dominate the assemblage. In addition a small number of other, non-Levallois, core types are present. These are characterised by flat debitage surfaces.

| **Core type** | **Number** |
|---|---|
| Nubian type 1 | 50 |
| Early stage Nubian type 1 | 36 |
| Nubian other (type 2/indet.) | 22 |
| Single platform core | 11 |
| Bidirectional core | 3 |
| Amorphous/indeterminate | 3 |

Table 6.16. Typology of 123-b cores.

The largest category consists of Nubian Type 1 cores. In the approach adopted here this refers to struck cores, from which a broadly triangular preferential removal has been struck from a faceted platform. These cores are primarily defined as Nubian due to their prominent median distal ridges. The distinction between Type 1 and Type 2 Nubian is somewhat arbitrary (see e.g. Usik *et al.* in press). In the present study the distinction is made on the grounds of the preparatory flakes forming the median distal ridge, and not the rest of the core. In the case of Type-1 cores, the scars forming the ridge are from the distal end. At least eleven of these cores have been struck and 'mildly re-prepared' after the removal of a preferential blank, and seven have been heavily re-prepared. The 'Nubian other' category refers either to Type 2 Nubian cores, or to Nubian-like cores whose precise character is unclear, for reasons such as breakage or weathering.

The category of 'early stage Nubian type 1' requires some explanation as this is not a commonly used category. It has been claimed that Nubian cores demonstrate centripetal preparation of the debitage surface followed by preparation of the Median distal ridge (e.g. Foley *et al.* in press). There may be regional variation here, but in the case of 123-b it is a clear and distinctive feature of the assemblage that the median distal ridge is prepared *before* the preparation of the rest of the debitage surface. This is visible in a number of cores which are primarily cortical but feature a clear attempt

to form what would become a median distal ridge (e.g. number 7 in Figure 6.16). Within the 'early' category a distinction can be made between an early stage (25 cores) and a late stage (11) of preparation.

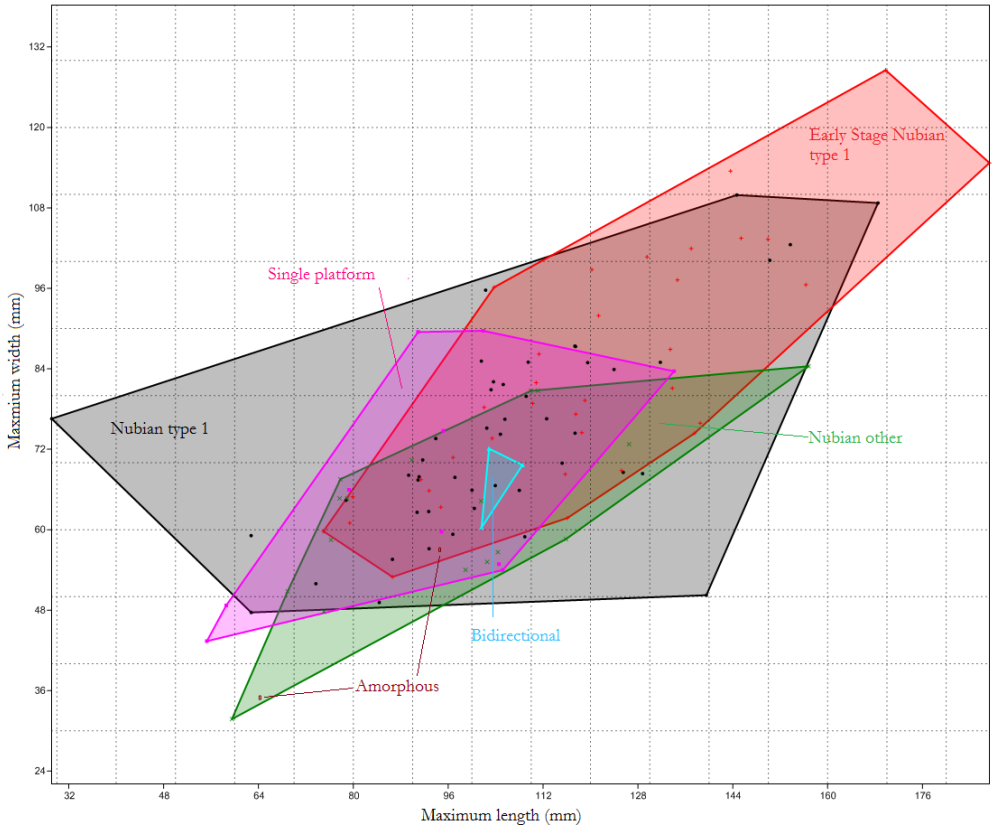



Figure 6.13. Scatterplot of length vs. width for all complete 123-b cores arranged by typology.

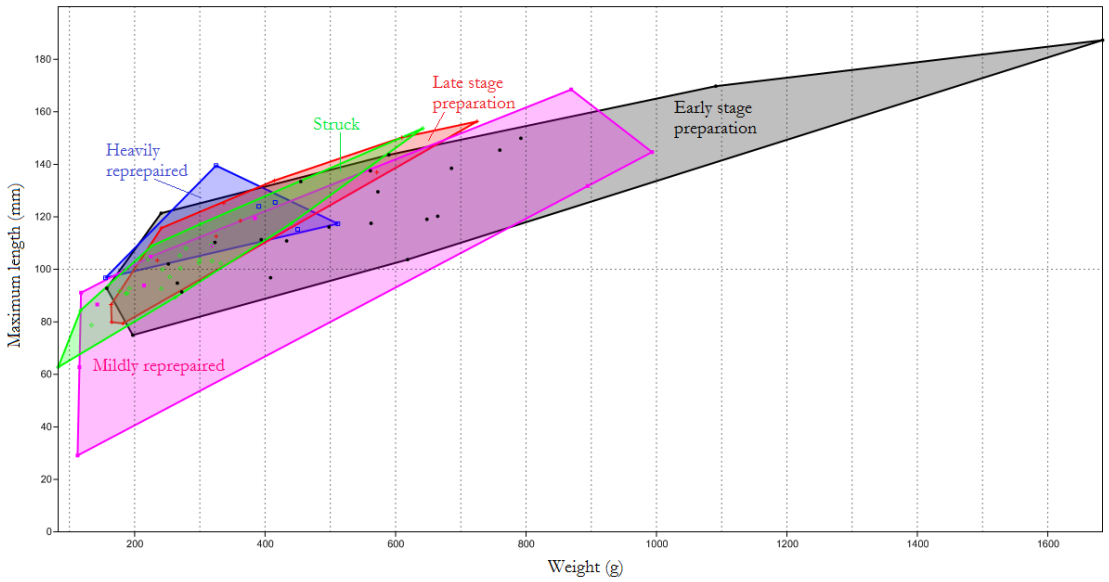



Figure 6.14. Scatterplot of weight vs. length for complete sub-types of Nubian core at 123b.

As Figures 6.13 shows, in terms of basic size attributes, there is considerable overlap between core types. In general, non-Nubian cores exist towards the smallest range of size variability. Figure 6.14 (above below) compares weight and thickness for the different types of Nubian core. As would be predicted the largest are cores at an early stage of preparation. A couple of outliers aside, the pattern of decreasing weight is at we would expect given a reduction centred perspective, next late stage preparation, then struck, then re-prepared. These points are broadly supported by the descriptive statistics presented in Tables 6.17 and 6.18.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 78 | 97 | 108 | 108 | 108 | 108 | 108 | 108 | 54 |
| **Min** | 0.0 | 5.0 | 1.0 | 0.0 | 30.2 | 29.1 | 31.8 | 18.6 | 27.4 |
| **Max** | 60.0 | 23.0 | 9.0 | 5.0 | 1791.0 | 187.3 | 128.6 | 99.1 | 105.2 |
| **Mean** | 17.4 | 12.8 | 4.5 | 1.0 | 374.5 | 108.7 | 74.8 | 43.0 | 66.1 |
| **Std. error** | 1.8 | 0.4 | 0.2 | 0.1 | 28.1 | 2.5 | 1.7 | 1.3 | 2.6 |
| **Std.dev** | 16.3 | 3.6 | 1.6 | 1.0 | 292.1 | 26.1 | 17.8 | 13.6 | 19.3 |
| **Median** | 12.5 | 13.0 | 4.0 | 1.0 | | | | | |
| **25%** | 0.0 | 10.5 | 3.0 | 0.0 | 186.9 | 91.5 | 63.2 | 34.2 | 50.7 |
| **75%** | 30.0 | 15.0 | 6.0 | 2.0 | 453.5 | 123.5 | 84.9 | 50.8 | 80.8 |
| **Skewness** | 0.7 | 0.0 | 0.3 | 1.0 | 2.3 | 0.3 | 0.5 | 1.2 | 0.1 |
| **Kurtosis** | -0.2 | 0.1 | -0.2 | 1.3 | 7.6 | 0.7 | 0.2 | 2.8 | -0.7 |

Table 6.17. Descriptive statistics of all complete 123-b cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Nubian type 1** | 14.4 | 13.7 | 5.0 | 1.0 | 303.2 | 103.2 | 72.4 | 39.6 | 65.4 |
| **Early type 1** | 27.5 | 11.3 | 3.9 | 1.2 | 498.4 | 120.0 | 83.6 | 52.0 | / |
| **Nub. other** | 14.0 | 13.2 | 4.0 | 0.9 | 334.0 | 102.6 | 66.0 | 36.2 | 65.4 |
| **Single plat.** | 15.7 | 10.1 | 4.4 | 1.5 | 332.1 | 92.0 | 66.4 | 50.3 | 61.1 |
| **Bidirectional** | / | 12 | 7 | 5 | 292.2 | 104.3 | 67.4 | 38.6 | 55.61 |
| **Amorph/other** | 0 | 6.5 | 4 | 1 | 363.4 | 99.9 | 65.7 | 38.5 | / |

Table 6.18. Descriptive statistics for complete 123-b cores groups by typology.

As the distinctive feature of Nubian technology, the median distal ridge of 123-b's Nubian cores was analysed by measuring the thickness of the ridge. As shown in Figure 6.15 the thickness of the ridge in most cases is between 20 and 30mm, a narrow range of variation. The similarity in the values for all cores, and cores from which a preferential removal were subsequently struck are of interest as they support the argument that the initial preparation of the ridge was the critical first step in the Nubian reduction process.

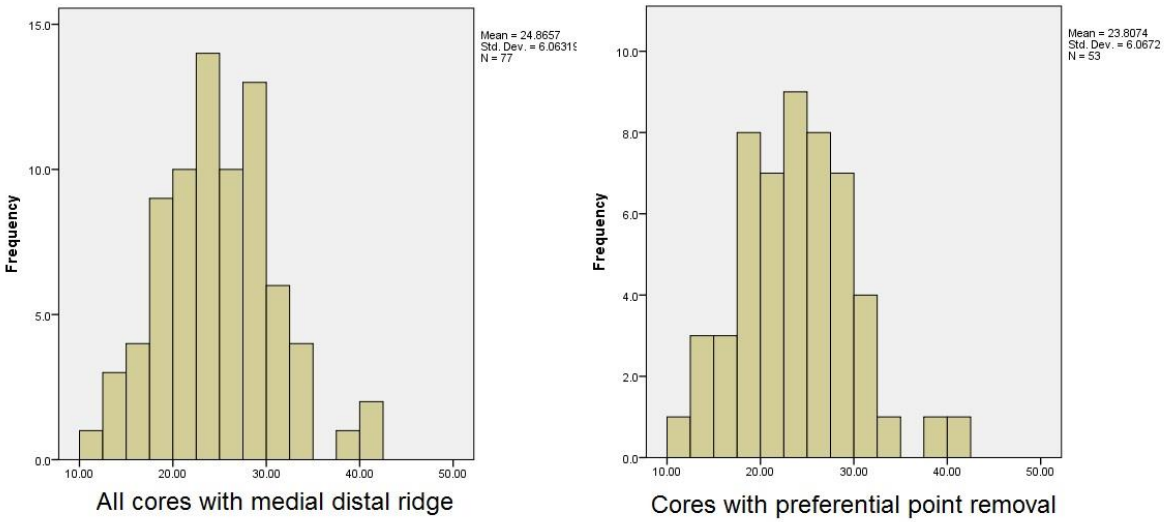



Figure 6.15. Histograms of median distal ridge thicknesses for all complete Nubian cores at 123-b. Left – all cores showing a median distal ridge, right – cores from which a preferential point has clearly been removed.

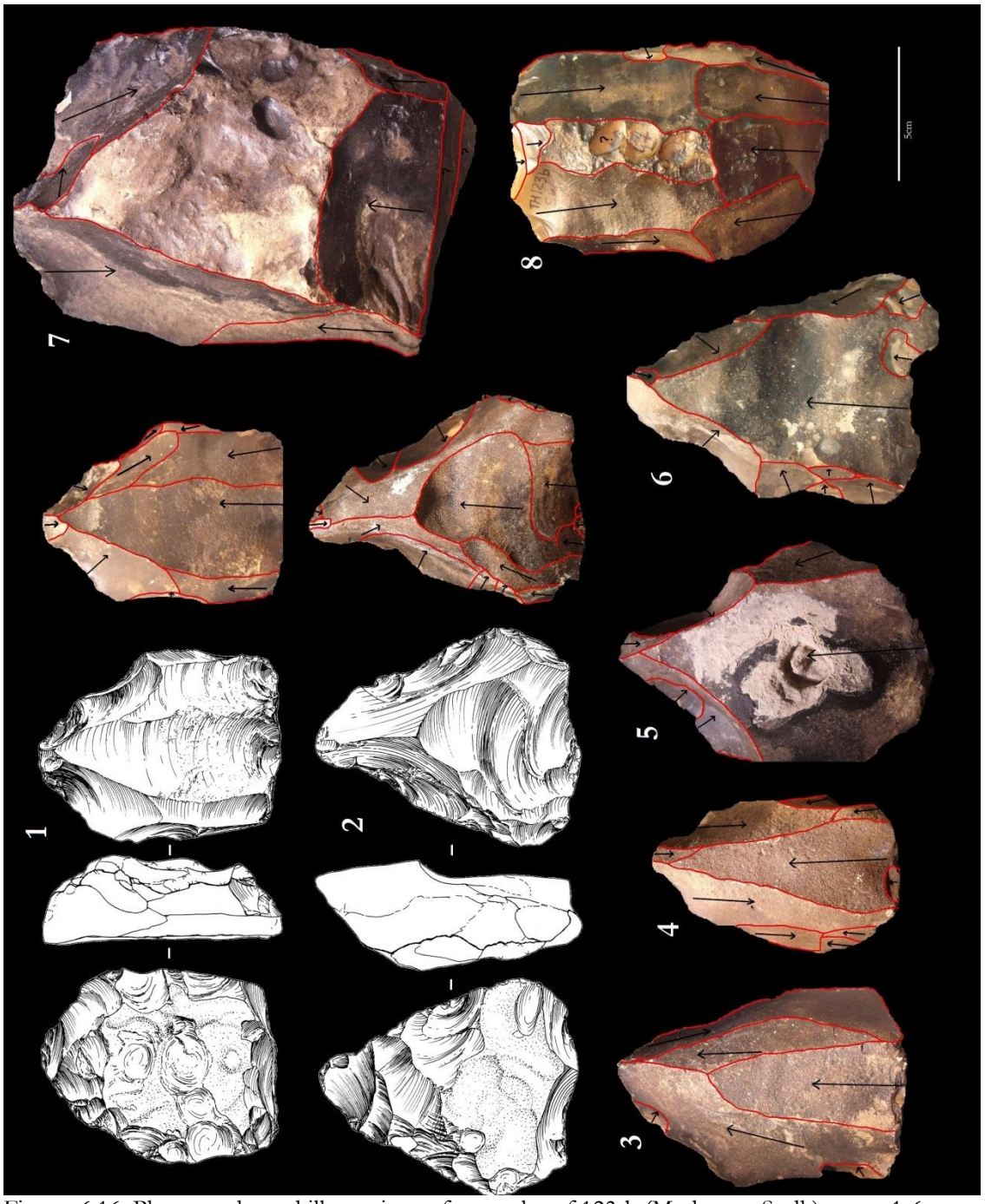


Figure 6.16. Photographs and illustrations of examples of 123-b (Mudayy as Sodh) cores. 1-6 – Nubian Type 1 Levallois cores, 7 – early stage Nubian core (preform), 8 – bidirectional core (illustrations modified from Rose *et al.* 2011).

### 6.9) Porc Epic C core technology

The typology of the layer C cores is shown table 6.19. Most (78%) are made on flint, with other rock types only accounting for two to four specimens each. The diversity of raw materials, within these broad categories, is considerable and complex. The cores of obsidian, which is believed to be an exotic raw material at the site, are small and heavily reduced.

| Raw mat. | Tested | Amorph. | Bidir. | Mulitplat. | discoidal | Pref. Lev | Rec. Cent. Lev | Rec. Uni. Lev. | Lev. Other. |
|---|---|---|---|---|---|---|---|---|---|
| Flint | 1 | 8 | / | / | 9 | 12 | 3 | 2 | 4 |
| Obsidian | / | / | / | / | / | / | 1 | 1 | / |
| Basalt | / | 2 | 1 | / | / | / | / | / | / |
| Quartzite | / | / | 1 | / | / | / | / | / | 1 |
| Quartz | 1 | 2 | / | 1 | / | / | / | / | / |

Table 6.19 Typology of Porc Epic layer C cores.

Layer C cores are small, heavily reduced and in many cases rather fragmentary. Several also have extensive calcification. There is little evidence for faceting. Aside from their diminutive size, the most distinctive feature of these cores is their heavily centripetal character.

A distinctive feature of the layer C assemblage is the prevalence of Levallois cores. Additionally, it is likely that many of the discoidal and amorphous cores were previously Levallois. In the case of the former, a few removals from a centripetal Levallois core could have resulted in a discoidal morphology.

The high levels of amorphous cores reflects the extensively reduced character of the assemblage. Among the fairly diverse Levallois cores, preferential Levallois cores with centripetal preparation are the most common category. These produced preferential flakes, generally of an oval character but including some convergent removals indicating that 'points' were produced by both 'debitage' and 'façonnage' methods.

The first point to make about the distribution of weight vs. length values shown in Figure 6.17 is the consistent relationship between these attributes, across typologies. This suggests an organised relationship of reduction and, to this author at least, the transformation of one core type into another. While there is considerable overlap, as a generalisation it appears that Levallois cores are typically larger and discoidal and amorphous cores smaller. These distinctions are, however, not

pronounced as the cores are fairly homogenous in size (i.e. small) characteristics. This suggests the size at which reduction was abandoned. If the core could be reduced to this point by Levallois methods then it was, if not, perhaps due to the presence of aberrant terminations on the debitage surface, then the reduction method was altered.

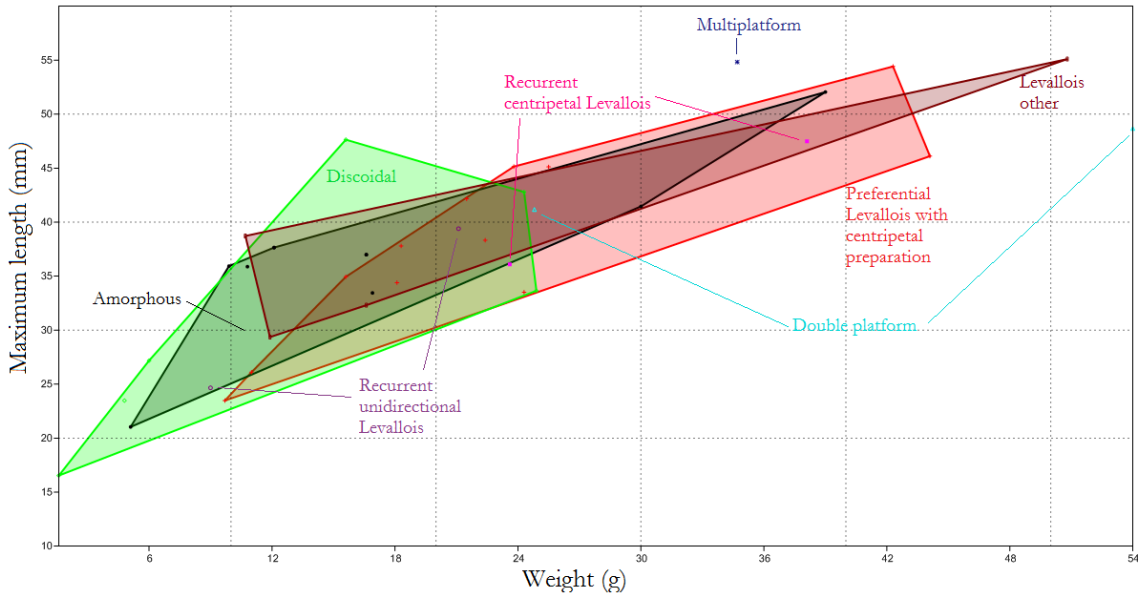



Figure 6.17. Scatterplot of weight vs. length for all complete Porc Epic C cores organised by typology. 2 outliers removed.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 41 | 44 | 45 | 47 | 50 | 50 | 50 | 50 | 25 |
| **Min** | 0 | 1 | 1 | 0 | 1.6 | 16.54 | 12.64 | 7.1 | 7.96 |
| **Max** | 85.0 | 16.0 | 10.0 | 5.0 | 77.7 | 221.4 | 52.0 | 34.5 | 38.3 |
| **Mean** | 9.0 | 8.6 | 5.8 | 1.4 | 23.8 | 41.6 | 31.0 | 17.7 | 20.1 |
| **Std. error** | 3.3 | 0.5 | 0.3 | 0.2 | 2.4 | 3.9 | 1.2 | 0.9 | 1.6 |
| **Std. dev** | 20.9 | 3.3 | 2.0 | 1.3 | 17.1 | 27.5 | 8.1 | 6.5 | 7.9 |
| **Median** | 0.0 | 8.0 | 6.0 | 1.0 | | | | 17.0 | |
| **25 prcntil** | 0.0 | 6.0 | 4.0 | 0.0 | 11.7 | 33.5 | 25.3 | 12.9 | 14.4 |
| **75 prcntil** | 0.0 | 11.0 | 7.0 | 2.0 | 26.6 | 45.1 | 35.2 | 21.9 | 26.3 |
| **Skewness** | 2.6 | 0.0 | 0.0 | 1.1 | 1.4 | 5.9 | 0.0 | 0.7 | 0.4 |
| **Kurtosis** | 6.0 | -0.4 | 0.0 | 0.9 | 1.6 | 38.9 | 0.3 | 0.3 | -0.3 |

Table 6.20. Descriptive statistics of all complete Porc Epic layer C cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Tested** | 80 | 2.5 | 1.5 | 1 | 44.8 | 39.8 | 32.2 | 19.4 | |
| **Amorph** | 0 | 7.1 | 6 | 0.9 | 17.6 | 34.3 | 24.6 | 17.5 | 17.5 |
| **Bidirect.** | 60 | 5.5 | 4.5 | 1.5 | 19.4 | 41.2 | 33.1 | 14.7 | 26.3 |
| **Multiplat.** | / | 7 | 5 | 5 | 25.5 | 45.12 | 39.76 | 14.27 | / |
| **Discoidal** | 1.7 | 10.5 | 7 | 2.3 | 34.8 | 43.2 | 35.2 | 24 | 14.6 |
| **Pref. Lev.** | 4.6 | 10.7 | 6.3 | 1.2 | 23.8 | 37.3 | 33.3 | 16.6 | 18.7 |
| **Rec. Cent Lev.** | 0 | 12.5 | 6 | 1 | 30.4 | 48.3 | 34.5 | 18.3 | 6.2 |
| **Rec. uni. Lev.** | 20.0 | 8 | 5.7 | 3 | 21.8 | 34.1 | 30.2 | 17.2 | 16.2 |
| **Lev. other** | 10 | 7.5 | 5.5 | 1 | 14.2 | 33.5 | 29.0 | 17.3 | 17.1 |

Table 6.21. Descriptive statistics for complete 123-b cores grouped by typology.

The points made above are supported by the descriptive statistics presented in Tables 6.20 and 6.21. These indicate the typical threshold at which reduction was abandoned was when the core was about 40mm in maximum dimension, and 15-20mm thick, and the general homogeneity of the cores in other regards, such as typical low values for cortex.

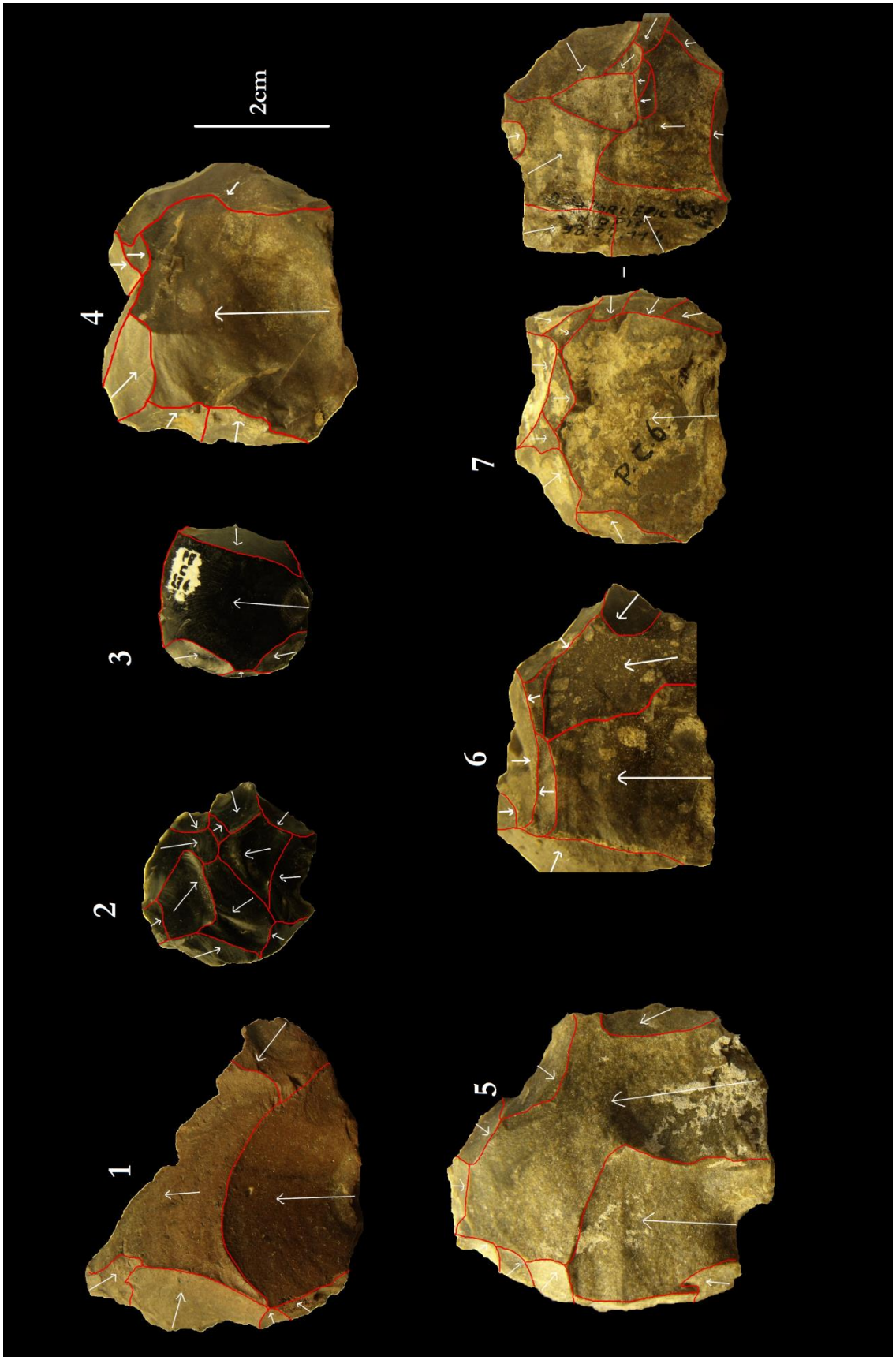


Figure 6.18. Photographs of examples of Porc Epic layer C cores. 1,3-7 – preferential Levallois cores with centripetal preparation. 2 – discoidal core.

### 6.10) Porc Epic E core technology

Table 6.22 outlines the typology of the cores from layer E of Porc Epic. Many of the characteristics of layer C apply here, such as the heavily reduced character of the cores. Flint is the dominant raw material, with the other raw materials represented in small numbers.

| Raw mat. | Amorph. | Sing. Plat. | Mulitplat. | discoidal | Pref. Lev | Rec. Cent. Lev | Rec. Uni. Lev. | Lev. Other. |
|---|---|---|---|---|---|---|---|---|
| Flint | 3 | 5 | 5 | 1 | 14 | 2 | 3 | / |
| Obsidian | / | / | / | 1 | / | 1 | / | 1 |
| Basalt | / | / | / | / | 3 | / | / | / |
| Quartz | / | 1 | / | / | / | / | / | / |

Table 6.22. Typology of Porc Epic layer E cores.

While typologically similar to layer C, with both assemblages being dominated by Levallois cores and particularly preferential Levallois cores with centripetal preparation, there are important differences between the assemblages. Layer E has significantly fewer amorphous cores than layer C (7.5% versus 24%). The same applies for discoidal cores, which constitute only 5% of layer E's cores, but 18% in layer C. Finally, single platform cores are found in layer E and not layer C. Although the most common core type in layer C, preferential Levallois cores only constitute 25% of this core assemblage, and 43% of layer C.

These factors – such as the greater level of amorphous and discoidal cores in layer C – may indicate that this level is more heavily reduced than layer C. However, when we look at the descriptive statistics for layer E, summarised below in Table 6.23, we see the data complicates this idea. In most cases, metric states are rather similar for the two assemblages. Some interesting trends are present, such as a typically greater number of scars and lesser number of aberrant terminations in layer E compared to C, but are these differences significant? Such a situation, of broad similarity but differences of unclear significance, are an excellent reminder of the need for detailed, multivariate statistics to clarify similarities and differences.

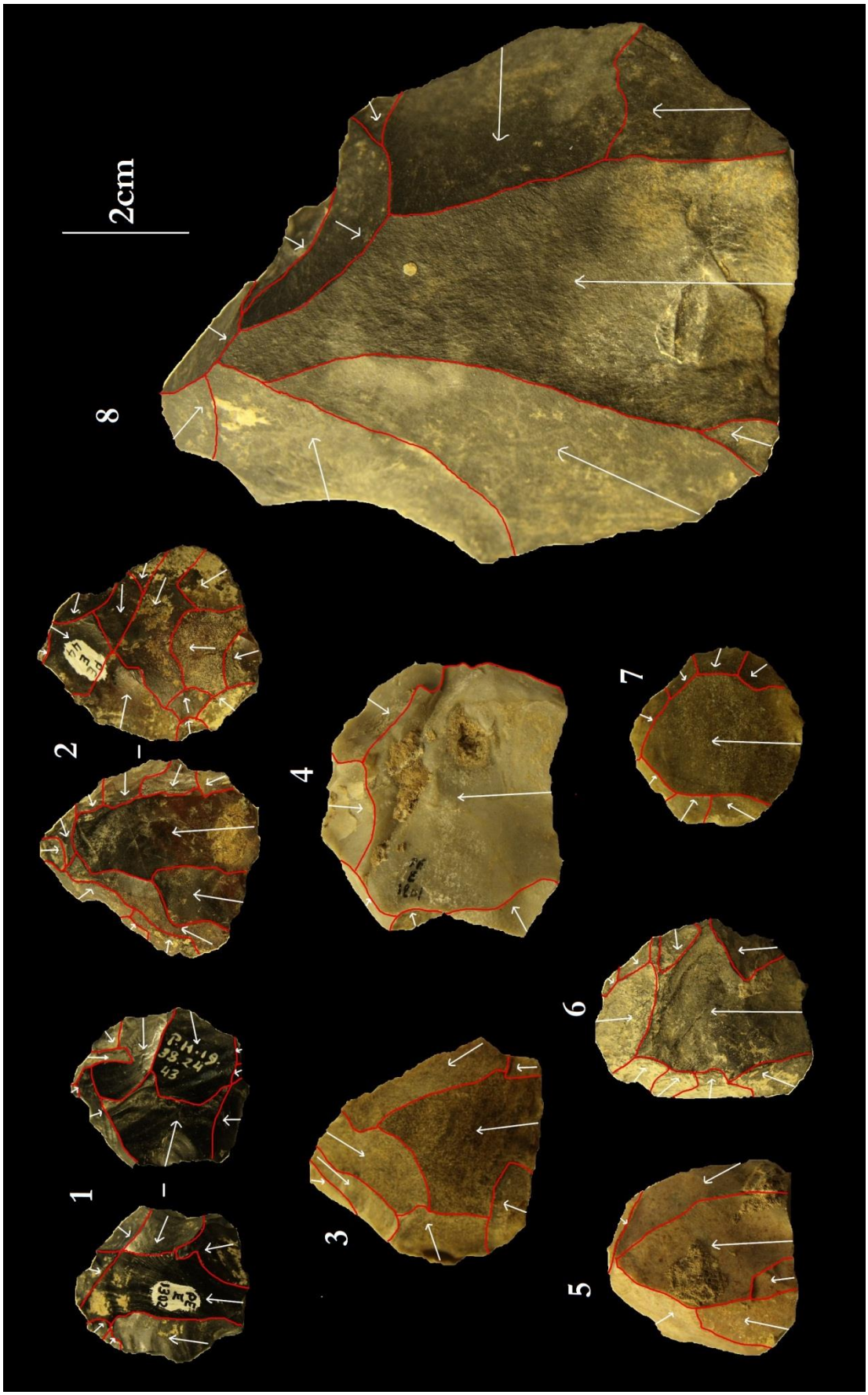


Figure 6.19. Photographs of examples of Porc Epic layer E cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) |
|---|---|---|---|---|---|---|---|---|
| **N** | 38 | 41 | 41 | 41 | 41 | 41 | 41 | 41 |
| **Min** | 0 | 5 | 2 | 0 | 3.7 | 21.0 | 17.2 | 5.5 |
| **Max** | 75 | 21 | 11 | 4 | 145.5 | 66.5 | 54.9 | 35.9 |
| **Mean** | 5.3 | 12.1 | 7.1 | 1.1 | 25.0 | 38.5 | 32.3 | 16.3 |
| **Std. error** | 2.4 | 0.5 | 0.3 | 0.2 | 4.3 | 1.7 | 73.3 | 1.0 |
| **Std. dev** | 14.8 | 3.3 | 3.9 | 1.1 | 27.5 | 10.9 | 8.6 | 6.4 |
| **Median** | 0 | 12 | 2.0 | 1 | 14.2 | 35.6 | 30.8 | 14.8 |
| **25 prcntil** | 0 | 10 | 6 | 0 | 8.8 | 30.0 | 26.9 | 11.5 |
| **75 prcntil** | 0 | 14 | 8 | 2 | 31.1 | 44.3 | 38.0 | 18.9 |
| **Skewness** | 3.8 | 0.4 | -.0.1 | 0.8 | 2.9 | 0.8 | 0.6 | 1.2 |
| **Kurtosis** | 15.2 | 0.7 | 0.0 | 0.1 | 9.6 | 0.2 | 0.3 | 1.6 |

Table 6.23. Descriptive statistics of all complete Porc Epic layer E cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Amorphous** | 0 | 10 | 6.7 | 1.3 | 12.7 | 34.4 | 26.6 | 15.5 | / |
| **Single platform** | 29.0 | 10 | 7 | 0.8 | 42 | 36.0 | 30.2 | 18.5 | / |
| **Multiplat** | 0 | 12.3 | 7.7 | 1.2 | 20.0 | 41.3 | 31.5 | 15.2 | / |
| **Pref. Lev.** | 2.1 | 12.8 | 7.0 | 0.9 | 26.8 | 38.0 | 33.3 | 17.2 | 25.1 |
| **Rec. Cent. Lev.** | 2.5 | 15 | 7.8 | 2 | 29.4 | 45.3 | 39.6 | 16.5 | / |
| **Rec. Uni. Lev** | 0 | 12 | 7 | 1 | 9.4 | 31.9 | 27.8 | 11.2 | 7.0 |
| **Lev. other** | 0 | 12 | 8 | 0 | 14.1 | 35.54 | 30.84 | 5.5 | 3.96 |

Table 6.24. Descriptive statistics for complete Porc Epic layer E cores by typology.

### 6.11) 1010-8 core technology

Twelve cores from 1010-8 were analysed at the British Museum. All cores from are made on a similar fine grained ferruginous quartzite and are complete. As shown in Table 6.25 the cores from 1010-8 are heavily Levallois, with various typological subdivisions.

| Core type | Number |
|---|---|
| Preferential Levallois with centripetal preparation | 4 |
| Nubian Type 1 | 3 |
| Bidirectional Levallois | 2 |
| Unidirectional Levallois | 1 |
| Levallois indeterminate | 1 |
| Unstruck Levallois core with centripetal preparation | 1 |

Table 6.25. Typology of 1010-8 cores.

The cores reveal a broadly homogenous technology, whereby preferential Levallois blanks were struck from faceted striking platforms. The preparatory scars were made in a centripetal manner. Variation comes from the striking of preferential blanks from two prepared platforms in the case of bidirectional Levallois cores, and from the distinctive features of the Nubian Levallois cores. In the latter preparatory scars from the distal end produced the distinctive median distal ridge, although these are not particularly pronounced, compared to those from, say, site 123-b. One 'preform' appears to be a centripetally prepared Levallois core which has not been struck. The indeterminate Levallois core is where the entire upper surface has been removed by the final strike, so the character of preparation cannot be seen.

Figure 6.20 compares length and width for the 1010-8 cores. A consistent relationship between these variables exist and typology appears to relate to the size of the cores, perhaps again indicating that morphological variability largely reflects reduction intensity, although small sample size prevents the robust clarification of this hypothesis. The relationship between preferential Levallois with centripetal preparation and Nubian Type 1 Levallois cores (i.e. did one type come after another in a pattern of core-preparation) is difficult to address as the former are varied in size. What, however, does seem to be the case is that unidirectional and bidirectional Levallois cores are smaller and either suggests they are more reduced or that these reduction schemes were applied to small pieces of raw material.

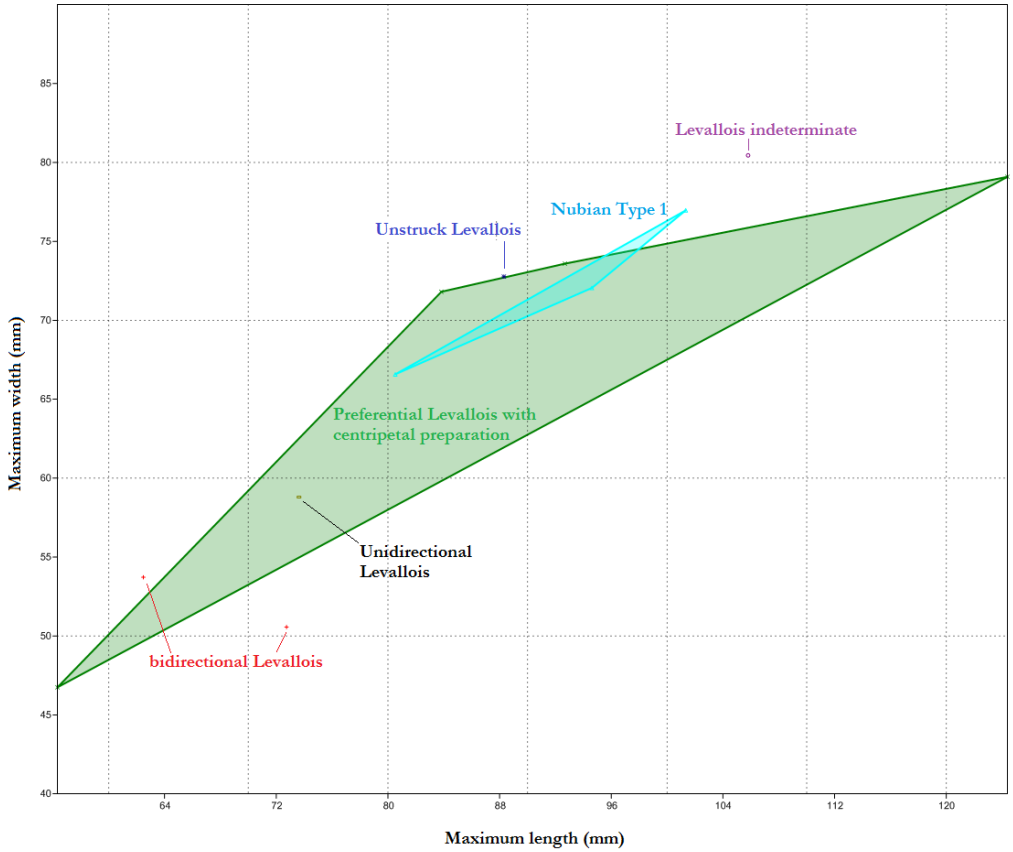


Figure 6.20. Scatterplot of length vs. width for all complete 1010-8 cores arranged by typology.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 |
| **Min** | 0.0 | 10.0 | 2.0 | 0.0 | 78.8 | 56.3 | 46.8 | 20.3 | 29.6 |
| **Max** | 35.0 | 21.0 | 7.0 | 2.0 | 678.9 | 124.4 | 80.5 | 59.3 | 107.1 |
| **Mean** | 17.5 | 16.0 | 4.4 | 0.6 | 242.3 | 86.4 | 66.9 | 30.3 | 59.9 |
| **Std. error** | 4.0 | 1.0 | 0.5 | 0.2 | 47.8 | 5.5 | 3.3 | 3.1 | 6.6 |
| **Std. dev** | 13.9 | 3.5 | 1.6 | 0.8 | 165.7 | 19.1 | 11.6 | 10.9 | 21.8 |
| **Median** | 20.0 | 15.0 | 4.0 | 0.0 | | | | | |
| **25 prcntil** | 0.0 | 13.5 | 3.3 | 0.0 | 111.1 | 73.0 | 55.0 | 22.2 | 48.6 |
| **75 prcntil** | 28.8 | 19.8 | 5.8 | 1.0 | 298.8 | 99.7 | 76.1 | 35.0 | 72.1 |
| **Skewness** | -0.3 | -0.1 | 0.5 | 1.0 | 1.8 | 0.3 | -0.7 | 1.8 | 1.0 |
| **Kurtosis** | -1.5 | -0.9 | -0.4 | -0.5 | 4.0 | 0.1 | -1.0 | 4.2 | 1.1 |

Table 6.26. Descriptive statistics of all complete 1010-8 cores.




Figure 6.21. Photographs of examples of 1010-8 cores.1, 4 – preferential Levallois cores with centripetal preparation. 2,3 – Type 1 Nubian core, 5-6 – bidirectional Levallois cores. (Photographs E. Scerri, Wendorf Collection, 1010-8, EA76000, copyright the British Museum).

Values for the percentage of cortex and number of scars can be a useful way to evaluate the extent of reduction. With Levallois cores, however, it is commonly the case that even heavily reduced cores will retain cortex on the lower surface. This seems to be the case here as all but one core retains between 15 and 30% cortex, all on the underside of the core. Interestingly, the single exception is a bidirectional Levallois core, which supports the idea that these cores are more reduced. The other important observation here is that Nubian Type-1 cores have relatively low amounts of cortex, ranging from 0 to 25% with a mean average of 15%. These low figures, given the relatively large size of the cores, can be interpreted as either suggesting that a distinctive reduction pathway was applied to these cores or that large blocks of raw material were used for their production. This interpretation from cortical cover is supported by the number of scars. Bidirectional Levallois cores, as predicted, have the greatest number of scars. The high number of scars on Nubian cores, which have the highest average figure for the number of scars over 1/3 the length of the core, also supports the idea that these cores are heavily reduced despite their fairly large size. In terms of the unidirectional Levallois core, it is perhaps significant that a relatively large number of aberrant terminations is found on this core. This may indicate that the later phase of reduction was characterised by more opportunistic flaking.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Pref. Lev with cent. Prep.** | 22.5 | 15.8 | 4.3 | 0.5 | 176.1 | 78.3 | 64.7 | 25.0 | 47.2 |
| **Nubian 1** | 15.0 | 16.3 | 4.7 | 0.0 | 170.4 | 78.9 | 60.4 | 28.1 | 70.0 |
| **Bidirec. Lev.** | 0.0 | 17.5 | 4.5 | 0.0 | 176.6 | 81.0 | 65.8 | 24.7 | 45.6 |
| **Unidirec. Lev** | 35 | 15 | 2 | 2 | 376.6 | 105.8 | 80.5 | 33.4 | 62.2 |
| **Lev. Indet.** | 20 | 10 | 4 | 2 | 678.9 | 124.4 | 79.1 | 59.3 | 107.1 |
| **Unstruck Lev.** | 20 | 20 | 7 | 1 | 283.4 | 94.61 | 72.05 | 37.33 | |

Table 6.27. Descriptive statistics for complete 1010-8 cores by typology.

### 6.12) Tor Faraj core technology

A total of 56 cores from Floor 1 of Tor Faraj were analysed, further examples being glued into refitting constellations. All cores are made on fine grained flint, the variation of which is rather complex (see Henry 2003 for more information).

Table 6.28 shows the typological division of the cores. Some workers may disagree with the application of the 'core on flake' category. The position of 'truncated-faceted' pieces is a long running problem. While I feel that these pieces seem to functioning as cores, the debate merely highlights the problem of rigidly typologising 'cores' and 'debitage'. It is reiterated that here such categories are merely used as organisational heuristics. It is not clear if such rigid distinctions existed in the minds of Palaeolithic hominins. Aside from cores on flakes, the largest category are heavily reduced 'amorphous' cores. Several Levallois methods are present, with unidirectional-convergent being the most common. A small number of non-Levallois cores were identified.

| **Core type** | **Number** |
|---|---|
| Core on flake | 30 |
| Amorphous | 9 |
| Unidirectional convergent Levallois | 6 |
| Bidirectional Levallois | 4 |
| Preferential Levallois with centripetal preparation | 3 |
| Multiplatform | 2 |
| Single platform | 1 |
| Discoidal | 1 |

Table 6.28. Typology of Tor Faraj cores.

The production of flakes cores on flakes appears to represent an essentially opportunistic form of reduction. Although nuancing this view, Demidenko and Usik (2003) showed that some of the cores on flakes from Tor Faraj produced Levallois points. In most cases small and non-predetermined flakes were produced. The cores on flakes feature variable levels of cortex, with an average of 8.9%. This is rather more than the cores on flakes at Warwasi, as will be discussed below. The cores on flakes at Tor Faraj are typically rather small, with an average weight of 20 g.

The Levallois cores were reduced until they were extremely small (see Table 6.31). The presence of tiny unidirectional-convergent point cores shows that this reduction strategy was pursued until the

core was almost exhausted. In these and other Levallois cores, some examples from Tor Faraj appear to have been abandoned because the preparatory removals did not produce a good surface for the removal of Levallois flakes. Often this was because of a build-up of mass distally which obstructed the debitage surface. In other cases the core was abandoned after the removal of a preferential blank, perhaps because it was felt the core was too small to continue.

The comparison of lengths and widths (Figure 6.22) reveals a rather different pattern to most other examples in this chapter. Typically most cores line up along a range of sizes, which correlate with typology and in the view favoured here this typically reflects reduction intensity. At Tor Faraj, however, aside from cores on flakes which have a rather wide range of values, and multiplatform, discoidal and single platform cores which are too unusual to say much, the key feature is the parallel distribution of Levallois and amorphous/multiplatform cores. This reflects that Levallois cores are wide for their width. Bidirectional Levallois cores overlap with amorphous cores, perhaps indicating a similarly derived position in the reduction process. Preferential Levallois cores with centripetal preparation are fairly uncommon, but those present are relatively large.

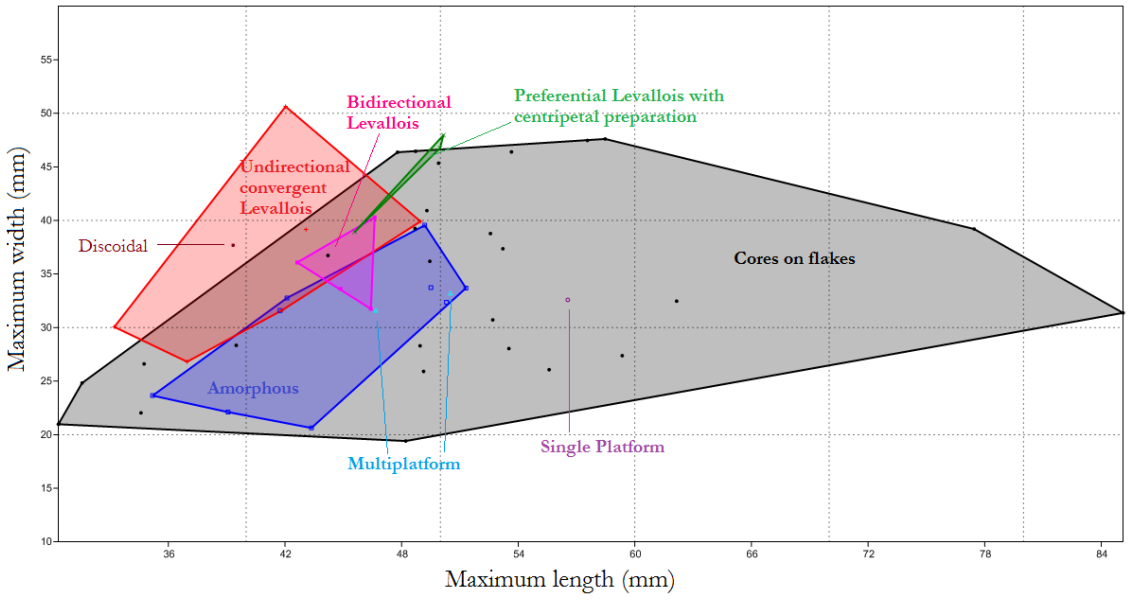



Figure 6.22. Scatterplot of length vs. width for all complete Tor Faraj floor 1 cores arranged by typology.

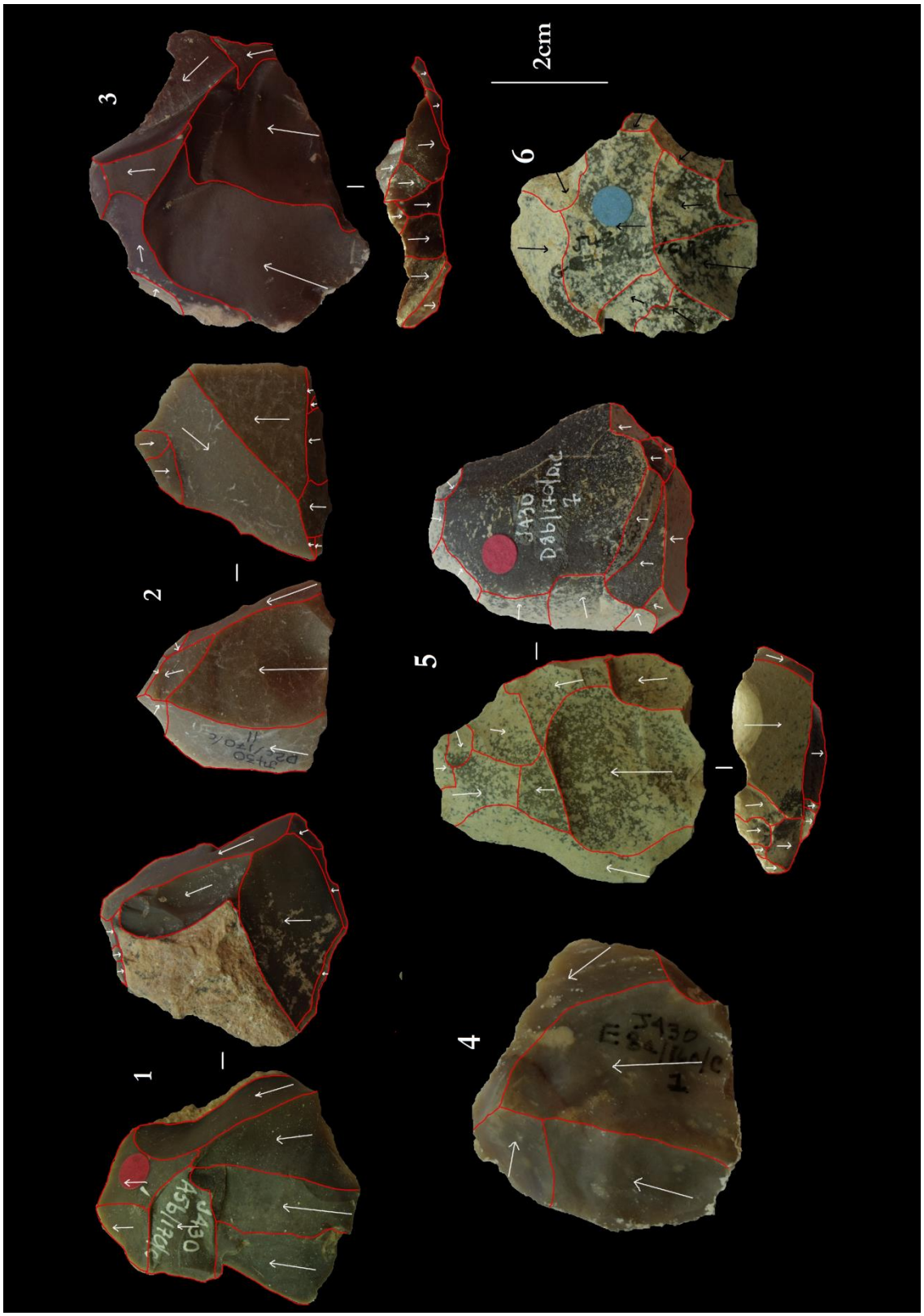


Figure 6.23. Photographs of examples of Tor Faraj floor 1 cores. 1-4 – unidirectional convergent Levallois cores, 5 – bidirectional Levallois core, 6 – discoidal core.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 |
| **Min** | 0.0 | 10.0 | 2.0 | 0.0 | 78.8 | 56.3 | 46.8 | 20.3 | 29.6 |
| **Max** | 35.0 | 21.0 | 7.0 | 2.0 | 678.9 | 124.4 | 80.5 | 59.3 | 107.1 |
| **Mean** | 17.5 | 16.0 | 4.4 | 0.6 | 242.3 | 86.4 | 66.9 | 30.3 | 59.9 |
| **Std. error** | 4.0 | 1.0 | 0.5 | 0.2 | 47.8 | 5.5 | 3.3 | 3.1 | 6.6 |
| **Std. dev** | 13.9 | 3.5 | 1.6 | 0.8 | 165.7 | 19.1 | 11.6 | 10.9 | 21.8 |
| **Median** | 20.0 | 15.0 | 4.0 | 0.0 | | | | | |
| **25 prcntil** | 0.0 | 13.5 | 3.3 | 0.0 | 111.1 | 73.0 | 55.0 | 22.2 | 48.6 |
| **75 prcntil** | 28.8 | 19.8 | 5.8 | 1.0 | 298.8 | 99.7 | 76.1 | 35.0 | 72.1 |
| **Skewness** | -0.3 | -0.1 | 0.5 | 1.0 | 1.8 | 0.3 | -0.7 | 1.8 | 1.0 |
| **Kurtosis** | -1.5 | -0.9 | -0.4 | -0.5 | 4.0 | 0.1 | -1.0 | 4.2 | 1.1 |

Table 6.29. Descriptive statistics of all complete Tor Faraj floor 1 cores on flakes.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 26 | 26 | 26 | 26 | 26 | 26. | 26 | 25 | 15 |
| **Min** | 0.0 | 6.0 | 4.0 | 0.0 | 8.5 | 33.2 | 20.6 | 7.7 | 10.4 |
| **Max** | 40.0 | 19.0 | 11.0 | 4.0 | 43.1 | 56.6 | 50.6 | 29.6 | 38.0 |
| **Mean** | 11.0 | 11.0 | 6.5 | 1.5 | 24.0 | 44.9 | 34.6 | 16.0 | 23.5 |
| **Std. error** | 2.5 | 0.7 | 0.4 | 0.2 | 2.1 | 1.1 | 1.4 | 1.0 | 2.0 |
| **Std. dev** | 12.7 | 3.4 | 2.0 | 1.2 | 10.5 | 5.5 | 7.3 | 4.9 | 7.9 |
| **Median** | 5.0 | 11.0 | 6.0 | 1.0 | | | | | |
| **25 prcntil** | 0.0 | 8.0 | 5.0 | 1.0 | 14.5 | 41.8 | 31.6 | 12.2 | 18.4 |
| **75 prcntil** | 20.0 | 13.3 | 8.0 | 2.3 | 32.5 | 49.6 | 39.3 | 19.1 | 29.9 |
| **Skewness** | 0.8 | 0.5 | 0.7 | 0.8 | 0.4 | -0.2 | 0.3 | 0.8 | -0.1 |
| **Kurtosis** | -0.6 | -0.4 | 0.0 | -0.3 | -1.1 | -0.2 | 0.3 | 1.2 | -0.7 |

Table 6.30. Descriptive statistics of all other complete Tor Faraj floor 1 cores.

The pattern shown in Figure 6.22 suggests that reduction, ignoring cores on flakes for the moment, primarily focussed on the reduction of unidirectional convergent cores. In some cases these cores were reduced until they were extremely small. When Levallois cores became difficult to work it seems that they were flaked 'opportunistically'. One effect of this was the removal of flakes from the lateral margins of the core, explaining the reduced width of the amorphous and multiplatform cores. With the small sample size it is unclear how the other Levallois types relate to the unidirectional convergent cores. The relatively high percentage of cortex on amorphous cores doesn't particularly support this narrative. But in virtually all cases we are dealing with small amounts of cortex in any case.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Core on flake** | 8.9 | 7.6 | 4.5 | 1.1 | 20.5 | 50.2 | 33.6 | 11.9 | |
| **Amorphous** | 13.8 | 9.4 | 5.9 | 1.0 | 23.7 | 44.0 | 29.5 | 18.5 | |
| **Uni. conv. Lev.** | 6.4 | 12.4 | 7.3 | 1.9 | 20.1 | 42.2 | 36.0 | 13.9 | 20.5 |
| **Bid. Lev.** | 8.8 | 10.5 | 6.3 | 1.3 | 23.3 | 45.1 | 35.4 | 15.9 | 26.5 |
| **Pref. Lev.** | 1.7 | 15.3 | 8.0 | 3.0 | 36.3 | 48.6 | 44.6 | 16.3 | 24.8 |
| **Multiplat** | 20.0 | 10.0 | 4.5 | 0.5 | 15.8 | 48.6 | 32.4 | 9.4 | |
| **Sing. Plat.** | 30 | 6 | 5 | 1 | 36.8 | 56.55 | 32.59 | 23.83 | 18.35 |

Table 6.31. Descriptive statistics for complete Tor Faraj cores by typology.

### 6.13) Warwasi WWXX core technology

Forty five cores, all of flint, come from layers WW and XX of Warwasi Cave. Of these 28 are cores on flakes and 17 belong to other types (see Table 6.32). Various types of flint are present, and are without detailed study difficult to classify in any more detail.

| **Core type** | **Number** |
|---|---|
| Core on flake | 28 |
| Discoidal | 4 |
| Multiplatform | 3 |
| Bidirectional | 3 |
| Single platform | 3 |
| Fragment | 1 |
| Recurrent centripetal Levallois | 1 |
| Preferential Levallois with centripetal preparation | 1 |
| Recurrent unidirectional Levallois | 1 |

Table 6.32. Typology of Warwasi WWXX cores.

Most of the cores on flakes possess a rather simple morphology. A 'truncation' of the proximal end of the core serves as the platform for the removal of further, small, blanks. Further analysis is required to see if cores on flakes were preferentially made on particular types of flint. For the most part cores on flakes lack cortex, and have a mean weight of just 13.1 g (see Table 6.33).

In regard to other core types, the first point to be made is the dominance of non-Levallois types (multiplatform, bidirectional and single platform). Levallois cores are present, but in small numbers. With a few exceptions, cores at Warwasi are very heavily reduced and rather amorphous in character. This point, as well as the exclusive use of flint, also applies to the cores from NNOO and

will not be repeated below. Discoidal core are the most common non-core on flake category. None are particularly 'classical' examples – i.e. with removals extending onto both (non-hierarchical) planes of the core from a clear and consistent central plane. They do however generally possess a plane between two non-hierarchical surfaces for most of their circumference, and blanks were removed at a steep angle. The Levallois cores are also not particularly good examples of this form of technology, but on volumetric terms can be assigned as such.

Figure 6.24 compares length and width for Warwasi WWXX cores. No particularly clear patterns can be observed. In these dimensions cores on flakes are similar to those for other core types, albeit with some clustering at the lower range of variability. This broad similarity in size indicates the size threshold for core abandonment. Levallois cores are wide for their lengths. Multiplatform cores occur across a range of sizes, but amongst single platform, bidirectional and discoidal cores size decreases from the former to the latter. Discoidal cores cluster in a narrow range of variability, indicating a strongly enforced – be it by 'culture' or physics – relationship between length and width.

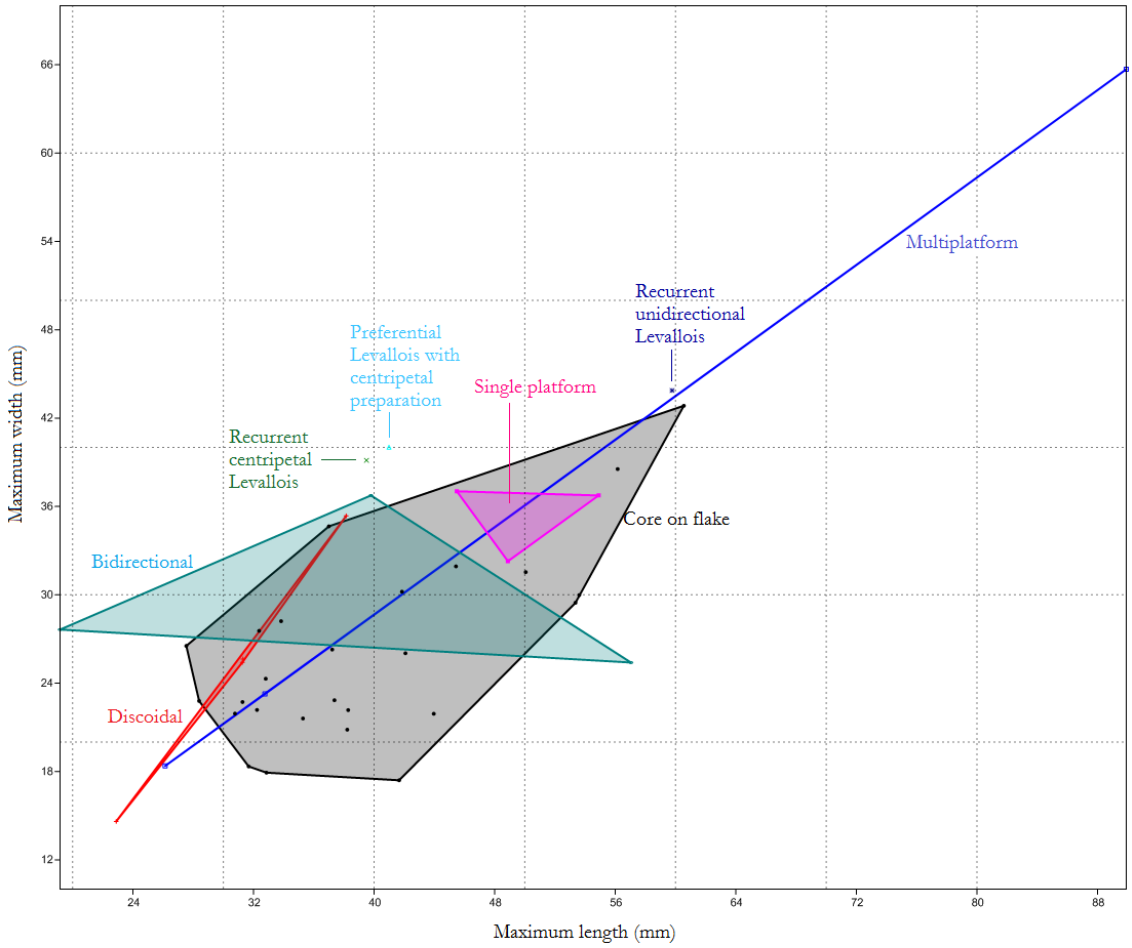



Table 6.24. Scatterplot of length vs. width for all complete WWXX cores arranged by typology.

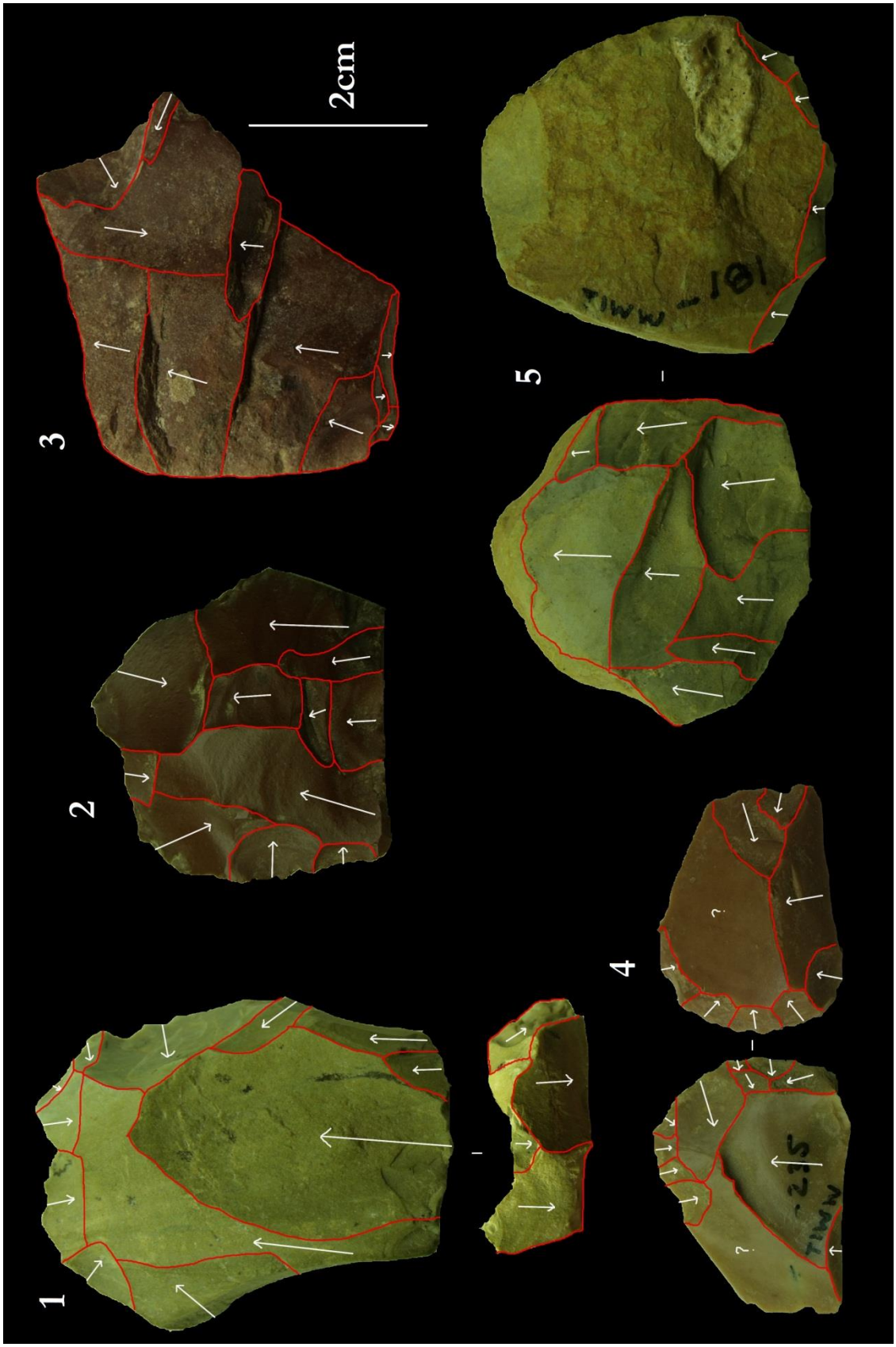


Figure 6.25. Photographs of examples of Warwasi WWXX cores. 1 – preferential Levallois with centripetal preparation, 2 – bidirectional core, 3 – multiplatform core, 4 – core on flake, 5 – single platform core

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) |
|---|---|---|---|---|---|---|---|---|
| **N** | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 25 |
| **Min** | 0.0 | 3.0 | 2.0 | 0.0 | 3.6 | 27.5 | 17.4 | 5.2 |
| **Max** | 15.0 | 10.0 | 9.0 | 3.0 | 47.5 | 60.6 | 42.8 | 20.7 |
| **Mean** | 1.2 | 6.7 | 4.8 | 1.3 | 13.1 | 39.5 | 26.2 | 11.1 |
| **Std. error** | 0.7 | 0.4 | 0.3 | 0.2 | 2.1 | 1.8 | 1.2 | 0.8 |
| **Std. dev** | 3.6 | 1.8 | 1.7 | 0.9 | 10.9 | 9.0 | 6.2 | 4.2 |
| **Median** | 0.0 | 7.0 | 5.0 | 1.0 | | | | |
| **25 prcntil** | 0.0 | 5.8 | 3.8 | 0.5 | 6.7 | 32.3 | 21.9 | 8.1 |
| **75 prcntil** | 0.0 | 7.3 | 6.0 | 2.0 | 16.7 | 44.3 | 30.0 | 14.3 |
| **Skewness** | 3.3 | 0.2 | 0.5 | 0.0 | 1.8 | 0.9 | 0.9 | 0.7 |
| **Kurtosis** | 10.4 | 0.0 | 0.3 | -0.9 | 3.0 | -0.1 | 0.8 | -0.5 |

Table 6.33. Descriptive statistics of all complete Warwasi WWXX cores on flakes.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 8 |
| **Min** | 0.0 | 4.0 | 2.0 | 1.0 | 4.0 | 19.2 | 14.6 | 11.0 | 8.6 |
| **Max** | 60.0 | 15.0 | 10.0 | 4.0 | 270.9 | 89.9 | 65.7 | 58.2 | 36.9 |
| **Mean** | 17.5 | 8.9 | 5.6 | 1.8 | 41.8 | 42.4 | 33.0 | 21.5 | 22.3 |
| **Std. error** | 5.2 | 0.9 | 0.7 | 0.3 | 16.0 | 4.3 | 3.0 | 3.0 | 3.5 |
| **Std. dev** | 20.8 | 3.4 | 2.7 | 1.0 | 64.2 | 17.4 | 12.0 | 12.1 | 9.8 |
| **Median** | 10.0 | 8.0 | 5.0 | 1.0 | | | | | |
| **25 prcntil** | 0.0 | 7.0 | 3.3 | 1.0 | 10.9 | 31.3 | 25.4 | 15.6 | 13.3 |
| **75 prcntil** | 37.5 | 11.0 | 7.0 | 3.0 | 46.1 | 53.4 | 38.6 | 22.2 | 30.9 |
| **Skewness** | 0.8 | 0.3 | 0.4 | 0.8 | 3.4 | 1.3 | 1.1 | 2.4 | 0.1 |
| **Kurtosis** | -0.7 | -0.8 | -1.0 | -0.8 | 12.5 | 2.6 | 2.7 | 5.7 | -1.0 |

Table 6.34. Descriptive statistics of all other complete Warwasi WWXX cores.

Table 6.35 presents average figures for various morphological and technological features of the different core types. The idea that discoidal cores are the most reduced is supported by their very low percentage of cortex, high number of scars and low weight. Small sample sizes prevent further understanding of the relationship between multiplatform, bidirectional and single platform cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Core on flake** | 1.2 | 6.7 | 4.8 | 1.3 | 13.1 | 39.5 | 26.2 | 11.1 | |
| **Discoidal** | 2.5 | 9.8 | 6.5 | 1.0 | 12.5 | 30.9 | 25.3 | 14.6 | |
| **Multiplat** | 3.3 | 9.7 | 7.7 | 1.7 | 97.0 | 49.6 | 35.8 | 30.0 | |
| **Bidirec.** | 26.7 | 6.3 | 5.0 | 1.7 | 36.5 | 49.8 | 35.4 | 19.4 | 29.7 |
| **Single plat** | 23.3 | 6.3 | 5.0 | 2.3 | 33.3 | 38.7 | 29.9 | 26.8 | 18.9 |
| **Rec. cent. Lev.** | 40.0 | 11.0 | 5.0 | 4 | 24 | 39.5 | 39.13 | 17.72 | 8.64 |
| **Pref Lev.** | 30.0 | 15.0 | 3.0 | 1 | 26.1 | 40.99 | 40.03 | 16.44 | 25.5 |
| **Rec. unidir. Lev.** | 40.0 | 10.0 | 2.0 | 3 | 69.2 | 59.77 | 43.88 | 22.76 | 17.17 |

Table 6.35. Descriptive statistics for complete Warwasi WWXX cores by typology.

### 6.14) Warwasi NNOO

These cores are broadly similar to those from the underlying WWXX assemblage. While a key difference is that greater number of cores in this layer (31 compared to 17, excluding cores on flakes). Table 6.36 presents the typological breakdown. Cores on flakes are (23/54) are still dominant, but less so than the deeper levels. Other core types account for the remaining 31 cores. Discoidal cores are particular common.

| **Core type** | **Number** |
|---|---|
| Core on flake | 23 |
| Discoidal | 13 |
| Multiplatform | 5 |
| Fragment | 4 |
| Unidirectional convergent Levallois | 3 |
| Bidirectional | 2 |
| Preferential Levallois with centripetal preparation | 3 |
| Single platform | 1 |

Table 6.36. Typology of Warwasi NNOO cores.

The cores on flakes are similar to those from WWXX. There are, however, a number of differences (see Tables 6.37 and 6.38). Cores on flakes from NNOO have less cortex, in fact they are all cortex free. They have more small scars, but marginally fewer scars >1/3 the length of the piece. NNOO cores on average weigh almost half that of those from XXWW, and are smaller on average in all major dimensions. In technological terms they appear at least broadly similar, but as demonstrated above there are in fact differences in a number of regards. Cores on flakes are less common in NNOO compared to WWXX, representing 43 and 62 % of the core population respectively. Conversely, discoidal cores make up 9% of WWXX, but 24% of NNOO.

Aside from the greater number of discoidal cores, Levallois cores are also more common. Figure 6.27 can, perhaps, be interpreting as suggesting that multiplatform and Levallois reduction was carried out on larger cores/in the earlier phase of a cores use life, with single platform, bidirectional and discoidal cores representing the most reduced specimens. Again, the tight clustering of most cores in terms of lengths and widths indicates the threshold for discard. Discoidal cores are very similar in dimensions and weight in both assemblages, as they are for the number of scars.

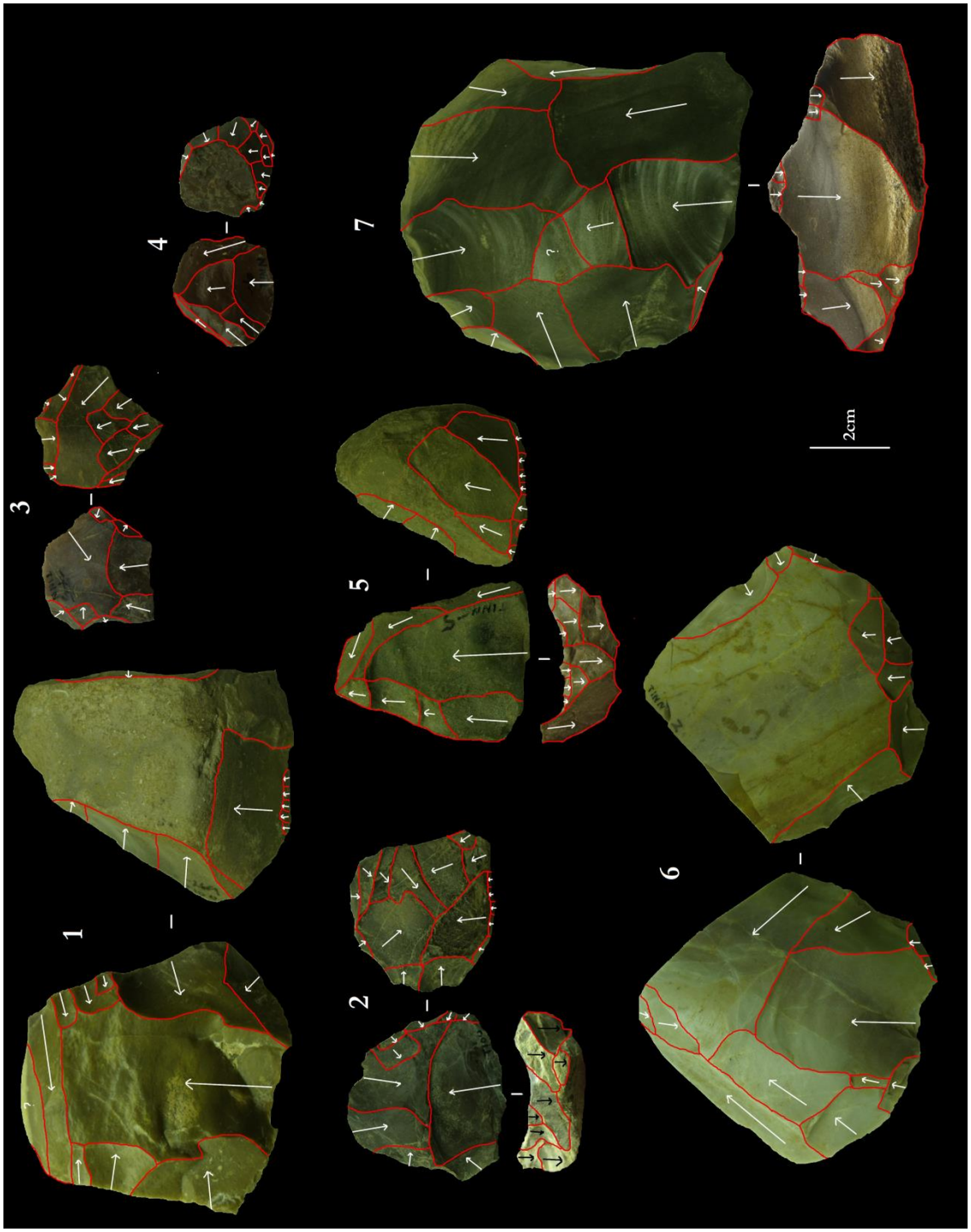


Figure 6.26. Photographs of examples of Warwasi NNOO cores. 1,2 – preferential Levallois with centripetal preparation, 3, 4 – discoidal, 5,6 – unidirectional convergent, 7 – multiplatform.

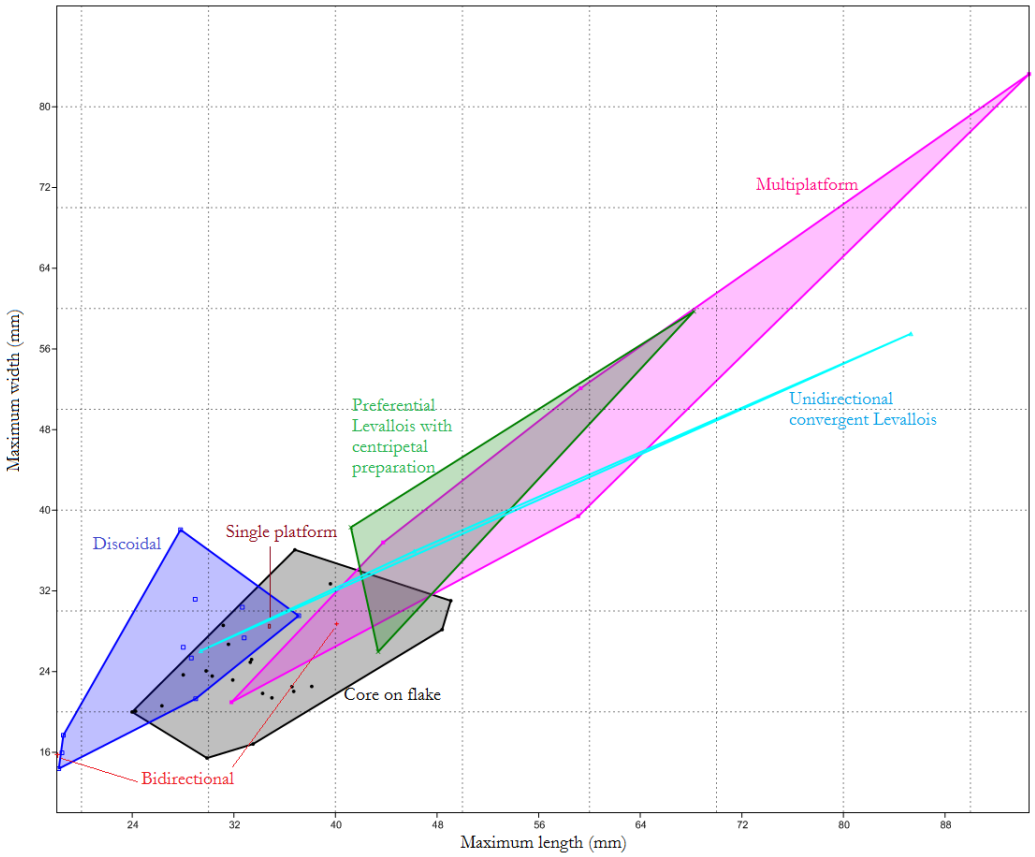



Figure 6.27. Scatterplot of length vs. width for all complete Warwasi NNOO cores arranged by typology.

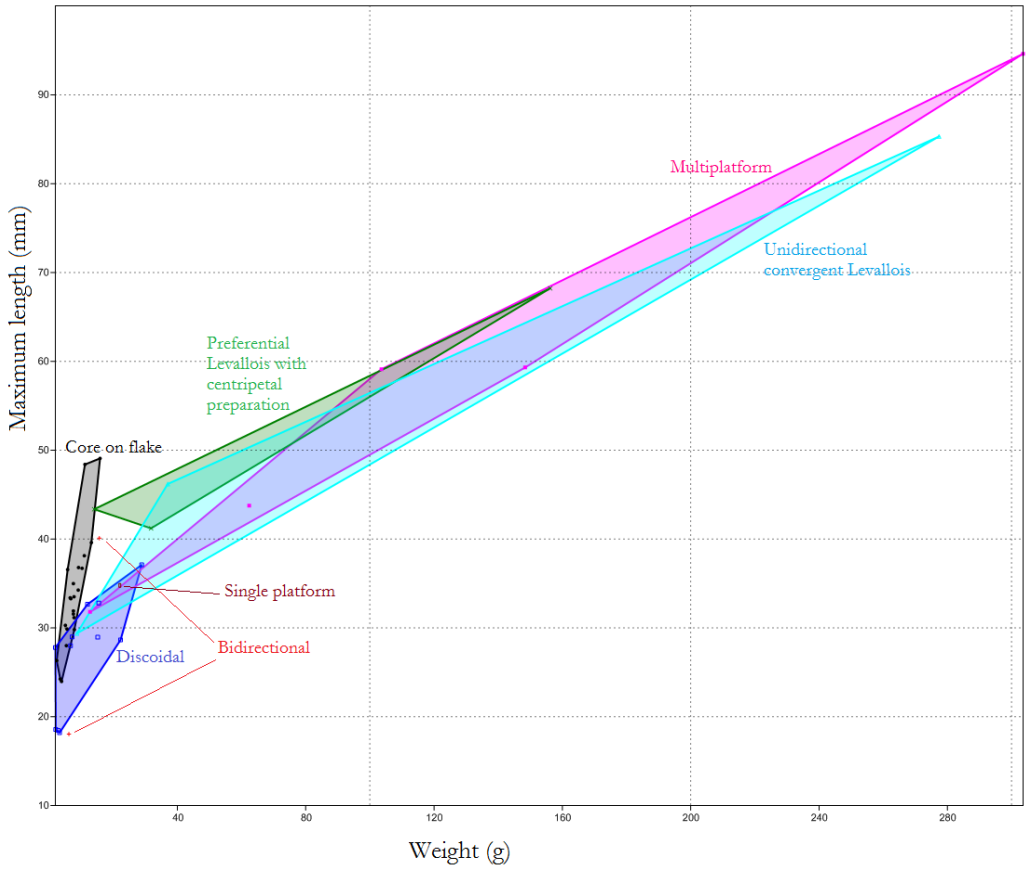



Figure 6.28. Scatterplot of weight x length for all complete Warwasi NNOO cores arranged by typology.

As Figure 6.28 shows, comparing weight and length is congruent with the above interpretation and again implies that, at least in size terms, Levallois and multiplatform cores lead down to single platform, bidirectional and discoidal cores. Introducing this comparison demonstrates the extremely close correlation between weight and length for cores on flakes, suggesting both similar intensities of reduction for these pieces and similar selection criteria from the blank population.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) |
|---|---|---|---|---|---|---|---|---|
| **N** | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| **Min** | 0.0 | 4.0 | 4.0 | 0.0 | 2.4 | 24.0 | 15.4 | 6.6 |
| **Max** | 0.0 | 11.0 | 8.0 | 3.0 | 15.9 | 49.1 | 36.1 | 15.3 |
| **Mean** | 0.0 | 7.4 | 5.7 | 0.9 | 7.8 | 33.7 | 24.1 | 10.3 |
| **Std. error** | 0.0 | 0.4 | 0.3 | 0.2 | 0.7 | 1.4 | 1.0 | 0.5 |
| **Std. dev** | 0.0 | 1.9 | 1.4 | 0.9 | 3.2 | 6.4 | 4.9 | 2.5 |
| **Median** | 0.0 | 7.0 | 5.0 | 1.0 | | | | |
| **25 prcntil** | 0.0 | 6.0 | 4.8 | 0.0 | 5.6 | 29.9 | 21.2 | 8.4 |
| **75 prcntil** | 0.0 | 9.0 | 7.0 | 1.3 | 9.5 | 36.7 | 27.1 | 11.9 |
| **Skewness** | 0.0 | 0.3 | 0.3 | 0.7 | 0.7 | 0.9 | 0.7 | 0.2 |
| **Kurtosis** | 0.0 | -0.6 | -1.3 | -0.2 | 0.8 | 1.2 | 0.7 | -0.7 |

Table 6.37. Descriptive statics of all complete Warwasi NNOO cores on flakes.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid. (mm) | max thick. (mm) | length of last scar (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **N** | 25 | 23 | 25 | 25 | 25 | 25 | 25 | 25 | 7 |
| **Min** | 0 | 5.0 | 3.0 | 0.0 | 2.0 | 18.1 | 14.4 | 8.5 | 9.1 |
| **Max** | 40.0 | 19.0 | 15.0 | 9.0 | 303.6 | 94.6 | 83.3 | 43.1 | 47.6 |
| **Mean** | 5.8 | 10.4 | 7.8 | 1.8 | 52.7 | 39.8 | 33.1 | 21.4 | 28.6 |
| **Std. error** | 2.4 | 0.8 | 0.6 | 0.4 | 16.7 | 4.0 | 3.2 | 2.2 | 5.2 |
| **Std. dev** | 11.9 | 4.0 | 3.0 | 1.9 | 83.3 | 19.9 | 15.9 | 11.1 | 13.7 |
| **Median** | 0 | 9.0 | 8.0 | 1.0 | | | | | |
| **25 prcntil** | 0 | 8.0 | 5.5 | 0.5 | 7.0 | 28.3 | 23.3 | 11.8 | 18.5 |
| **75 prcntil** | 5 | 13.0 | 9.5 | 2.5 | 49.7 | 45.0 | 38.2 | 29.7 | 42.4 |
| **Skewness** | -1.9 | 0.8 | 0.4 | 2.3 | 2.2 | 1.4 | 1.6 | 0.6 | 0.1 |
| **Kurtosis** | 2.5 | -0.1 | 0.3 | 7.3 | 4.1 | 1.8 | 3.1 | -1.0 | -1.1 |

Table 6.38. Descriptive statistics of all other complete Warwasi NNOO cores.

| | % cortex | N scars (>5mm) | N scars (>1/3 length) | N aberrant terminations | Weight (g) | Max dim (mm) | max wid (mm) | max thick (mm) | Last scar length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| **Core on flake** | 0.0 | 7.4 | 5.7 | 0.9 | 7.8 | 33.7 | 24.1 | 10.3 | |
| **Discoidal** | 0.9 | 9.2 | 7.8 | 1.9 | 10.7 | 27.3 | 25.2 | 16.6 | |
| **Multiplat** | 25.0 | 15.0 | 10.0 | 1.4 | 126.2 | 57.7 | 46.5 | 32.2 | |
| **Bidirec.** | 0.0 | 8.0 | 6.5 | 2.5 | 11.0 | 29.1 | 22.3 | 13.8 | |
| **Single plat** | 0 | 9 | 8 | 3 | 22.1 | 34.79 | 28.5 | 24.1 | |
| **Uni. Conv. Lev.** | 11.7 | 13.3 | 8.7 | 2.0 | 107.7 | 53.6 | 39.8 | 25.6 | 29.0 |
| **Pref Lev.** | 20.0 | 8.7 | 3.7 | 1.0 | 67.4 | 50.9 | 41.3 | 21.2 | 33.0 |

Table 6.39. Descriptive statistics for complete Warwasi NNOO cores by typology.

### 6.15) Summary of basic core morphology

Figure 6.29 shows box plots for basic attributes for all cores analysed. These reveal some important aspects of size variability. All the plots show the same basic pattern, with variation between sites with large cores (the Arabian sites and 1010-8) and those with small cores (Porc Epic, Tor Faraj and Warwasi). The Jubbah assemblages actually fall between the two groups in most cases. Different variables stress this relationship in different strengths. Weight, for instance, gives strong contrasts between the assemblages dominated by large cores and those by small. For instance maximum dimension and weight show a similar relationship, but it is more muted for maximum dimension and exaggerated by weight. Thickness is the least varied of the attributes, reflecting physical factors associated with knapping. The similarity of these plots indicate the considerable equifinality in broad factors of core morphology and technology.

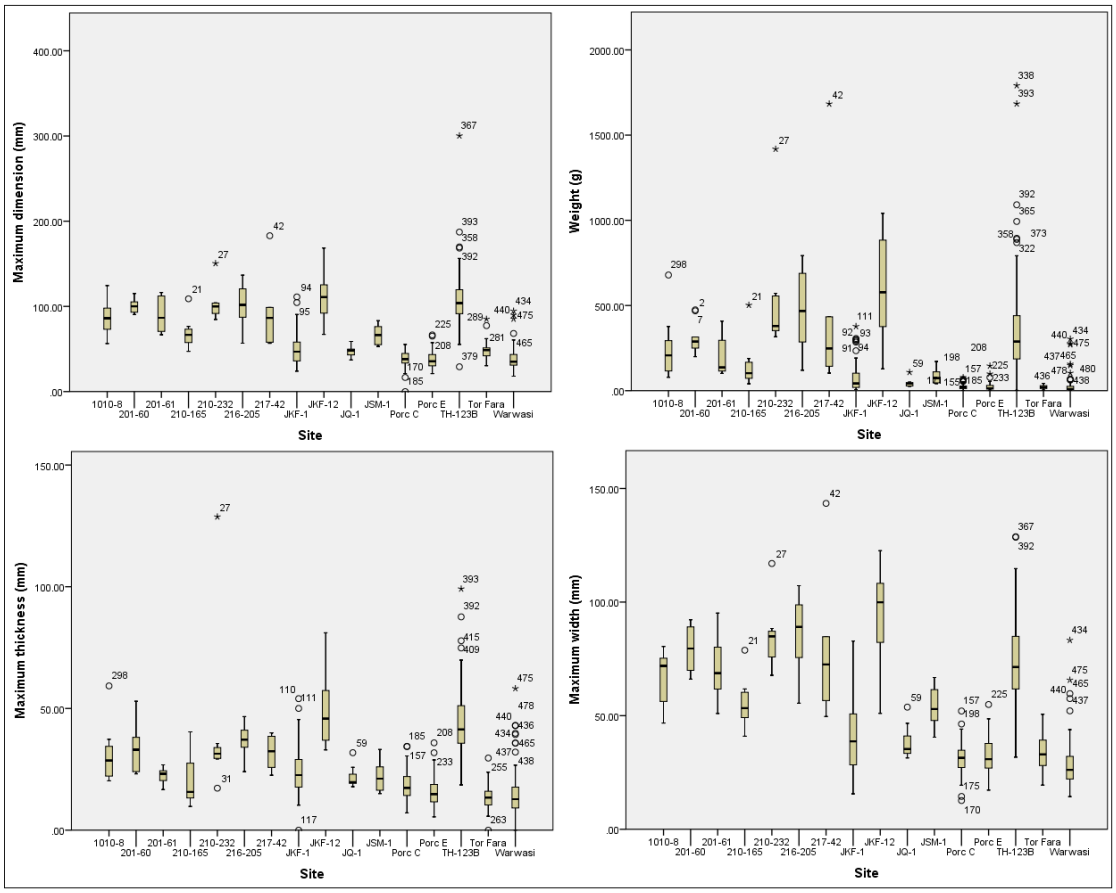



Figure 6.29. Boxplots of maximum dimension, weight, maximum thickness and maximum width for all assemblages.

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Figure 6.30 again demonstrates the considerable equifinality in terms of core morphology across assemblages. The previous pages have demonstrated some interesting differences in terms of typology. Underlying these typological differences, however, are very similar relationships in terms of basic size and shape attributes. Aside from certain geometrical requirements imposed by the physical properties of fracture mechanics, we must remember that the cores in the archaeological record are those which the knappers stopped reducing. Often this was because they had become too small, or the debitage surface was affected by aberrant terminations. Given such factors it is debatable about how much the final form of core morphology tells us about the process of reduction. On the other, as shown in Figure 6.30, there are some differences between even basic size variables. Comparing the cores from 123-b to those from JKF-12 and JKF-1 shows that the former are consistently longer relative to their width. Such factors indicate that adopting more nuanced comparative methods focussing on shape rather than size have considerable potential to clarify the relationship between core assemblages.

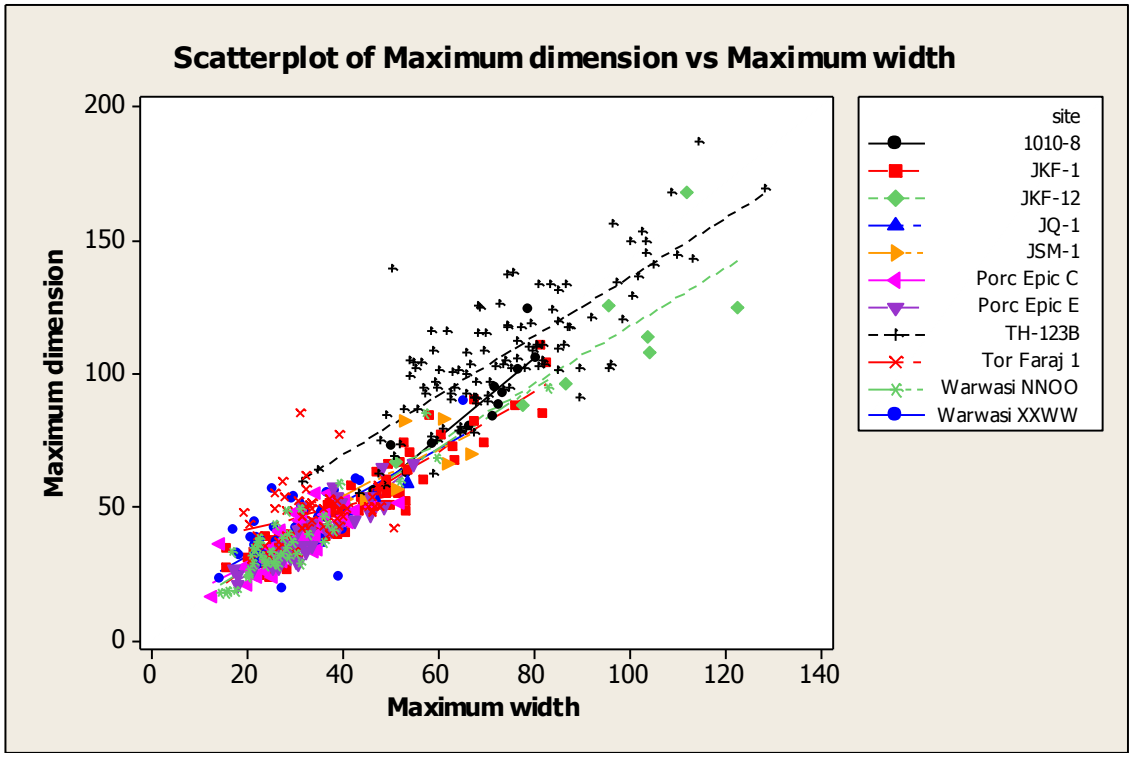


Figure 6.30. Scatterplot of maximum dimension against maximum width for the major assemblages in this study. 2 outliers removed (from 123b).

**Multivariate analysis of cores**

The following pages present the results of a series of Principal Components and Correspondence Analyses. In most cases 'cores on flakes' were excluded from analysis as it difficult to compare the character of these pieces, which are themselves removed from other cores, and cores in the sense of pieces with only negative removals. In many cases a desirable sample size (n=20) could not be reached for samples from a particular assemblage. In such cases the possibility that the sample may be not be particularly representative must be kept in mind.

### 6.16) (1) What is the relationship between raw material type and the technological character and intensity of core reduction?

A correspondence analysis was used to address this question. The variables used were core typology, raw material type, number of scars over 5mm, maximum dimension, maximum width and maximum thickness. As with other correspondence analyses in this study, the continuous variables were transformed into categorical data divided into five categories. Incomplete cores were excluded, as were cores on flakes. The JKF-1 assemblage was divided into a quartz assemblage and a quartzite assemblage. The reader is reminded that **bold** variables are important drivers of variability, and **underlined** are even more so.

| *Component (% of variance/ cumulative %)* | - | + |
|---|---|---|
| 1 (19%) | Quartz raw material, low number of scars, low weight, low maximum dimension, low width, low thickness | Single platform cores, large number of scars, large weight, large maximum dimension, large width, large thickness |
| 2 (13%, 32%) | Low weight, large weight, low maximum dimension, large maximum dimension, low width, large width, low thickness, large thickness | Levallois cores, **medium weight**, **medium maximum dimension**, **medium width, medium thickness** |
| 3 (11%, 43%) | Medium weight, largest weight, medium maximum dimension, medium width, **largest width,** medium thickness, **largest thickness** | Large weight, **large width**, **large thickness** |
| 4 (8%, 51%) | Low number of scars, **low weight**, **low maximum dimension** | Medium weight, medium maximum dimension, low maximum width |
| 5 (7%, 58%) | **Nubian cores, Quartz raw material**, small number of scars | **Discoidal cores**, Levallois cores, flint raw material, large number of scars |
| 6 ( 6%, 63%) | Single platform cores, **flint raw material**, low number of scars | **Levallois cores**, **quartzite raw material** |
| 7 (5%, 68%) | **Amorphous cores**, small number of scars | **Multiplatform cores**, **large number of scars** |
| 8 (4%, 72%) | **Discoidal cores, Nubian cores, large number of scars** | **Amorphous cores, multiplatform cores,** |
| 9 (4%, 76%) | **Multiplatform cores**, **low number of scars** | **Medium number of scars** |
| 10 (4%, 80%) | **Multiplatform cores, large number of scars** | **Medium number of scars** |

Table 6.39. Loading of components.

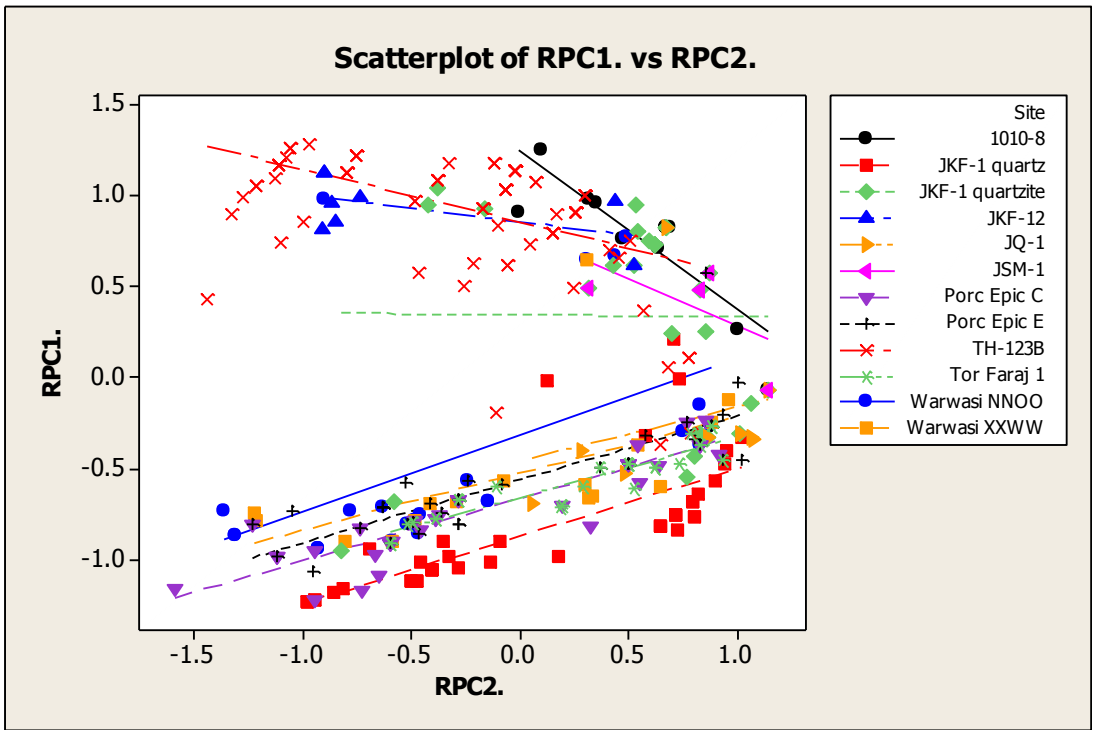


Figure 6.31. Scatterplot and regressions of first and second components.

The first component is quite 'noisy' and nothing scores highly in driving the component. It essentially seems to divide cores into large and small sizes. Quartz is also associated with the latter, but it is hard to distinguish the meaning of this as quartz in the sample always comes in the form of small pieces. In any case, quartz does not play a strong role in driving RPC1. It is of interest that for RPC2-4 no raw material plays a significant factor in determining variability.

RPC 2 somewhat confusingly divides assemblages into, on the one hand both large and small cores, and on the other hand medium sized cores which weakly correlates with Levallois cores. This can be interpreted as essentially indicating medium sized broadly Levallois-like cores, giving high scores, and cores which are different from this receiving low scores. The following components seem to reflect unclear combinations size variables, and no obvious patterns emerge.

RPC1:

| Site | N | Mean | Grouping |
|---|---|---|---|
| TH-123B | 106 | 0.9287 | A |
| JKF-1 quartzite | 28 | 0.3374 | B |
| Warwasi NNOO | 25 | -0.4655 | C |
| Porc Epic E | 40 | -0.5636 | C D |
| Tor Faraj 1 | 26 | -0.5821 | C D |
| Porc Epic C | 39 | -0.7273 | D |
| JKF-1 quartz | 49 | -0.8492 | D |

RPC2:

| Site | N | Mean | Grouping |
|---|---|---|---|
| JKF-1 quartzite | 28 | 0.5092 | A |
| Tor Faraj 1 | 26 | 0.2398 | A B |
| JKF-1 quartz | 49 | 0.0714 | A B C |
| Porc Epic E | 40 | 0.0019 | A B C |
| Porc Epic C | 39 | -0.1737 | B C |
| TH-123B | 106 | -0.2525 | C |
| Warwasi NNOO | 25 | -0.3506 | C |

Table 6.40. Tukey grouping of ANOVA results for question 1.

For the assemblages which have large enough sample sizes for the ANOVA scores the Tukey groupings for the first two components are presented (Table 6.40). In both cases the range of variability is not particularly large, and this reflects the division of variability into a number of components, none explaining a large amount. RPC1 separates large cores (123-b) from medium (JKF-1 quartzite) and small (Porc Epic, Tor Faraj and Warwasi) cores. The narrow range of variability of the assemblages characterised by small cores can be taken, at least in part, as an indication of typical abandonment thresholds for cores in these assemblages. The low scores for JKF-1 quartz cores can be interpreted as primarily reflecting the small initial size of quartz pebbles used. Aside from this the structure of RPC1 essentially reflects reduction intensity, and not raw material type.

The second component is given as an example of the difficulty of interpreting the results of this question. The meaning of the distinction between 'medium' and 'non-medium' is not clear, and the variation in mean scores for the different assemblages in any case not large. The strongest driver seems to be the representation of 'medium' cores at JKF-1 and Tor Faraj.

### 6.17) (2) How does core morphology vary in non-Levallois cores?

A principal components analysis was conducted on non-Levallois cores to examine variation within this subgroup. The variables chosen are intended to give an insight into both morphological variation and the extent of core reduction. The variables are percentage cortex, the number of scars covering more than 1/3 the length of the core, elongation (maximum dimension/maximum width), flattening (maximum width/maximum thickness). Unfortunately this analysis is restricted by small

sample sizes, with only JKF-1 having more than twenty non-Levallois cores (not including cores on flakes).

| Variable | PC1 (62%) | PC2 (25%) | PC3 (12%) | PC4 (1%) |
|---|---|---|---|---|
| % cortex | 0.546 | 0.060 | -0.728 | -0.410 |
| N. scars >1/3 length | -0.553 | 0.152 | -0.669 | 0.474 |
| Elongation | 0.032 | 0.986 | 0.147 | -0.072 |
| Flattening | 0.629 | 0.031 | 0.037 | 0.776 |

Table 6.41. Loading of components.

The first component explains 62% of the variability and primarily reflects a positive correlation of cortex and flattening and, inversely, the number of scars. This differentiates cores with high levels of cortex and few scars, in other words cores which are not heavily reduced, from those with little cortex, more scars and flattening, or more heavily reduced cores. The second component explains 25% of the variability and is strongly driven by elongation. The variable focusses on shape, distinguishing between squat and elongated cores. The third component accounts for 12% of the variability and is driven positively by elongation and, most strongly, by a negative correlation of the percentage of cortex and the number of scars. This component seems to again reflect reduction intensity.

In some cases only one or two non-Levallois cores are found in an assemblage, and clearly little can be said about such a small sample size. As the score plot for the first and second components (Figure 6.32) shows, for the first component JKF-1 quartz, in particular, has high scores. Tor Faraj cores also score quite highly, which is interpreted as reflecting the retention of some cortex on even the amorphous cores here. Cores from JKF-1 quartzite and Warwasi WWXX seem diverse. Assemblages with low Scores for the first component are Porc Epic E and C and Warwasi NNOO, which makes sense as the qualitative and metric impression is that these cores are heavily reduced.

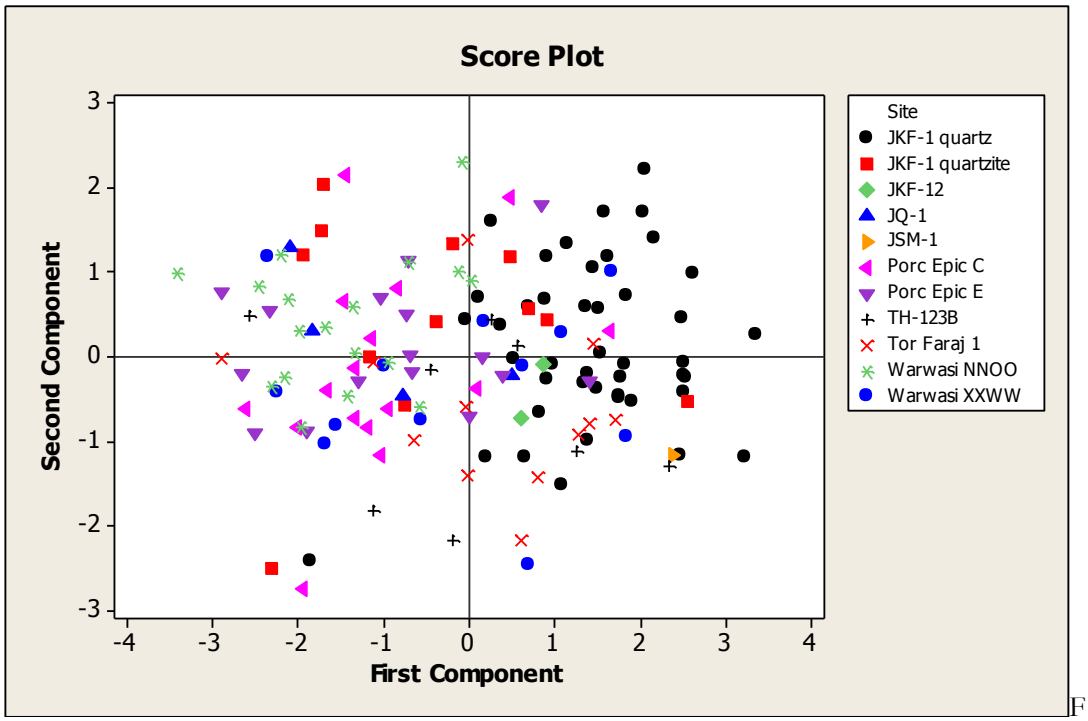



Figure 6.32. Score plot of first and second components.

On the second component, primarily relating to elongation a rather different patterning is visible. 123-b and Tor Faraj have similar low scores, despite these assemblages being in very different states of reduction, indicating that shape does not purely follow size. Most assemblages have quite variable, but broadly intermediate scores indicating that the cores are neither typically particular elongate nor particular squat. JKF-1 quartz is very varied, but JKF-1 quartzite has the highest scores indicating the basic shape of the cores is squat and not elongate.

## 6.18) (3) How does morphology vary in Levallois cores?

| Variable | PC1 (78%) | PC2 (14%) | PC3 (4%) | PC4 (2%) |
|---|---|---|---|---|
| Weight | 0.459 | 0.079 | -0.103 | 0.044 |
| Maximum dimension | 0.448 | 0.144 | 0.130 | 0.284 |
| Proximal width | 0.425 | 0.159 | 0.626 | -0.584 |
| Medial width | 0.443 | -0.115 | 0.096 | 0.644 |
| Distal width | 0.182 | -0.957 | -0.003 | -0.179 |
| Thickness | 0.422 | 0.136 | -0.755 | -0.359 |

Table 6.42. Loading of components.

Given the very high proportion of variance explained by the first component, only PC1 and PC2 will be considered. The first score components reflects size, with a positive correlation of all variables. As core get heavier they get longer, wider and thicker. The second component is strongly driven by convergence (i.e. small values for distal width). This structure then mirrors that of the previous component where size explained the majority of variation followed by a shape factor. In this case the latter distinguishes between cores which are broadly parallel sided and those which are pointed.

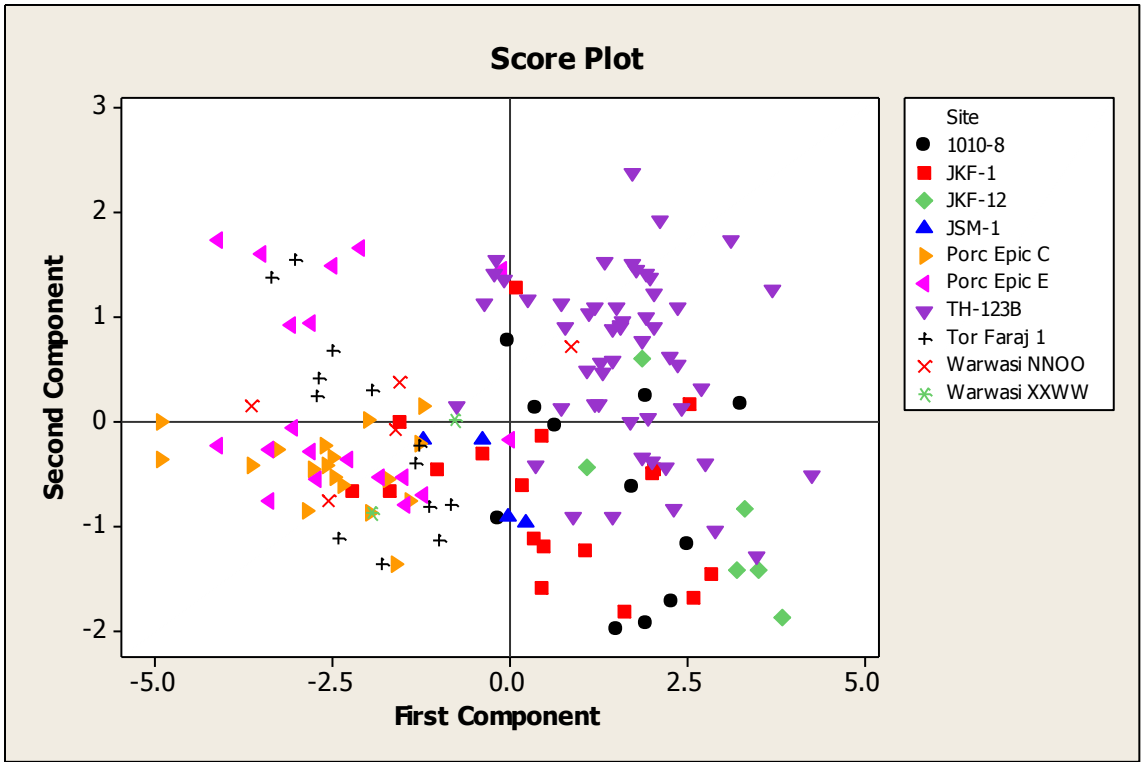


Figure 6.33. Score plot of first and second components.

The first component presents few surprises. JKF-12, 123-b, and 1010-8 cores are large. JKF-1 display a range of variability, averaging at medium size. Tor Faraj, Warwasi and Porc Epic have similar, low, scores indicating the small size of these cores and abandonment thresholds.

With the second component the distribution of variability arranges into relatively distinct groups. 123-b cores are typically convergent, 1010-8 are moderately convergent and JKF-12 and JKF-1 are not convergent shaped in almost all cases. Porc Epic, Warwasi and Tor Faraj are, for the most part, also clustered together as not particularly convergent. There are, however, some interesting

exceptions to this. At Porc Epic E a group of outliers which are substantially more convergent are present, as well as a small number from Tor Faraj.

### 6.19) (4.) How does reduction intensity impact core morphology?

As a recurring theme through this chapter has been the apparent importance of reduction intensity on core morphology, this question is addressed by the use of Principal Components Analysis to explicitly address this topic. The variables used – core elongation (maximum length/maximum width), percentage cortex, number of scars over 1/3 the length of the core and the number of aberrant terminations – all relate to the extent of reduction of the core.

| Variable | PC1 (40%) | PC2 (25%) | PC3 (23%) | PC4 (12%) |
|---|---|---|---|---|
| % cortex | -0.605 | 0.161 | -0.165 | 0.626 |
| Elongation | -0.303 | 0.560 | 0.760 | 0.128 |
| N. scars >5mm | 0.676 | 0.045 | 0.114 | 0.727 |
| N. non-feather terminations | 0.292 | 0.811 | -0.439 | -0.252 |

Table 6.43. Loading of components.

The first component divides cores which have a low percentage of cortex, are elongate, have few scars and not many aberrant terminations (high scores) from cores which have little, are squat and have more non feather terminations. This structure essentially gives a general overview of the extent of reduction, suggesting that as reduction increases cortex decreases, the number of scars increases, cores become less elongate and there are more non-feather terminations.

The second component primarily distinguishes reduction from the perspective of the number of aberrant terminations, rather than the 'all round' reduction perspective of PC1. This focus reveals a problem of equifinality with such analyses. The number of aberrant terminations may reflect heavy reduction, but it may also simply be the case that particular raw materials are more prone to aberrant termination types and also two aberrant terminations on a very small core has very different implications to two aberrant terminations on a very large core. The structure suggests that an index of aberrant terminations and another value, such as length or width, would probably offer a better method.

Aberrant terminations are also important in PC3, but less so than elongation. In this case then reduction is primary seen in terms of changing shape, with more reduction corns typically being less elongate.

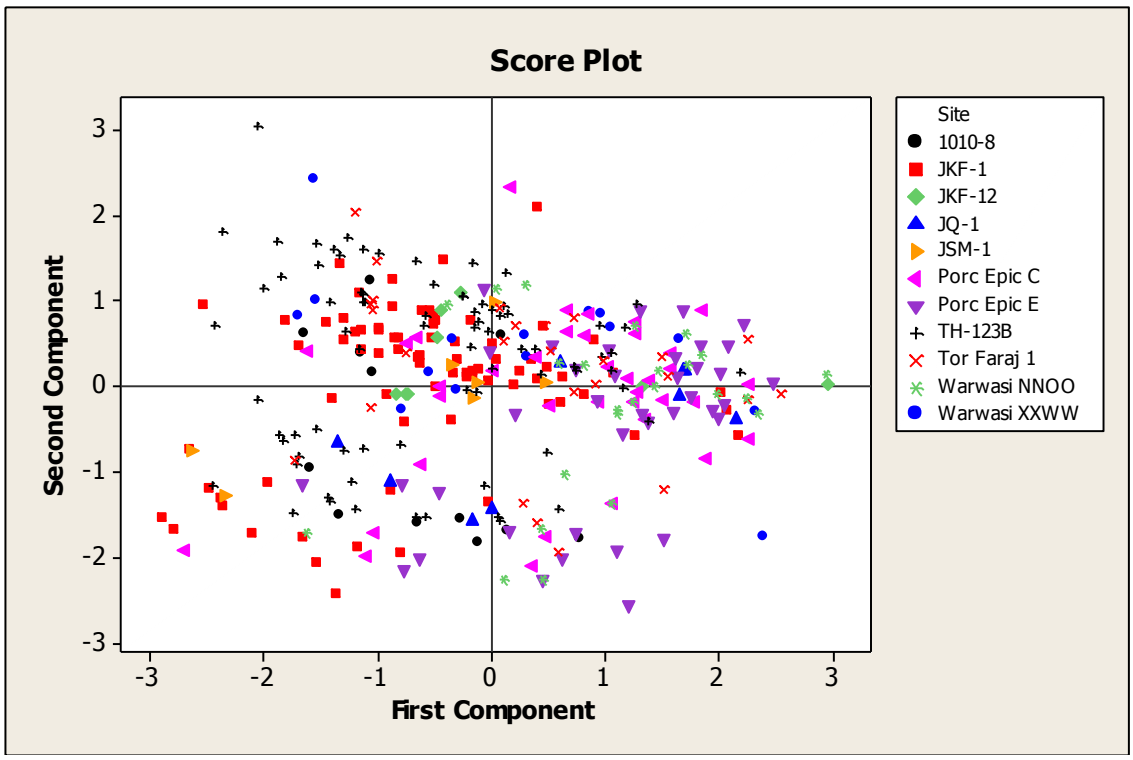



Figure 6.34. Score plot of first and second components.

Although there is quite a range of variability visible in the score plot (Figure 6.24) there is nevertheless some interesting patterning. Assemblages with high scores for the first component are both of the Porc Epic assemblages and Warwasi NNOO. This makes sense as these assemblages from cave sites have repeatedly appeared to be highly reduced. At a medium level of reduction are cores from Tor Faraj. In some cases cores from this assemblage cluster with the more highly reduced specimens, but there is a considerable range of variability and some have low scores. This is explained by the combination of heavily reduced Levallois cores, which cluster with Porc Epic and Warwasi NNOO, with the amorphous cores which although appearing heavily reduced feature fairly high levels of cortex and not many scars. This is interpreted as reflecting a reduction process heavily focussed on unidirectional-convergent Levallois reduction. When this process could not be followed, due, for instance, to a knapping error, then a few removals were made giving the core an amorphous character and the cortex typical to the lower surface of less heavily reduced Levallois cores was retained. JQ-1 and Warwasi XXWW also have medium scores. In both cases cores

appear quite varied. Most cores from JSM-1 fall in the middle, reflecting that they have passed through a cycle of preferential Levallois flake production, but do not appear to have been reprepaired. It is unclear what to make of this. Assemblages with low scores for the first component are 1010-8, JKF-1, JKF-12 and TH-123b. Although in all cases some cores are more reduced, the bulk of examples have low scores which makes sense as these are sites close to raw material sources and certainly have a qualitative feel of being less reduced.

With the second component, most sites cluster together with intermediate or slightly high scores. These represent cores with few aberrant terminations on them. A moderate number of cores have low scores indicating a prevalence of non-feather terminations. Both JKF-1 and 123-b are well represented here. Considering the relationship between PC1 and PC2, it is interesting that, particularly in the cases of JKF-1, JSM-1 and Porc Epic E, cores with low scores for the second component have considerably lower scores for the first component than other specimens from that assemblage. This indicates that the obstruction of the debitage with aberrant terminations meant that reduction was not pursued as extensively on these cores so they remain somewhat larger, more cortical, etc., than others in their assemblage. In contrast, Warwasi, in particular, demonstrates a more homogenous character perhaps indicating greater care in avoiding non-feather terminations. Alternatively it may be that because of raw material shortages reduction continued despite the presence of aberrant terminations, whereas in other contexts, close to raw material sources, it was grounds to abandon the core.

**6.20)** (**5.) What is the character of morphological variability of Arabian cores**?

The primary sources of information on Arabian Middle Palaeolithic technology in this thesis come from the Jubbah assemblages and the Dhofari site of TH-123B. In this section I supplement these datasets with measurements recorded by Prof. Petraglia on cores collected by the Comprehensive Survey for sites in Saudi Arabia. Because in most cases sample sizes are very small the aim here is a general morphological comparison, the results of which should be taken as providing an indication into variability and a spur to further research rather than providing any definitive assessment on the implications of core variability.

The variables in this Principal Components Analysis are percentage cortex, elongation (maximum dimension/maximum width), weight, maximum thickness and the number of scars over 5mm. Sample sizes prevent the inclusion of features such as those specific to Levallois cores.

| Variable | PC1 (41%) | PC2 (29%) | PC3 (20%) | PC4 (7%) | PC5 (2%) |
|---|---|---|---|---|---|
| % cortex | -0.411 | -0.545 | -0.229 | -0.692 | 0.056 |
| Elongation | 0.202 | -0.196 | 0.919 | -0.263 | 0.088 |
| Weight (g) | 0.544 | -0.427 | -0.233 | 0.144 | 0.669 |
| Maximum thickness (mm) | 0.615 | -0.275 | -0.169 | -0.149 | -0.703 |
| N. scars >5mm | 0.340 | 0.638 | -0.143 | -0.639 | 0.218 |

Table 6.44. Loading of components.

The first component effectively distinguishes between cores which are large and heavily reduced and those which are small and not so heavily reduced. This seems to reflect an important role for the form of raw material used. In contrast the second component provides the more familiar type of distinction which we have previously seen, between heavily reduced small and round cores, on the one hand, and less heavily reduced, more cortical and elongate cores. It should be noted that both of the first components explain a significant proportion of variation The third component primarily emphasises elongation, with elongate cores typically being light, thin and having few scars. In summary, the first three components can be interpreted, broadly, as reflecting size, reduction intensity and shape.

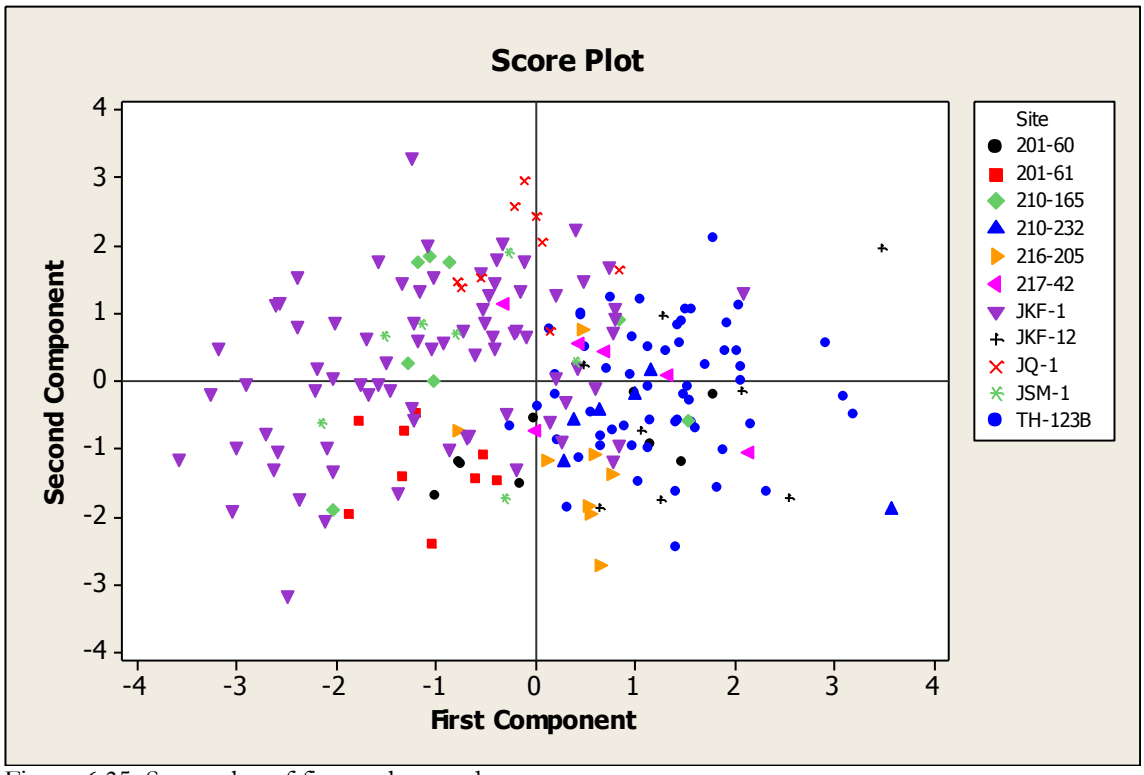


Figure 6.35. Score plot of first and second components.

In this case Figure 6.35 shows that the analysis quite effectively separates assemblages in most cases. Assemblages with high scores for the first component are 123-b, JKF-12, 210-232, 217-42, indicating that these are assemblages with large cores. Medium scores characterised JQ-1, 201-60 and 216-205. JSM-1, JKF-1 and 201-61 have low scores, indicating that the cores are quite small but also have a fair amount of cortex.

For PC2 the large samples of JKF-1 and 123b demonstrate a range of variability. JKF-12 is also highly varied. In most other cases the cores cluster quite tightly indicating similar levels of reduction. 201-61 and 216-205 demonstrate low levels of reduction. In the former case, the combined low scores for both the first and second components indicates that while reduction was not intensive the original size of the raw material must have been small. 201-60 and 216-205 also both demonstrate low scores for PC2, and therefore appear relatively unreduced. 217-42 has a middling score, which combined with the large score for the first component indicates large cores which were not extensively reduced. 210-65 and JQ1 emerge as the most reduced, with JSM-1 also scoring relatively highly.

### 6.21) (6) How do Arabian cores compare to non-Arabian cores in general morphological character?

This question again addresses the cores analysed in chapter 6 but now introduces all the other cores analysed in questions 1-4. The reason this wasn't done earlier is the issue of small sample sizes for the Arabian assemblages, but it is felt to be important to attempt at least some form of overall comparison. Here JKF-1 has been divided into quartz and quartzite assemblages. The variables considered are the percentage cortex, elongation (maximum dimension/maximum width), weight, maximum thickness and the number of scars over 5mm.

| Variable | PC1 (45%) | PC2 (24%) | PC3 (19%) | PC4 (10%) | PC5 (2%) |
|---|---|---|---|---|---|
| % cortex | 0.419 | -0.517 | -0.170 | 0.727 | -0.006 |
| Elongation | -0.206 | -0.064 | -0.964 | -0.152 | 0.043 |
| Weight (g) | 0.595 | 0.305 | -0.152 | -0.169 | -0.708 |
| Maximum thickness (mm) | 0.556 | 0.448 | -0.114 | -0.023 | 0.691 |
| N. scars >5mm | -0.344 | 0.660 | -0.078 | 0.648 | -0.142 |

Table. 6.45. Loading of components.

The first component distinguishes between large cores, which get more cortical, less elongate, thicker and have fewer scars as they get bigger, and small elongate cores which are have little cortex. This variable then repeats the distinction between heavily and less heavily reduced, with a fairly weak correlation for shape (elongation) to change as cores get more reduced (smaller).

The second component is most strongly driven by an inverse correlation of cortex and the number of scars, and therefore can again be seen as largely reflecting reduction intensity. In this case, however, the inverse correlation of percentage cortex and weight and thickness suggests a distinction between cores which are large and less cortical and those which are small and more cortical. This presumably reflects situations where just a few removals are made from small pieces of raw material, in contrast to cores which are reduced but started on much larger pieces of rock.

The third component suggests a changing shape with reduction intensity, with more reduced cores being more elongated and thinner.

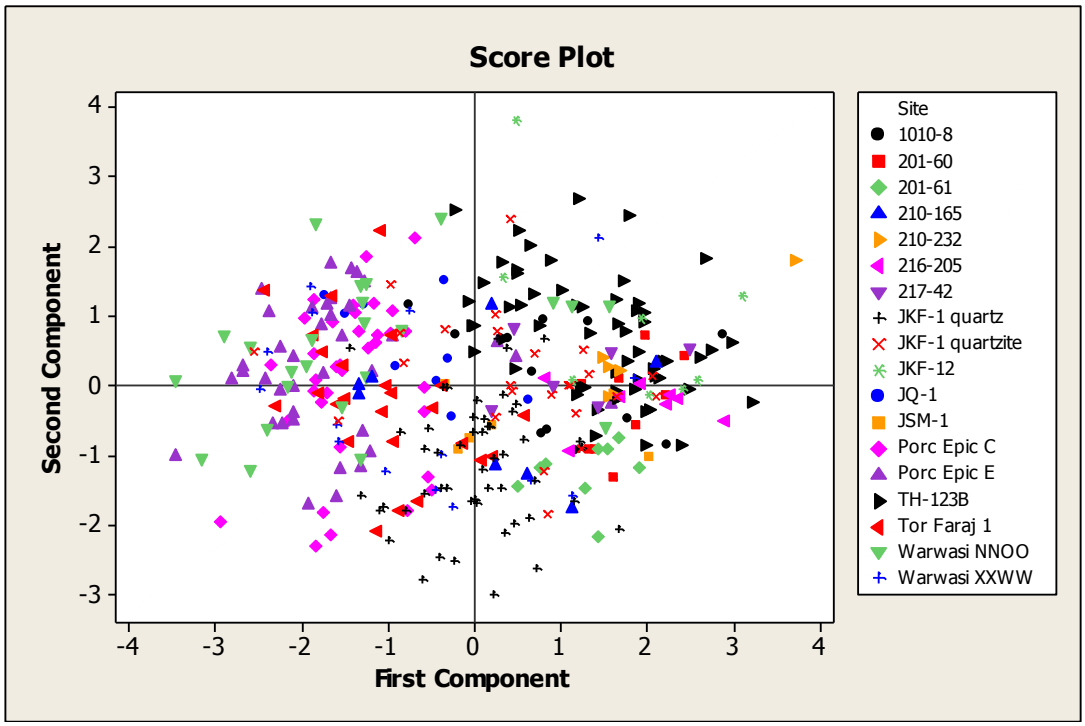


Figure 6.36. Score plot of first and second components.

While acknowledging the considerable intra-assemblage variability shown in Figure 6.36, some basic points can be made. Three broad groups can be suggested, the first being the less reduced sites consists of 210-232, 216-205, JKF-12, 201-60, 123-b, 201-61 and 217-42. The entirely Arabian composition of this group suggests that many assemblages in the peninsula are dominated by large and not heavily reduced cores. The middle group consists of JKF-1, JSM-1, 210-165, Warwasi WWXX and JQ-1. Finally the group with small, heavily reduced cores consists of Tor Faraj, Warwasi NNOO and Porc Epic. On the whole then PC1 repeats earlier observations which distinguish between the heavily reduced assemblages such as Warwasi and the more primary assemblages in Arabia.

The second component is rather confusing. Let us simply note the two ends of the variability. At one end are JKF-12 and 123-b with large but decortified cores, and at the other end JKF-1 quartz and 201-61 where small raw material packages were typically not heavily reduced. It is not particularly clear if the variation in between these extremes is important. In a broad sense, the component indicates the form of raw material available, but this is interacting with reduction intensity in a complex way.

**Discussion**

A summary of the results of this chapter will be presented in Chapter 9, as will an exploration of how the different lines of evidence correlate with each other. For now some basic points suffice. This chapter has repeatedly demonstrated that much of the variability in cores relates to reduction intensity. Figure 6.37 gives another example of such 'pragmatic' explanations for core variability, showing clearly that the number of core types in large part reflects the number of cores present.

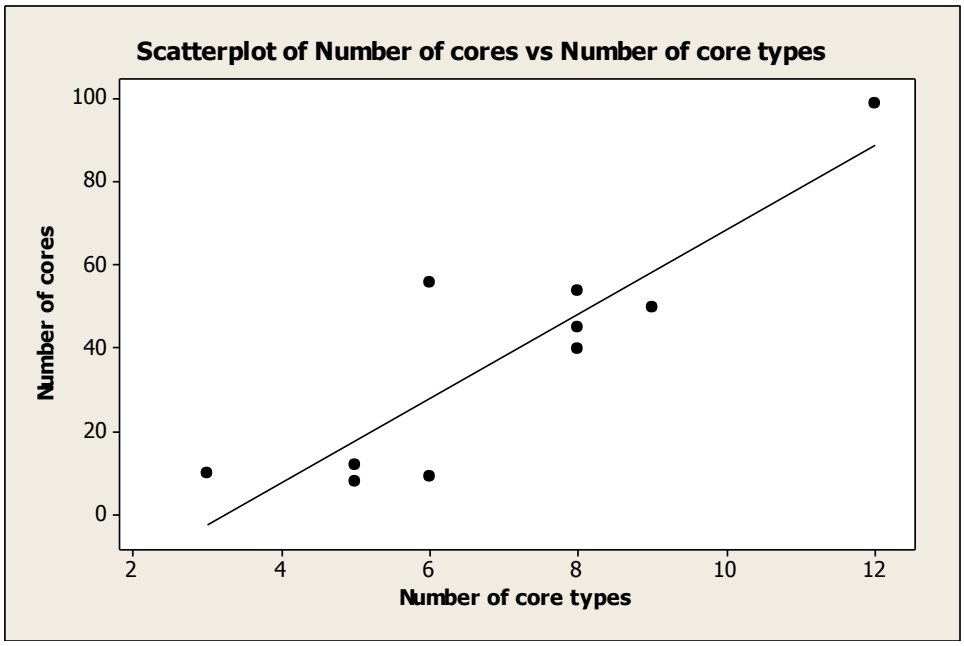



Figure 6.37. Scatterplot of number of core types and number of cores. The plot and regression (r-squared = 78%) clearly shows that much of the relationship relates to the size of the assemblage.

However, it has also been repeatedly shown that some factors do not merely relate to size/reduction intensity in a simplistic manner. While typology changes with reduction intensity, it does so in a different manner in the different assemblages. In terms of shape characters such as convergence and elongation, some variation seems reduction related while in other cases they seem somewhat independent and therefore offer insights into the choices made by the knappers. The overall picture seems to be that cores can offer important insights into 'cultural' behaviours, and hence factors such as dispersals, but factors such as size and reduction intensity variation must be considered *before* such factors are strongly emphasised.

# Chapter 7: Debitage

## 7.1) Introduction

The previous chapter, on variations in the morphological and technological characteristics of cores in the assemblages studied, highlighted both considerable equifinality and significant patterns of similarity and difference. The particular characteristics of cores, including their relative rarity and preservation of only evidence for the terminal phase of knapping, means that for a more complete picture of the reduction process we must turn to the debitage. Each blank reflects both a moment of the reduction process - when it was struck it was removed from the core 'system' - and, in attributes such as dorsal scar patterns we gain an insight into the process which went before this. Cumulatively, the attributes of blanks offer, in theory, a complete reconstruction of the reduction process.

In contrast to cores, where it is felt that features such as varying volumetric relationships and interacting dorsal scars justify the use a reasonably large typology, if only as a means to organise questions, in the case of the typology plays only a minor role here. This approach recognises the considerable equifinality which can affect blank morphology, in that different core reduction systems can produce seemingly identical blanks. It is suggested that rather than focussing on individual blanks, the robust understanding of the reduction process in a comparative sense is best achieved through the comparison of attributes at the assemblage level. Following an introduction of the basic characteristics of the various assemblages, this chapter explores similarity and difference in terms of a number of key attributes. From this foundation the chapter presents a number of multivariate analyses of blank variability.

### 7.2. Basic assemblage typology and qualitative description

Table 7.1 outlines the composition of the debitage in the various assemblages used in this study. While sample sizes vary considerably, it is felt that in all cases they are large enough for the purposes of the present analysis. The broad similarity in assemblage composition should be noted. For instance, flakes dominate all assemblages. Variation in chips and chunks reflects both the vagaries of collection procedures and also the character of reduction/raw material. There are considerable differences in the laminarity of the assemblages, both between sites, being for example low at the Jubbah sites and high at Tor Faraj, and within a site, such as Porc Epic layers E (11% laminar) and C (27%).

| Site | Flakes | Blades/ microblades | Core management | chunks/ chips | Total |
|---|---|---|---|---|---|
| *JQ-1* | 76 (80) | 3 (3) | 0 | 16 (17) | 95 |
| *JSM-1* | 49 (66) | 1 (1) | 1 (1) | 23 (31) | 74 |
| *JKF-1* | 744 (67) | 21 (2) | 50 (4) | 298 (27) | 1113 |
| *JKF-12* | 69 (81) | 2 (2) | 12 (14) | 2 (2) | 85 |
| *Porc Epic layer C* | 107 (71) | 40 (27) | 1 (1) | 2 (1) | 150 |
| *Porc Epic layer E* | 145 (84) | 19 (11) | 0 (0) | 9 (5) | 173 |
| *1010-8* | 103 | 5 | 6 | 0 | 114 |
| Bir Sahara 1 | 192 (67) | 3 (1) | 1 | 89 (31) | 286 |
| *Tor Faraj, floor 1* | 365 (67) | 118 (21) | 12 (2) | 55 (10) | 550 |
| *Warwasi NNOO* | 317 (62) | 70 (14) | 0 | 123 (24) | 510 |
| *Warwasi WWXX* | 225 (66) | 69 (20) | 4 (1) | 42 (12) | 340 |
| *123-b* | 199 (78) | 17 (7) | 37 (15) | 2 (1) | 255 |

Table 7.1. Composition of debitage in the assemblages studied. In brackets are the % that category constitutes of that total assemblage. No figures given for 1010-8 as this represents a sample.

This section precedes the quantitative and attribute oriented analysis which follows. It seeks to contextualise these concerns in terms of a number of factors, such as considering the 'types' of site, the nature of sampling which led to the formation of the assemblage as examined, and the qualitative technological features. The individual site descriptions below are primarily qualitative in character.

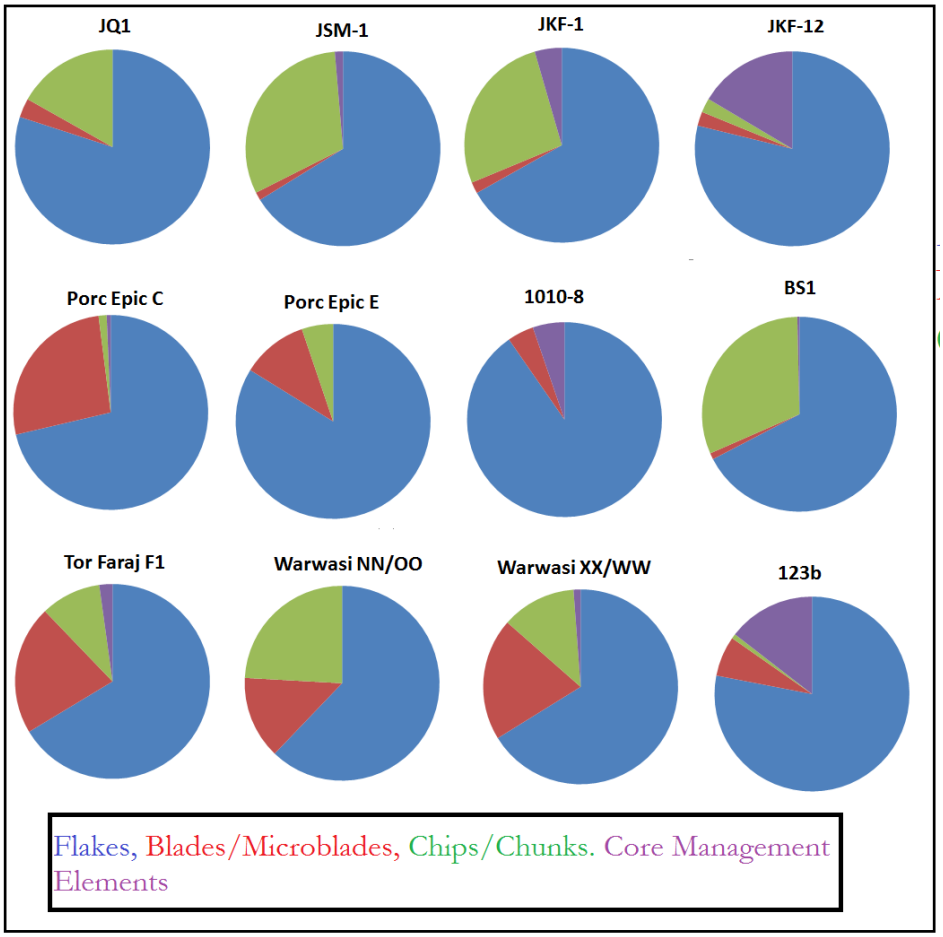



Figure 7.1. Pie charts of basic typological composition of debitage in the lithic assemblages studied.

### JQ-1

The assemblage seems to demonstrate the hard hammer reduction of Levallois and discoidal cores, producing a variety of typically small flakes (with unidirectional scar patterns, 'preparatory' flakes), although several flakes are larger, feature centripetal scar patterns and appear to be predetermined (see Figure 7.2). A small number of laminar blanks are present, but they are rare. Core management elements are absent. One very large flake is present, and stands in stark contrast to the rest of the assemblage. Most are 'ordinary' flakes, but specific types include a 'pseudo-Levallois' point. The patination/weathering of the assemblage varies from fresh to moderate.

**JSM-1**

The JSM-1 assemblage consists of a relatively small assemblage dominated by flakes and chips/chunks, with single examples of both a blade and a core management element recover. The assemblage, like that of JQ-1, contains both small flakes with unidirectional scar patterns and a few larger blanks with sub-centripetal to centripetal preparation. Judging from the classic Levallois cores present at the site, large preferential flakes have been removed, or have simply not yet been discovered at the site. Several flakes are highly cortical (e.g. 6 in Figure 7.3), which indicates that the entire reduction sequence was carried out at the site. The debitage is consistent with the core technology, and indicates a focus on preferential Levallois reduction with centripetal preparation. Patination/weathering is in most cases moderate. A low concentration acid solution was used to remove calcretions from some specimens.

**JKF-1**

The JKF-1 assemblage is dominated by flakes, mostly of quartzite, but with quartz also common (See Figures 7.3 to 7.10). A small number of blades and fairly high number of core management elements (Figure 7.6) are present. The prevalence of chips and chunks suggests that knapping took place on site. Most quartz flakes are either highly cortical or small and simple. The rather more complex removals suggested by some of the quartz cores seem to have been removed. The reduction of quartzite was heavily Levallois in character, with the debitage suggesting a diverse approach to blank production apparently using hard hammer direct percussion. The production of triangular flakes, some of which can be classified as 'Levallois points', such as those shown in Figures 7.8 and 7.9, was clearly an important part of reduction at JKF-1. However, many blanks feature unidirectional, bidirectional, and centripetal scar patterns (Figures 7.4, 7.5, 7.10 ). Buried artefacts are sharp and in the case of quartz in very fresh condition, but quartzite artefacts are somewhat oxidised. Artefacts from the surface are slightly more patinated, but lack the chemical weathering of the *in situ* specimens. Their generally good condition supports the idea that the recently eroded onto the surface from stratum H.

**JKF-12**

The collection of debitage from the JKF-12 area results from two transects walked through the locality. It is therefore likely that the collection underestimates small debitage and chips/chunks, explaining why the latter are poorly represented in the collection. In addition because the site is a surface site, some small material may have been washed away. Despite this, the good visibility at the site means the collection is at least reasonably representative. It is dominated by flakes and includes a high proportion of core management elements (Figure 7.1). The material is almost entirely quartzite, and demonstrates Levallois reduction of large quartzite blocks, most by unidirectional reduction, with scars in two directions also common, indicating the rotation of large cores. In virtually all cases patination/weathering is of medium intensity

**Porc Epic layer C and E**

As broadly similar characteristics apply, both of the Porc Epic assemblages are here considered together (see Figures 7.13 and 7.14). In both cases diverse raw materials are represented, which appear to have been reduced by a diversity of methods, particularly preferential Levallois with centripetal preparation but also including recurrent methods. It appears that more local raw materials, such as flint and quartz, were, predictably, reduced from a more primary state at the site, while the exotic, such as obsidian, and jasper, are both typically smaller and more refined. It seems that for primary flaking only a hard hammer was used, at least if features such as the absence of platform lipping are a guide, although a soft-hammer may have been used in some cases as some bulbs of percussion are rather diffuse. Most of the assemblage consists of flakes, but unretouched points are also present alongside oval flakes with centripetal preparation. Blades and microblades are relatively common, particularly in layer C. Core management elements are virtually absent. At least two pieces can be identified as burin spalls. Chips and chunks are present, but not particularly common, but the presence of some, along with many incomplete flakes, appears to demonstrate that the collection does not seem to be particularly selective. Patination/weathering of the collection is generally light, in a few cases moderate. Some specimens have calcretions on them.

**1010-8**

Due to the absence of most of the debitage – which is presumed to have been left in Sudan – the systematic collection described by Marks (1968a) could not be analysed in full. As a result, chips and chunks and 'normal' flakes are under-represented. The original collection was, in any case, not particularly large so enough material is analysed in this study to give a relatively robust insight into reduction at the site (see Figure 7.14). Most of the collection studied consists of flakes, with blades and core management elements also present in moderate numbers. In several cases lithics marked or bagged as retouched tools are treated here as unretouched debitage, the small chipping to the margins more likely reflecting damage. The blanks include some points, although they are rather robust, and two pseudo-Levallois points. All lithics were made of the same fine grained quartzite and most are only lightly weathered. Reduction featured various methods of Levallois reduction, particularly centripetal, bidirectional and Nubian.

**Bir-Sahara 1**

The sample from BS-1, with examples shown in Figure 7.15, is dominated by quartzite flakes and chips/chunks, which although fairly lightly patinated/weathered are rather fragmentary and typically small. In most cases the small blanks preserve 'from proximal' scar patterns, and seem like preparatory flakes for Levallois cores. Some larger examples feature more complex scar patterns. On the whole the flakes appear 'simple'. A few microblades and a single core management element were identified.

**Tor Faraj floor 1**

The analysis of the sample of debitage from floor one of Tor Faraj suggests similar features to that identified in the larger-scale analyses of Henry (e.g. 2003) and Demidenko and Usik (2003). The sample is dominated by flakes, but also contains a significant proportion of laminar blanks (Figure 7.16). All lithics are on fine grained flint, which occurs in a variety of different colours and textures. Many of the lithics exhibit evidence of heating and are considerably whitened. The fundamental character of lithic reduction seems to be the unidirectional-convergent preparation of lateral and distal convexity and subsequent removal of triangular blanks (Levallois points, see Figure 7.17).

These fine flakes, and many 'preparatory' elements, have carefully faceted striking platforms. The longitudinal axis of the preparatory blanks explains the laminarity of much of the debitage. Alongside this reduction sequence other methods occur, such as small numbers of centripetally prepared flakes, and the production of very small flakes from cores on flakes. Several burin spalls are present.

**Warwasi NNOO/WWXX**

Both assemblages will be considered together given their broad similarity and their mutual excavation and storage. The flints used are diverse in colour and texture, and there appears to be notable variation in the quality of the material. Most of the debitage appears relatively 'simple', the fine chapeau du gendarme platforms found at Tor Faraj, for instance, do not occur in the studied material at Warwasi. Although Levallois-like blanks are present, they are quite uncommon. The Warwasi material studied is dominated by flakes, but blades/microblades are also common, particularly in WWXX, while NNOO has double the percentage of chunks/chips. The high representation of the latter suggests that the collection is not heavily biased. The abundance of microblades remains relatively constant at around 10% of the total lithics for each spit, while the proportion of blades (those over 40mm) varies quite considerably. Overall there is little typological diversity among the debitage. Some pseudo-Levallois points are present.

Further indications of variability through the sequence were observed. These included the fact that all of the core management elements recognised were found in a single spit (WW), which also has the highest proportion of cores of the layers analysed. Likewise, the only two hammerstones observed are from the spit with the highest ratio of fragments and chunks (OO). Given that only a few spits from the site were evaluated, these observations are hard to substantiate but may be taken as indicating variation in the character of reduction at the site through time. Most of the material is in reasonably good condition, with little weathering/patination, although rather amorphous and in some cases fragmentary. Quite a few pieces appear to be burnt.

**Mudayy As Sodh (TH-123b)**

The assemblage from 123-b is manufactured on high quality flint, which was available immediately adjacent to the site. The assemblage is dominated by flakes, with a moderate number of blades (see Figure 7.20). The site features the highest proportion of core management elements for all sites. Despite systematic collection of the site and scraping of the surface, very few chunks/chips were present. Likewise very few small flakes were collected. While this may suggest that small elements were washed downhill, it also appears to reflect the mode of reduction at the site and the evident skill of the knappers. Compared to the number of Levallois cores with triangular scars, few points are present. Those which are, are typically 'deformed' in some way, or at the least are rather robust (numbers 5 to 7 on Figure 7.20). The site appears to have functioned as a 'workshop' for Nubian Levallois points. Alongside this an array of debitage products were struck from both Levallois and non Levallois cores, particularly single platform, cores. While mostly in good condition, with, for instance, the direction of scars normally being readable, much of the assemblage is moderately strongly weathered/patinated, and some parts are strongly affected by heat 'pot-lidding'.

### 7.3. Photographs and illustrations of selected debitage

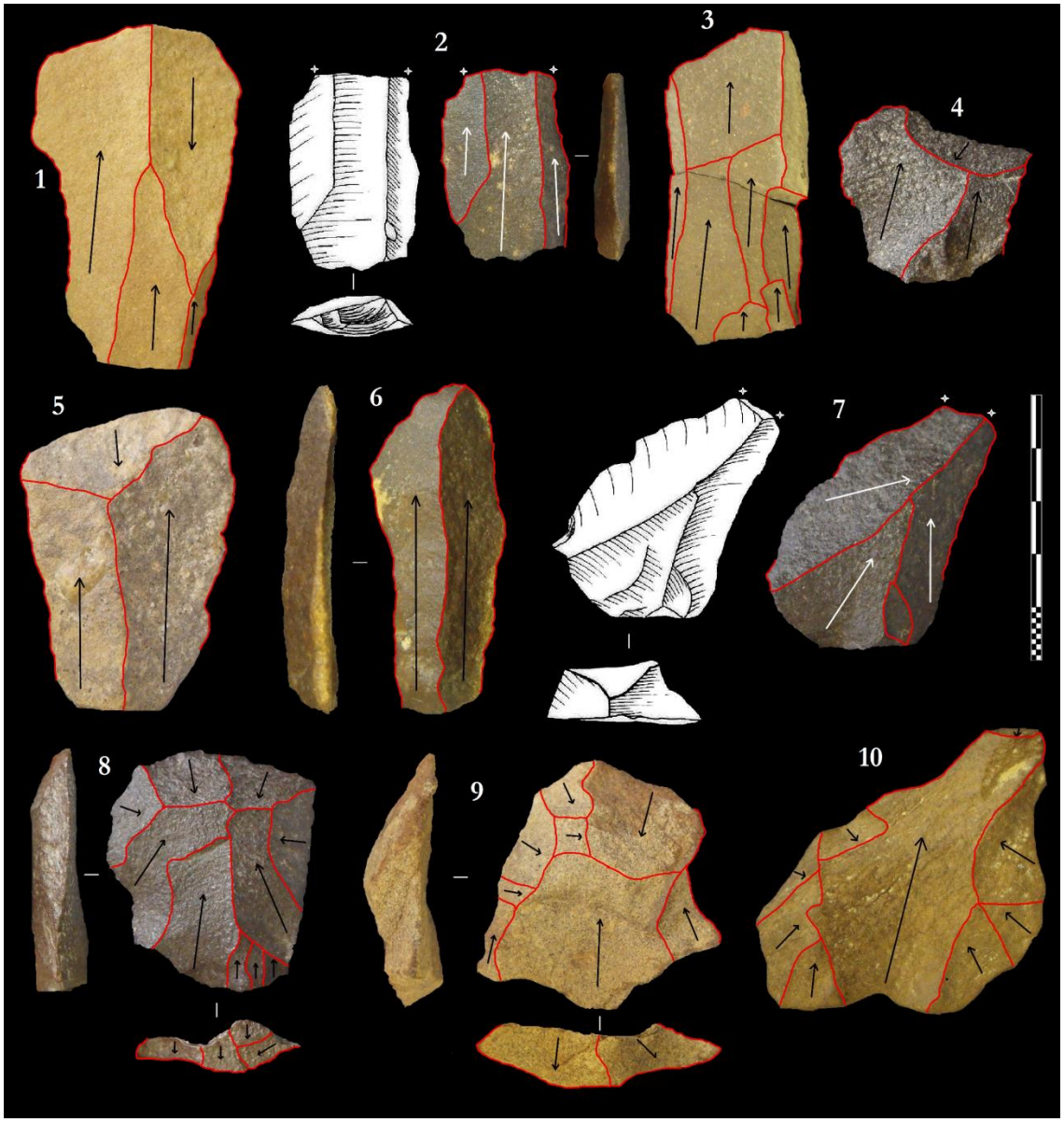



Figure 7.2. Examples of debitage from JQ-1. 1,4,5 – bidirectional flakes, 2 – proximal part of unidirectional blank, 3,6 – blades, 7 – pseudo-Levallois point, 8,9,10 – preferential Levallois flakes with centripetal preparation. All quartzite/sandstone, except 3 = rhyolite.

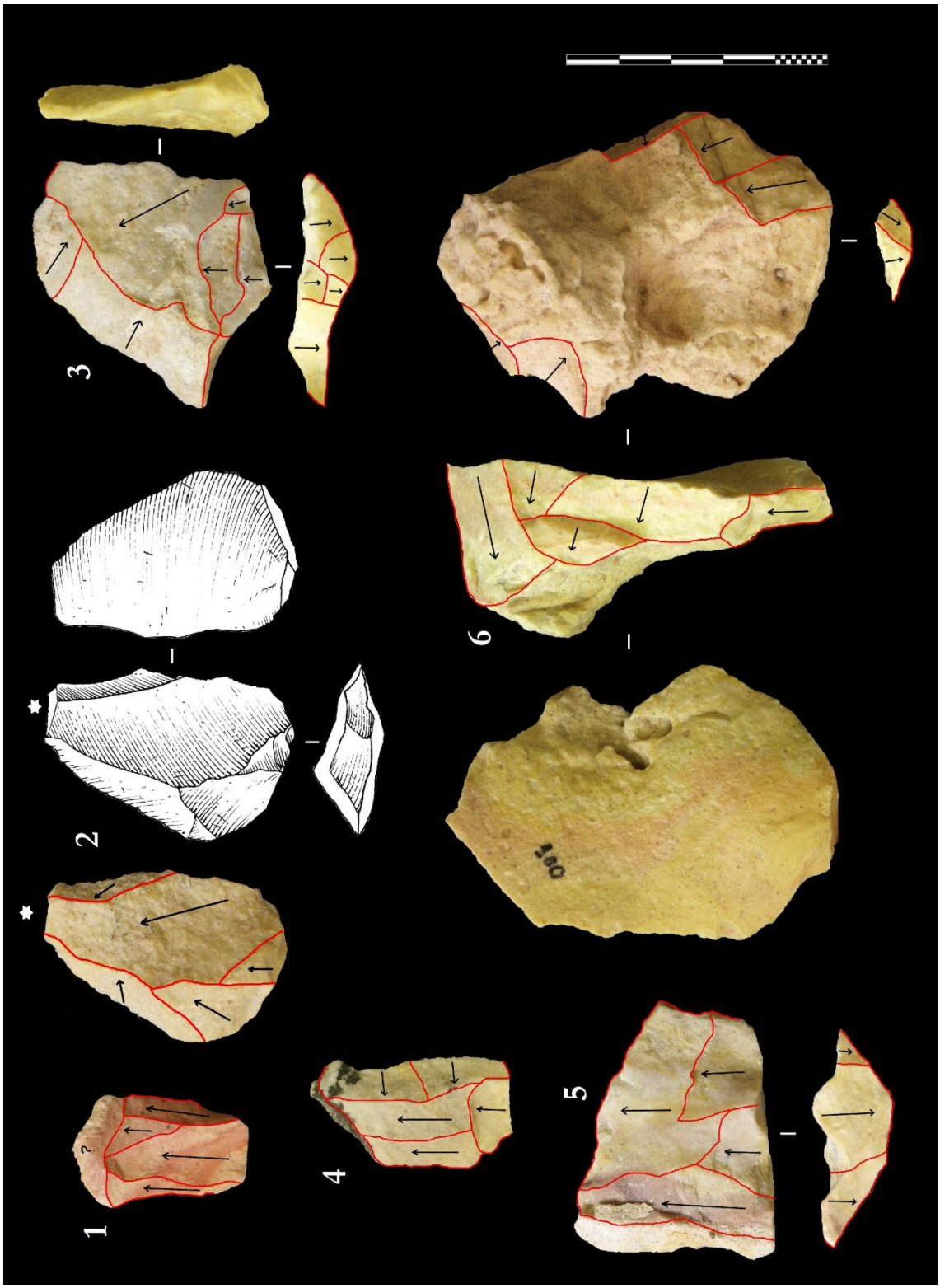



Figure 7.3. JSM-1 debitage. 1 – small flake with unidirectional scar pattern, 2, 3 – preferential Levallois flakes, 4 – small flake with from proximal and from right scat pattern, 5 – thick flake with cortical left margin and from proximal scar pattern, 6 – decortification flake, struck after a series of short and steep removals were made from the right lateral and distal.

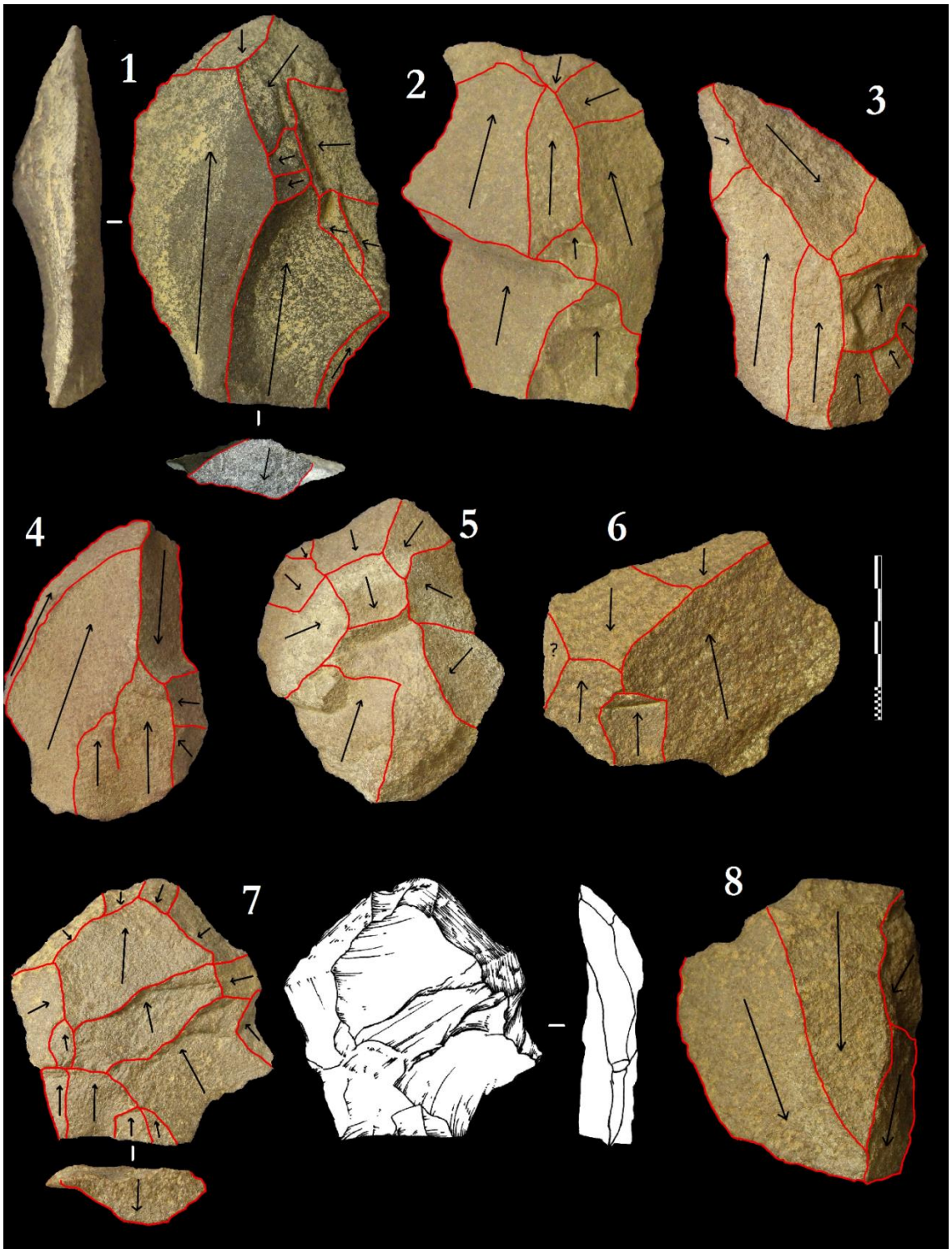



Figure 7.4. Examples of large flakes from JKF-1. 1, 5, 7 - centripetal scar patterns, 2, 3 4, 6 – bidirectional scar patterns, 8 – from distal scar patterns, showing 180 degree rotation of the core and demonstrating a change from unidirectional convergent to bidirectional reduction. (Illustration by M. Terrade).

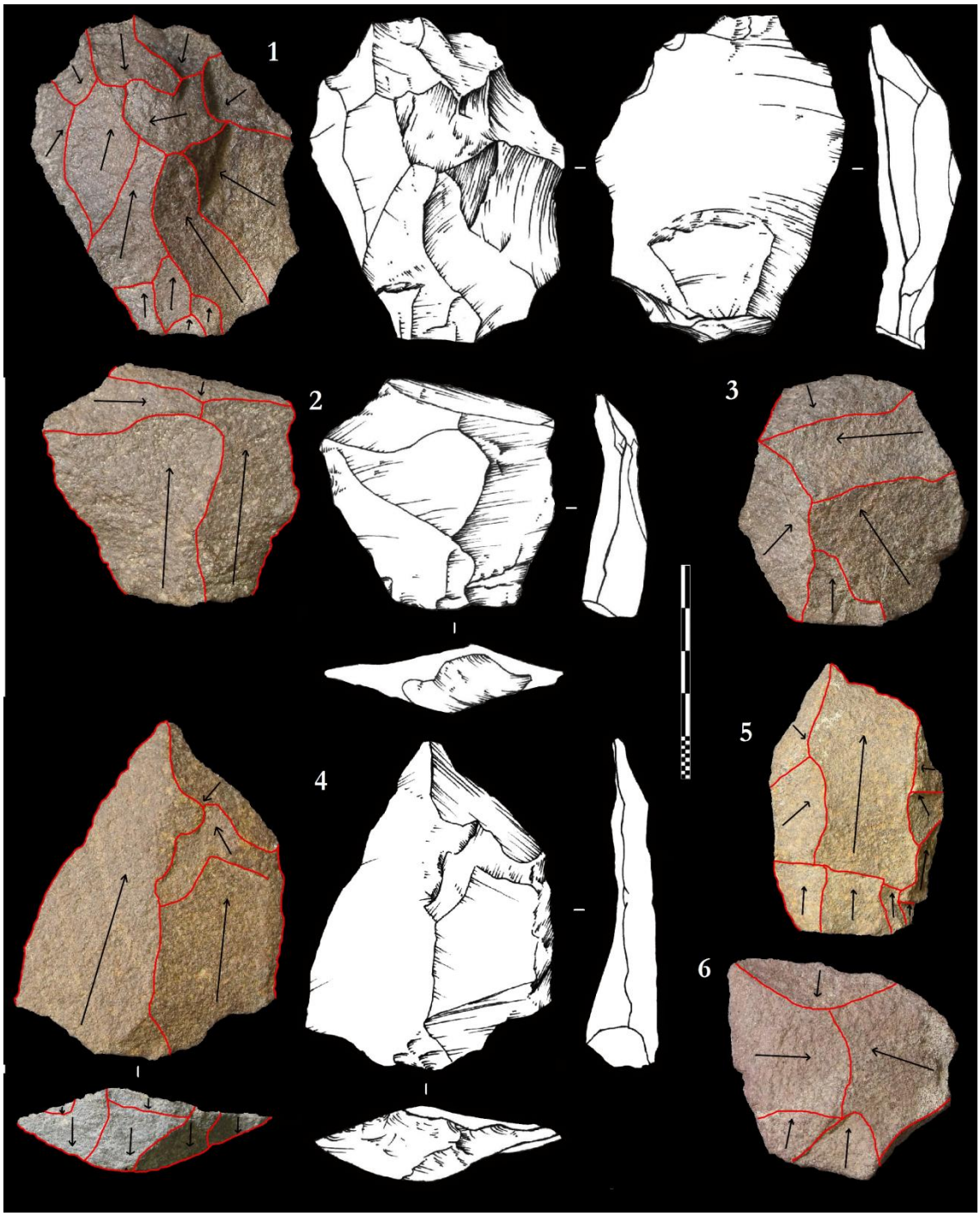



Figure 7.5. Examples of flakes with centripetal and bidirectional scar patterns from JKF-1. All quartzite. 4 – bidirectional scar pattern, all others centripetal.

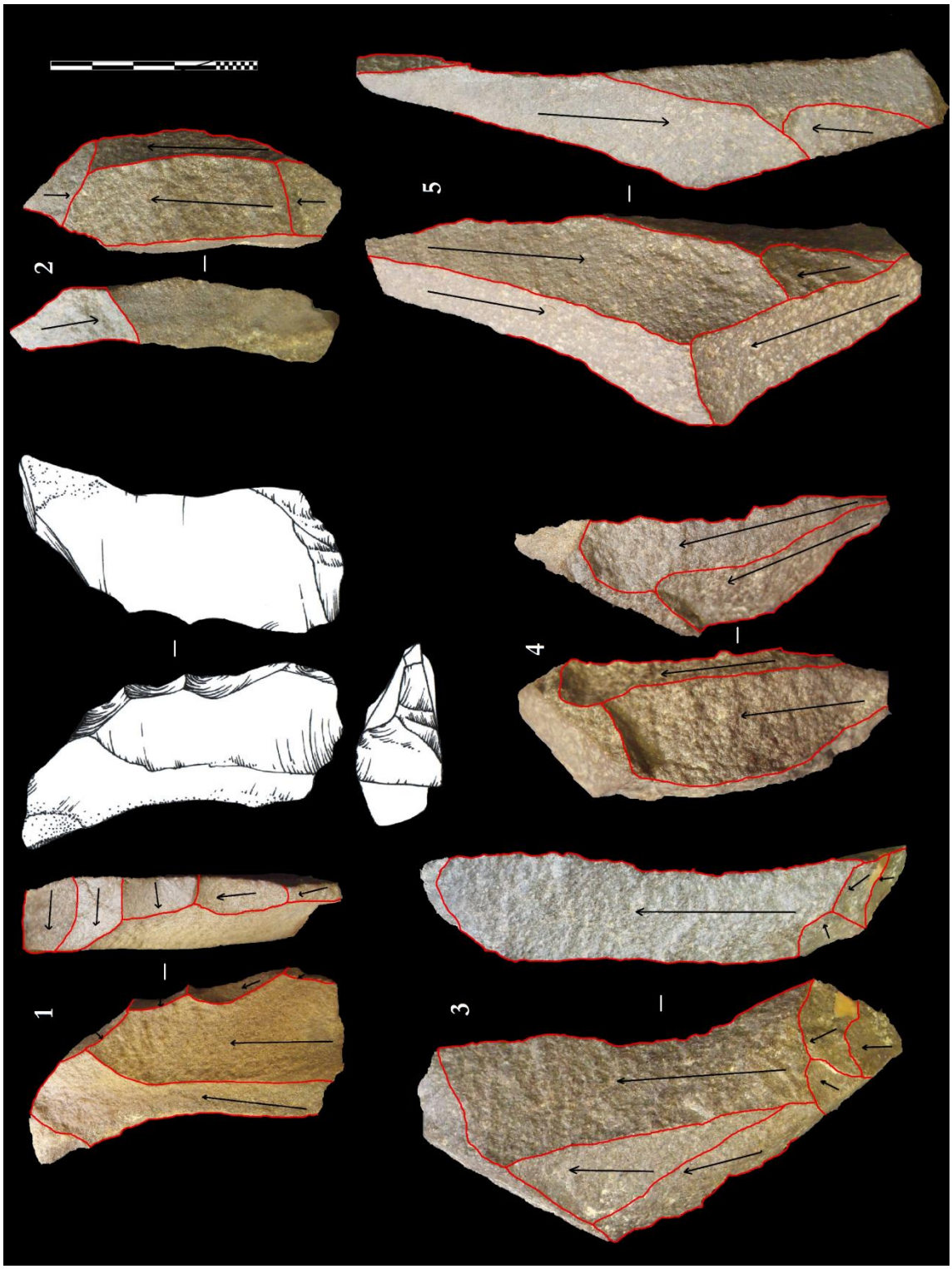



Figure 7.6. JKF-1 core management elements (blanks struck from side of core to maintain lateral convexity). In all photographs the right hand image represents the former superior surface of the core and the left side image the lateral margin of the core.1 – from proximal and from right scar pattern, 2, 5 – bidirectional scar pattern, 3-4 – from proximal scar pattern (illustration by M. Terrade).

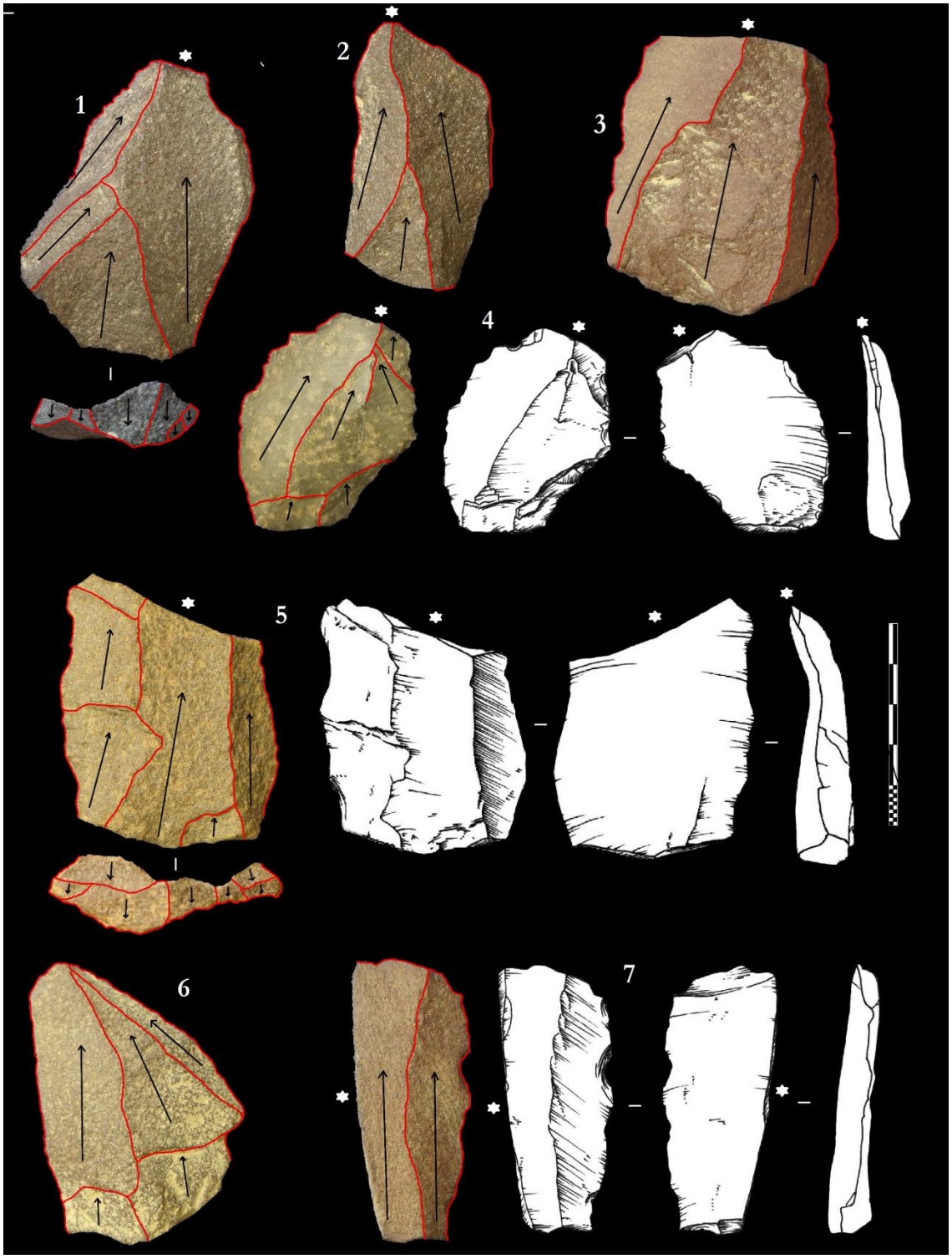



Figure 7.7. Examples of blanks with from proximal and from proximal convergent scar patterns from JKF-1. All quartzite except 4 = rhyolite (illustrations by M. Terrade).

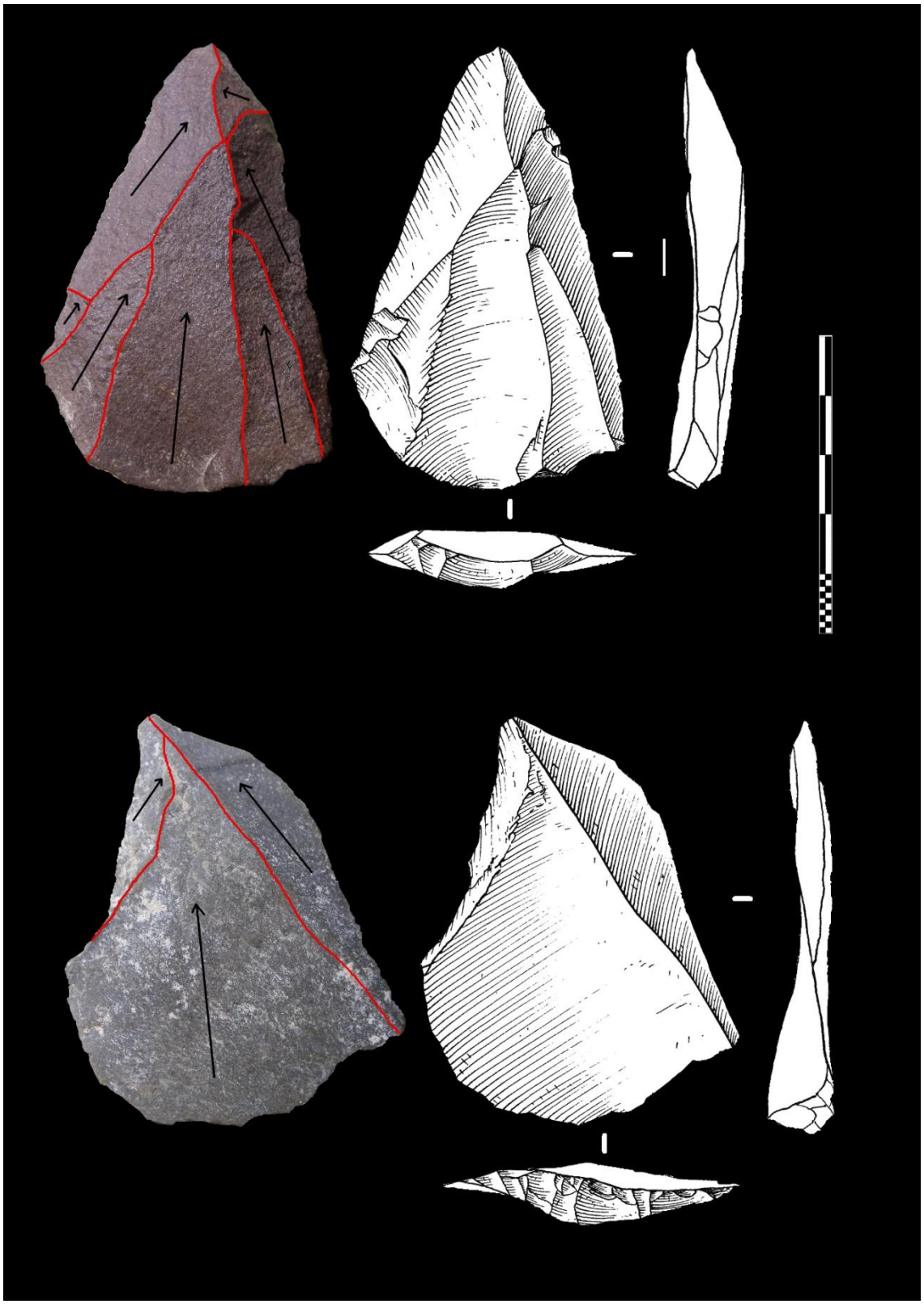


Figure 7.8. Examples of Levallois points from JKF-1. Top – quartzite, bottom – flint (note finely faceted platform). (illustrations R. Crassard and G. Devilder, modified from Petraglia *et al.* 2012).

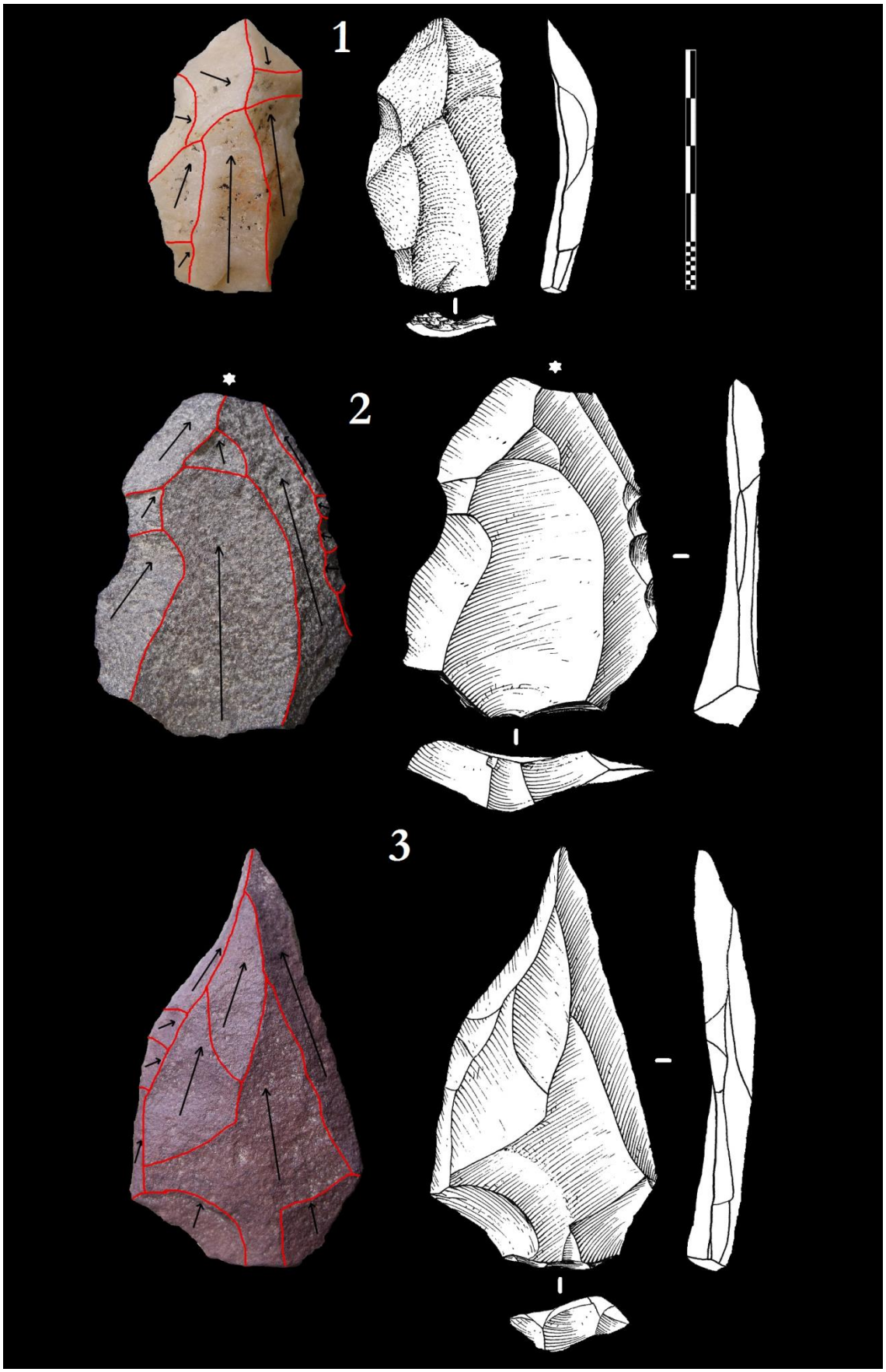



Figure 7.9. Examples of Levallois points from JKF-1. 1 – quartz, 2,3 – quartzite. (Illustrations by R. Crassard and G. Devilder, modified from Petraglia *et al.* 2012).

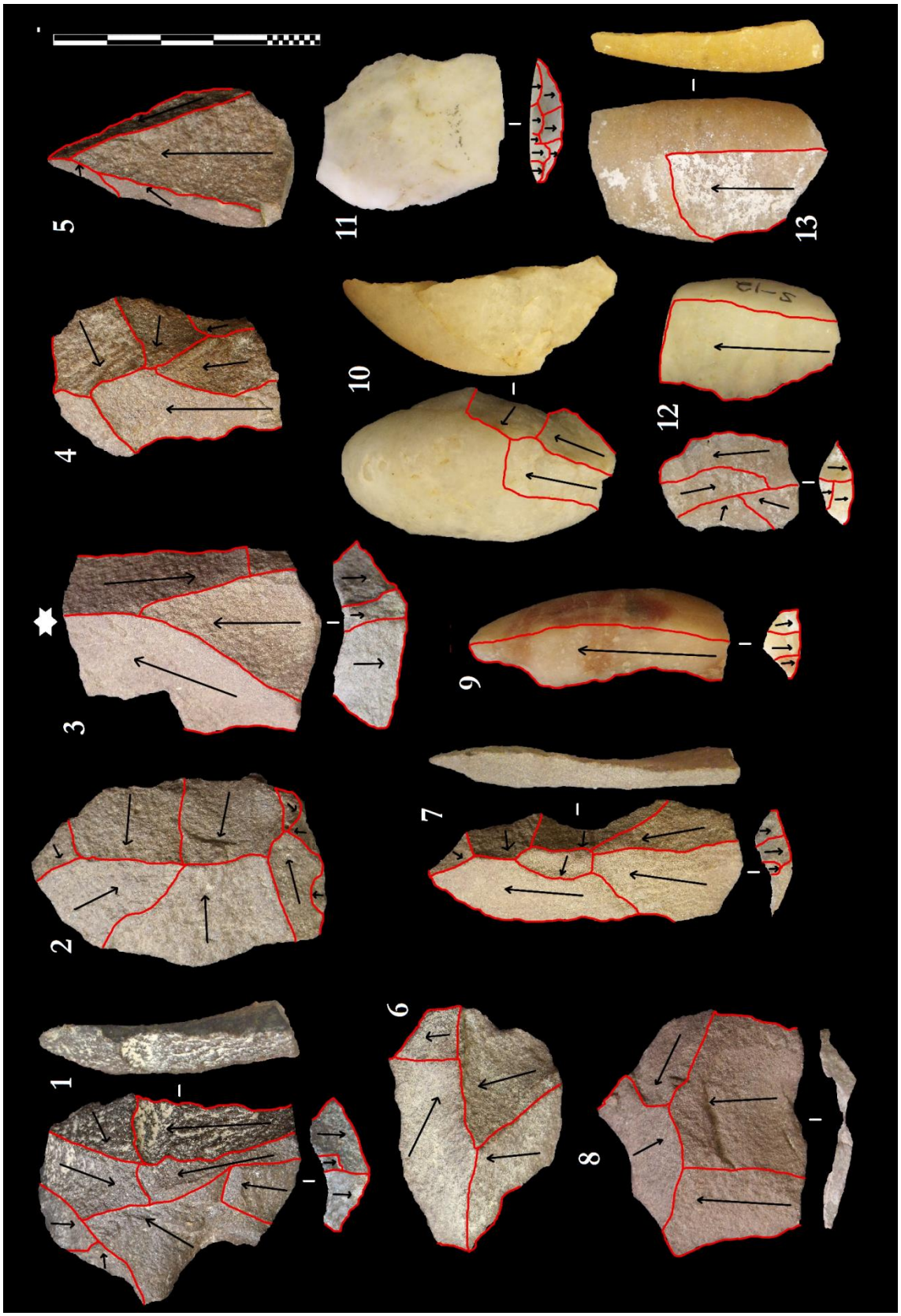



Figure 7.10. Examples of small/medium sized debitage from JKF-1. 1-7 = quartzite, 10-13 – quartz. 1, 2, 8, 12 – centripetal scar patterns, 3,6 – bidirectional scar patterns, 5 – small point with unidirectional convergent scar pattern, 7 – blade with from proximal and from right scar pattern, 9 – blade with single scar from proximal, 10 – thick quartz flake with from proximal scar pattern, mostly cortical, 11 – cortical quartz flake with faceted platform, 13 – quartz flake with single from proximal scar, mostly cortical.

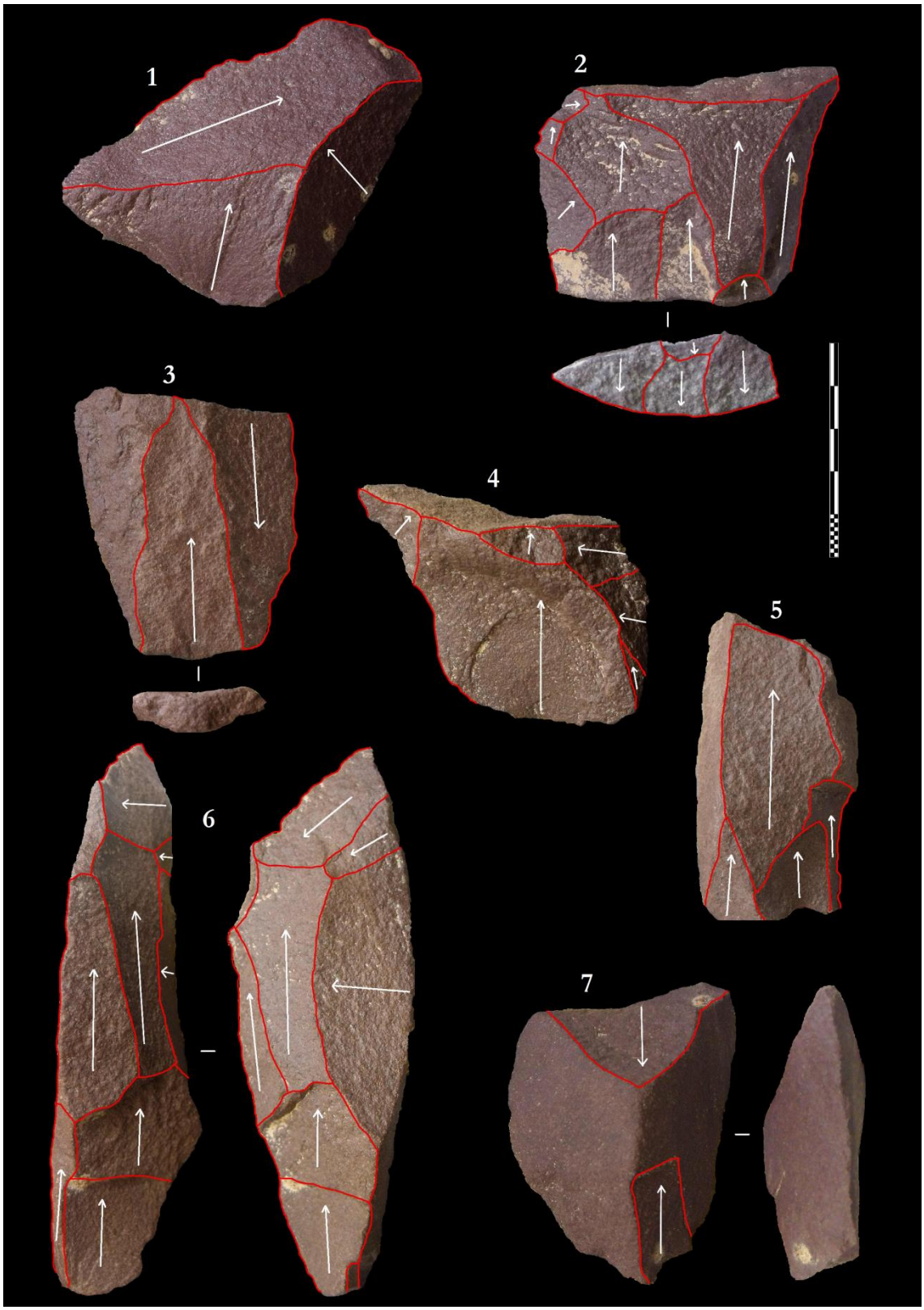



Figure 7.1. Examples of debitage from JKF-12. All quartzite. 1 – Flake with weakly radial scar pattern, 2 – thick flake with faceted platform, from proximal scar patterns and cortex at distal, 3, flake with bidirectional scar pattern and cortex on left lateral and cortical striking platform, 4 – flake with radial scar pattern and cortex at distal, 5 – flake with from proximal scar pattern and cortex on both laterals, 6 – core management element (left = former top of core), 7 – thick cortical flake with bidirectional scar pattern.

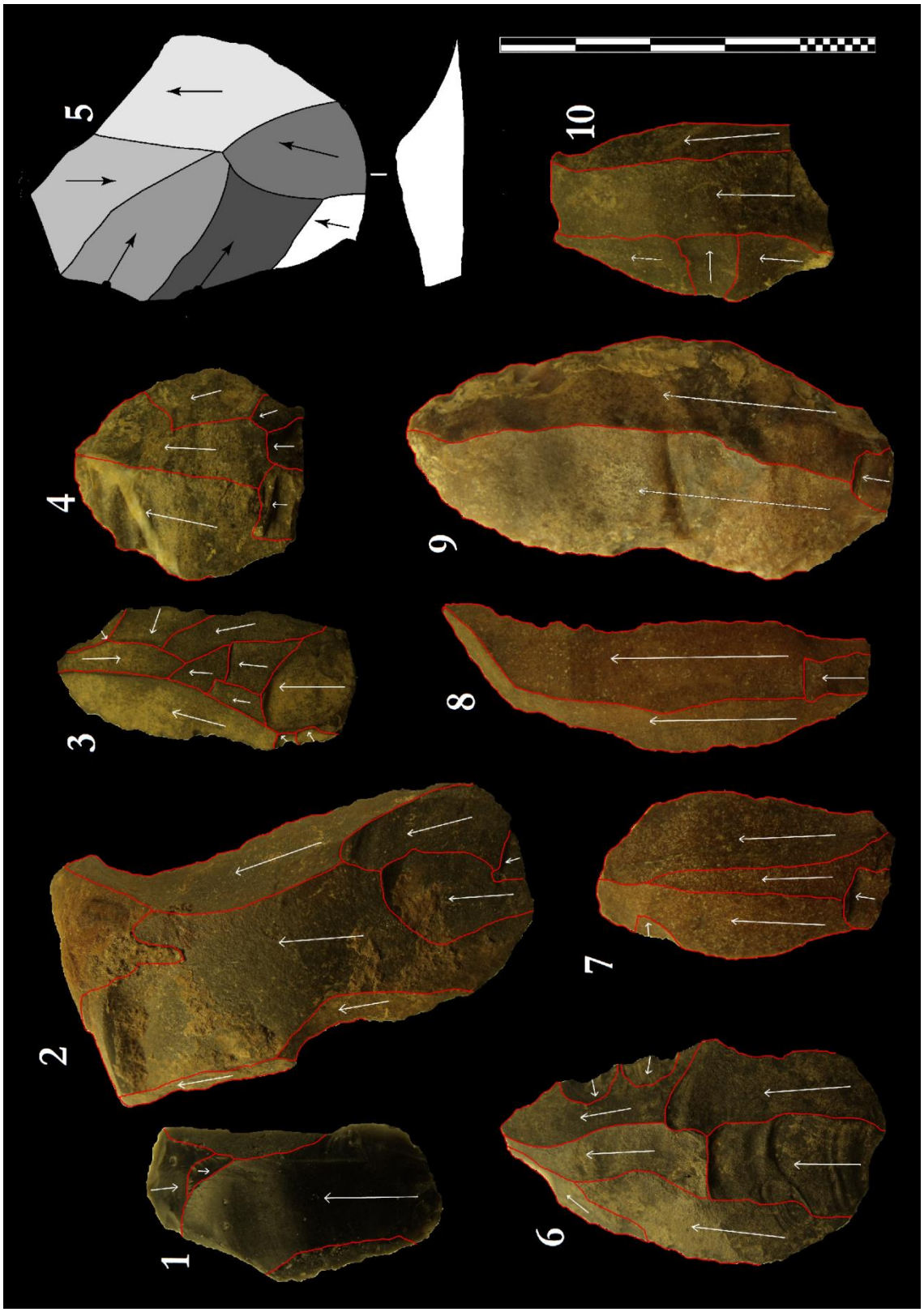


Figure 7.12. Examples of debitage from Porc Epic layer C. 1 – obsidian, 2, 5 – basalt, others – flint. 1 –flake with bidirectional scar pattern and cortex on both margins, 2 – flake with from proximal scar patterns and cortex at distal, 3 – blade with centripetal scar pattern, 4 – flake with from proximal scar pattern, 5, 6 –flake with centripetal scar pattern, 7 – flake with from proximal convergent scar pattern, 8, 9 – blades with from proximal scar patterns, 10 – flake with from proximal and from left scar pattern (illustration modified from Pleurdeau 2004).

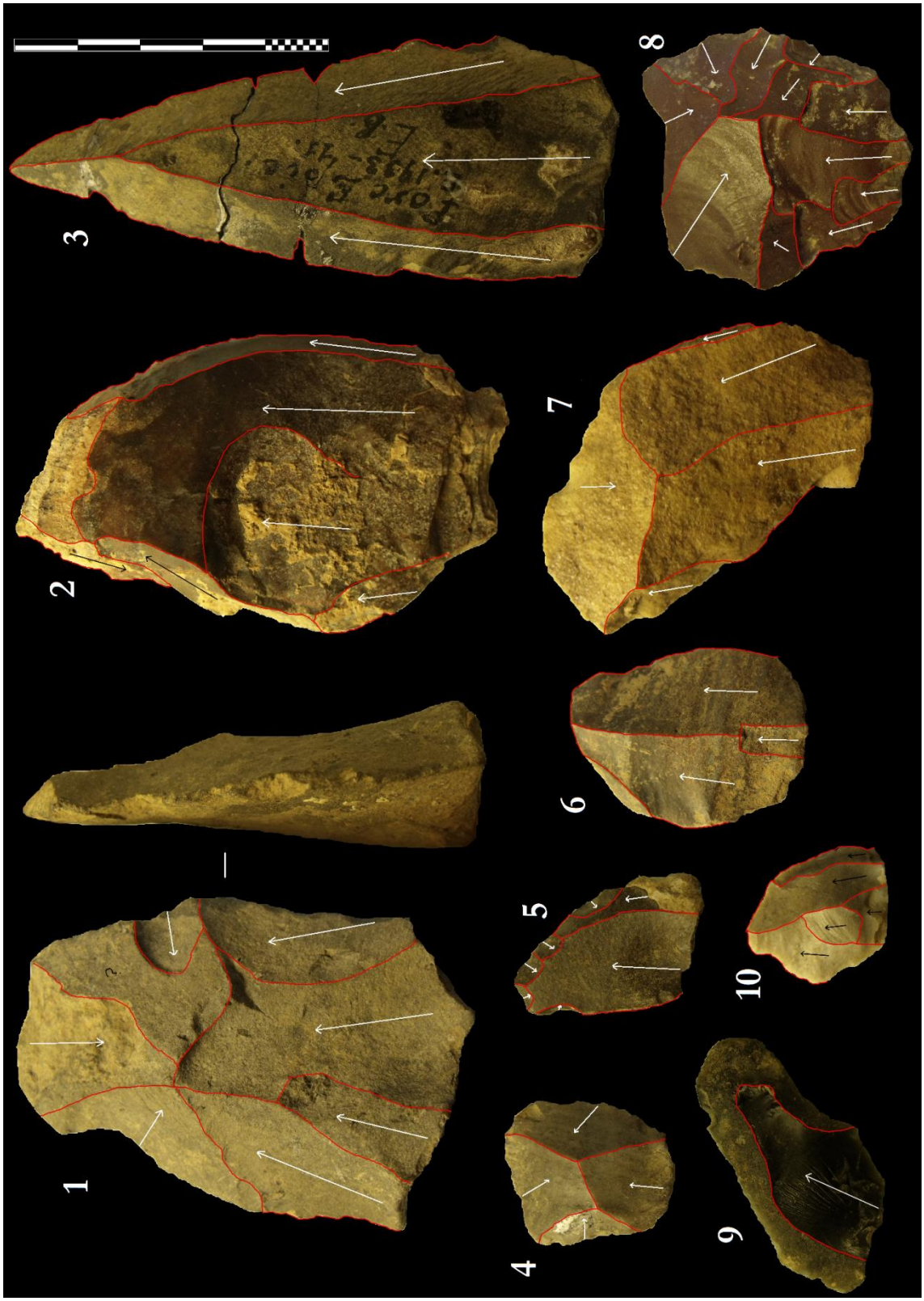



Figure 7.13. Examples of debitage from Porc Epic layer E. 1, 3 – basalt, 7 – quartzite, 9 – obsidian, others – flint. 1, 4, 5, 8 – flakes with centripetal scar patterns, 2,7 – flakes with bidirectional scar patterns, 3 – Levallois point with from proximal convergent scar pattern, 6, 9 , 10 – flakes with from proximal scar patterns.

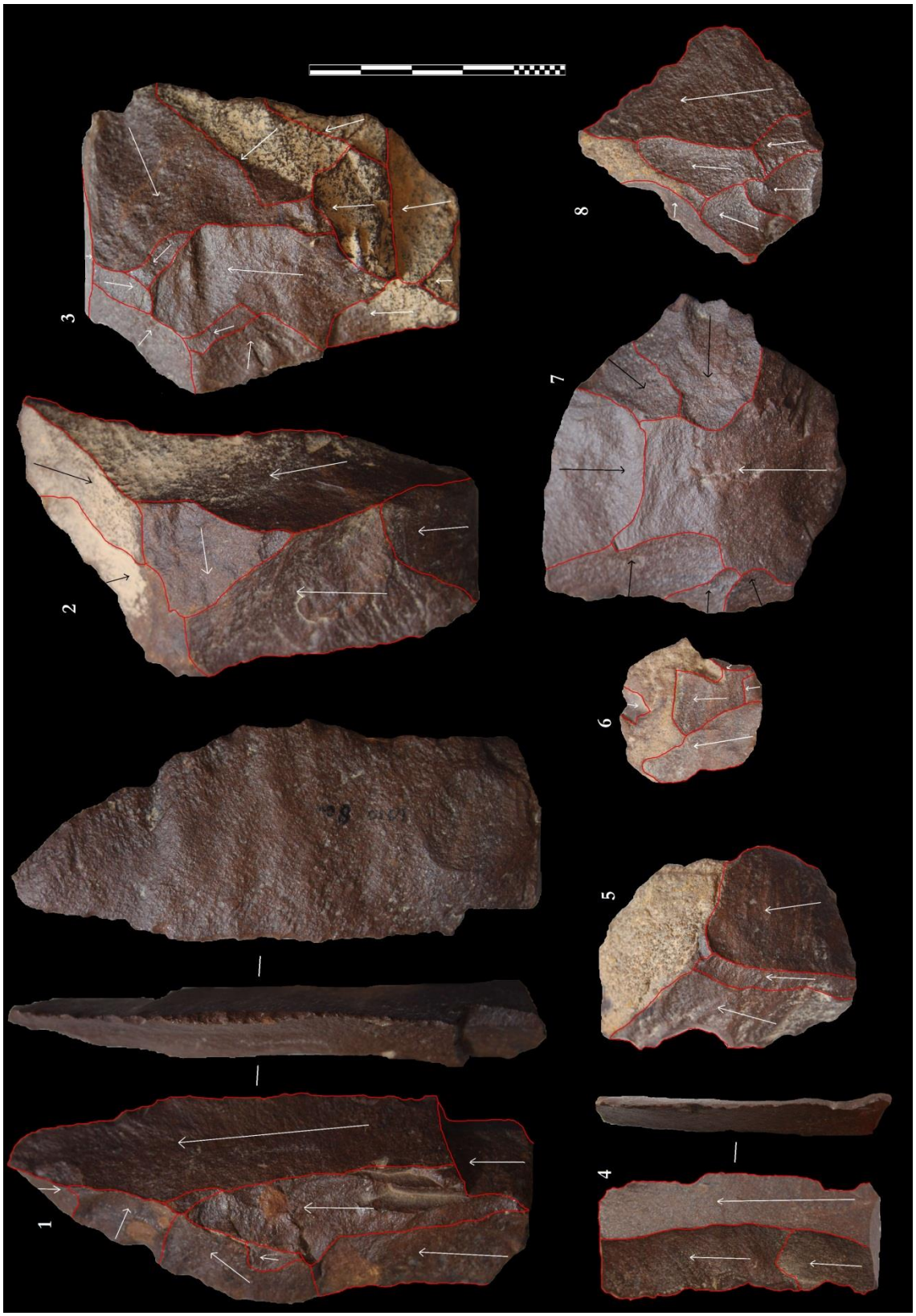


Figure 7.14. Examples of debitage from 1010-8. 1 – a somewhat atypical Nubian Levallois point? 2 – Levallois flake with bidirectional scar pattern, 3 – Levallois flake with strongly radial scar pattern, 4 – blade with from proximal scar pattern, 5,6 – blanks with from proximal scar pattern and cortex at distal, 7 – Levallois flake with strongly radial scar pattern, 8 – flake with from proximal and from left scar pattern and cortex at distal. (Photographs E. Scerri, Wendorf Collection, 1010-8, EA 76000, copyright the British Museum).

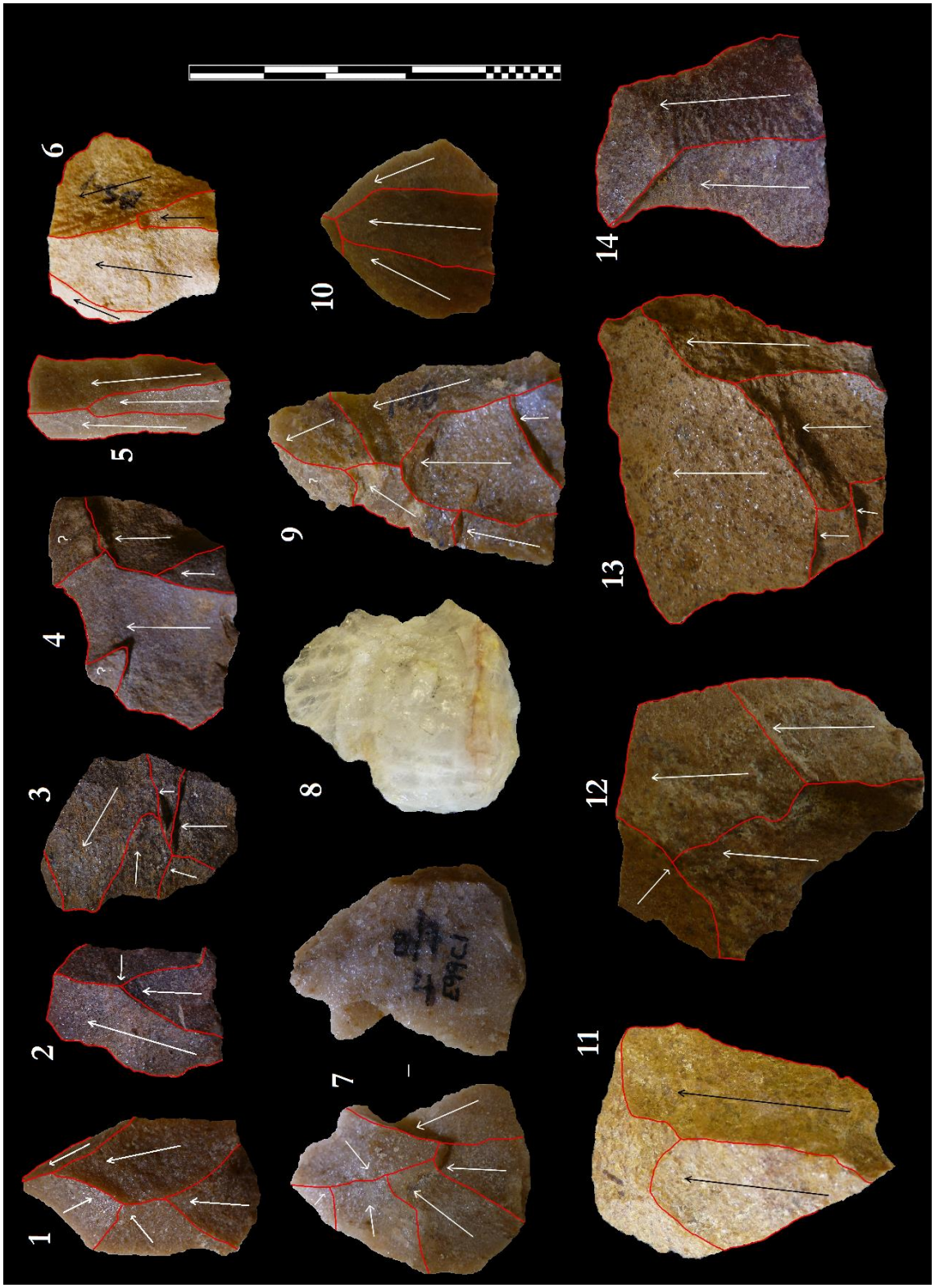



Figure 7.15. Examples of debitage from Bir-Sahara 1. 8 – quartz, all others – quartzitic sandstone. 1, 12 – flakes with bidirectional scar patterns, 2 – flake with from proximal and from right scar pattern, 3, 7 – flakes with radial scar patterns, 4, 11, 13, 14 – flakes with from proximal scar patterns, 5 – blade with from proximal convergent scar pattern, 6, 9, 10 – flakes with from proximal convergent scar patterns. (Photographs Huw Groucutt, Wendorf Collection, BS-1, EA 76000, copyright the British Museum).

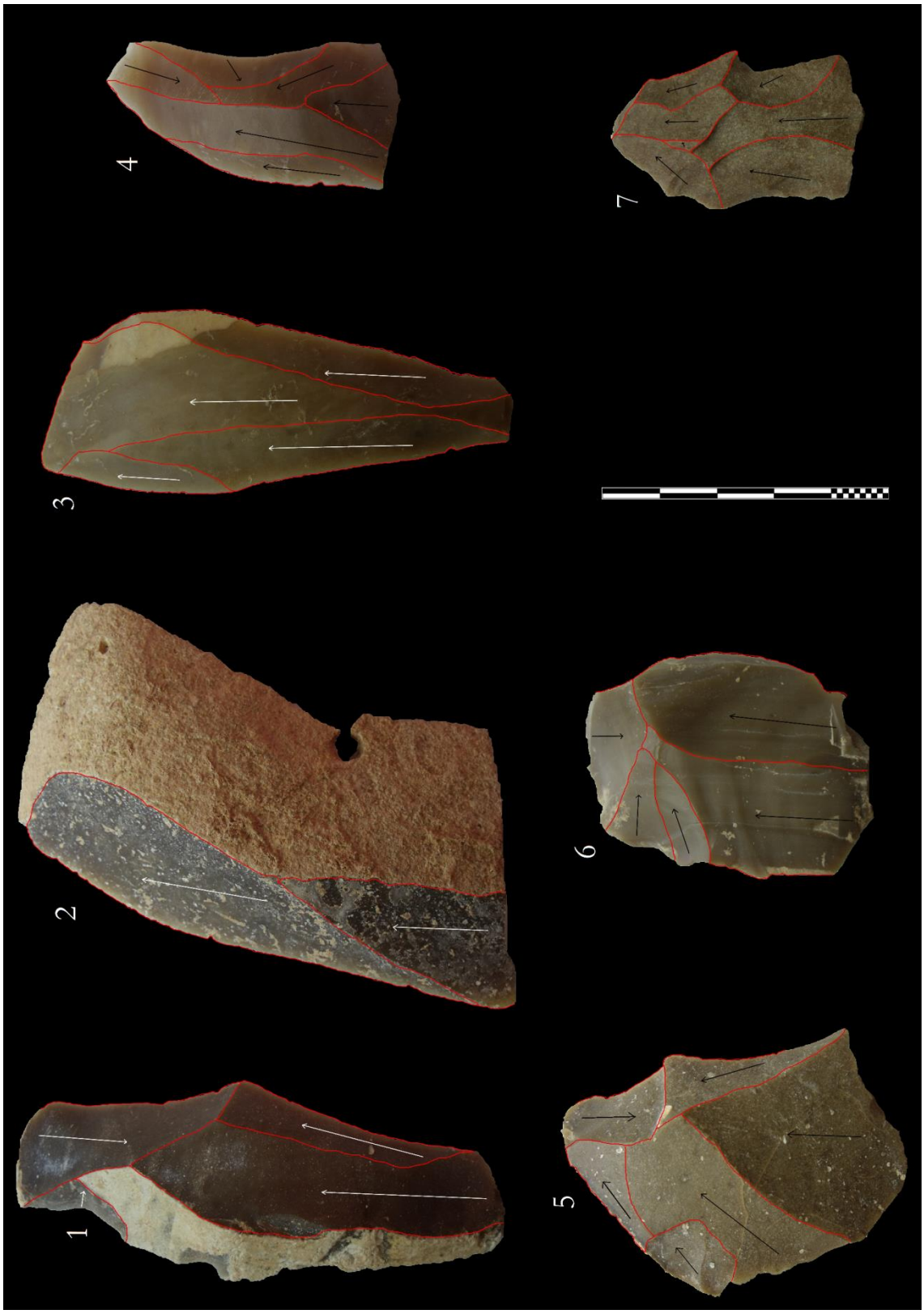


Figure 7.16. Examples of debitage from Tor Faraj. 1 – blade with bidirectional scar pattern and cortex on left lateral, 2 – flake with from proximal scar pattern and cortex on right lateral, 3 – blade with from proximal scar pattern, 4 , 5, 6 – flakes with weakly radial scar patterns, 7 – flake with from proximal scar pattern.

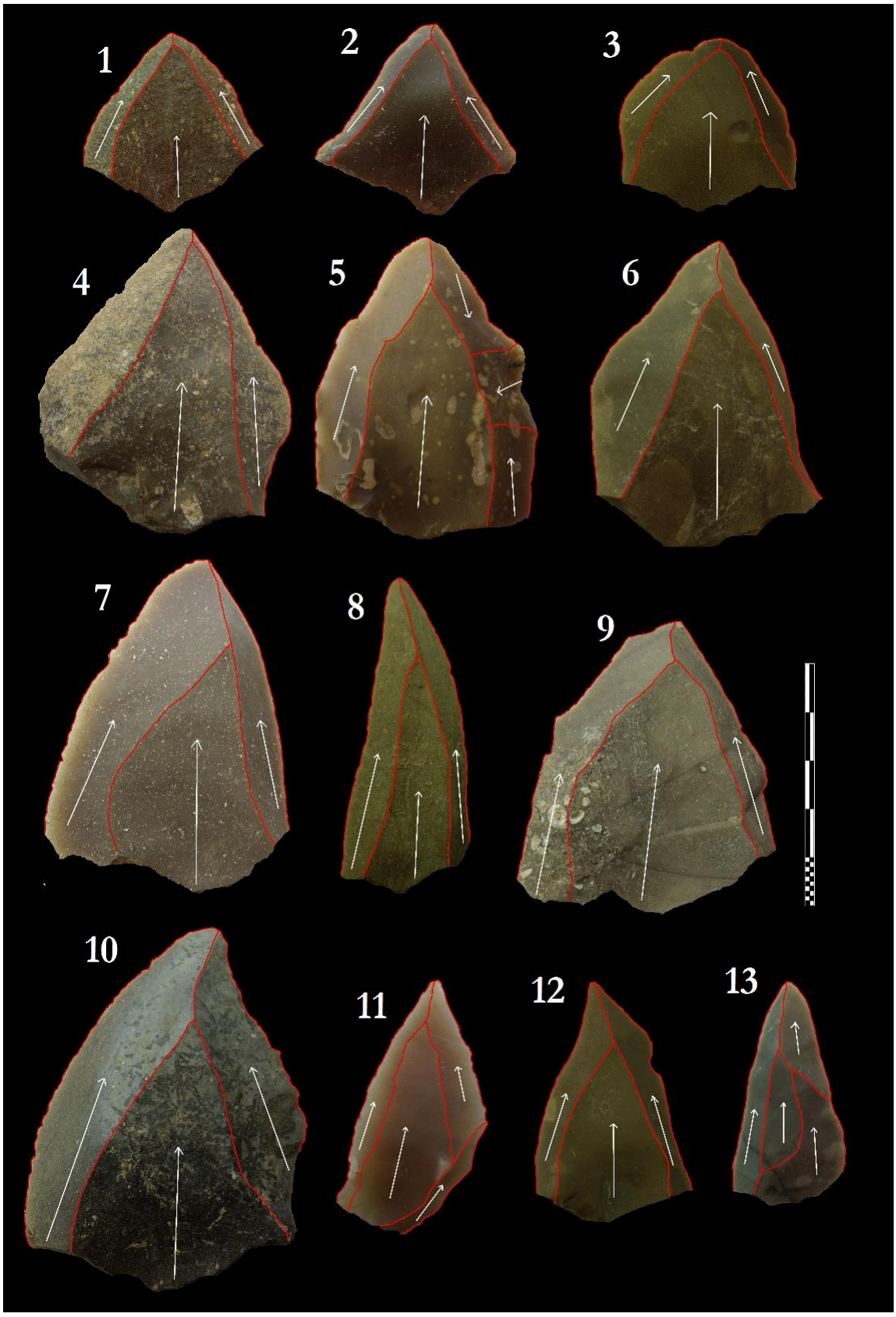


Figure 7.17. Examples of Levallois points from floor 1 of Tor Faraj. All flint. All from proximal convergent scar patterns except 4 (cortex on left lateral) and 5 (weakly radial scar pattern).

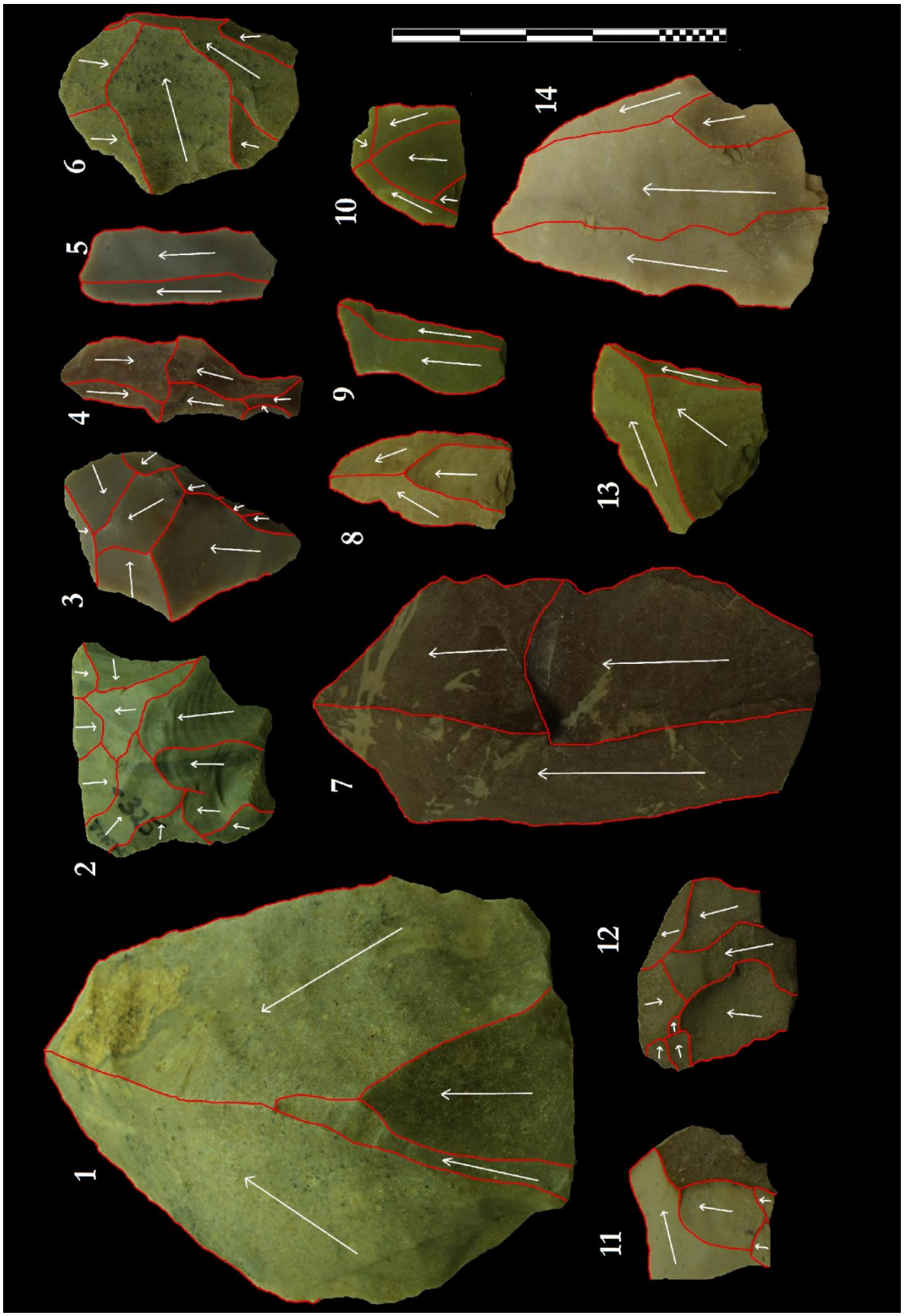



Figure 7.18. Examples of Warwasi NNOO debitage. 1 – large flake with unidirectional convergent scar pattern, 2, 3, 6, 12 – flakes with radial scar patterns, 4, 10 – blanks with bidirectional scar patterns, 5, 7, 9 – blades with from proximal scar patterns, 8, 13 – flakes with from proximal convergent scar patterns (the latter is a pseudo-Levallois point), 14 – excellent example of a unidirectional Levallois flake.

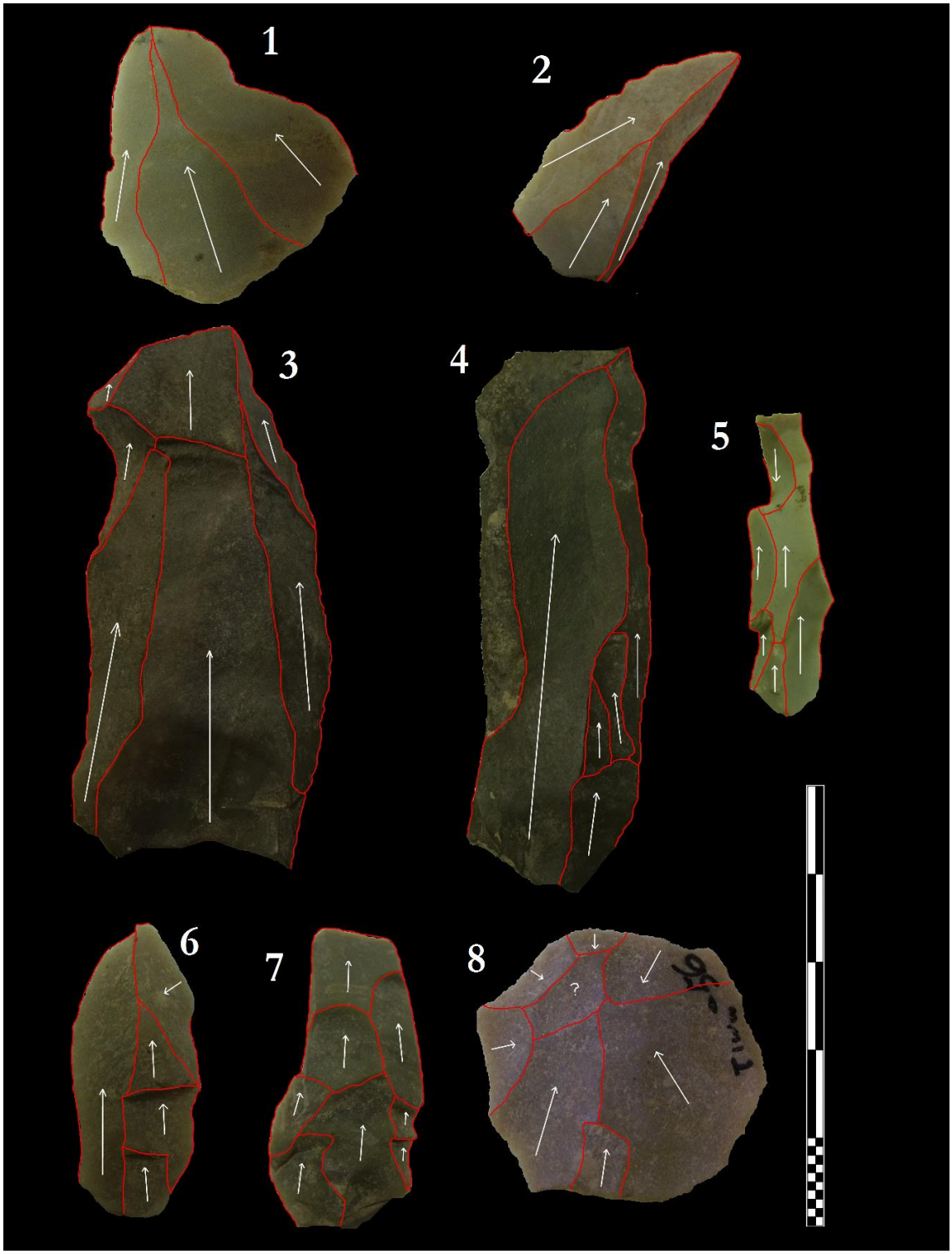



Figure 7.19. Examples of Warwasi WWXX debitage. 1,2 – blanks with from proximal convergent scar papptersn (later is a pseudo Levallois point), 3, 4 – blades with from proximal scar patterns, 5, 6 – blade with bidirectional scar patterns, 7 – flake with from proximal scar pattern, 8 flake with radial scar pattern.



Figure 7.20. Examples of Mudayy as Sodh debitage. 1-3 – flakes with bidirectional scar patterns, 4 – cortical flake with a from proximal scar pattern, 5-7 – Levallois points.

### 7.4) Raw material composition

Tables 7.2 and 7.3 show the raw material composition of the debitage populations studied, and Figure 7.21 shows the overall raw material of the entire collection of material used for this study. In the present study a simple geological classification is used, which divides rocks into major types, but does not consider the complex variation within each category. In some cases, such as 1010-8 and 123-b the situation is simple in that the entire as assemblage produced from a single raw material, available immediately adjacent to the site. In fact, as Tables 7.2 and 7.3 show, in most cases the assemblages are dominated by a single, usually local, raw material. In the case of the Jubbah assemblages, quartzite is dominant and is supplemented by varying levels of quartz and varying, but small, levels of apparently more exotic raw materials.

The only assemblages which really deviate from this pattern are those from Porc Epic. Here, while presumably local raw materials such as flint dominate, there is a relatively significant contribution of 'exotic' raw materials, particularly obsidian. At Porc Epic, Tor Faraj and Warwasi the variation of the flint is complex and is likely that future analysis of its variability at these sites would be useful.

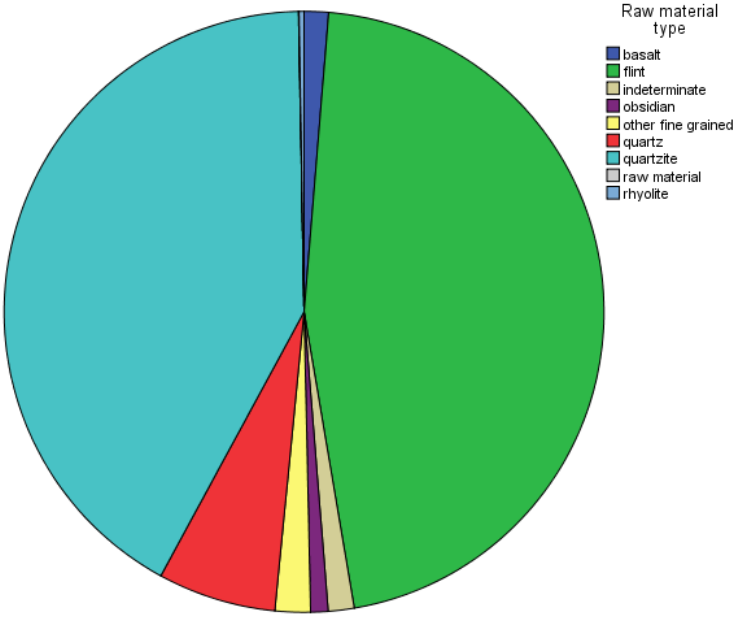



Figure 7.21. Pie chart of raw material type for all debitage used in this study. Flint and quartzite are by the far the most important raw materials in the study area.

| | Flint | Quartzite | Quartz | Basalt | Indet. | Obsidian | Other fine grained. | Rhyolite |
|---|---|---|---|---|---|---|---|---|
| *JQ-1* | 7 (7) | 70 (74) | 13 (14) | | 3 (3) | | | 2 (2) |
| *JSM-1* | 1 (1) | 69 (93) | 4 (5) | | | | | |
| *JKF-1* | 6 (1) | 880 (79) | 215 (19) | | 5 | | 1 | 6 (1) |
| *JKF-12* | | 84 (99) | | | | | | 1 |
| *Porc Epic layer C* | 86 (57) | 13 (9) | | 24 (16) | 8 (5) | 18 (12) | 1 | |
| *Porc Epic layer E* | 108 (62) | 10 (6) | 2 (1) | 25 (14) | 10 (6) | 17 (10) | 1 | |
| *1010-8* | | 114 (100) | | | | | | |
| Bir Sahara 1 | | 282 (99) | 4 (1) | | | | | |
| *Tor Faraj* | 550 (100) | | | | | | | |
| *Warwasi NN OO* | 510 (100) | | | | | | | |
| *Warwasi WW XX* | 340 (100) | | | | | | | |
| *123-b* | 255 (100) | | | | | | | |

Table 7.2. Raw material composition for all debitage.

As Table 7.3 shows, the raw material composition of complete debitage elements is on the whole similar to that for the whole debitage sample. The only real exception is quartz, which occurs far more frequently in an incomplete form, but this is understandable given the brittle qualities of this material.

| | Flint | Quartzite | Quartz | Basalt | Indet. | Obsidian | Other fine grained. | Rhyolite |
|---|---|---|---|---|---|---|---|---|
| *JQ-1* | 2 (5) | 30 (79) | 3 (8) | | 1 (3) | | | 2 (5) |
| *JSM-1* | | 25 (100) | | | | | | |
| *JKF-1* | 1 | 316 (84) | 57 (15) | | | | | 2 |
| *JKF-12* | | 70 (100) | | | | | | |
| *Porc Epic layer C* | 62 (65) | 6 (6) | | 13 (13) | 4 (4) | 12 (12) | 1 (1) | |
| *Porc Epic layer E* | 75 (60) | 7 (6) | 2 (2) | 20 (16) | 8 (6) | 13 (10) | | |
| 1010-8 | | 84 (100) | | | | | | |
| Bir Sahara 1 | | 52 (99) | 1 (1) | | | | | |
| *Tor Faraj* | 324 (100) | | | | | | | |
| *Warwasi NNOO* | 124 (100) | | | | | | | |
| *Warwasi WWXX* | 152 (100) | | | | | | | |
| *123-b* | 211 (100) | | | | | | | |

Table 7.3. Raw material composition for all complete flakes and blades over 20mm.

### 7.5. Condition/completeness/breakage patterns

Table 7.4 gives the breakdown of the number and percentage of complete blanks and types of fragments, with the percentages shown visually in Figure 7.22. This is potentially informative on technological variability, although little research has been conducted on correlations between, say, different scar patterns and breakage patterns. The data is informative on raw material quality/characteristics, the nature of collections (i.e. the extent of bias, although as previously discussed the collections in this study are all fairly representative), and provides an insight into taphonomic processes.

| | | *Transverse breakage* | | | *Longitudinal breakage* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Complete** | **proximal** | **medial** | **distal** | **right** | **medial** | **left** | **Comb.** | **Other/indet** |
| *JQ-1* | 46 (48) | 9 (9) | 4 (4) | 13 (14) | 2 (2) | | 1 (1) | 2 (2) | 18 (19) |
| *JSM-1* | 28 (38) | 6 (8) | 3 (4) | 7 (9) | 2 (3) | | 2 (3) | 3 (4) | 23 (31) |
| *JKF-1* | 404 (36) | 158 (14) | 50 (4) | 97 (9) | 38 (3) | 1 | 28 (3) | 34 (3) | 303 (27) |
| *JKF-12* | 70 (83) | 5 (6) | | 3 (4) | 1 | | 3 (4) | | 3 (4) |
| *Porc Epic layer C* | 98 (65) | 17 (11) | 2 (1) | 27 (18) | / | | 3 (2) | 1 (1) | 2 (1) |
| *Porc Epic layer E* | 125 (72) | 14 (8) | 1 (1) | 22 (13) | 1 (1) | | | | 10 (6) |
| *1010-8* | 84 (74) | 12 (11) | 2 (1) | 14 (12) | 1 (1) | | 1 (1) | | |
| Bir Sahara 1 | 63 (22) | 39 (14) | 20 (7) | 56 (20) | 3 (1) | | | 14 (5) | 93 (33) |
| *Tor Faraj, floor 1* | 338 (61) | 44 (8) | 18 (3) | 81 (15) | 4 (1) | | 1 | 6 (1) | 58 (11) |
| *Warwasi NNOO* | 203 (40) | 53 (10) | 26 (5) | 94 (18) | | | 3 (1) | 2 | 129 (25) |
| *Warwasi WWXX* | 182 (54) | 36 (11) | 16 (5) | 55 (16) | 1 | | 3 (1) | 2 (1) | 45 (13) |
| *123-b* | 211 (83) | 19 (7) | 1 | 9 (4) | 6 (2) | | 4 (2) | | 4 (2) |

Table 7.4. Proportions of complete blanks and types of breakage. For all debitage types. Combination refers to combination such as proximal and right, or medial and left (bracket shows % of total).

It is up to the analyst to distinguish between the factors responsible for variation in the frequency of complete and broken blanks in an assemblage. In this study the high proportion of complete blanks for 1010-8 reflects the fact that not all of the collection could be located by the author. In the case of 123-b, however, the situation appears to reflect a combination of taphonomy, with smaller and broken pieces washed away, and technological factors. Overall it appears that a 'normal' Middle Palaeolithic assemblage in the study area contains ~35-70% complete blanks. At both Porc Epic and Warwasi the younger assemblages have fewer complete blanks.

The meaning of particular patterns of breakage is a rather unclear subject. What, for instance, does a dominance of right over left fragments indicate? Chance? The handedness of the knapper? A tendency for knappers to strike around the core in a particular, say clockwise, manner? This is a

topic worthy of more research, so while the present work will do little to advance our understanding of this topic, it presents information which may be of use to a future scholar.

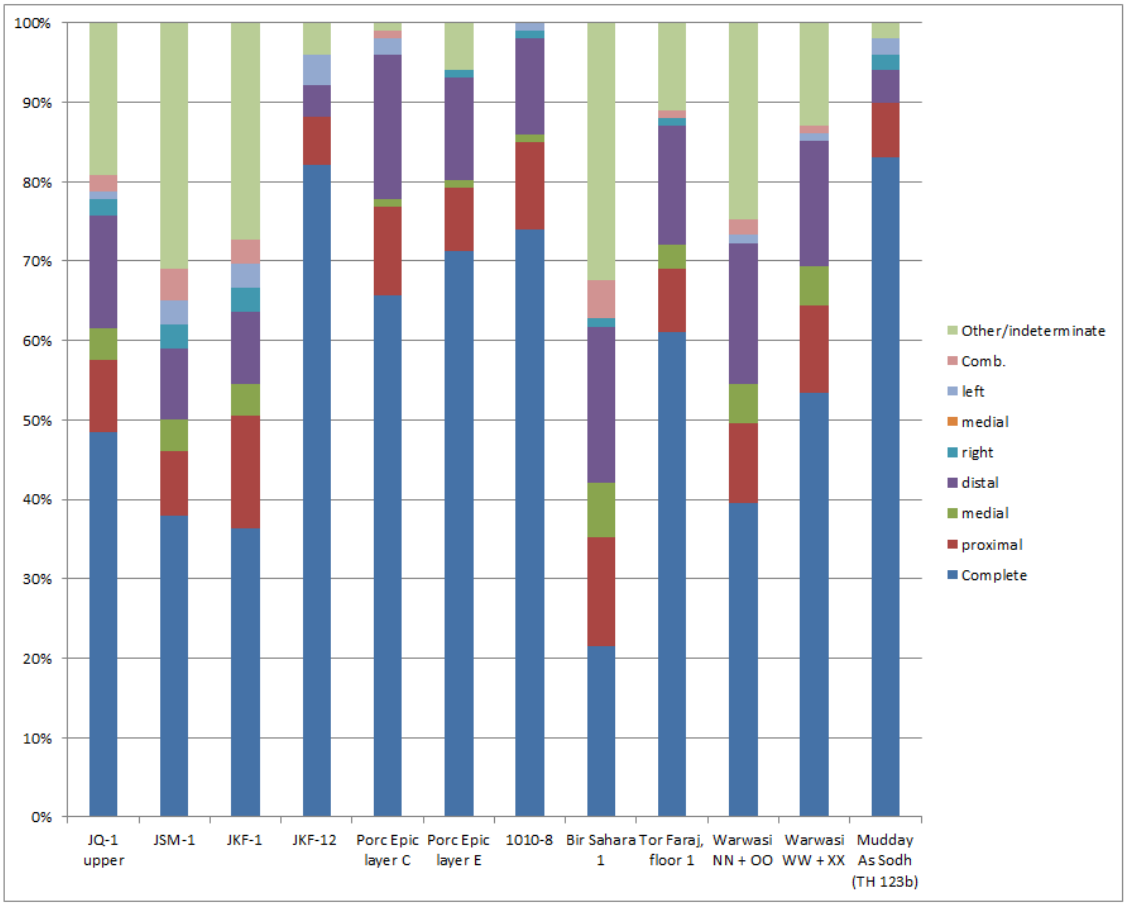



Figure 7.22. Bar chart of condition/completeness/breakage patterns

The 'other/indeterminate' category primary consists of 'chips' and 'chunks', i.e. incomplete debitage elements which cannot be orientated to a knapping axis, yet which seem to reflect deliberate knapping. The highest percentage for this category, for BS-1, seems to reflect the poor quality, 'quartzitic sandstone', material used. Yet, similar proportions of this category at JKF-1 and Warwasi NNOO indicate that this is not something which simplistically reflects raw material factors. The presence of this category suggests that knapping took place on site.

Medial fragments, in both transverse and longitudinal axes, are relatively uncommon, as would be expected as these involve a double breakage. The fact that they relatively abundant in at least some assemblages, such as BS-1, suggests a combination of poor quality raw material and taphonomic

factors, perhaps including trampling. The same applies to combination (e.g. right and distal) fragments. Right and left fragments are roughly equally represented.

In general, distal fragments are more common than proximal fragments. This is rather unusual, as every distal fragment must have a proximal counterpart. In fact, if anything, we would expect proximal fragments to be more common, as we can imagine the 'distal' failing to be detachment from the core, leaving only a proximal element. On the other hand, distal fragments can only exist where there are proximal fragments. What does this often considerable difference imply? It is possible that proximal fragments were preferentially used for retouch and cores on flakes, taking advantage of their greater dimensions than their distal counterparts. Both direct transformation and removal of these broken blanks from the site might account for this discrepancy between proximal and distal fragments. The exceptions to this pattern, JKF-1 and 123-b, are also, as we shall see in the following chapter, characterised by low levels of retouch, perhaps supporting the interpretation above.

An alternative interpretation might be that what were interpreted as blanks with step terminations are actually proximal fragments. This might work in some situations. At Warwasi and Porc Epic, for instance, if *all* step terminations were actually breaks and therefore the pieces proximal fragments, then the number of proximal and distal fragments would be roughly equal. But in other situations the numbers do not add up. At Tor Faraj, for instance, unless the sample taken was somehow strongly biased in this regard, the sample includes 44 proximal fragments, 81 distal fragments and 22 blanks with step terminations. While it can be difficult to differentiate a break from a step fracture, it is unlikely that *all* examples were thus wrongly diagnosed, and hence the imbalance between proximal and distal fragments remains. A number of step terminations are visible on the cores at sites like Warwasi and Porc Epic so we should expect to see the corresponding blanks. In addition, the site with both the highest number and equal highest percentage of step terminations, JKF-1, is also the site with the highest number and percentage of proximal fragments.

**7.6) Size and shape variation**

Figure 7.23 provides boxplots for various size related attributes for debitage, including broken pieces. Tables 7.5 to 7.8 focus on complete pieces, as these are likely to be of more importance for making technological comparisons whereas the whole collection of debitage gives a coarse overview of the nature of the assemblage and taphonomic processes which have affected it.

In terms of weight, it is possible to distinguish four groups (Figure 7.23). The group with the assemblages with the smallest weights, although in each case having a reasonable number of heavier outliers, consists of BS-1, JQ-1, JSM-1, Porc Epic C and E, Tor Faraj, Warwasi NNOO and XXWW. In these cases almost all of the debitage is very small, always below 100 grams and mostly a lot less. The second group contains JKF-1, whose debitage can be regarded as 'low medium', although some pieces are a lot larger. 1010-8 is 'large medium', while the final group consists of JKF-12 and TH-123b, both of which are characterised by heavy debitage. Variation in debitage length follows, for the most part, a similar pattern. The only real difference to emerge at a coarse level is the greater lengths for Tor Faraj and Porc Epic C. For width measurements the pattern described for weight also seems to apply. Except that here JKF-1, although with quite a large number of outliers, shares similar width values to the sites with small weights. Likewise for thickness, the sites with light debitage all share a similar range of thicknesses, with JKF-1 only slightly larger. 1010-8 is also only slightly thicker than these sites. It would seem then that in the sampled assemblages, width and thickness do not vary as much as length does.

The values for blank area and volume shown in Figure 7.23 encapsulate the various dimensions previously discussed. Similar values are recorded for these two indices. With Warwasi (in particular), Tor Faraj, Porc Epic, JSM-1, JQ-1 and BS-1 all being characterised by small debitage. JKF-1 is a little larger, although with a considerable 'tail', and 1010-8 on average rather larger still. With these indexes, as with all measures, JKF-12 and TH-123b emerge as considerably larger than all the other assemblages.

Tables 7.5 to 7.8 provide descriptive statistics for complete blanks flakes and blades (i.e. not chips/chunks and including core management elements).

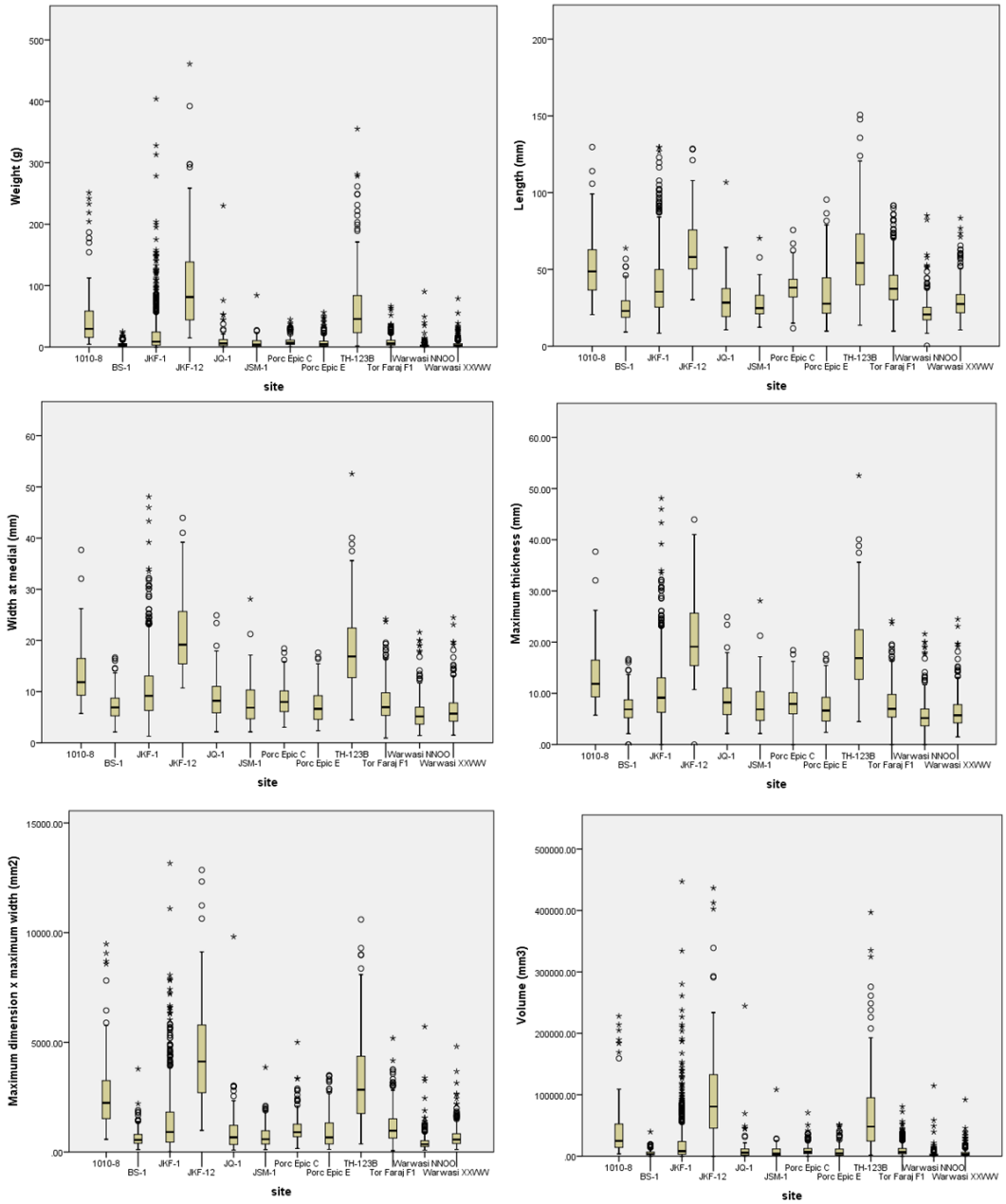



Fig 7.23. – Boxplots of various size related features for all debitage (including incomplete pieces).

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 376 | 70 | 97 | 106 | 84 | 53 | 324 | 124 | 152 | 211 |
| **Min.** | 0.7 | 1.3 | 0.9 | 14.9 | 0.6 | 0.5 | 4.5 | 1.1 | 0.6 | 0.3 | 0.4 | 2.3 |
| **Max** | 230.2 | 84.3 | 404.0 | 1100.0 | 39.3 | 56.4 | 537.3 | 25.2 | 63.4 | 90.3 | 78.9 | 355.2 |
| **Mean.** | 20.4 | 14.4 | 33.9 | 125.3 | 8.6 | 11.0 | 59.5 | 5.9 | 9.2 | 4.6 | 6.1 | 68.3 |
| **St dev** | 6.0 | 16.6 | 47.8 | 145.4 | 7.3 | 12.2 | 76.4 | 5.3 | 8.3 | 9.8 | 9.8 | 60.7 |
| **25 %** | 5.4 | 4.6 | 7.3 | 43.7 | 4.5 | 2.7 | 17.6 | 2.3 | 3.3 | 1.3 | 1.8 | 25.7 |
| **75 %** | 20.8 | 19.5 | 40.1 | 161.1 | 9.5 | 16.4 | 70.6 | 7.5 | 12.1 | 4.5 | 6.0 | 96.1 |
| **Skew.** | 5.1 | 3.3 | 3.6 | 4.7 | 2.1 | 1.8 | 3.7 | 2.0 | 2.2 | 6.8 | 4.4 | 1.7 |
| **Kurtosis** | 29.1 | 13.5 | 18.2 | 29.4 | 4.8 | 2.9 | 18.4 | 4.2 | 8.0 | 52.6 | 24.7 | 3.6 |

Table 7.5. Weight (g) for complete blanks (>20mm).

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 375 | 70 | 98 | 106 | 84 | 53 | 324 | 124 | 152 | 211 |
| **Min.** | 20.7 | 21.1 | 20.0 | 30.3 | 20.1 | 20.4 | 22.9 | 20.2 | 20.0 | 20.1 | 20.1 | 20.2 |
| **Max** | 106.8 | 70.4 | 129.7 | 159.9 | 75.7 | 95.4 | 129.7 | 63.8 | 91.7 | 85.1 | 83.5 | 150.7 |
| **Mean.** | 39.3 | 33.8 | 45.7 | 67.0 | 39.5 | 40.2 | 55.4 | 30.0 | 42.8 | 28.8 | 33.2 | 60.1 |
| **St dev** | 16.6 | 12.4 | 21.5 | 24.8 | 9.3 | 17.4 | 22.6 | 8.6 | 13.2 | 10.5 | 11.9 | 25.2 |
| **25 %** | 28.4 | 23.9 | 30.1 | 51.2 | 33.8 | 25.3 | 36.4 | 23.2 | 33.0 | 22.4 | 24.7 | 42.2 |
| **75 %** | 47.9 | 41.5 | 57.3 | 77.8 | 43.6 | 49.0 | 68.8 | 33.3 | 50.0 | 31.1 | 37.8 | 77.4 |
| **Skew.** | 2.0 | 1.4 | 1.2 | 1.3 | 0.8 | 1.0 | 0.9 | 1.9 | 1.0 | 3.0 | 1.8 | 0.9 |
| **Kurtosis** | 6.3 | 1.9 | 1.4 | 2.4 | 1.8 | 0.4 | 0.5 | 4.5 | 41.0 | 11.5 | 3.7 | 0.9 |

Table 7.6. Technical length (mm) for complete blanks (>20mm).

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 376 | 70 | 98 | 106 | 84 | 53 | 324 | 124 | 152 | 211 |
| **Min.** | 13.9 | 13.1 | 5.1 | 9.7 | 8.4 | 3.8 | 20.3 | 8.1 | 3.8 | 3.8 | 5.7 | 11.0 |
| **Max** | 84.0 | 45.4 | 79.5 | 127.6 | 56.4 | 44.4 | 95.8 | 49.4 | 63.8 | 58.5 | 65.3 | 121.1 |
| **Mean.** | 30.0 | 28.0 | 33.2 | 55.8 | 22.8 | 22.8 | 42.1 | 23.2 | 24.4 | 18.0 | 20.0 | 45.1 |
| **St dev** | 2.3 | 1.9 | 13.7 | 21.3 | 8.9 | 9.1 | 14.6 | 8.0 | 9.3 | 8.2 | 9.4 | 17.8 |
| **25 %** | 19.7 | 20.3 | 22.2 | 40.7 | 17.3 | 16.3 | 31.8 | 18.4 | 17.9 | 12.9 | 13.3 | 32.4 |
| **75 %** | 36.9 | 27.1 | 40.9 | 67.4 | 27.0 | 29.2 | 49.1 | 29.0 | 30.4 | 22.1 | 24.4 | 53.2 |
| **Skew.** | 1.8 | 0.4 | 0.9 | 0.7 | 1.5 | 0.3 | 1.3 | 0.8 | 0.3 | 1.7 | 1.5 | 0.9 |
| **Kurtosis** | 4.9 | -1.0 | 0.7 | 0.9 | 2.8 | -0.3 | 2.8 | 1.3 | 0.3 | 5.6 | 3.6 | 1.3 |

Table 7.7. Width at mid-point (mm) for complete blanks (>20mm).

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 376 | 70 | 97 | 106 | 84 | 53 | 324 | 124 | 151 | 209 |
| **Min.** | 2.3 | 3.1 | 3.2 | 9.0 | 2.1 | 1.8 | 4.9 | 3.2 | 1.6 | 1.0 | 1.6 | 5.1 |
| **Max** | 24.4 | 18.0 | 44.7 | 46.0 | 15.7 | 14.7 | 27.5 | 11.2 | 35.2 | 17.6 | 21.5 | 37.5 |
| **Mean.** | 9.2 | 9.2 | 11.2 | 18.6 | 6.9 | 6.8 | 11.9 | 6.1 | 6.6 | 5.4 | 5.4 | 16.0 |
| **St dev** | 4.0 | 3.8 | 5.6 | 7.0 | 2.5 | 2.9 | 4.9 | 1.9 | 3.4 | 2.6 | 2.9 | 6.2 |
| **25 %** | 6.8 | 6.8 | 7.2 | 13.3 | 5.2 | 4.5 | 7.9 | 4.4 | 4.5 | 3.4 | 3.4 | 11.2 |
| **75 %** | 11.8 | 12.0 | 13.8 | 22.4 | 8.5 | 8.5 | 14.6 | 7.0 | 8.0 | 6.8 | 6.5 | 19.9 |
| **Skew.** | 1.5 | 0.4 | 1.9 | 1.3 | 0.7 | 0.7 | 1.0 | 0.7 | 2.8 | 1.4 | 2.3 | 0.6 |
| **Kurtosis** | 4.3 | -0.3 | 6.1 | 2.4 | 0.7 | -0.1 | 0.7 | -0.2 | 16.8 | 3.6 | 7.9 | 0.3 |

Table 7.8. Thickness at medial (mm) for complete blanks (>20mm).

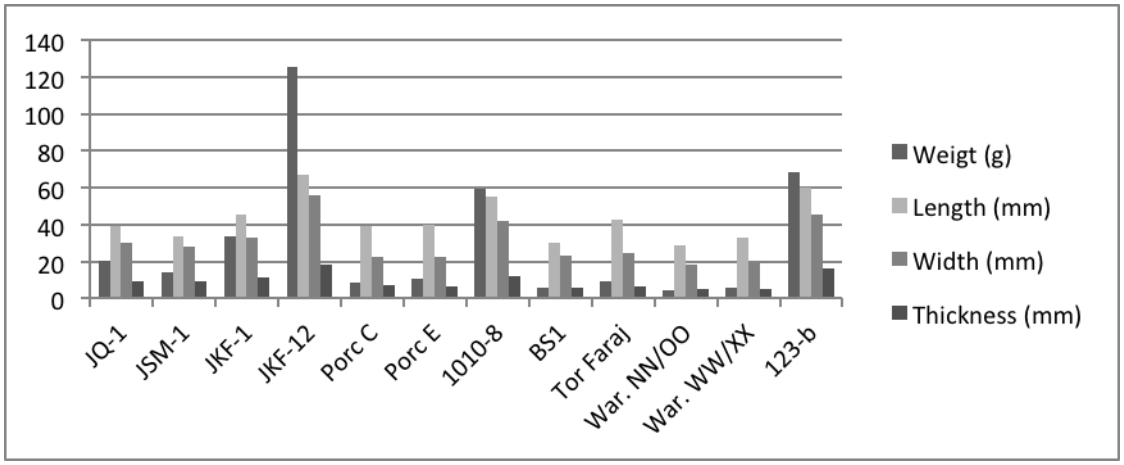



Figure 7.24. Bar chart of mean values for blank weight, length, width and thickness.

The description given here will focus on mean values. The basic structure of mean weight, length, width and thickness can be structured into three groups. The Porc Epic and Warwasi assemblages and BS-1 have an essentially similar structure. A key feature is that these blanks are typically long compared to their weight and thickness. This is particularly marked for Porc Epic C and Tor Faraj. The second group consists of JQ-1, JSM-1 and JKF-1. Here the lengths and widths are slightly

larger on average than sites of the previous group, but not dramatically so. The key difference is the greater weight of the blanks in this second group. This may reflect raw material factors, technological differences or reduction intensity (or all three). The final group consists of the 'primary' sites of JKF-12, 1010-8 and 123-b. The markedly high value for JKF-12 may reflect the means of sampling here which perhaps biased against smaller blanks. Nevertheless, there is a clear structure to the relationship between metric attributes at these three sites. Most notable is the feature of them having greater average weight (g) than length (mm) (i.e. they are heavy relative to their length). This might even be used as a definition of a primary/early stage reduction site.

In general the 25% and 75% percentiles, which can reveal the role of outlying values, cluster in a fairly even manner around the mean figures, suggesting that describing mean values gives a good overview of the variance between assemblages. The quartiles vary more for weight than for length (in particular), width and thickness. This suggests that the aim was typically to produce blanks which were as large (particularly long) as possible given a particular core morphology.

Volume ($mm^3$) provides a useful summary of blank size (see Table 7.9). The mean values reflect the same pattern as the figures for length, width and thickness described. As shown in Figure 7.25, however, the mean figures have a rather different structure compared to the individual variables. This reflects the differing combination of these features, in a manner congruent with the aim of producing large blanks.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 375 | 69 | 97 | 106 | 84 | 53 | 324 | 124 | 151 | 209 |
| **Min.** | 668.8 | 966.1 | 862.8 | 7599.3 | 479.3 | 271.1 | 2588.3 | 1037.0 | 246.7 | 291.2 | 391.7 | 2037.5 |
| **Max** | 218757.6 | 57457.3 | 261994.2 | 204799.1 | 21725.0 | 39209.7 | 222612.7 | 20210.7 | 71246.7 | 87529.0 | 61131.9 | 237692.3 |
| **Mean.** | 16453.8 | 10763.4 | 24251.03 | 71538.8 | 7064.5 | 8427.4 | 35064.0 | 4847.7 | 7924.8 | 4021.8 | 4950.7 | 50084.3 |
| **St dev** | 34925.9 | 11503.4 | 32839.9 | 49393.6 | 5929.7 | 9132.5 | 38635.3 | 4010.3 | 7700.3 | 911.2 | 7738.6 | 43605.3 |
| **25 %** | 4097.1 | 4072.9 | 5187.7 | 31004.3 | 3229.4 | 2096.6 | 12426.7 | 2150.3 | 2983.4 | 1155.2 | 1447.3 | 19310.2 |
| **75 %** | 15551.7 | 15162.3 | 29762.0 | 99662.4 | 8959.4 | 12005.4 | 40851.2 | 6310.6 | 10312.6 | 3908.0 | 4965.1 | 65758.1 |
| **Skew.** | 5.5 | 2.9 | 3.3 | 0.9 | 2.1 | 1.8 | 2.5 | 1.8 | 3.1 | 7.3 | 4.1 | 1.6 |
| **Kurt.** | 32.5 | 11.3 | 15.1 | 0.3 | 5.1 | 3.1 | 7.5 | 3.3 | 16.7 | 61.1 | 21.8 | 2.5 |

Table 7.9. Volume ($mm^3$, length x width x thickness) for complete blanks (>20mm).

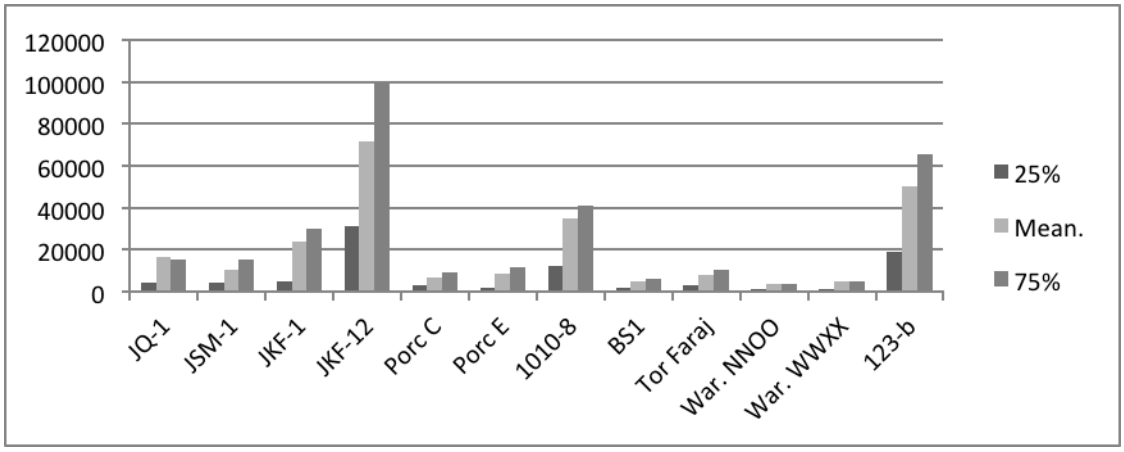


Figure 7.25. Bar chart of mean, 25% and 75% values for volume ($mm^3$). In general the mean falls between the 2, as would be expected, but at JQ-1 you can see the effect that one very large flake has on the mean volume.

While size to a considerable degree appears to reflect raw material form and reduction intensity, it is unclear to what extent that such factors influence shape variation, in contrast to an emphasis on 'desired' or 'designed' morphological characteristics. Tables 7.10, 7.11 and 7.12 present descriptive statistics for the Index of Elongation, Index of Flattening and Index of distal convergence for all complete blanks over 20mm, as discussed below.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 375 | 70 | 98 | 106 | 84 | 53 | 324 | 124 | 152 | 211 |
| **Min.** | 0.7 | 0.5 | 0.4 | 0.4 | 0.5 | 0.8 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.3 |
| **Max** | 3.4 | 2.4 | 6.5 | 5.7 | 4.3 | 8.4 | 2.9 | 4.5 | 10.3 | 6.0 | 4.6 | 5.1 |
| **Mean** | 1.4 | 1.3 | 1.5 | 1.4 | 1.9 | 2.0 | 1.4 | 1.4 | 2.1 | 1.8 | 1.9 | 1.5 |
| **St dev** | 0.6 | 0.5 | 0.6 | 0.8 | 0.7 | 1.1 | 0.5 | 0.6 | 1.1 | 0.8 | 0.8 | 0.8 |
| **25 %** | 1.1 | 0.9 | 1.1 | 0.9 | 1.4 | 1.4 | 0.9 | 1.0 | 1.4 | 1.2 | 1.3 | 0.9 |
| **75 %** | 1.7 | 1.6 | 1.7 | 1.8 | 2.3 | 2.2 | 1.7 | 1.6 | 2.4 | 2.3 | 2.4 | 1.9 |
| **Skew.** | 1.7 | 0.5 | 2.3 | 2.7 | 0.6 | 3.5 | 0.9 | 2.9 | 2.4 | 1.6 | 0.9 | 1.4 |
| **Kurtosis** | 3.0 | 0.2 | 12.1 | 11.7 | 0.7 | 18.0 | 0.2 | 13.0 | 9.8 | 4.5 | 1.1 | 3.5 |

Table 7.10. Index of elongation (length divided by width) for complete blanks.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 38 | 25 | 376 | 70 | 97 | 106 | 84 | 53 | 324 | 124 | 151 | 209 |
| **Min.** | 1.1 | 1.7 | 0.7 | 0.7 | 1.9 | 0.5 | 1.6 | 1.3 | 0.5 | 0.5 | 1.1 | 0.8 |
| **Max** | 6.5 | 4.6 | 6.8 | 6.1 | 6.1 | 8.2 | 6.9 | 7.7 | 12.6 | 12.1 | 9.6 | 8.6 |
| **Mean.** | 3.4 | 3.3 | 3.2 | 3.2 | 3.4 | 3.5 | 3.8 | 4.0 | 4.2 | 3.8 | 4.2 | 3.1 |
| **St dev** | 1.1 | 0.9 | 1.0 | 1.1 | 0.9 | 1.0 | 0.1 | 0.2 | 1.8 | 1.6 | 1.7 | 1.3 |
| **25 %** | 2.5 | 2.5 | 2.4 | 2.4 | 2.8 | 2.9 | 2.9 | 3.0 | 3.0 | 2.6 | 3.0 | 2.2 |
| **75 %** | 3.9 | 4.2 | 3.8 | 2.8 | 4.0 | 4.0 | 4.4 | 4.7 | 5.0 | 4.7 | 5.2 | 3.5 |
| **Skew.** | 0.7 | -0.3 | 0.5 | 0.4 | 0.4 | 0.9 | 0.6 | 0.5 | 0.9 | 1.6 | 0.6 | 1.6 |
| **Kurtosis** | 0.8 | -1.1 | 0.1 | 0.1 | 0.3 | 4.2 | 0.1 | 0.9 | 1.8 | 5.8 | 0.3 | 4.0 |

Table 7.11. Index of flattening (width/thickness) for all complete blanks.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 37 | 25 | 375 | 70 | 98 | 106 | 84 | 53 | 324 | 124 | 152 | 211 |
| **Min.** | 0.6 | 0.9 | 0.6 | 0.7 | 0.8 | 0.6 | 0.7 | 0.7 | 0.7 | 0.9 | 0.6 | 0.6 |
| **Max** | 2.3 | 3.6 | 26.0 | 7.8 | 16.9 | 21.8 | 10.0 | 22.8 | 45.6 | 22.2 | 14.7 | 6.7 |
| **Mean.** | 1.3 | 1.6 | 2.2 | 1.8 | 3.3 | 3.0 | 1.6 | 3.7 | 4.5 | 3.0 | 3.0 | 1.5 |
| **St dev** | 0.4 | 0.7 | 2.8 | 1.5 | 3.4 | 0.4 | 1.6 | 4.5 | 6.4 | 3.6 | 13.0 | 0.8 |
| **25 %** | 1.0 | 1.0 | 1.1 | 1.0 | 1.4 | 1.2 | 1.0 | 1.3 | 1.2 | 1.1 | 1.2 | 1.0 |
| **75 %** | 1.5 | 1.9 | 2.0 | 1.7 | 4.1 | 2.9 | 1.6 | 4.3 | 4.4 | 2.6 | 3.1 | 1.6 |
| **Skew.** | 0.9 | 1.4 | 4.8 | 2.7 | 2.3 | 3.3 | 4.1 | 2.7 | 3.1 | 3.2 | 2.1 | 3.0 |
| **Kurtosis** | 0.3 | 1.3 | 27.7 | 6.9 | 5.2 | 11.9 | 17.5 | 7.5 | 11.3 | 10.8 | 3.9 | 12.1 |

Table 7.12. Index of distal convergence (medial width/distal width) for all complete blanks.

The mean figures for the Index of Elongation can be divided into two groups, each with a narrow range of variation. The group with typically less elongated blanks (1.3-1.5) consists of the Jubbah sites, 1010-8, BS-1 and 123-b. The second group, with more elongated blanks (1.8-2.1) consists of the Porc Epic and Warwasi assemblages and Tor Faraj. When the inter-quartile range is compared to the means it is interesting to note that a similar structure is visible for all assemblages, with the mean falling between the interquartile values. This can be taken as a reflection of desired morphology in terms of blank elongation, and again suggests that mean figures can give good insights into such variability.

The Index of flattening demonstrates quite similar mean values for all of the assemblages studied. A rather arbitrary division can be made between groups with a low score (<3.5) and those with a high score (>3.8), although in reality the variation between the assemblages does not neatly fit into groups. The former group consists of the Jubbah assemblages, the Porc Epic assemblages and, particularly, 123-b. The latter, consisting of assemblages with relatively flat blanks, consists of 1010-8, BS-1, Tor Faraj and the Warwasi assemblages. Again, in all cases the mean figures fall broadly midway between the interquartile values. On these figures then we can state that some assemblages have a tendency towards relatively flat blanks, but it is not a feature strongly defining particular assemblages.

The Index of Distal Convergence aims to offer a characterisation of the shape of the distal end of the blank, distinguishing between convergent (pointed) and roughly parallel (rectangular, ovoid, etc.) lateral margins. Compared to the previous indices, this reveals quite marked differences between assemblages. The sites with low mean values (<2.2), indicating distal ends which are not

strongly convergent, are JQ-1, JSM-1, JKF-12, 1010-8 and 123-b, and JKF-1. Sites with highly convergent debitage (3-4.5) are Porc Epic, Warwasi, BS-1 and Tor Faraj. The 25% values are all closely similar (all 1-1.4), perhaps indicating the existence of similar, typically broadly rectangular, flakes in all the assemblages. It is then with the larger blanks that differences in distal convergence become more pronounced. Variation in blank convergence does not seem to be size dependent as such. JQ-1 and 123-b, for instance, have similar values despite cores being substantially larger and debitage on average more than three times heavier at the latter. These assemblages also used very different raw materials.

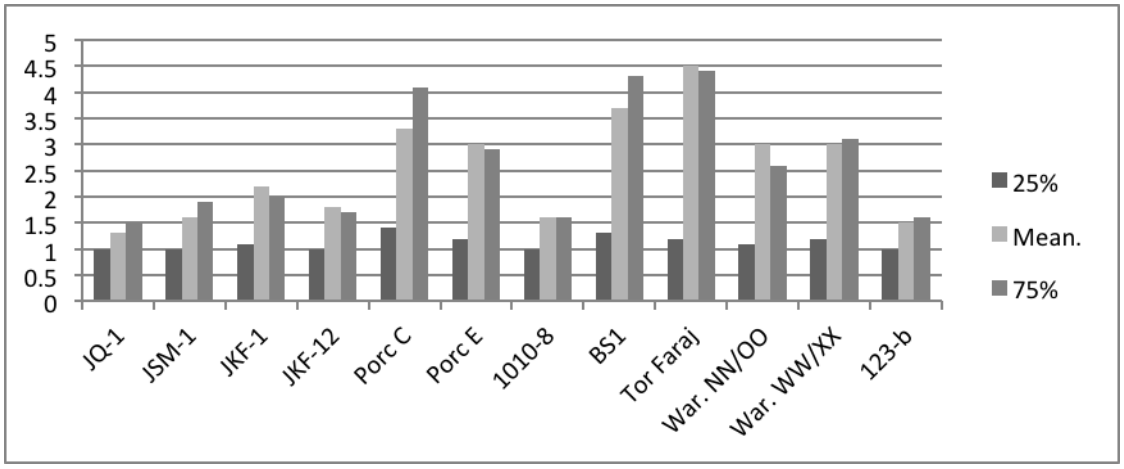


Figure 7.26. Bar chart of mean, 25% and 75% values for Index of Distal Convergence.

**7.7) Distal terminations**

The character of distal terminations for unretouched blanks is given below, both for all examples where a distal termination could be discerned (Table 7.13) and for complete pieces over 20mm in length (Table 7.14). By giving the two sets of results in this way, one inclusive and one exclusive, it is possible to see in effect minimum and maximum values for distal termination type. The inclusive results are important because otherwise much of an assemblage would be ignored, but given the different composition of assemblages giving percentages of exclusive counts gives a more comparable way of describing distal terminations.

| | ***Feather*** | ***Step*** | ***Hinge*** | ***Outrepassé*** | ***Indeterminate*** |
|---|---|---|---|---|---|
| ***JQ-1*** | 42 (54) | 1 (1) | 16 (21) | / | 19 (24) |
| ***JSM-1*** | 34 (67) | 2 (4) | 1 (2) | / | 14 (27) |
| ***JKF-1*** | 337 (42) | 73 (9) | 56 (7) | 8 (1) | 338 (42) |
| ***JKF-12*** | 56 (67) | 3 (4) | 9 (11) | 5 (6) | 10 (12) |
| ***Porc Epic layer C*** | 84 (57) | 10 (7) | 13 (9) | / | 35 (24) |
| ***Porc Epic layer E*** | 112 (68) | 14 (9) | 10 (6) | 1 (1) | 27 (16) |
| ***1010-8*** | 75 (66) | 3 (3) | 5 (4) | 1 (1) | 30 (26) |
| Bir Sahara 1 | 80 (41) | 3 (2) | 7 (4) | 2 (2) | 104 (53) |
| ***Tor Faraj, floor 1*** | 314 (63) | 22 (4) | 51 (10) | 3 (1) | 105 (21) |
| ***Warwasi NN OO*** | 178 (46) | 36 (9) | 56 (15) | 6 (2) | 102 (26) |
| ***Warwasi WW XX*** | 164 (53) | 17 (6) | 32 (10) | 1 | 93 (30) |
| ***123-b*** | 123 (48) | 20 (8) | 49 (19) | 8 (3) | 55 (22) |

Table 7.13. Distal termination types for all examples of debitage (not including chips and chunks).

| | ***Feather*** | ***Step*** | ***Hinge*** | ***Outrepassé*** | ***Indeterminate*** |
|---|---|---|---|---|---|
| ***JQ-1*** | 21 (55) | 1 (3) | 12 (32) | / | 4 (11) |
| ***JSM-1*** | 21 (84) | 2 (8) | 1 (4) | / | 1 (4) |
| ***JKF-1*** | 215 (57) | 51 (14) | 37 (10) | 6 (2) | 67 (18) |
| ***JKF-12*** | 51 (73) | 3 (4) | 8 (11) | 5 (7) | 3 (4) |
| ***Porc Epic layer C*** | 67 (68) | 6 (6) | 10 (10) | / | 15 (15) |
| ***Porc Epic layer E*** | 81 (76) | 9 (8) | 7 (7) | 1 (1) | 8 (8) |
| ***1010-8*** | 62 (74) | 3 (4) | 5 (6) | / | 14 (17) |
| Bir Sahara 1 | 33 (62) | 2 (4) | 4 (8) | 1 (2) | 13 (25) |
| ***Tor Faraj, floor 1*** | 237 (70) | 16 (5) | 33 (10) | 2 (1) | 50 (15) |
| ***Warwasi NNOO*** | 72 (58) | 17 (14) | 23 (18) | 4 (3) | 9 (7) |
| ***Warwasi WWXX*** | 106 (70) | 11 (7) | 20 (13) | / | 15 (10) |
| ***123-b*** | 107 (51) | 17 (8) | 45 (21) | 8 (4) | 35 (17) |

Table 7.14. Distal termination types for all complete blanks over 20mm in length.

As Tables 7.13 and 7.14 show, feather terminations constitute a majority of terminations for complete blanks and also in most cases for incomplete specimens. Step and hinge terminations are also common, as are indeterminate terminations. The latter commonly occur on blanks which are classed as complete, in that all major measurements can be recorded, but with minor damage to the distal end meaning an accurate recording of distal termination type is not possible. Outrepassé terminations are relatively uncommon. The difference between percentages of different termination types for inclusive and exclusive counts varies between assemblages. The major change, understandably, is a large reduction in the number of indeterminate terminations for complete blanks. The effects of this change include a large increase in the prominence of hinge terminations at JQ-1 and, at JSM-1, an increase in the preponderance of feather terminations. At JKF-1 both step and hinge terminations increase, and this assemblage in fact has the lowest percentage of feather terminations for complete blanks of all the study sites.

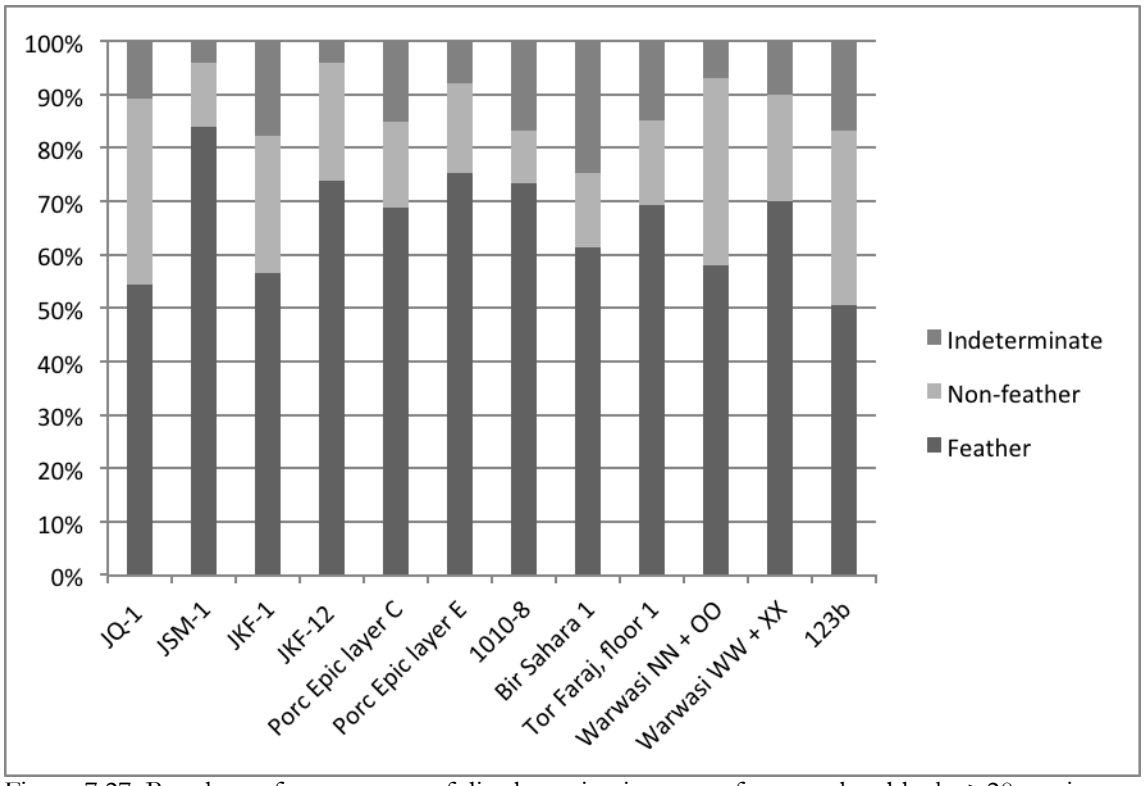


Figure 7.27. Bar chart of percentages of distal termination types for complete blanks >20mm in length.

What does the variation in distal termination types mean? The answers to this question remain unclear, but it is probably an area in which considerable strides can be made with experimental knapping. Why, for example, given seemingly similar raw material characteristics are hinge fractures common at JQ-1 and step fractures more so at JKF-1? Perhaps this emphasises the size of raw material packages, i.e. hinge terminations may be more common on small cores. But then why does NNOO have twice as high a percentage of step fractures as WWXX of the same site? As we saw in the previous chapter, cores are on average similarly sized in the these two assemblages. In terms of blank dimensions, however, NNOO blanks are thinner, less wide and shorter. Might this typically larger size of blanks for NNOO explain the higher number of step terminations?

It is possible that in some circumstances 'aberrant' terminations were actually desirable features, perhaps for choosing a flake to retouch which was less likely to break. Likewise, the 'Nubian technique' creates a tendency towards a termination type which could be described as "hinge-feather", which seems to result from the 'backing up' of force against the median-distal ridge which

characterises Nubian cores. This design feature perhaps reflecting a desire to create strong distal ends, an understandable concern if Nubian Levallois points were hafted, for instance.

When considering the character of termination types their role can be considered from the differing perspectives of the blank and the core. From the perspective of the blank, a feather termination is not so important and as indicated above aberrant terminations may be beneficial in some situations. From the perspective of the core, however, a step/hinge termination can severely impact continuing reduction, whereas a feather termination is conducive to continued reduction. The feather termination, then, may not so much be a desired end goal in itself, but a means to continue reduction. Variation in distal termination types, aside from reflecting differences in factors such as raw material quality and size and the competency of the knapper, may therefore reflect the desire of the knapper to continue the reduction of the core.

**7.8) Cortex**

Given the existence of many broken lithics in these assemblages, it is difficult to give a simple measure of the proportion of pieces which have cortex on them. As was done for distal termination then, the following table and pie chart provide information on the percentage cortex on unretouched debitage for, firstly, all debitage (Table 7.15) and secondly for complete blanks (Table 7.16 and Figure 7.28).

| | ***0%*** | ***1-25%*** | ***26-50%*** | ***51-75%*** | ***76-99%*** | ***100%*** | ***Indet.*** |
|---|---|---|---|---|---|---|---|
| ***JQ-1 upper*** | 55 (58) | 9 (9) | 3 (3) | 2 (2) | 8 (8) | | 18 (19) |
| ***JSM-1*** | 24 (32) | 7 (9) | 10 (14) | 3 (4) | 6 (8) | | 24 (32) |
| ***JKF-1*** | 501 (45) | 108 (10) | 92 (8) | 36 (3) | 31 (3) | 28 (3) | 317 (28) |
| ***JKF-12*** | 29 (34) | 34 (40) | 10 (12) | 5 (6) | 4 (5) | 1 (1) | 2 (2) |
| ***Porc Epic layer C*** | 118 (79) | 9 (6) | 6 (4) | 3 (2) | 1 (1) | 1 (1) | 12 (8) |
| ***Porc Epic layer E*** | 143 (83) | 7 (4) | 5 (3) | 1 (1) | 3 (2) | 1 (1) | 13 (8) |
| ***1010-8*** | 88 (77) | 16 (14) | 5 (4) | 3 (3) | 2 (2) | | |
| Bir Sahara 1 | 167 (58) | 6 (2) | 9 (8) | | 2 (1) | 2 (1) | 100 (35) |
| ***Tor Faraj*** | 404 (73) | 78 (14) | 42 (8) | 12 (2) | 11 (2) | 3 (1) | 0 |
| ***Warwasi NNOO*** | 477 (94) | 14 (3) | 9 (2) | 7 (1) | 2 | | 1 |
| ***Warwasi WWXX*** | 308 (91) | 17 (5) | 7 (2) | 3 (1) | 5 (1) | | |
| ***123-b*** | 118 (46) | 65 (25) | 29 (11) | 11 (4) | 11 (4) | 1 | 20 (8) |

Table 7.15. Percentage of ventral surface covered by cortex for all debitage.

Comparing Tables 7.15 and 7.16 it can be noted that the percentages of each class of cortical coverage are similar for both the inclusive and the exclusive counts. The largest category to change is the 'indeterminate' one. This reflects the presence of small fragmentary pieces in the first table. In the case of 123-b much of the material has been strongly affected by heating, and so in some cases

reliable figures for cortical coverage cannot be given. The approximate similarity for inclusive and exclusive counts is significant, but clearly only complete blanks can reliably be used to understand the position of cortex. Given this recognition, the comments below will be restricted to the examples of complete blanks.

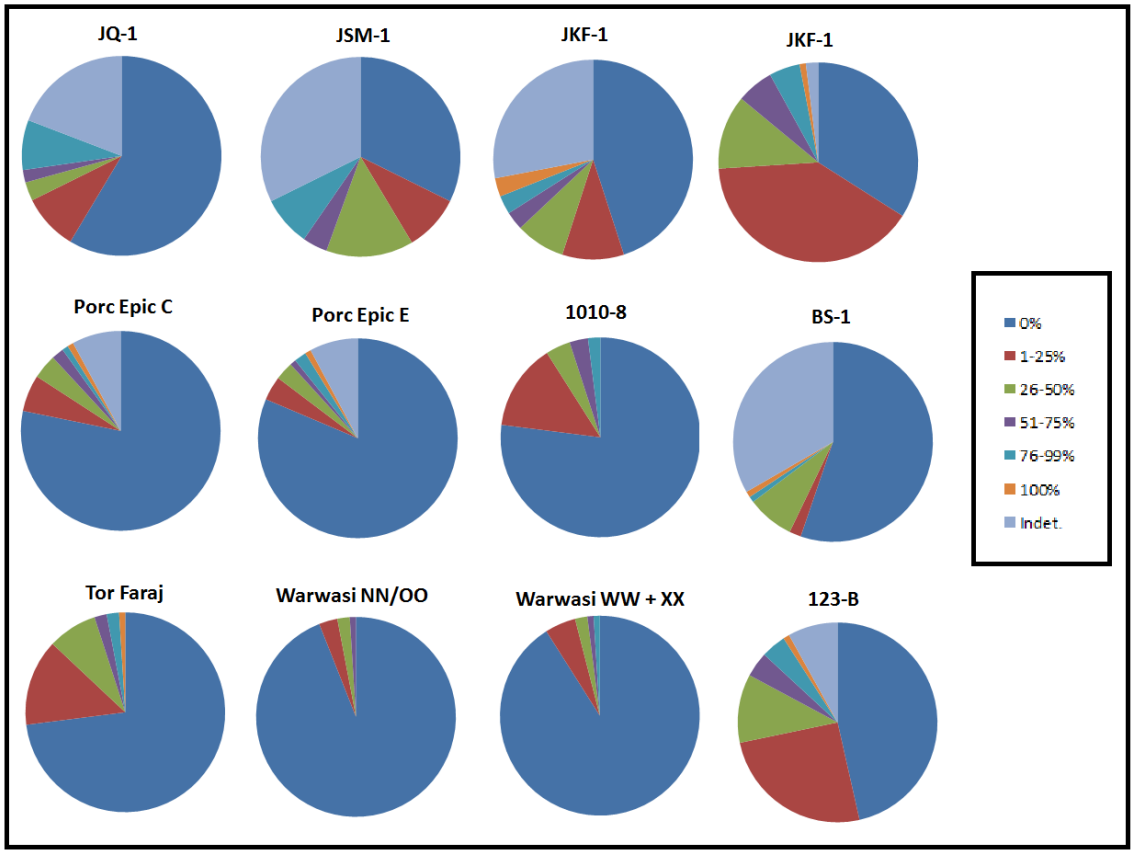



Figure 7.28. Pie charts of cortical coverage for complete blanks over 20mm in length

| | *0%* | *1-25%* | *26-50%* | *51-75%* | *76-99%* | *100%* | *Indet.* |
|---|---|---|---|---|---|---|---|
| ***JQ-1*** | 25 (66) | 7 (18) | 1 (3) | 1 (3) | 3 (8) | | 1 (3) |
| ***JSM-1*** | 10 (40) | 5 (20) | 6 (24) | 1 (4) | 2 (8) | | |
| ***JKF-1*** | 196 (52) | 73 (19) | 53 (14) | 17 (5) | 19 (5) | 12 (3) | 6 (2) |
| ***JKF-12*** | 20 (29) | 33 (47) | 9 (13) | 4 (6) | 3 (4) | 1 (1) | |
| ***Porc Epic layer C*** | 79 (80) | 8 (8) | 3 (3) | 2 (2) | 1 (1) | | 5 (5) |
| ***Porc Epic layer E*** | 90 (85) | 5 (5) | 5 (5) | 2 (2) | 3 (3) | 2 (2) | 2 (2) |
| ***1010-8*** | 63 (75) | 15 (18) | 3 (4) | 2 (2) | 1 (1) | | |
| Bir Sahara 1 | 41 (77) | 3 (6) | 4 (8) | | 2 (4) | | 3 (6) |
| ***Tor Faraj*** | 236 (73) | 51 (16) | 25 (8) | 4 (1) | 7 (2) | 1 | |
| ***Warwasi NNOO*** | 108 (87) | 7 (6) | 4 (3) | 5 (4) | | | |
| ***Warwasi WW XX*** | 133 (88) | 10 (7) | 3 (2) | 2 (1) | 4 (3) | | |
| ***123-b*** | 97 (46) | 54 (26) | 25 (12) | 10 (5) | 10 (5) | 1 | 14 (7) |

Table 7.16. Percentage of ventral surface covered by cortex for all complete debitage over 20mm in length.

At a broad level most of the assemblages share the feature of most blanks having no, or very little, cortex. This is predictable given the existence of cortex only on the outer part of the core. The

assemblages with the highest levels of cortex free debitage are from Warwasi, another indication of the highly reduced character of these assemblages. JSM-1, JKF-12 and 123-b are assemblages with quite high levels of cortex. In all these cases the sites are located close to raw material sources. For the higher percentages of cortical coverage, in most cases each category for an assemblage contains only a very small numbers of examples. This may be because much decortification was carried out near the raw material source. Alternatively it may be because cortical flakes were preferentially removed from sites (see e.g. Douglass *et al.* 2008).

The percentage of cortex on a blank can mean different things. From a straightforward perspective it may represent the extent of reduction. However, it is possible to imagine a situation where a heavily reduced core retained cortex on the underside. Should the knapper then decide to switch the platform and debitage surfaces, the first flakes to be removed from the new surface would be highly cortical. Without extensive refitting there is no clear way to differentiate between these two possibilities.

On the whole the assemblages can perhaps be divided into three categories. On the one hand are the assemblages with little cortex; Porc Epic, Warwasi and BS-1. While, Tor Faraj, 1010-8, JQ-1, JSM-1 and JKF-1 seem indeterminate in character, also having blanks with mostly little cortex, but more than the previous assemblages. These assemblages are located near raw material sources, with the exception of Tor Faraj where flint nodules retaining cortex were imported (Henry 2003). 123-b and JKF-12 have rather more cortex, but even in these cases there is overall not a large number of highly cortical flakes, the 1-25% category being well represented. With the exception of the small assemblage from JSM-1, in each example more than 70%, and normally well over 80% of complete blanks, have less than 25% cortex.

### 7.9) Position of cortex

If the percentage of cortex seems broadly similar between sites, perhaps the location of cortex will be more informative on varying characters of reduction between assemblages. The number and percentage of blanks with cortex in particular positions is shown in Table 7.17.

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***JQ-1*** | 3 (25) | | | | 4 (33) | 1 (8) | 1 (8) | | 1 (8) | | 1 (8) | | | | | | 1 (8) | |
| ***JSM-1*** | 2 (14) | | | | 5 (36) | 1 (7) | 1 (7) | | 2 (14) | | | | 1 (7) | | | | 2 (14) | |
| ***JKF-1*** | 21 (13) | 17 (10) | | | 37 (23) | 3 (2) | 32 (20) | | 9 (6) | 4 (2) | 7 (4) | | | | 2 (1) | 1 (1) | 29 (18) | |
| ***JKF-12*** | 1 (2) | 1 (2) | 3 (6) | 1 (2) | 6 (13) | 10 (21) | 3 (6) | 2 (4) | 2 (5) | | 4 (9) | 1 (2) | 6 (13) | 4 (9) | 2 (5) | | 1 (2) | |
| ***Porc Epic layer C*** | 2 (13) | | 1 (6) | | 4 (25) | | 2 (13) | | | | | | 1 (6) | | | | 3 (19) | 1 (6) |
| ***Porc Epic layer E*** | 2 (15) | 1 (8) | | 2 (15) | 3 (23) | | 3 (23) | | | | | | | | | | 3 (23) | |
| ***1010-8*** | 1 (4) | 1 (4) | | | 10 (43) | 1 (4) | 3 (13) | | | | | | | | 2 (9) | | 4 (17) | |
| **Bir Sahara** | 2 (33) | | | | | | | | | | 1 (17) | | 1 (17) | | | | 1 (17) | 1 (17) |
| ***Tor Faraj*** | 9 (10) | | | | 23 (26) | | 21 (24) | | | 1 (1) | 6 (7) | | | 1 (1) | 1 (1) | | 25 (29) | |
| ***War. NNOO*** | 2 (13) | | | | 5 (31) | | 8 (50) | | | | 1 (6) | | | | | | | |
| ***War. WWXX*** | 3 (15) | 1 (5) | | | 5 (25) | | 5 (25) | | | | 1 (5) | | | | | | 4 (20) | |
| ***123-b*** | 11 (9) | 2 (2) | 2 (2) | 3 (3) | 20 (17) | 4 (3) | 22 (18) | 2 (2) | 6 (5) | 4 (3) | 4 (3) | | 2 (2) | 3 (3) | 1 (1) | 1 (1) | 15 (13) | 1 (1) |

Table 7.17. Position of cortex on complete blanks over 20mm. 1-all dorsal, 2-platform and all dorsal, 3-both laterals, 4 – both laterals and distal, 5 – distal, 6 – distal and platform, 7 – left lateral, 8 – left lateral and distal, 9 – mesial, 10 – patchy, 11 – platform, 12 – platform and both laterals, 13 – platform and left lateral, 14 – platform and right lateral, 15 – proximal, 16 – proximal and distal, 17 – right lateral, 18 – right lateral and distal.

From Table 7.17, it is clear that the sites with diverse locations of cortex, 123-b and JKF-12, are also those with the highest proportions of cortical blanks. Figure 7.29 attempts to show the percentages of cortex location in graphical form. What it, and the subsequent Table 7.18 which summarises the most common cortex locations for each assemblage, seem to show is that in general the assemblages for the most part share a broadly similar pattern. Minor differences reflect the small sample sizes and an element of contingency in the decortification process. In most cases the prominence of blanks with cortex at the distal end suggests decortification by removals from the proximal end, followed by removals from the laterals. In some cases there are somewhat more blanks with left lateral cortex, in others the right lateral is dominant. While the broad picture seems to be that the position of cortex does not particularly distinguish between assemblages, the

similarity between, firstly, JSM-1 and JKF-1, secondly, Porc Epic E and C, and, finally, Warwasi NNOO and WWXX can be noted. The similarity of these assemblages might suggest cultural factors in decortification, but there are no major differences.

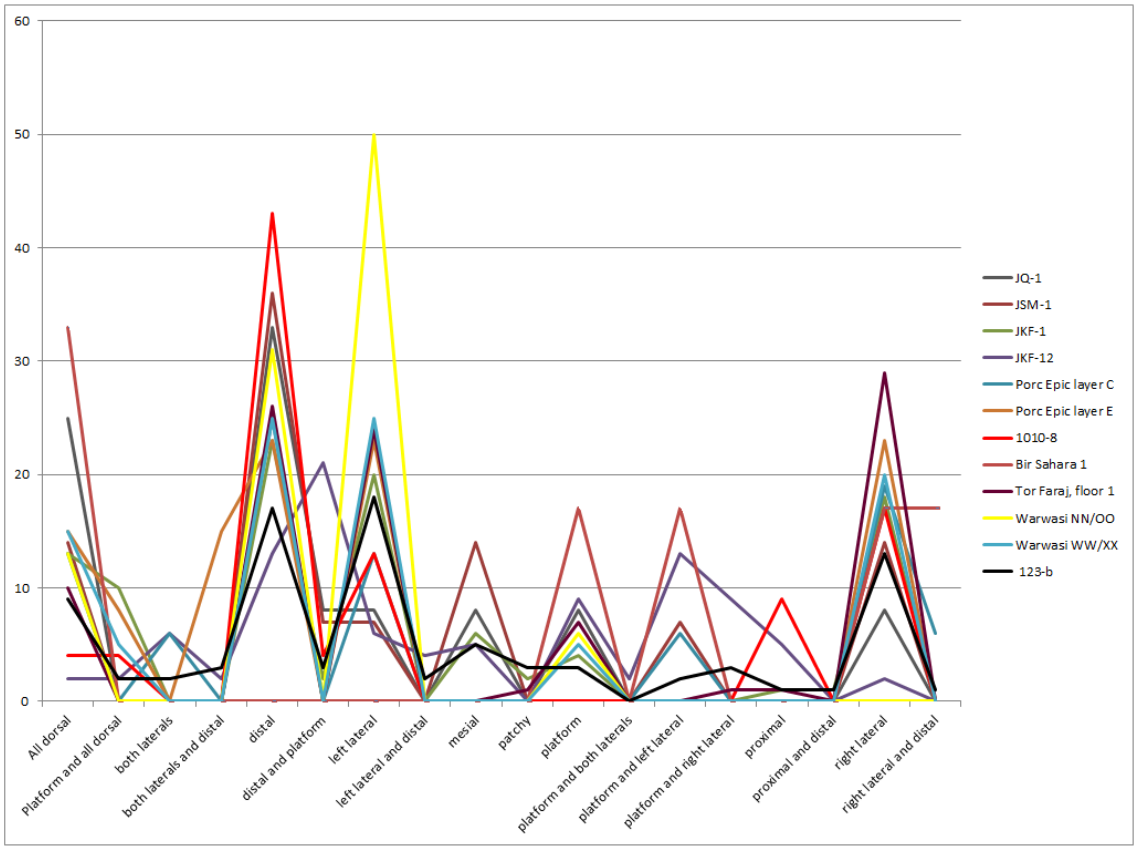


Figure 7.29. Line graph of locations of cortex. Note dominance of distal, left lateral, and right lateral.

| Assemblage | Primary locations of cortex |
|---|---|
| JQ-1 | All dorsal, distal |
| JSM-1 | Distal, all dorsal, mesial, right lateral |
| JKF-1 | Distal, left lateral, right lateral, distal, all dorsal |
| JKF-12 | Distal, platform and all distal, platform and left lateral |
| Porc Epic C | Distal, right lateral, all dorsal, left lateral |
| Porc Epic E | Distal, left lateral, right lateral, all dorsal, both laterals and distal |
| 1010-8 | Distal, right lateral, platform and left lateral |
| BS-1 | All dorsal, platform, platform and left lateral, right lateral, right lateral and distal |
| Tor Faraj | Right lateral, distal, left lateral |
| Warwasi NNOO | Left lateral, distal, all dorsal |
| Warwasi WWXX | Distal, left lateral, right lateral, all dorsal |
| 123-b | Left lateral, distal, right lateral |

Figure 7.18. Summary of the dominant categories of cortex location on blanks, in descending order of commonality.

A planned Correspondence Analysis analysing the correlation of the location of cortex with features relating to the morphology of the blanks, to clarify the changing character of cortex location through the reduction process, was abandoned due to small sample sizes. Instead, as an initial experiment to investigate this relationship, a simple comparison of certain attribute states and the location of cortex will be explored for the site of JKF-1, which has the largest sample of cortical blanks (see Table 7.19 below). Location categories with four or less examples will be excluded for clarity and because of their small sample size.

| | **Right lateral** | **Mesial** | **Distal** | **Platform** | **Left lateral** | **All dorsal** | **Platform and all dorsal** |
|---|---|---|---|---|---|---|---|
| **Mean weight (g)** | 47.4 | 44.6 | 37.8 | 37.2 | 35.3 | 22.2 | 9.4 |
| 25% | 9.1 | 7.1 | 7.5 | 3.8 | 4.8 | 4.8 | 3.5 |
| 75% | 69.3 | 65.8 | 36.3 | 87.7 | 50.9 | 31.7 | 14.9 |
| S. dev. | 65.0 | 39.6 | 57.2 | 45.3 | 41.7 | 28.8 | 6.4 |
| S. error | 12.3 | 13.2 | 9.4 | 16 | 7.4 | 6.3 | 1.5 |
| **Mean length (mm)** | 57 | 51.3 | 45 | 50 | 44.4 | 41.8 | 30.5 |
| 25% | 35 | 32.9 | 31.4 | 21.9 | 24.5 | 28.2 | 24 |
| 75% | 74.2 | 73.2 | 55.5 | 88 | 58.5 | 40.7 | 34.3 |
| S. dev. | 29.1 | 25.8 | 20.1 | 39.8 | 21.4 | 25.5 | 7.4 |
| S. error | | 8.6 | 3.3 | 14.1 | 3.8 | 5.6 | 1.8 |
| **Mean thickness (mm)** | 15 | 16.3 | 12.6 | 13.6 | 13.7 | 11.1 | 9.8 |
| 25% | 9.8 | 32.9 | 9.8 | 8 | 24.5 | 7.1 | 7.5 |
| 75% | 19.8 | 73.2 | 123.8 | 20.6 | 58.5 | 15.0 | 12.2 |
| s. dev | 7.8 | 6.1 | 5.4 | 6.4 | 21.4 | 4.5 | 3.2 |
| s. error | 1.5 | 2 | 0.9 | 2.3 | 3.8 | 1.0 | 0.8 |

Table 7.19. Descriptive statistics for cortical blanks at JKF-1 organised by the location of cortex.

As the interquartile figures and standard deviations and standard errors suggest, there is a considerable variability of blank morphology associated with particular cortex locations. This is to be expected given factors such as variation in initial raw material morphology. Focussing on the mean figures, as shown in Figure 7.30, it can be hypothesised that there is a relationship between cortical location and blank morphology and that, everything else being equal, these features of blank morphology correlate with reduction intensity and therefore may offer insights into the reduction process. In terms of highly cortical blanks (the last two categories of Table 7.19 above) it is clear that these are typically small flakes. They are highly cortical because the removal has not extended far over the dorsal surface, not because they are large 'decortification' flakes as such. What can we make of typically diminishing size for blanks with, in order, cortex on their right lateral, mesial area, distal, platform and left lateral? In the present example it is clear from the dorsal scar patterns that bidirectional flaking was a significant element of the reduction process. Given

that cores were being rotated in this manner 'right', 'left', 'proximal' and 'distal' are merely relative terms. The large size of blanks with cortex on their right lateral may indicate that early removals typically began on the left hand side of the core, but given problems such as that discussed above it is difficult to advance such lines of thought in a meaningful manner. The point for now is merely to observe that such quantifiable pattern exists.

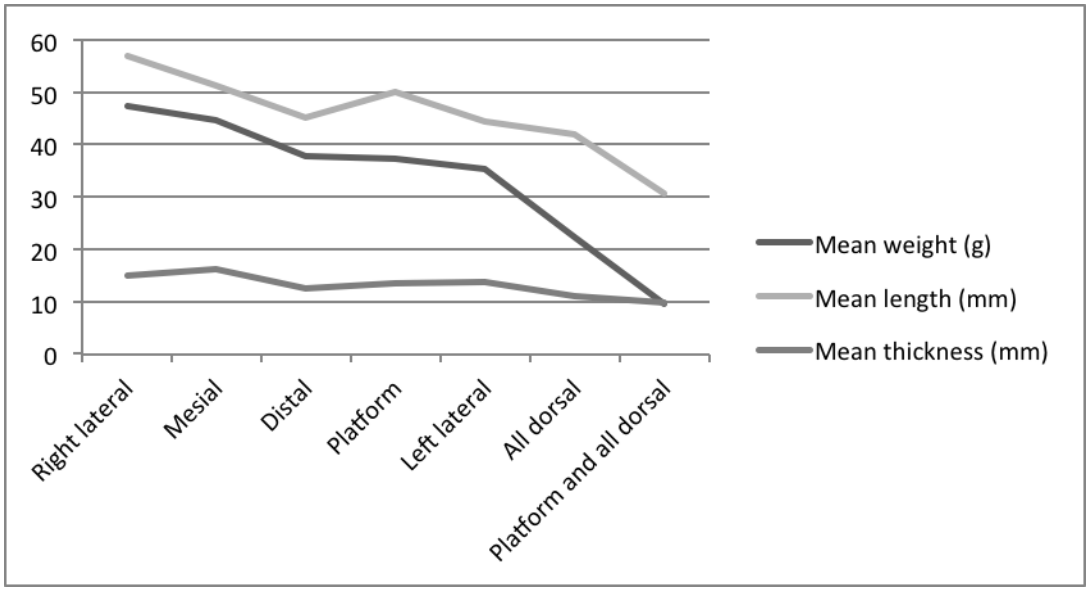



Figure 7.30. Lines graph of mean values for weight, length and thickness for blanks with different cortical locations at JKF-1. Length and weight both decrease considerably, while thickness stays more or less the same.

**7.10) Striking platform characteristics**

Table 7.20 presents information on size variation in striking platforms. In most cases intra-assemblage variability for thickness is limited. JKF-12 and 123-b have a wider range of platform thicknesses, and higher mean averages than other sites. 1010-8 platforms are also typically fairly thick, and JKF-1 a little less so. Thickness reflects choice of where the knapper strikes the core, so for these sites with much 'primary' debitage thick platforms ensure large flakes are removed which cover the face of the core. In the cases of the heavily reduced assemblages, which typically have less of a focus on decortification and the early stage working of cores, the homogeneity of platform thickness is quite striking. For JQ-1, JSM-1, Porc Epic, Tor Faraj and Warwasi almost all platforms are between 1 and 20 mm thick, with 50% falling in a range of less than 10mm. At Warwasi, Tor Faraj and Porc Epic 50% of platforms occur within a range of less than 4mm, indicating careful and precise knapping. Values for widths follow a broadly similar pattern, but are less tightly constrained.

Platform size (thickness x width) understandably follows a similar relationship to that of its constituent variables. Variability is amplified by the multiplication of the components, so the sites with larger platforms have a large range of variability. A 'normal' Middle Palaeolithic assemblage, i.e. not one at a raw material source or one extremely heavily reduced, and here represented by BS-1, Tor Faraj and Porc Epic has platforms of on average ~100mm$^2$. The averages for these site all occur in the range from 98 – 107 mm$^2$, with the range for the middle 50% of their platform sizes also occurring in the range of ~40-150mm$^2$. The case of Warwasi is interesting as an example of apparent raw material efficiency by the repeated careful use of small platforms.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N. for thickness** | 46 | 32 | 570 | 79 | 100 | 109 | 88 | 87 | 344 | 139 | 170 | 199 |
| **Min thickness** | 1.6 | 1.6 | 1.8 | 3.5 | 1.4 | 0.83 | 3.0 | 1.3 | 0.7 | 0.66 | 1.2 | 2.8 |
| **Max thickness** | 19.4 | 17.1 | 38.2 | 50.4 | 13.2 | 24.1 | 37.1 | 14.5 | 16.4 | 15.6 | 18.8 | 64.4 |
| **Mean thickness** | 8.2 | 6.8 | 9.0 | 16.9 | 5.8 | 6.2 | 10.4 | 5.5 | 5.2 | 4.0 | 4.3 | 13.2 |
| **25 %** | 5.3 | 4.9 | 5.6 | 11.5 | 4.1 | 4.2 | 6.6 | 3.6 | 3.5 | 2.4 | 2.3 | 8.6 |
| **75 %** | 10.1 | 8.1 | 11.4 | 20.0 | 7.0 | 8.2 | 13.1 | 6.9 | 6.6 | 5.2 | 5.7 | 16.3 |
| **N. for width** | 42 | 30 | 506 | 78 | 102 | 111 | 89 | 81 | 342 | 146 | 180 | 190 |
| **Min width** | 7.4 | 2.9 | 3.7 | 11.3 | 3.7 | 1.7 | 10.5 | 4.6 | 1.1 | 1.5 | 1.4 | 6.7 |
| **Max width** | 44.3 | 44.4 | 71.2 | 139.2 | 50.9 | 46.0 | 107.2 | 31.8 | 56.2 | 36.5 | 55.4 | 97.5 |
| **Mean width** | 20.3 | 17.3 | 22.8 | 44.1 | 16.2 | 15.7 | 32.1 | 15.6 | 17.1 | 10.8 | 12.6 | 32.1 |
| **25 %** | 13.0 | 8.3 | 14.0 | 26.4 | 11.0 | 10.2 | 20.9 | 10.7 | 8.9 | 6.4 | 6.9 | 20.5 |
| **75 %** | 25.5 | 24.3 | 29.1 | 53.0 | 19.2 | 20.6 | 42.0 | 19.6 | 22.7 | 13.9 | 16.5 | 40.6 |
| **N. for plat size (w x t)** | 36 | 24 | 349 | 69 | 83 | 95 | 74 | 51 | 302 | 116 | 137 | 167 |
| **Min size** | 15.4 | 12.6 | 6.9 | 113.9 | 6.7 | 1.4 | 37.3 | 9.2 | 2.0 | 1.0 | 2.0 | 19.2 |
| **Max size** | 682.4 | 702.5 | 1921.2 | 5586.4 | 60.8 | 592.4 | 3967.9 | 329.7 | 484.9 | 569.7 | 1040.6 | 1988.5 |
| **Mean** | 193.6 | 151.5 | 257.4 | 894.1 | 102.5 | 106.9 | 417.8 | 97.9 | 101.5 | 56.8 | 65.9 | 481.3 |
| **25 %** | 63.4 | 51.5 | 75.3 | 323.9 | 45.5 | 41.7 | 142.8 | 32.0 | 30.2 | 14.9 | 17.4 | 193.8 |
| **75%** | 305.3 | 213.7 | 339.6 | 1052.1 | 14.0 | 145.9 | 530.0 | 153.6 | 135.1 | 74.5 | 94.8 | 648.6 |
| **N. for relative plat size** | 36 | 24 | 349 | 69 | 83 | 95 | 74 | 51 | 302 | 116 | 137 | 167 |
| **Min rel siz** | 1.9 | 1.4 | 1.0 | 1.1 | 2.6 | 2.7 | 1.7 | 2.4 | 1.8 | 2.7 | 3.2 | 0.9 |
| **Max rel siz** | 50.6 | 94.5 | 223.1 | 22.5 | 109.9 | 208.4 | 101.6 | 183.1 | 625.6 | 219.2 | 171.7 | 57.7 |
| **Mean rel siz** | 11.2 | 16.2 | 13.0 | 7.0 | 14.4 | 19.8 | 11.2 | 16.4 | 24.9 | 22.1 | 22.8 | 10.4 |
| **25 %** | 4.2 | 4.5 | 4.9 | 3.1 | 6.7 | 6.9 | 4.6 | 4.3 | 7.7 | 7.0 | 9.9 | 4.3 |
| **75 %** | 13.7 | 17.5 | 12.3 | 9.2 | 15.7 | 17.9 | 12.2 | 16.9 | 23.9 | 23.9 | 25.5 | 13.7 |

Table 7.20. Metric attributes of blanks organised by striking platform type. Weight/size only for complete flakes. Relative platform size = (blank length x blank width)/(platform width x platform thickness).

As shown graphically below in Figure 7.31, the Warwasi assemblages and Tor Faraj demonstrate high values for relative platform size, indicating that relatively large blanks were struck from relatively small platforms. In this they differ markedly from the Arabian and African assemblages.

With the exception of JKF-12 and 123-b, all the remaining assemblages demonstrate the 'normal' Middle Palaeolithic relative platform size in the study area, a mean average of 10-20 with a typical range of 10 between the 25th and 75th percentiles. In the case of Warwasi and Tor Faraj the relative platform sizes cluster closely together from 22 to 25, with assemblages sharing closely similar ranges of 7 to 26. The close similarity of these measurements indicate that the producers of these assemblages shared a concern with using small striking platforms to produce large blanks.

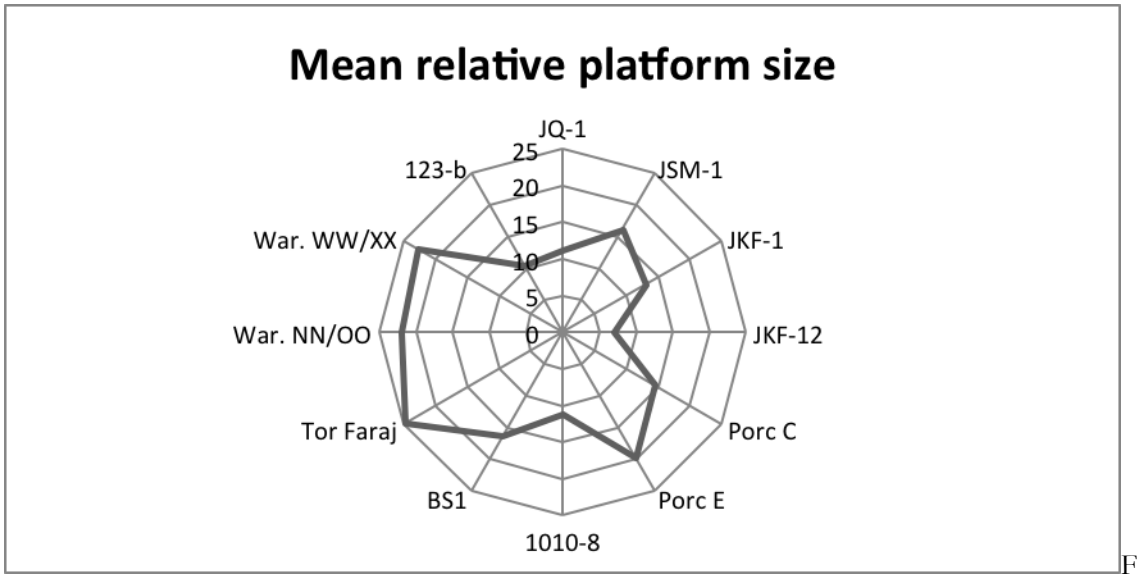


Figure 7.31. Radar chart of relative platform size.

Aside from, and interacting with, size elements there are various forms of platform which experimental knapping have demonstrated play an important role in determining blank morphology. The extent to which variation in platform preparation is 'culturally', versus 'situationally' specific, is a topic in need of further research. There are also questions over the extent to which certain types of platform preparation, particularly faceting, are possible on certain forms of raw material, particularly those which are particularly brittle.

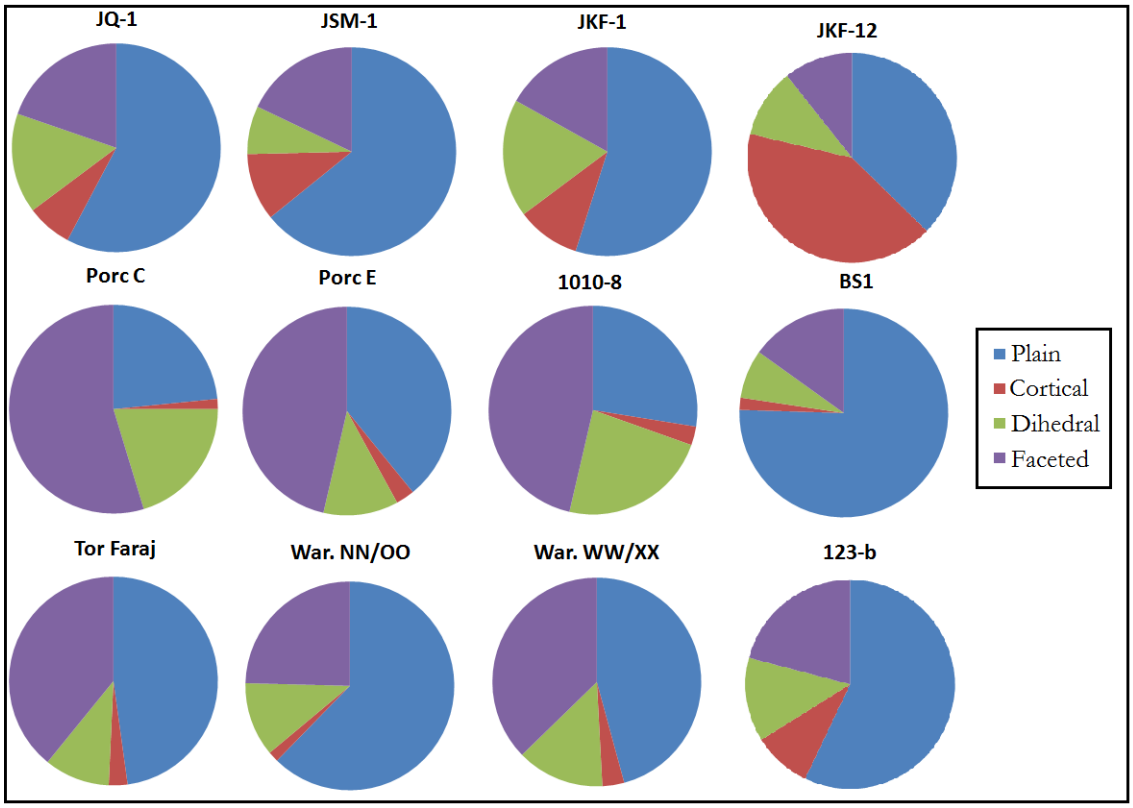



Figure 7.32. Pie charts showing the proportions of major platform types.

The fairly high numbers of platforms assigned to the indeterminate category (typically around 30%) reflects the fact that in many cases it is unclear if small removals on the platform are intentional or post-depositional in origin. These problems are exaggerated in the BS1 assemblage made on poor quality raw material. The proportion of plain platforms varies from 15 to 43% and does not correlate with the assemblages raw material composition. It is also interesting that at Porc Epic and Warwasi a 12% and 11% difference respectively in the percentage of plain platforms exists between the sampled layers at each site. In both of these cases higher levels of faceting are seen in the younger deposits. The frequency of plain platforms varies considerably then. Cortical platforms occur at all sites, although typically in very small amounts, only rising to significant levels at the Jubbah sites and 123b. The prevalence of faceting is an extremely important variable, as this is widely held to have both 'functional' (in knapping terms) and cultural significance. Porc Epic has the highest levels of faceting, reaching 43% in layer E, although this may be exaggerated as the assemblage was sampled, while Tor Faraj and Warwasi WWXX also have high values at over 20%. The Jubbah sites and 123-b have moderate values, still representing a considerable proportion of the debitage. BS1 is low in faceted flakes, but this may relate to the removal of 'preferential' flakes

with faceted platforms. Punctiform platforms are rare, but present in small numbers in several assemblages.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N. plain** | 23 (41) | 18 (43) | 287 (39) | 27 (33) | 21 (15) | 36 (27) | 22 | 54 (40) | 152 (33) | 79 (38) | 68 (27) | 100 (40) |
| **Mean flattening** | 2.5 | 2.1 | 2.5 | 2.5 | 2.6 | 2.3 | 3.0 | 3.1 | 2.8 | 2.6 | 2.7 | 2.4 |
| **Mean size** | 182.8 | 68.6 | 212.5 | 743.9 | 77.1 | 78.1 | 200.7 | 84.9 | 67.7 | 52.4 | 62.3 | 374.9 |
| **Mean blank weight** | 27.9 | 15.5 | 35.6 | 95.4 | 10.1 | 9.7 | 44.5 | 5.8 | 11.1 | 4.7 | 6.5 | 66.1 |
| **Mean blank length** | 40.2 | 36.5 | 46.2 | 58.5 | 42.3 | 40.0 | 50.0 | 30. | 41.9 | 28.9 | 32.0 | 58.6 |
| **Relative plat size** | 11.0 | 68.6 | 14.3 | 8.1 | 17.2 | 19.2 | 19.8 | 18.6 | 25.7 | 21.8 | 21.1 | 12.4 |
| **N. cortical** | 3 (5) | 3 (7) | 51 (7) | 31 (37) | 1 (1) | 2 (2) | 2 | 1 (1) | 10 (2) | 2 (1) | 4 (2) | 39 (15) |
| **Mean flattening** | 2.8 | 3.4 | 2.4 | 2.8 | 3.6 | 1.9 | 2.7 | 1.8 | 2.7 | 3.3 | 3.2 | 2.8 |
| **Mean size** | 81.2 | 105.8 | 208.4 | 768.9 | 53.1 | 18.5 | 760.9 | 76.8 | 96.6 | 416.5 | 17.4 | 834.7 |
| **Mean blank weight** | 5.1 | 5.6 | 29.3 | 139.7 | 2.4 | 2.2 | 139.3 | 1.4 | 9.6 | 51.4 | 4.8 | 107.4 |
| **Mean blank length** | 30.7 | 23.5 | 36.0 | 69.4 | 27.1 | 29.9 | 69.2 | 21.7 | 41.0 | 60.0 | 27.8 | 65.0 |
| **Relative platform size** | 9.9 | 5.2 | 6.5 | 7.0 | 6.8 | 24.4 | 10.7 | 3.3 | 21.5 | 6.9 | 84.9 | 6.7 |
| **N. dihedral** | 6 (11) | 2 (5) | 92 (13) | 8 (10) | 19 (13) | 11 (8) | 18 | 6 (4) | 33 (7) | 15 (7) | 19 (8) | 23 (9) |
| **Mean flattening** | 2.8 | 3.0 | 3.0 | 3.7 | 3.3 | 3.5 | 3.5 | 3.3 | 3.8 | 3.8 | 3.7 | 2.8 |
| **Mean size** | 340.5 | 440.0 | 325.3 | 1417.9 | 108.4 | 117.3 | 448.6 | 141.9 | 144.9 | 50.9 | 75.2 | 787.3 |
| **Mean blank weight** | 17.7 | 12.1 | 35.2 | 100.9 | 9.8 | 6.9 | 71.8 | 4.5 | 9.0 | 2.9 | 8.5 | 101.7 |
| **Mean blank length** | 37.2 | 21.2 | 47.0 | 59.1 | 36.3 | 34.0 | 57.9 | 27.8 | 46.1 | 28.8 | 39.3 | 69.2 |
| **Relative platform size** | 5.2 | 2.4 | 6.1 | 5.8 | 10.6 | 7.9 | 7.0 | 5.0 | 15.0 | 12.9 | 13.8 | 8.1 |
| **N. faceted** | 8 (14) | 5 (12) | 90 (12) | 8 (10) | 49 (35) | 56 (43) | 42 | 11 (8) | 123 (27) | 31 (15) | 54 (22) | 37 (15) |
| **Mean flattening** | 3.0 | 3.9 | 3.3 | 3.2 | 2.8 | 3.0 | 3.4 | 3.6 | 4.6 | 3.4 | 3.5 | 3.1 |
| **Mean size** | 203.3 | 310.4 | 432.4 | 1640.9 | 100.3 | 139.9 | 417.0 | 155.5 | 142.2 | 49.2 | 93.5 | 438.3 |
| **Mean blank weight** | 13.2 | 40.4 | 38.3 | 191.2 | 36.3 | 13.8 | 55.5 | 6.8 | 11.6 | 3.1 | 7.4 | 69.5 |
| **Mean blank length** | 41.2 | 20.2 | 52.6 | 75.1 | 39.2 | 42.4 | 60.3 | 30.0 | 48.2 | 28.5 | 35.2 | 64.5 |
| **Relative platform size** | 11.8 | 5.0 | 6.1 | 4.6 | 13.0 | 12.1 | 8.7 | 5.9 | 12.5 | 17.4 | 12.9 | 8.7 |
| **N. punctiform** | 1 (2) | 1 (2) | 9 (1) | | | | | 3 (5) | | 5 (2) | 10 (4) | |
| **Mean flattening** | 4.0 | 2.3 | 2.7 | | | | | 5.5 | | 3.9 | 2.3 | |
| **Mean size** | 25.6 | 12.7 | 24.7 | | | | | 19.9 | | 7.3 | 8.6 | |
| **Mean blank weight** | 11.8 | 4.5 | 46.2 | | | | | 9.7 | | 1.2 | 1.5 | |
| **Mean blank length** | 38.5 | 24.9 | 55.8 | | | | | 33.1 | | 24.6 | 28.3 | |
| **Relative platform size** | 50.6 | 57.4 | 105.9 | | | | | 69.8 | | 86.3 | 79.1 | |
| **N. missing/ Indet** | 14 (25) | 13 (31) | 198 (27) | 9 (11) | 52 (37) | 26 (20) | 30 | 61 (45) | 140 (31) | 78 (37) | 96 (38) | 77 (30) |

Table 7.21. Platform morphology and associated metric attributes for blanks over 20mm in length. Plat size = plat width x thickness. Weight and tech length only for complete example. Brackets are percentages.

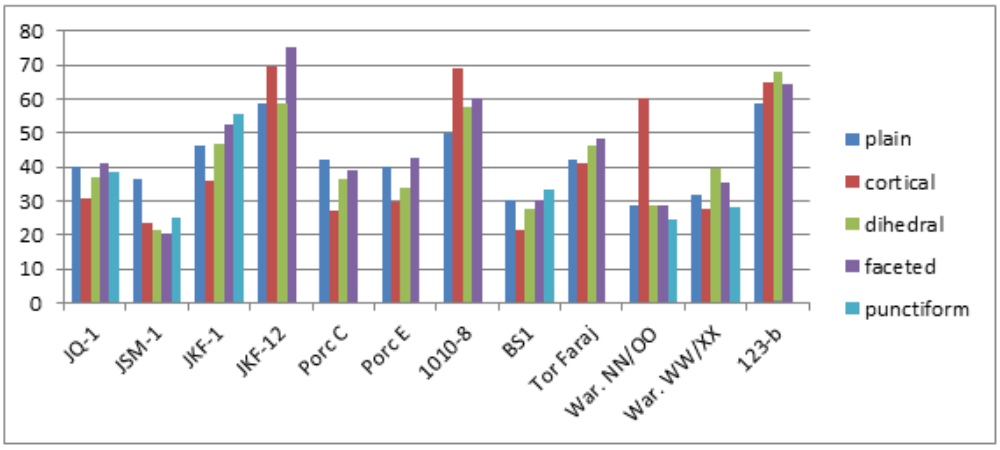



Figure 7.33. Bar chart of mean lengths (mm) for blanks arranged by platform type.

Table 7.21 summarises a considerable amount of data, so description of mean values for blank length for each platform type gives a good overview of the relationship between flake morphology and characteristics of the platform. The mean values are shown in Figure 7.21. Firstly, for all assemblages blanks with faceted platforms are on average the longest, with a mean length of 44.8 mm, although this is not a huge amount larger than plain (42.1mm) or cortical (41.8mm). On a site by site basis the effects of platform morphology vary quite considerably. At JQ-1 cortical flakes are typically the shortest, followed by dihedral, punctiform, plain and finally faceted. At JSM-1 blanks with plain platforms are considerably larger, with all other types clustering together with means of 20-25mm. This, however, is another example of a site where it seems the end of the reduction sequence, i.e. preferential Levallois removals, are missing from the assemblage. JKF-1 follows a similar pattern to JQ-1, but at JKF-1 dihedral platforms are typically on longer flakes than those with plain platforms. Punctiform platforms are on the longest flakes, but these are not much above those with faceted platforms.

At Porc Epic length values for different platform types are clustered together. For layer C, flakes with cortical platforms are short, but the lengths of blanks with other platform types cluster together and the longest are typically plain. In layer E blanks are still quite similar in length, but

those with faceted platforms are the longest. At 1010-8 cortical platforms are associated with the longest blanks, indicating the removal of long blanks early in the reduction process, while plain are the smallest and dihedral and faceted platforms are associated with similar length values in the middle of the range. At BS-1 cortical platforms are the smallest, with other types clustered close together. At Tor Faraj mean averages for blank length are similar for all platform types, with cortical slightly smaller, followed by plain, dihedral and faceted. At Warwasi NNOO, ignoring cortical as these are rare and so produce unrepresentative results, mean blank lengths are almost identical for different platform types. For Warwasi WWXX a similar picture applies, although blanks are typically slightly longer than for NNOO, and here dihedral and faceted platforms are the longest. Finally at 123b plain platforms are typically on short flakes, while cortical and faceted platforms are typically found on longer blanks.

The overall pattern to emerge, although with a considerable amount of noise, is that prepared platforms are typically associated with longer flakes. As Figure 7.33 makes clear, however, this difference is not particularly great and there is actually quite considerable intra-assemblage homogeneity.

**7.11) Dorsal scar patterns**

Table 7.22 presents information on dorsal scar patterns for complete blanks. A clear point is that in most cases assemblages demonstrate a small number of these various options for scar patterns. The few assemblages demonstrating great diversity (although many types are still rare), JKF1, JKF12, and 123b, are sites close to raw material sources. This diversity then both represents a flexible approach to producing flakes early in the reduction process, and the fact that the large flakes typical of such assemblages are perhaps more likely to preserve examples of the more unusual examples of types of scar patterns.

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***JQ-1*** | 16 (35) | 2 (4) | 4 (9) | | | | | | | 1 (2) | 10 (22) | 2 (4) | 1 (2) | 10 (22) |
| ***JSM-1*** | 11 (39) | 1 (4) | | | | | | | | | 10 (36) | 2 (7) | | 4 (14) |
| ***JKF-1*** | 191 (47) | 42 (10) | 3 (1) | 1 | 3 (1) | | 2 | 28 (7) | 12 (3) | 24 (6) | 13 (3) | 8 (2) | 12 (3) | 65 (16) |
| ***JKF-12*** | 31 (44) | 8 (11) | 8 (11) | 2 (3) | 2 (3) | 1 (1) | 1 (1) | | | 5 (7) | 5 (7) | 1 (1) | 1 (1) | 8 (11) |
| ***Porc Epic C*** | 43 (44) | 5 (5) | | | | | | | 1 (1) | 8 (8) | 20 (20) | 10 (10) | 1 (1) | 10 (10) |
| ***Porc Epic E*** | 44 (35) | 12 (10) | | | | | | | 1 (1) | 7 (6) | 25 (20) | 7 (6) | 2 (2) | 27 (22) |
| ***1010-8*** | 24 (29) | 10 (12) | 1 (1) | | | | | | 9 (11) | 2 (2) | 32 (38) | 5 (6) | | 1 (1) |
| **Bir Sahara** | 30 (48) | 1 (2) | | 1 (2) | | | | | | | 4 (6) | 1 (2) | | 26 (41) |
| ***Tor Faraj,*** | 200 (59) | 23 (7) | | 1 | | | | 4 (1) | | 50 (15) | 4 (1) | 1 | 3 (1) | 52 (15) |
| ***War. NN OO*** | 80 (39) | 19 (9) | 1 | | | | | | 1 | 3 (1) | 8 (4) | | | 91 (44) |
| ***War.WW XX*** | 81 (45) | 36 (20) | 1 (1) | | | | | | 4 (2) | 1 (1) | 6 (3) | 1 (1) | 1 (2) | 51 (28) |
| ***123b*** | 74 (35) | 24 (11) | 1 | 2 (1) | 2 (1) | 2 (1) | 3 (1) | | 20 (9) | 1 | 36 (17) | 3 (1) | 1 | 41 (19) |

Table 7.22. Numbers and percentages of scar pattern types on complete blanks for each assemblage. 1 – from proximal, 2 – bidirectional, 3 – from left, 4 – from right, 5 – from both laterals, 6 – from distal, 7 – from distal and lateral, 8 – from proximal and from right, 9 – from proximal and from left, 10 – from proximal convergent, 11 – weakly radial, 12 – strongly radial, 13 – cortical, 14 – indeterminate.

Figure 7.34 shows pie charts for the common forms of scar pattern. This emphasises the considerable diversity in the proportions of scar patterns between assemblages. Indeterminate scar patterns are unfortunately common, particularly for BS1 (41%) and the Warwasi assemblages (44 and 28%) where much of the debitage is small and rather amorphous. The differences in the proportion of indeterminate patterns between the two assemblages and both Porc Epic and Warwasi is interesting, and may in itself reflect changing approaches to knapping and reduction. Clearly, in both cases, the site is not homogenous throughout the sequence. From proximal scars are important in all assemblages, varying from 35% to 59% excluding 1010-8 (29%), their relative underrepresentation at 1010-8 probably reflecting the sampling issues with this assemblage discussed earlier. This scar pattern then is not necessarily particularly informative on technological choices, as these flakes can result from very different reduction sequences.

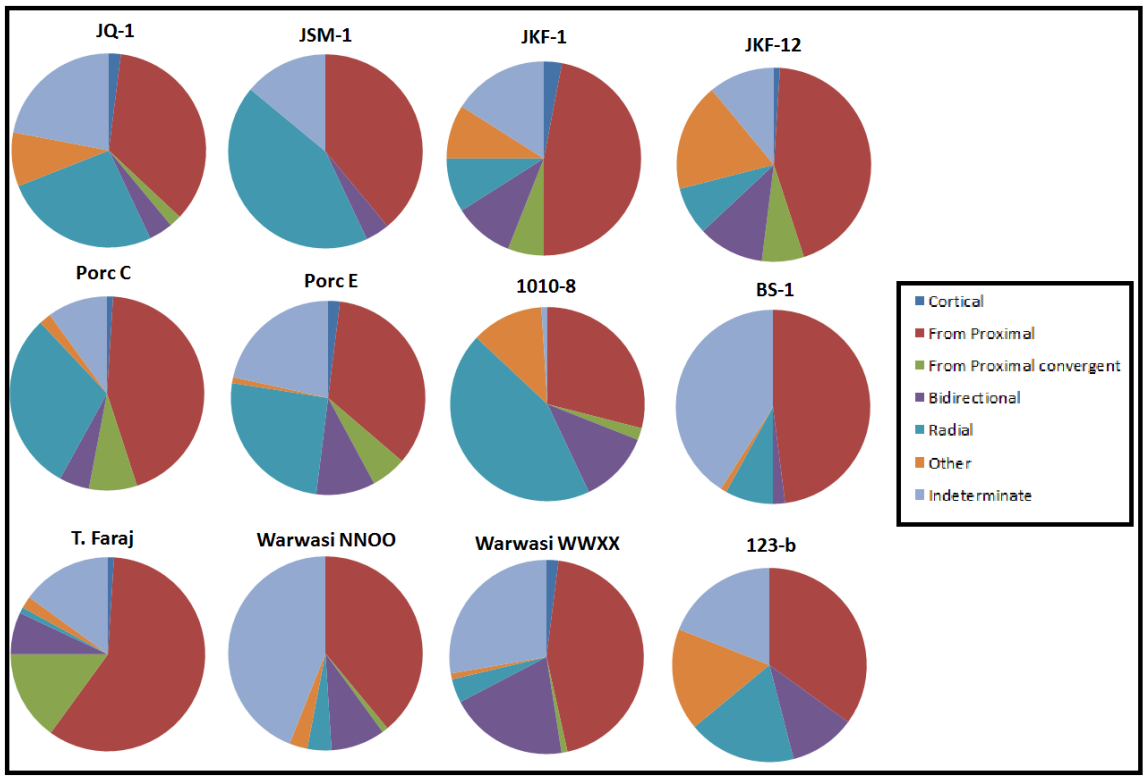



Figure 7.34. Pie charts showing proportions of major scar patterns.

In most cases bidirectional scar patterns are not particularly common, but are present in varying proportions at all sites. Three groupings can be discerned for the commonality of bidirectional scars. They are fairly uncommon (2-5%) at JQ-1, JSM-1, BS-1 and Porc Epic E. For JKF-1, JKF-12, Porc Epic C, 1010-8, JKF-1, Warwasi NNOO and TH-123b – most assemblages in other words – there are found in moderate numbers (7-12%). Only in the case of Warwasi XXWW are they a particularly significant component of the assemblage, rising to a considerable 20%. Again the considerable difference *within* Porc Epic (5% for E and 10% for C) and Warwasi (9% for NNOO and 20% for WWXX) reveals that these assemblages are by no means homogenous. In the case of Warwasi this may some extent be explained by the higher numbers of 'indeterminate' scars in NNOO, but this can hardly account for the whole picture and it seems unlikely that flakes with bidirectional scars would preferentially be rendered indeterminate. This reinforces the considerable temporal variability, which in the absence of good chronological control frustrates efforts to understand spatial variability.

The proportion of 'from proximal convergent' scars is of considerable interest, as the predominance of this has often been regarded as a characteristic of the late Levantine Middle Palaeolithic. And indeed here Tor Faraj is the only assemblage in which they make up a large proportion (15%). In the case of JQ-1, JSM-1, 1010-8, the Warwasi assemblages and 123-b blanks with this scar pattern are typically present, but rare (0-2%). Their frequency at Porc Epic varies from 6% in layer C to 8% in E. JKF-1 and JKF-12 record similar, moderate, frequencies of from proximal convergent scar patterns, 6% and 8% respectively.

What of radial scar patterns? Broadly similar frequencies are found for both weakly and strongly radial patterns, although some differences exist. Weakly radial scar patterns are uncommon at JKF-1, JKF-12, BS-1, Tor Faraj (in particular) and the Warwasi assemblages In these cases weakly radial scar patterns make up less than 7% of scar patterns. Moderate levels of weakly radial scar patterns are found at JQ-1, the Porc Epic Assemblages, and TH-123B. These sites vary from 17% to 22%. JSM-1 and 1010-8 have the highest proportions of weakly radial scar patterns. For strongly radial scar patterns JKF-1, JKF-12, BS-1, Tor Faraj, the Warwasi assemblages and 123 all have less than 2%. JQ-1, JSM-1, Porc Epic C and 1010-8 range from 4 to 7%. While Porc Epic E has the highest levels with 10% strongly radial scar patterns. For combined radial scar patterns then, Tor Faraj has a very low level (1%), while JKF-1, JKF-12, BS-1 and the Warwasi assemblages all have a small but significant component of 4% to 8%. JQ-1 and JSM-1 are a little higher (12%) while Porc Epic, 1010-8 (although remembering the nature of the sample of this assemblage) and 123-b all record values of 30-39% radial scar patterns.

It is difficult to factor in the scar patterns on broken pieces, as it is likely incorrect recordings would result. This is a problematic issue, as it will be difficult to understand scar pattern variation in heavily fractured assemblages. As an experiment Table 7.23 compares scar patterns for complete blanks and for all pieces of debitage, including broken specimens, with a maximum dimension over 20mm at JKF-1. Perhaps surprisingly, the figures are remarkably similar. The only change of any note is the increased representation of from proximal convergent scar patterns, although it should be note that even with this method, JKF-1 still has considerably less than Tor Faraj. This similarity

is perhaps surprising, although care should be taken as the 'indeterminate' category still accounts for a considerable proportion of cases.

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***JKF-1 comp.*** | 191 (47) | 42 (10) | 3 (1) | 1 | 3 (1) | 1 | 2 | 28 (7) | 12 (3) | 24 (6) | 13 (3) | 8 (2) | 12 (3) | 65 (16) |
| ***JKF-1 all*** | 330 (45) | 67 (9) | 6 (1) | 1 | 3 | 1 | 1 | 41 (6) | 23 (3) | 62 (9) | 23 (3) | 8 (1) | 31 (4) | 131 (18) |

Table 7.23. Comparison of scar patterns types on complete and all blanks at JKF-1. For complete blanks over 20mm and for all pieces with a max dim over 20mm, including broken pieces. 1 – from proximal, 2 – bidirectional, 3 – from left, 4 – from right, 5 – from both laterals, 6 – from distal, 7 – from distal and lateral, 8 – from proximal and from right, 9 – from proximal and from left, 10 – from proximal convergent, 11 – weakly radial, 12 – strongly radial, 13 – cortical, 14 – indeterminate.

Table 7.24 compares mean blank weights and lengths for each assemblage by scar pattern to evaluate the relationship between the latter and basic metric conditions. This data highlights the considerable differences between assemblages. In other words blanks with a particular scar pattern are typically more similar in weight to blanks with other scar patterns in the same assemblage than they are to blanks with the same scar pattern in other assemblages. So we have blanks with from proximal convergent scar patterns weighing, on average, three times more at JKF-1 than at Tor Faraj. When it comes to length, however, the picture is a little different. Here there seems to be more homogeneity between scar patterns rather than assemblages. With the exception of the very primary sites, for instance, several sites share similar mean lengths for flakes with radial scar patterns of ~30-40 mm. At the primary sites this is more typically ~60mm. Flakes with from proximal scar patterns typically also average around 30-40 mm. In this case there seems to be less variation in the case of primary sites, although these are still typically associated with longer blanks.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | BS1 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **From prox mean weight (g)** | 26.0 | 10.7 | 25.0 | 161.2 | 6.8 | 9.4 | 47.1 | 5.1 | 8.5 | 4.5 | 6.4 | 68.1 |
| **From proximal convergent mean weight (g)** | | | 37.7 | 93.9 | 7.8 | 7.5 | | | 11.0 | 3.8 | | |
| **Bidirectional mean weight (g)** | | | 55.6 | 122.6 | 7.3 | 14.3 | 70.1 | | 12.0 | 4.1 | 4.3 | 55.7 |
| **Radial mean weight (g)** | 11.7 | 19.3 | 57.5 | 91.1 | 9.7 | 15.0 | 71.1 | 8.0 | 12.8 | 4.8 | 7.0 | 74.6 |
| **From prox mean length (mm)** | 40.7 | 32.1 | 41.7 | 67.3 | 40.2 | 39.5 | 46.3 | 28.8 | 42.3 | 28.0 | 34.0 | 54.8 |
| **From proximal convergent mean length (mm)** | | | 57.8 | 89.0 | 41.5 | 38.2 | | | 49.9 | 34.5 | | |
| **Bidirectional mean length (mm)** | | | 51.8 | 72.6 | 38.9 | 52.0 | 64.0 | | 45.8 | 31.2 | 33.5 | 59.0 |
| **Radial mean length (mm)** | 32.9 | 36.9 | 63.2 | 61.1 | 38.5 | 41.1 | 58.1 | 32.8 | 40.0 | 28.5 | 31.7 | 66.3 |

Table 7.24. Basic morphological features arranged by blank scar pattern. Examples with 1 or 2 specimens are excluded for their biasing effects.

## Multivariate Analyses

### 7.12) (1) How is variability in blank size structured?

This question uses Correspondence Analysis to explore the relationship within and between and assemblages focusing on size variation, and how this relates to shape and raw material type. In this case all complete blanks were included, whereas subsequent questions focus on those over 20mm in length. The variables used here are Lateral Shape Index (proximal width/medial width/distal width, i.e. a measure of convergence), technical length (mm), weight (g), thickness at medial (mm) and raw material type. All variables were classed into 5 groups in Minitab. Due to the rarity of most raw material types only flint and quartzite were included as primary variables, as other types made up less than 5% of the category and so were included as supplementary variables.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (22%, 22%) | Medium LSI (convergence), long blanks, **heavy blanks**, **thick blanks** | High LSI (strongly convergent), **short blanks, light blanks**, thin blanks, **medium thickness blanks**, quartzite raw material |
| 2 (15%, 38%) | Medium length blanks, **medium weight**, **medium thickness** | Short blanks, long blanks, **heavy blanks**, **thick blanks** |
| 3 (11%, 49%) | High LSI, | Low weight, **low/medium thickness**. |
| 4 (9%, 58%) | **high LSI,** flint raw material | Medium LSI, quartzite raw material |
| 5 (9%, 67%) | **High/medium LSI,** long blanks | **Low/medium LSI,** highest LSI, medium length blanks |
| 6 (8%, 74%) | **Low LSI, Quartzite raw material** | High LSI, **Flint raw material** |
| 7 (7%, 82%) | **High LSI,** medium length blanks | **Low/medium LSI, short blanks** |
| 8 (6%, 88%) | **High LSI, long blanks** | **Medium length blanks** |

Table 7.25. Loading of components for question 1. Variables in bold indicate a strong role in driving the relationship. Underlined examples are particularly strong drivers.

Space prevents the thorough discussion of the contribution of each variable in this and subsequent questions, but some clear tendencies are driving the structure of the components outlined in Table 7.25. An important point is that the largest amount of variability is being driven by size, with the first component stressing the difference between thick and heavy blanks and those which are light and short. The second component then follows a pattern we saw in the previous chapter, dividing between 'medium' and 'non-medium', the latter mostly being driven by thick and heavy blanks, but also featuring a contribution from short blanks. The third component is most strongly driven by thickness, emphasising that although there is some correlation between size related variables, there is also some independence between them. From the fourth component in particular onwards, shape

variables become important. Something of a tendency for the correlation of broadly parallel sided blanks (low LSI scores) with long blanks can be seen, while higher convergence correlates with short and medium length. Here then we see an example of the correlation of size and shape. Overall, raw material type does not appear to play a strong or simplistic role in determining this structure, and where they do it appears to be in a fairly 'incoherent' manner. For example, quartzite correlates with high LSI scores in the first component and low LSI scores in the 6th component.

**RPC1:**

| Site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 70 | 1.0822 | A |
| 1010-8 | 84 | 0.7217 | B |
| TH-123B | 212 | 0.6537 | B |
| JKF-1 | 402 | 0.2913 | C |
| JQ-1 | 45 | 0.0464 | C D |
| JSM-1 | 28 | -0.0577 | D E |
| Porc Epic E | 125 | -0.2224 | D E |
| Tor Faraj F1 | 298 | -0.2395 | E |
| Porc Epic C | 97 | -0.2909 | E |
| BS-1 | 63 | -0.3707 | E F |
| Warwasi XXWW | 182 | -0.5997 | F G |
| Warwasi NNOO | 203 | -0.7484 | G |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 203 | 0.3628 | A |
| JKF-12 | 70 | 0.3607 | A |
| TH-123B | 212 | 0.2629 | A |
| Warwasi XXWW | 182 | 0.2357 | A B |
| Porc Epic E | 125 | 0.0074 | C |
| 1010-8 | 84 | -0.0411 | C D |
| BS-1 | 63 | -0.0833 | C D |
| JKF-1 | 402 | -0.1324 | C D |
| JSM-1 | 28 | -0.1367 | B C D E |
| Tor Faraj F1 | 298 | -0.2529 | D E |
| JQ-1 | 45 | -0.3269 | D E |
| Porc Epic C | 97 | -0.4068 | E |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JSM-1 | 28 | 0.2034 | A |
| 1010-8 | 84 | 0.1177 | A |
| JKF-1 | 402 | 0.0546 | A |
| Porc Epic E | 125 | 0.0500 | A |
| JQ-1 | 45 | 0.0284 | A |
| Warwasi XXWW | 182 | 0.0103 | A |
| Warwasi NNOO | 203 | -0.0090 | A |
| BS-1 | 63 | -0.0529 | A |
| Porc Epic C | 97 | -0.0576 | A |
| Tor Faraj F1 | 298 | -0.0758 | A |
| TH-123B | 212 | -0.0855 | A |
| JKF-12 | 70 | -0.3926 | B |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 45 | 0.2840 | A |
| JKF-12 | 70 | 0.2298 | A |
| JKF-1 | 402 | 0.2083 | A |
| BS-1 | 63 | 0.2041 | A |
| JSM-1 | 28 | 0.1906 | A B |
| 1010-8 | 84 | 0.1737 | A B |
| Porc Epic E | 125 | 0.0404 | A B |
| Warwasi NNOO | 203 | -0.0949 | B C |
| Porc Epic C | 97 | -0.1046 | B C D |
| Warwasi XXWW | 182 | -0.1433 | C D |
| TH-123B | 212 | -0.1480 | C D |
| Tor Faraj F1 | 298 | -0.2622 | D |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 97 | 0.2646 | A |
| Tor Faraj F1 | 298 | 0.0776 | B |
| Warwasi XXWW | 182 | 0.0634 | B C |
| JKF-12 | 70 | 0.0278 | B C |
| BS-1 | 63 | 0.0140 | B C |
| Porc Epic E | 125 | 0.0061 | B C |
| TH-123B | 212 | -0.0149 | B C |
| Warwasi NNOO | 203 | -0.0518 | B C |
| JKF-1 | 402 | -0.0633 | C |
| JQ-1 | 45 | -0.0963 | B C |
| 1010-8 | 84 | -0.1303 | C |
| JSM-1 | 28 | -0.1823 | B C |

**RPC 6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| TH-123B | 212 | 0.5198 | A |
| Tor Faraj F1 | 298 | 0.2766 | B |
| Warwasi XXWW | 182 | 0.2394 | B C |
| Warwasi NNOO | 203 | 0.1875 | C |
| Porc Epic C | 97 | 0.1555 | C |
| JSM-1 | 28 | 0.0741 | C |
| JQ-1 | 45 | -0.2441 | D |
| JKF-12 | 70 | -0.2954 | D |
| 1010-8 | 84 | -0.2978 | D |
| JKF-1 | 402 | -0.3223 | D |
| Porc Epic E | 125 | -0.4569 | E |
| BS-1 | 63 | -0.5880 | E |

**RPC 7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 97 | 0.1258 | A |
| TH-123B | 212 | 0.1240 | A |
| Tor Faraj F1 | 298 | 0.0710 | A B |
| Warwasi NNOO | 203 | 0.0236 | A B C |
| Warwasi XXWW | 182 | 0.0041 | A B C |
| Porc Epic E | 125 | -0.0040 | A B C |
| JSM-1 | 28 | -0.0270 | A B C |
| JKF-1 | 402 | -0.0595 | C |
| 1010-8 | 84 | -0.0703 | A B C |
| JQ-1 | 45 | -0.1049 | A B C |
| JKF-12 | 70 | -0.1217 | C |
| BS-1 | 63 | -0.1222 | B C |

**RCP 8:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 70 | 0.1427 | A |
| 1010-8 | 84 | 0.1253 | A |
| Porc Epic E | 125 | 0.1038 | A |
| BS-1 | 63 | 0.0881 | A B |
| JQ-1 | 45 | 0.0874 | A B |
| JKF-1 | 402 | 0.0716 | A B |
| Porc Epic C | 97 | 0.0455 | A B |
| Warwasi XXWW | 182 | -0.0240 | A B C |
| JSM-1 | 28 | -0.0612 | A B C |
| Tor Faraj F1 | 298 | -0.0664 | B C |
| TH-123B | 212 | -0.1254 | C |
| Warwasi NNOO | 203 | -0.1418 | C |

Table 7.26. Tukey grouping of ANOVA results for question 1

The ANOVA results for RPC1 are both in a sense predictable and also interesting in the number of groups they define and the limited overlap between groups. JKF-12 blanks are the largest and form their own group. These are followed by 1010-8 and TH-123-b. JKF-1 and JQ-1 can be described as 'medium-large'. The 'small medium' group is the largest group, with JSM-1, Porc Epic E and C, Tor Faraj and BS1. Two groups contain the smallest blanksand Warwasi. Blanks from Warwasi, particularly NNOO, emergence from this analysis as being very small.

The ANOVA of the second component is rather more complex, and shows a very different structure to that of the first component. A group defined by a prevalence of medium sized debitage

includes Tor Faraj, JQ-1 and Porc Epic C. A group of medium 'mediumness', so to say, consists of JKF-1, BS-1, 1010-8 and Porc Epic E, while the final group, characterised by the most 'non-medium' blanks are the Warwasi assemblages, JKF-12 and 123-b. This pattern can perhaps broadly be related to the prevalence of Levallois like flakes in the former group, and their relative rarity in the latter. Such blanks are distinguishable from both small 'preparatory' flakes and large 'primary' removals. The large difference between the Porc Epic assemblages should be observed.

It is not clear what RPC3 is indicating, and the scores for most assemblages are relatively tightly clustered. The only grouping indicated by the Tukey Method is the separation of JKF-12 from the other assemblages, primarily indicating this site is characterised by thick blanks.

The results of RPC4 are rather counter-intuitive, as Tor Faraj, which we saw earlier has the most convergent blanks of all the assemblages, has the lowest (least convergent) score. In such cases the orthogonal characteristics of the method must be remembered. Each component reflects only an element of the assemblage variability. This component is highlighting an element of the debitage found at Tor Faraj, 123-b, Warwasi and Porc Epic C, which is the presence of parallel sided flint blanks, and, conversely, the presence of more convergent quartzite debitage at the Jubbah sites, in particular.

RPC 5 seems like a more coherent comparison of blank shape, particularly lateral convergence. Although the Tukey Method does not produce a neat grouping, we can see the important role of convergent debitage at Porc Epic C and Tor Faraj, in particular. Conversely JKF-1, JQ-1, 1010-8 and JSM-1 lack this convergent character. A broadly similar result is seems is found for RPC 7, which also contrasts convergence results. That both components produce a similar structure indicates it is quite a robust characterisation of the prominence of convergent debitage in these assemblages and how it relates to other variables.

This analysis then suggests that variability in size terms is not simply driven by raw material type, that the most important dimension of variability divides small and large blanks, followed by medium and non-medium, and that shape variability is significant, but complex and does not relate to size variation in a simple manner.

**2) What is the character of morphological variability in the debitage?**

This question attempts to understand basic morphological variability in the blank sample using a Principal Components Analysis. The variables used are weight, technical length, medial width, thickness at medial and platform flattening (platform width/thickness). 2a addresses all complete debitage over 20mm in length, while 2b deals only with debitage between 30 and 60mm in length.

### 17.13.) 2a.) What is the character of morphological variability for blanks over 20mm in length?

| Variable | PC1 (65%) | PC2 (21%) | PC3 (10%) | PC4 (4%) | PC5 (1%) |
|---|---|---|---|---|---|
| Weight (g) | 0.549 | 0.008 | 0.043 | -0.002 | -0.835 |
| Length (mm) | 0.437 | 0.037 | -0.865 | -0.004 | 0.243 |
| Width (mm) | 0.504 | 0.146 | 0.363 | -0.694 | 0.353 |
| Thickness (mm) | -0.503 | 0.174 | -0.341 | -0.694 | -0.345 |
| Platform flattening | -0.007 | 0.973 | 0.039 | 0.226 | 0.006 |

Table 7.27. Loading of components.

PC1 reflects a distinction between blanks which are light, short, narrow and thick (low scores) and those which are heavy, long, wide and thin. This then is basically a simple size driven structure, but the relationship of thickness is interesting as this is shown to be strongly inversely correlated to other size related variables. In other words blanks which are heavier tend to be longer and wider, but also thinner. On the other hand, those which are lighter and shorter tend to be thicker. The subsequent components emphasise shape rather than size. PC2 is most strongly driven by platform morphology, high scores equating with relatively wide (flattened) platforms. As platforms get flatter then the blanks typically get slightly thicker and wider. PC3 seems to distinguish between short, thick and narrow flakes, on the one hand, and long, thin and wide blanks on the other. This might broadly be taken as an indication of 'Levalloisness'.

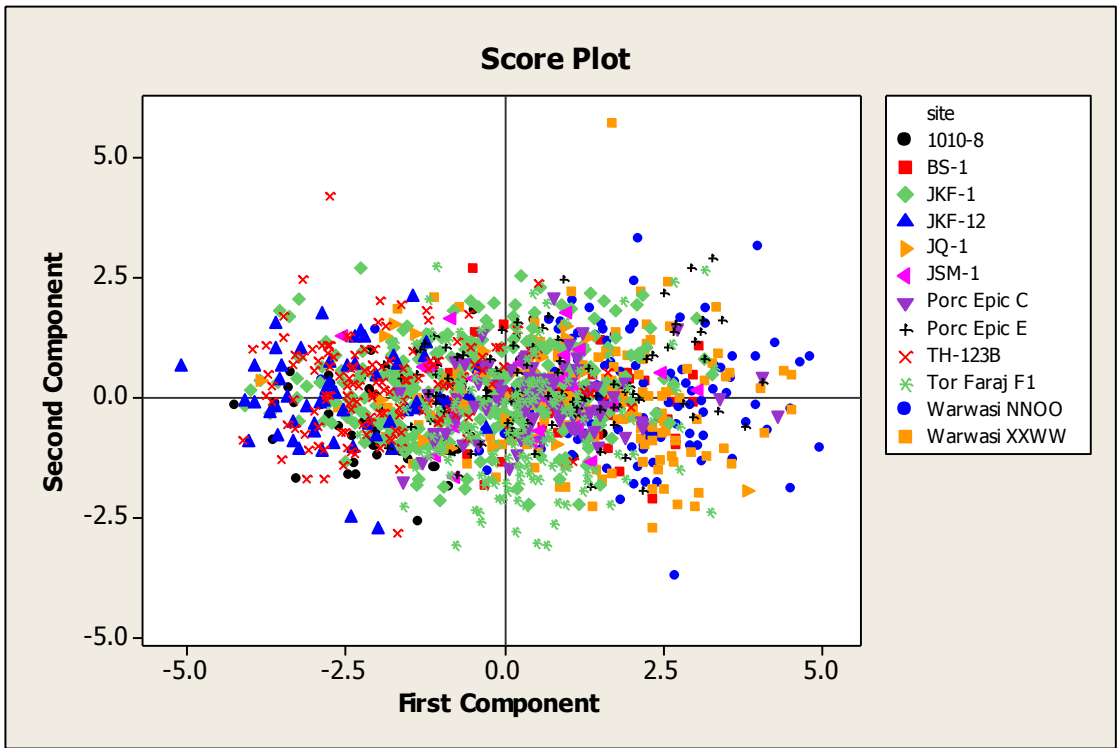



Figure 7.35. Score plot.

**PC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 116 | 1.933 | A |
| Warwasi XXWW | 135 | 1.482 | A B |
| BS-1 | 50 | 1.139 | B C |
| Porc Epic E | 95 | 0.701 | C D |
| Porc Epic C | 82 | 0.615 | C D |
| JSM-1 | 23 | 0.314 | C D E |
| Tor Faraj F1 | 265 | 0.249 | D E |
| JQ-1 | 36 | 0.012 | D E |
| JKF-1 | 310 | -0.460 | E |
| 1010-8 | 69 | -1.446 | F |
| TH-123B | 139 | -1.847 | F |
| JKF-12 | 58 | -2.552 | G |

**PC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 95 | 0.2701 | A |
| TH-123B | 139 | 0.2132 | A |
| JKF-1 | 310 | 0.1971 | A |
| JQ-1 | 36 | 0.1894 | A B |
| JSM-1 | 23 | 0.1176 | A B C |
| Warwasi NNOO | 116 | 0.0371 | A B C |
| JKF-12 | 58 | 0.0035 | A B C |
| Porc Epic C | 82 | -0.0460 | A B C |
| BS-1 | 50 | -0.0637 | A B C |
| Warwasi XXWW | 135 | -0.1405 | A B C |
| 1010-8 | 69 | -0.2980 | B C |
| Tor Faraj F1 | 265 | -0.5087 | C |

**PC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 265 | 0.4282 | A |
| Porc Epic C | 82 | 0.3530 | A B |
| Porc Epic E | 95 | 0.2166 | A B C |
| Warwasi XXWW | 135 | 0.1761 | B C |
| 1010-8 | 69 | 0.0021 | B C D |
| Warwasi NNOO | 116 | -0.1174 | D |
| TH-123B | 139 | -0.1568 | D |
| JKF-12 | 58 | -0.1651 | D |
| JQ-1 | 36 | -0.1786 | C D |
| JKF-1 | 310 | -0.2163 | D |
| BS-1 | 50 | -0.2939 | D |
| JSM-1 | 23 | -0.4749 | D |

**PC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 265 | 0.1247 | A |
| BS-1 | 50 | 0.0988 | A B |
| Warwasi XXWW | 135 | 0.0672 | A B |
| 1010-8 | 69 | 0.0522 | A B |
| Porc Epic E | 95 | 0.0273 | A B |
| JQ-1 | 36 | -0.0282 | A B |
| TH-123B | 139 | -0.0406 | B |
| JKF-1 | 310 | -0.0426 | B |
| JKF-12 | 58 | -0.0579 | A B |
| Porc Epic C | 82 | -0.0610 | B |
| JSM-1 | 23 | -0.0721 | A B |
| Warwasi NNOO | 116 | -0.0940 | B |

**PC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 69 | 0.0975 | A |
| JKF-1 | 310 | 0.0281 | B |
| JKF-12 | 58 | 0.0237 | A B C |
| JSM-1 | 23 | 0.0212 | A B C |
| Porc Epic E | 95 | 0.0054 | B C |
| TH-123B | 139 | 0.0019 | B C |
| JQ-1 | 36 | -0.0030 | A B C |
| Porc Epic C | 82 | -0.0198 | B C |
| Warwasi NNOO | 116 | -0.0213 | B C |
| Warwasi XXWW | 135 | -0.0275 | C |
| BS-1 | 50 | -0.0452 | B C |
| Tor Faraj F1 | 265 | -0.0478 | C |

Table 7.28. Tukey grouping of ANOVA results.

The ANOVA results for the first component reveal an almost identical structure to that seen in question 1. Both Principal Components and Correspondence Analyses seem to detect a very similar basic structure to blank variability. The interpretation of this Tukey grouping is the same as that for RPC1 of question 1. The ANOVA of the second component reveals broad and overlapping groupings. Most sites cluster in the middle, but we can distinguish between assemblages characterised by wide platforms, particularly Warwasi WWXX, 1010-8 and Tor Faraj, in contrast to

those with relatively thicker platforms, particularly JQ-1, JKF-1, 123-b and Porc Epic E. Finally, the ANOVA of RPC3 produces a fairly distinct grouping where, to simplify the grouping somewhat, we can separate sites characterised in particular by the presence of long, thin and wide blanks, consisting of Warwasi WWXX, Porc Epic E and C and, most strongly, Tor Faraj. In contrast Warwasi NNOO, 123-b, BS-1 and the Jubbah assemblages are characterised more by shorter, thicker and wider blanks.

**7.14)(2b) What is the character of morphological variability for complete blanks between 30 and 60mm long?**

This repeats the previous question, but uses only blanks between 30 and 60mm, so it does not include small flakes which are perhaps more likely to be homogenous, and larger blanks which are only present in some assemblages. This size range is perhaps the typically 'desired' size range for Middle Palaeolithic knappers. By reducing some of the 'noise', the score plot is much clearer and some clear grouping can be seen. Due to inadequate sample sizes for this size range JQ-1, JSM-1 and BS-1 were not included in the ANOVAs.

| Variable | PC1 (59%) | PC2 (22%) | PC3 (15%) | PC4 (4%) | PC5 (1%) |
|---|---|---|---|---|---|
| Weight (g) | 0.577 | 0.032 | -0.058 | 0.021 | 0.814 |
| Length (mm) | 0.328 | -0.233 | 0.901 | 0.026 | -0.160 |
| Width (mm) | -0.533 | 0.073 | 0.306 | -0.668 | 0.413 |
| Thickness (mm) | -0.523 | -0.272 | 0.167 | 0.695 | 0.376 |
| Platform flattening | 0.048 | -0.930 | -0.253 | -0.262 | -0.009 |

Table 7.29. Loading of components

The structure of the components, shown in Table 7.29, is, for the most part, broadly similar to that seen in question 2a, but there are some important differences. The role of width has changed for the first component, so that now this distinguishes between blanks which are heavy, long, narrow and thin and those which are light, short, wide and thick. Broadly seems to separate short and robust flakes from larger and more laminar blanks. In terms of the latter, as blanks get longer they get narrower and thinner. PC2 remains strongly driven by platform flattening. This now correlates with length and thickness, so as platforms get relatively wider (flatter) blanks get longer and thinner. PC3 distinguishes blanks which are long (in particular), wide, thick and have thick platforms from

those which are short, narrow, thin and have thin platforms. Broadly repeating distinction of PC1, but from a slightly different perspective (length and platform features, more than width and thickness). It is again a combination of size and shape factors driving the variable.

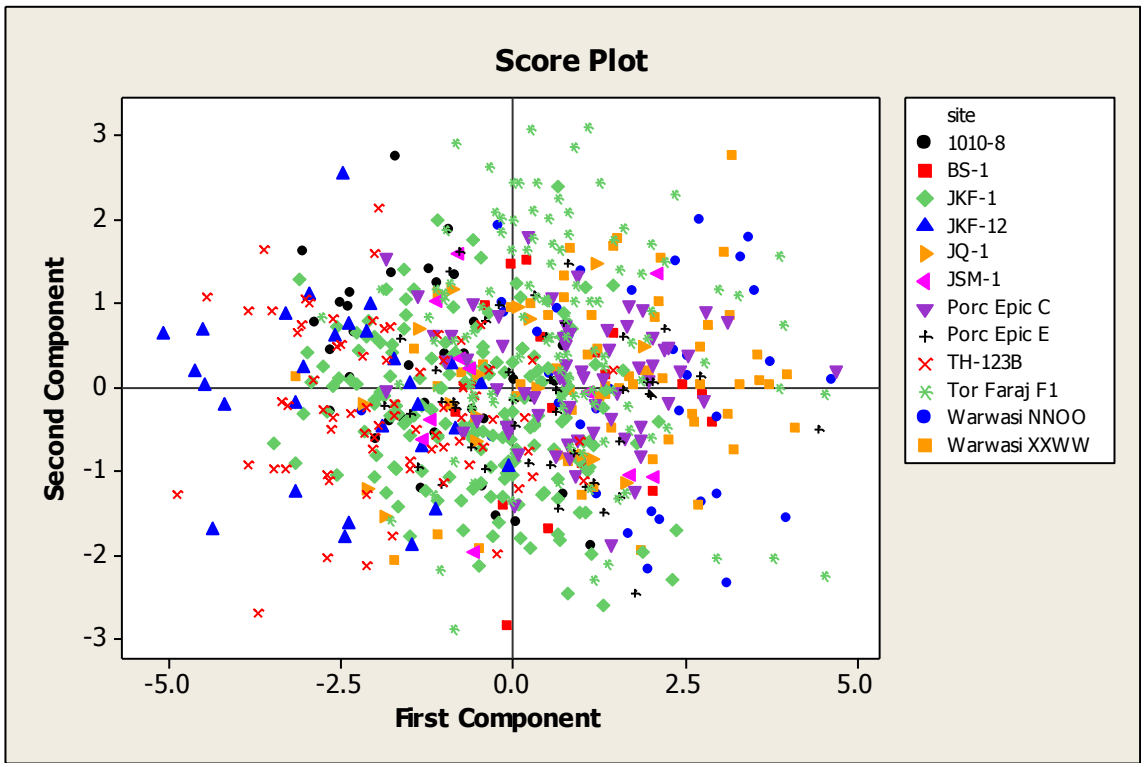


Figure 7.36. Score plot

**PC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 37 | 1.793 | A |
| Warwasi XXWW | 62 | 1.452 | A B |
| Porc Epic C | 70 | 0.924 | B C |
| Tor Faraj F1 | 122 | 0.650 | C D |
| Porc Epic E | 44 | 0.482 | C D |
| JKF-1 | 171 | -0.526 | E |
| 1010-8 | 38 | -1.112 | E F |
| TH-123B | 74 | -1.762 | F G |
| JKF-12 | 29 | -2.469 | G |

**PC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 122 | 0.547 | A |
| 1010-8 | 38 | 0.180 | A B |
| Porc Epic C | 70 | 0.108 | A B |
| Warwasi XXWW | 62 | 0.087 | A B |
| Warwasi NNOO | 37 | 0.009 | A B |
| JKF-12 | 29 | -0.116 | A B |
| Porc Epic E | 44 | -0.177 | B |
| TH-123B | 74 | -0.243 | B |
| JKF-1 | 171 | -0.310 | B |

**PC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-1 | 171 | 0.1898 | A |
| JKF-12 | 29 | 0.1298 | A B |
| 1010-8 | 38 | 0.1281 | A B |
| TH-123B | 74 | 0.0983 | A B |
| Warwasi NNOO | 37 | 0.0693 | A B |
| Warwasi XXWW | 62 | -0.0681 | A B |
| Porc Epic C | 70 | -0.1236 | A B |
| Tor Faraj F1 | 122 | -0.2493 | B |
| Porc Epic E | 44 | -0.4378 | B |

**PC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 37 | 0.0970 | A |
| TH-123B | 74 | 0.0813 | A |
| Porc Epic C | 70 | 0.0652 | A |
| JKF-1 | 171 | 0.0461 | A |
| JKF-12 | 29 | -0.0167 | A |
| Warwasi XXWW | 62 | -0.0178 | A |
| Porc Epic E | 44 | -0.0323 | A |
| 1010-8 | 38 | -0.0514 | A |
| Tor Faraj F1 | 122 | -0.1243 | A |

**PC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 37 | 0.0531 | A |
| Tor Faraj F1 | 122 | 0.0493 | A B |
| Warwasi XXWW | 62 | 0.0378 | A B |
| JKF-12 | 29 | 0.0277 | A B |
| Porc Epic E | 44 | 0.0136 | A B |
| TH-123B | 74 | 0.0111 | A B |
| Porc Epic C | 70 | 0.0097 | A B |
| JKF-1 | 171 | -0.0484 | B C |
| 1010-8 | 38 | -0.1211 | C |

Table 7.30. Tukey grouping of ANOVA

Comparing the ANOVA results (Table 7.30) to those for question 2a, we can see that those for PC1 are very similar indeed and for PC 2 and 3 they are for the most part the same. For PC1 we can simplify the complex grouping of the Tukey grouping to distinguish between sites with positive

scores, consisting of Warwasi, Porc Epic and Tor Faraj, and those with low scores, JKF-1, 1010-8, 123-b and JKF-12. The component seems be driven by a distinction between the greater laminarity of the former and dominance of wide and thick flakes in the latter.

The second component also follows a broadly similar structure to PC2 is question 2a. Tor Faraj is again distinguished by its narrow platforms, in association with long and thin blanks. The incorporation of such shape related features explains the slight difference seen in this question compared to the last, JKF-1 now scoring lowest indicating the site is characterised by typically relatively thick platforms and thicker and shorter blanks. At this point it can be emphasised that the pattern seen dose not correlate with raw material type, with both the highest and lowest scoring two sites consisting of flint and quartzite.

The third component, largely driven by blank length, again puts JKF-1 at an extreme position, indicating the important role of long and robust blanks. The lowest scores, indicating short, narrow, thin blanks with thin platforms, are found for Porc Epic E, in particular, and also Tor Faraj. The component essentially separates the Jubbah and the Nubian sites, characterised by some long and robust blanks, from Warwasi, Por Epic and Tor Faraj's gracile blanks.

**7.15.)(3) How were knappers utilising striking platforms to control blank length?**

This question uses Correspondence Analysis on all complete blanks over 20mm in length to explore the relationship between striking platform characteristics and the length and terminations of the blanks. The variables used are relative length [(platform width/platform thickness)/blank technical length], platform type and distal termination type. High scores for the first variable typically indicate blanks that are short relative to platform thickness.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (17%, 17%) | **Cortical platforms**, **short relative length** | **Dihedral platforms**, faceted platforms, **long relative length** |
| 2 (16%, 32%) | **Plain platforms**, **hinge terminations**, **step terminations**, medium relative length | **Cortical platforms**, **dihedral platforms,** feather terminations |
| 3 (14%, 47%) | **Faceted platforms**, medium relative length | **Dihedral platforms,** plain platforms, long relative length |
| 4 (14%, 61%) | **Faceted platforms**, **hinge terminations**, **long relative length** | **Medium relative length** |
| 5 (14%, 75%) | **Hinge termination** | **Medium relative length** |
| 6 (13%, 88%) | **Plain platforms,** feather terminations, **short relative length** | **Cortical platforms**, dihedral platforms, **hinge terminations**, medium relative length |
| 7 (12%, 99%) | **Dihedral platforms, short relative length** | **Cortical platforms**, **long relative length** |

Table 7.31. Loading of components for question 3.

Table 7.31 presents the combinations of variables driving each component. The fact that the variables explain broadly similar amounts of variability mean we must try and think about each of their meanings. RPC1 suggests a correlation between cortical platforms and short length relative to platform size, associated with low scores, and positive score correlate dihedral and faceted platforms with relatively longer blanks. The second component emphasises termination types, correlating plain platforms with hinge and step terminations (as well as blanks with medium relative length), and, weakly, cortical and dihedral platforms with feather terminations. RPC3 is primarily divided by the presence of faceted platforms versus dihedral platforms, with medium relative length correlating with the former, and plain platforms and long relative length with the latter. Both RPC4 and 5 contrast medium length blanks with those with aberrant terminations, in the former case hinge terminations correlating with faceted platforms and short relative length. RPC6 divides relatively short blanks with plain platforms and feather terminations from relatively medium length blanks with cortical and dihedral platforms and hinge terminations. Finally, RPC7 correlates dihedral platforms and relatively short blanks, on the other hand, and cortical platforms and relatively long blanks on the other.

Clearly, this is quite a complicated pattern of variability. And it is difficult to generalise from it. The first component can be interpreted as reflecting initial ('decortification') flakes which may be large in absolute terms, but are small in relative terms. In contrast to this is the careful use of striking platforms to produce relatively large blanks. The various combinations of platform and termination

types indicate the lack of simplistic correlations between these factors. Component 3 emphasises the use of dihedral platforms to create relatively long blanks, while RPC4 correlates faceted platforms with long blanks.

**RPC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 65 | 0.2931 | A |
| Warwasi XXWW | 111 | 0.2365 | A |
| Warwasi NNOO | 105 | 0.2304 | A |
| Tor Faraj F1 | 214 | 0.2066 | A B |
| Porc Epic E | 85 | 0.1532 | A B C |
| 1010-8 | 61 | 0.1245 | A B C |
| BS-1 | 35 | 0.1081 | A B C |
| JSM-1 | 21 | 0.0996 | A B C |
| JKF-1 | 277 | -0.0443 | C |
| JQ-1 | 31 | -0.1629 | B C D |
| TH-123B | 131 | -0.5049 | D E |
| JKF-12 | 63 | -0.6747 | E |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 63 | 0.3598 | A |
| 1010-8 | 61 | 0.2228 | A B |
| Tor Faraj F1 | 214 | 0.0516 | A B C |
| Porc Epic E | 85 | 0.0353 | A B C |
| Porc Epic C | 65 | 0.0143 | A B C |
| JSM-1 | 21 | 0.0040 | A B C |
| TH-123B | 131 | -0.0071 | B C |
| JKF-1 | 277 | -0.0245 | B C |
| Warwasi XXWW | 111 | -0.0709 | B C |
| BS-1 | 35 | -0.1305 | B C |
| Warwasi NNOO | 105 | -0.1780 | C |
| JQ-1 | 31 | -0.1799 | B C |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 65 | 0.2931 | A |
| Warwasi XXWW | 111 | 0.2365 | A |
| Warwasi NNOO | 105 | 0.2304 | A |
| Tor Faraj F1 | 214 | 0.2066 | A B |
| Porc Epic E | 85 | 0.1532 | A B C |
| 1010-8 | 61 | 0.1245 | A B C |
| BS-1 | 35 | 0.1081 | A B C |
| JSM-1 | 21 | 0.0996 | A B C |
| JKF-1 | 277 | -0.0443 | C |
| JQ-1 | 31 | -0.1629 | B C D |
| TH-123B | 131 | -0.5049 | D E |
| JKF-12 | 63 | -0.6747 | E |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 63 | 0.3598 | A |
| 1010-8 | 61 | 0.2228 | A B |
| Tor Faraj F1 | 214 | 0.0516 | A B C |
| Porc Epic E | 85 | 0.0353 | A B C |
| Porc Epic C | 65 | 0.0143 | A B C |
| JSM-1 | 21 | 0.0040 | A B C |
| TH-123B | 131 | -0.0071 | B C |
| JKF-1 | 277 | -0.0245 | B C |
| Warwasi XXWW | 111 | -0.0709 | B C |
| BS-1 | 35 | -0.1305 | B C |
| Warwasi NNOO | 105 | -0.1780 | C |
| JQ-1 | 31 | -0.1799 | B C |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 31 | 0.2464 | A |
| Porc Epic C | 65 | 0.1219 | A B |
| BS-1 | 35 | 0.1198 | A B |
| Warwasi XXWW | 111 | 0.0667 | A B |
| Tor Faraj F1 | 214 | 0.0404 | A B |
| 1010-8 | 61 | 0.0328 | A B |
| JKF-1 | 277 | -0.0087 | A B |
| JSM-1 | 21 | -0.0390 | A B |
| Warwasi NNOO | 105 | -0.0450 | A B |
| Porc Epic E | 85 | -0.0619 | A B |
| TH-123B | 131 | -0.0732 | A B |
| JKF-12 | 63 | -0.1879 | B |

**RPC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 31 | 0.1940 | A B C |
| JKF-12 | 63 | 0.1896 | A |
| Porc Epic C | 65 | 0.0728 | A B C D |
| JKF-1 | 277 | 0.0694 | A B C |
| TH-123B | 131 | 0.0270 | A B C D |
| Warwasi XXWW | 111 | -0.0276 | A B C D |
| Warwasi NNOO | 105 | -0.0491 | A B C D |
| Tor Faraj F1 | 214 | -0.0938 | C D |
| 1010-8 | 61 | -0.1042 | A B C D |
| Porc Epic E | 85 | -0.1331 | B C D |
| JSM-1 | 21 | -0.1500 | A B C D |
| BS-1 | 35 | -0.2714 | D |

**RPC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 35 | 0.3999 | A |
| JSM-1 | 21 | 0.2575 | A B C D E F |
| Warwasi NNOO | 105 | 0.2360 | A B |
| JKF-12 | 63 | 0.1290 | A B C D E F |
| Warwasi XXWW | 111 | 0.0814 | A B C D E F G |
| TH-123B | 131 | -0.0060 | F G |
| Tor Faraj F1 | 214 | -0.0071 | E F G |
| JQ-1 | 31 | -0.0159 | B C D E F G H |
| JKF-1 | 277 | -0.0785 | D E F G H |
| Porc Epic E | 85 | -0.1469 | C D E F G H |
| Porc Epic C | 65 | -0.1679 | G H |
| 1010-8 | 61 | -0.2906 | H |

Table 7.32. Tukey grouping of ANOVA results.

The ANOVA of RPC1 repeats the broadly similar arrangement we have seen several times, with 123-b and JKF-12 at one end of the variability, indicating the presence of cortical platforms and relatively long flakes, and the other end the heavily reduced assemblages which correlate with prepared platforms and relatively longer blanks. Here it seems that at Porc Epic, Tor Faraj and Warwasi the knappers were using dihedral and faceted platforms to create relatively longer blanks. This pattern is not repeated for RPC2. Here the sites with high scores, particularly JKF-12 and 1010-8 are characterised by cortical and dihedral platforms and feather terminations. JKF-1, the Warwasi assemblages, BS-1 and JQ-1 assemblages have low scores driven by the presence of plain platforms on medium length blanks and an association with aberrant terminations. We might see the sites with high scores as demonstrating large, successful removals, and those with low scores as

having an emphasis on plain platforms, associated with shorter blanks and higher levels of aberrant terminations. This could be seen as a measure of reduction intensity.

For RPC3 we see an identical structure to RPC1, although it is driven by different variables. Here the primary division is between sites with high scores – the Porc Epic and Warwasi Assemblages and Tor Faraj – with high levels of dihedral platforms, and those lacking dihedral platforms. Here Tor Faraj, the Warwasi assemblages and Porc Epic C are characterised by blanks with a high relative length and high number of dihedral platforms. In contrast are the Jubbah sites and 123-b. These sites feature faceting, but the component suggests that this faceting is not correlated with long relative length, whereas the dihedral platforms on the former sites are associated with relative greater length. Combined with RPC1, this suggests that at Porc Epic, Tor Faraj and Warwasi knappers were able to produce relatively long blanks by the use of dihedral and faceted platforms. The same was not applied at the Jubbah sites, perhaps indicating that because there was not a stress on heavy reduction and raw materials were locally available, there was less effort to maximise length.

With RPC4 we likewise see a correlation of faceting and relatively long blanks. In this case the situation is rather different to that just described for RPC3. The Tukey grouping suggested rather overlapped groups, but here faceted platforms are associated with relatively long blanks at JQ-1 and Warwasi, in particular. This is not a very strong correlation, however.

### 7.16)(4) How were knappers utilising platforms to control blank width?

This question is the same as number 3, but rather than relative blank length, it uses relative blank width (platform flattening/blank width). The other variables are the same as in question 3.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (18%, 18%) | Large relative width, **dihedral platforms**, faceted platforms | **Small relative widths, cortical platforms** |
| 2 (15%, 33%) | **Plain platforms, hinge terminations, step terminations** | **Cortical platforms**, **dihedral platforms**, feather terminations |
| 3 (15%, 48%) | **Large relative width, faceted platforms.** | **Medium relative width, step terminations** |
| 4 (14%, 62%) | Small relative width, **dihedral platforms**, plain platforms | **Faceted platforms**, **step terminations** |
| 5 (14%, 76%) | **Small relative width** | Medium plat size/width, **hinge terminations** |
| 6 (13%, 88%) | **Plain platforms, feather terminations** | **Small relative width, cortical platforms, hinge terminations** |
| 7 (11%, 99%) | **Large relative width** | Medium relative width, cortical platforms. |

Table 7.33. Loading of components.

Interpretation and description will here focus on the relationship between platform characteristics and relative width. The first components suggest a correlation between dihedral, in particular, and faceted platforms and relatively large widths. In contrast, cortical platforms strongly correlate with relatively small widths. The correlation of relatively large widths and faceted platforms is repeated for RPC3. Finally, for now, RPC7 contrasts large relative widths to the correlation of medium relative width and cortical platforms. As with the previous question, Table 7.33 reveals a rather complex structure but there is clearly a correlation between platform preparation in the form of shaping faceted and dihedral platforms, and relatively wide blanks.

Table 7.34 shows the Tukey grouping of the ANOVA's for each component. The first component can be divided into four groups, although with quite a lot of overlap. JKF-12 and 123-b have high scores, indicating that blanks here typically have typically small relative widths, and cortical platforms are present. In contrast Warwasi, Porc Epic and Tor Faraj demonstrate a clear use of dihedral and faceted platforms to produce relatively wide blanks. The other assemblages fall inbetween, but as was the case in the previous question a basic distinction can be drawn between Warwasi, Porc Epic and Tor Faraj and the Arabian and Nubian sites, at the latter there seems to have been less focus on using striking platforms to control width.

**RPC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 63 | 0.8128 | A |
| TH-123B | 131 | 0.6142 | A |
| JQ-1 | 31 | 0.1037 | B |
| JKF-1 | 277 | 0.0983 | B |
| JSM-1 | 21 | 0.0073 | B C |
| 1010-8 | 61 | -0.0847 | B C |
| BS-1 | 35 | -0.1050 | B C D |
| Warwasi NNOO | 105 | -0.2470 | B C D |
| Porc Epic E | 85 | -0.2761 | C D |
| Warwasi XXWW | 111 | -0.3007 | C D |
| Tor Faraj F1 | 214 | -0.3248 | C D |
| Porc Epic C | 65 | -0.4479 | D |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 63 | 0.4094 | A |
| 1010-8 | 61 | 0.2115 | A B |
| JKF-1 | 277 | 0.0443 | B C |
| Porc Epic C | 65 | 0.0420 | B C |
| Porc Epic E | 85 | 0.0394 | B C |
| JSM-1 | 21 | 0.0349 | A B C D |
| Tor Faraj F1 | 214 | 0.0156 | B C D |
| TH-123B | 131 | -0.0044 | B C D |
| JQ-1 | 31 | -0.1273 | B C D |
| Warwasi XXWW | 111 | -0.1344 | C D |
| BS-1 | 35 | -0.1516 | B C D |
| Warwasi NNOO | 105 | -0.3156 | D |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-1 | 277 | 0.2550 | A |
| JSM-1 | 21 | 0.1504 | A B |
| BS-1 | 35 | 0.0609 | A B |
| JQ-1 | 31 | -0.0150 | A B |
| Porc Epic E | 85 | -0.0588 | B |
| TH-123B | 131 | -0.0683 | B |
| 1010-8 | 61 | -0.0748 | B |
| Tor Faraj F1 | 214 | -0.1003 | B |
| Warwasi NNOO | 105 | -0.1237 | B |
| JKF-12 | 63 | -0.1464 | B |
| Warwasi XXWW | 111 | -0.1476 | B |
| Porc Epic C | 65 | -0.1523 | B |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 85 | 0.2241 | A |
| JKF-12 | 63 | 0.1709 | A B |
| 1010-8 | 61 | 0.0980 | A B C |
| TH-123B | 131 | 0.0877 | A B C |
| Porc Epic C | 65 | 0.0623 | A B C |
| Tor Faraj F1 | 214 | 0.0428 | A B C |
| JQ-1 | 31 | -0.0350 | A B C |
| JSM-1 | 21 | -0.0404 | A B C |
| Warwasi XXWW | 111 | -0.0713 | B C |
| JKF-1 | 277 | -0.0748 | B C |
| Warwasi NNOO | 105 | -0.1586 | C |
| BS-1 | 35 | -0.2283 | C |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 31 | 0.3207 | A |
| 1010-8 | 61 | 0.0971 | A B |
| Porc Epic C | 65 | 0.0658 | A B |
| Tor Faraj F1 | 214 | 0.0517 | A B |
| Porc Epic E | 85 | 0.0261 | A B |
| JKF-1 | 277 | 0.0082 | A B |
| TH-123B | 131 | 0.0005 | A B |
| Warwasi XXWW | 111 | -0.0265 | A B |
| JSM-1 | 21 | -0.0976 | A B |
| BS-1 | 35 | -0.1118 | A B |
| Warwasi NNOO | 105 | -0.1357 | B |
| JKF-12 | 63 | -0.1359 | B |

**RPC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 63 | 0.1470 | A |
| Warwasi NNOO | 105 | 0.1072 | A |
| Porc Epic C | 65 | 0.0437 | A B |
| JKF-1 | 277 | 0.0396 | A B |
| Warwasi XXWW | 111 | 0.0219 | A B |
| TH-123B | 131 | 0.0202 | A B |
| JQ-1 | 31 | 0.0197 | A B |
| Tor Faraj F1 | 214 | -0.0866 | A B |
| 1010-8 | 61 | -0.0879 | A B |
| Porc Epic E | 85 | -0.1359 | A B |
| JSM-1 | 21 | -0.1966 | A B |
| BS-1 | 35 | -0.3027 | B |

**RPC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 35 | 0.3157 | A |
| Warwasi NNOO | 105 | 0.2474 | A |
| Warwasi XXWW | 111 | 0.1401 | A B |
| JSM-1 | 21 | 0.1013 | A B C |
| JQ-1 | 31 | 0.0850 | A B C |
| Tor Faraj F1 | 214 | 0.0683 | A B C |
| JKF-12 | 63 | 0.0333 | A B C |
| Porc Epic C | 65 | 0.0137 | A B C |
| Porc Epic E | 85 | -0.0670 | B C |
| JKF-1 | 277 | -0.0935 | C |
| TH-123B | 131 | -0.1179 | C |
| 1010-8 | 61 | -0.3801 | D |

Table 7.34. Tukey grouping of ANOVA results

For RPC3 the Tukey method groups JKF-1, JSM-1, BS-1 and JQ-1 together as being characterised by smaller relative widths than the other sites, correlating with step terminations. The other sites have quite close clustering, but Tor Faraj, Warwasi, JKF-12 and Porc Epic C are the assemblages with the lowest scores, indicating a correlation between faceted platforms and relatively wide blanks.

RPC 7 provides a final insight into relative width. Here 1010-8 forms its own group suggesting large relative widths, but this does not correlate with particular platform features. 123-b and JKF-1 also have fairly low scores. Most sites cluster around the midpoint, while Warwasi NNOO and BS-1 have high scores, indicating blanks with medium relative width correlating with cortical platforms. On the whole comparing the results for questions 3 and 4 reveals many similarities. Knappers were utilising dihedral and platform faceted platforms to obtain relatively long and wide blanks

### (17).(5a) How do characteristics of platforms and dorsal surfaces relate?

This question uses Correspondence Analysis to explore the relationship between the striking platform and the dorsal surface. It includes all complete blanks over 20mm and the variables used are platform flattening (platform width/platform thickness), platform type, dorsal scar pattern and blank elongation (length/width).

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (13%, 13%) | Relatively thick platforms, **plain platforms** | **Relatively thin platforms, faceted platforms, from proximal convergent scar patterns** |
| 2 (11%, 24%) | **Relatively thick platforms, narrow blank** | **Wide blanks, cortical platforms, combination scar patterns** |
| 3 (10%, 34%) | **Relatively thick platforms**, **cortical platforms** | **Medium relative thickness platforms, radial scar patterns** |
| 4 (10%, 44%) | **Cortical platforms**, combination scar patterns | **Dihedral platforms**, **from proximal scar patterns** |
| 5 (9%, 53%) | **Narrow blanks, from proximal scar patterns** | **Moderately broad blanks**, **radial scar patterns** |
| 6 (9%, 62%) | **Thick platforms**, from proximal scar patterns | **Dihedral platforms, bidirectional scar patterns** |
| 7 (9%, 70%) | **Moderately relatively thin platforms**, moderately wide blanks | **Relatively thick platforms,** wide blanks**, bidirectional scar patterns, radial scar patterns** |
| 8 (8%, 79%) | **Moderately relatively thin platforms,** from proximal scar patterns | **Relatively thick platforms, combination scar patterns** |
| 9 (7%, 86%) | **Wide blanks**, plain platforms | **Narrow blanks, dihedral platforms, radial scar patterns** |
| 10 (7%, 93%) | **Wide blanks, from proximal convergent scar patterns** | Moderately narrow blanks, **faceted platforms** |
| 11 (6%, 99%) | **Relatively thin platforms, plain platforms** | **Relatively thick platforms, faceted platforms** |

Table 7.35. Loading of components.

There is again a complicated structure, and space prevents a thorough discussion of all 11 components and how these vary across all sites. The first component is most strongly divided by, on the one hand, faceted platforms (the strongest driver), thin platforms and from proximal convergent scar patterns, and, on the other, plain platforms which weakly correlates with thick platforms. This suggests a separation between triangular Levallois flakes (Levallois points) with carefully prepared platforms, and other blanks.

For RPC2 we see a distinction between wide blanks with cortical platforms and combination scar patterns and, secondly, narrow blanks with thick platforms. The former relates to removals early in reduction, and while it is not obvious how the latter relates to this, and is in any case a very weak correlation, so we can interpret this component broadly in terms of reduction intensity.

RPC3 can likewise be interpreted as being structured in terms of reduction intensity, contrasting thick blanks with cortical platforms to radial scar patterns and platforms of medium thickness.

RPC4 also follows this pattern, repeating the combination of cortical platforms and combination scar patterns. Against this is a very strong contribution from dihedral platforms, which correlate with from proximal scar patterns. This apparently repeated contrast between early and more reduced shows itself in various guises, and demonstrates the different ways in which increasing reduction can be manifested.

For RPC5 the perspective moves from the previous components, where for each of the components explaining the first 44% of variability a platform related variability was a major factor in driving variability, to one associating blank shape and scar pattern, with narrow blanks correlating with from proximal scar patterns, and broader blanks with radial scar patterns. For all subsequent components platform attributes are involved.

RPC6 suggests a correlation between, on the one hand, thick platforms and from proximal scar patterns, perhaps suggesting earlier stage reduction, and, on the other hand, dihedral platforms and bidirectional scar patterns, perhaps suggesting both a more advanced stage of reduction and a specific approach to platform preparation for blanks whose dorsal surface was prepared in this way.

From RPC7 things become in a sense confusing, but looking at the major drivers will demonstrate important patterns, while some apparent correlations be coincidental. For RPC7 the major distinction is between moderately thin platforms and blanks with bidirectional scar patterns, the latter being associated with thick platforms. This can again be taken as a reduction intensity indicator.

Finally, RPC8 again combines combination scar patterns and thick platforms, indicating an early stage of reduction, with thin blanks, with a weak contribution from blanks with from proximal scar patterns, which can be taken as typical of the 'middle' of a reduction cycle. Subsequent variables demonstrate strange combinations which do not seem to be behaviourally significant, and seem to merely be clustering the remaining data which has not been explained by the previous variables.

Drawing out some particular threads from this mass of correlations it is possible to repeatedly contrast less reduced material with more reduced. The latter, however, shows itself in a variety of forms, each also correlating with a different form of striking platform. So for RPC1 we find a correlation of thin and faceted platforms with from proximal convergent scar patterns. For RPC3 platforms of medium thickness correlate with radial scar patterns, while for RPC4 dihedral platforms correlate with from proximal scar patterns. Taking these three components we might hypothesise a focus on three different forms of Levallois, firstly unidirectional-convergent, secondly centripetal and thirdly unidirectional. Each can be contrasted to less reduced material, but each also represents in some sense a distinctive approach to reduction.

**RPC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 232 | 0.4223 | A |
| 1010-8 | 64 | 0.2285 | A B |
| Porc Epic C | 68 | 0.2049 | A B |
| Porc Epic E | 81 | 0.0285 | B C |
| Warwasi XXWW | 99 | -0.0259 | B C |
| JKF-12 | 45 | -0.0919 | B C |
| JQ-1 | 32 | -0.1151 | B C |
| JKF-1 | 245 | -0.1336 | C |
| Warwasi NNOO | 92 | -0.1348 | C |
| BS-1 | 30 | -0.2145 | C |
| TH-123B | 113 | -0.2276 | C |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 45 | 0.4276 | A |
| TH-123B | 113 | 0.1755 | A |
| 1010-8 | 64 | 0.1714 | A B |
| JKF-1 | 245 | 0.1430 | A B |
| JQ-1 | 32 | 0.1193 | A B C |
| BS-1 | 30 | 0.0123 | A B C |
| Porc Epic C | 68 | -0.1207 | B C |
| Warwasi XXWW | 99 | -0.1360 | C |
| Porc Epic E | 81 | -0.1807 | C |
| Warwasi NNOO | 92 | -0.1882 | C |
| Tor Faraj F1 | 232 | -0.2224 | C |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 64 | 0.3121 | A |
| Porc Epic C | 68 | 0.2234 | A B |
| Porc Epic E | 81 | 0.1872 | A B |
| BS-1 | 30 | 0.1288 | A B C |
| JQ-1 | 32 | 0.0982 | A B C |
| Warwasi XXWW | 99 | 0.0105 | B C |
| TH-123B | 113 | -0.0106 | B C |
| Warwasi NNOO | 92 | -0.0771 | B C D |
| JKF-1 | 245 | -0.1050 | B C D |
| Tor Faraj F1 | 232 | -0.1458 | C D |
| JKF-12 | 45 | -0.3312 | D |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 30 | 0.2572 | A |
| Warwasi NNOO | 92 | 0.1258 | A |
| Porc Epic C | 68 | 0.0983 | A |
| JQ-1 | 32 | 0.0816 | A B |
| Warwasi XXWW | 99 | 0.0432 | A B |
| JKF-1 | 245 | 0.0363 | A B |
| Tor Faraj F1 | 232 | 0.0026 | A B C |
| Porc Epic E | 81 | -0.0139 | A B C |
| 1010-8 | 64 | -0.0218 | A B C |
| TH-123B | 113 | -0.2398 | B C |
| JKF-12 | 45 | -0.3670 | C |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 30 | 0.1573 | A B |
| JQ-1 | 32 | 0.1299 | A B |
| Porc Epic E | 81 | 0.1114 | A B |
| JKF-12 | 45 | 0.0940 | A B |
| TH-123B | 113 | 0.0740 | A B |
| 1010-8 | 64 | 0.0686 | A B |
| Porc Epic C | 68 | 0.0243 | A B |
| JKF-1 | 245 | -0.0070 | A B |
| Warwasi NNOO | 92 | -0.0529 | A B |
| Tor Faraj F1 | 232 | -0.1465 | B |
| Warwasi XXWW | 99 | -0.1507 | B |

**RPC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi XXWW | 99 | 0.1274 | A |
| JKF-1 | 245 | 0.1086 | A |
| 1010-8 | 64 | 0.0450 | A |
| JKF-12 | 45 | -0.0211 | A |
| Warwasi NNOO | 92 | -0.0378 | A |
| Tor Faraj F1 | 232 | -0.0557 | A |
| BS-1 | 30 | -0.0578 | A |
| TH-123B | 113 | -0.0750 | A |
| Porc Epic C | 68 | -0.0801 | A |
| Porc Epic E | 81 | -0.1058 | A |
| JQ-1 | 32 | -0.1119 | A |

**RPC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 64 | 0.2099 | A |
| Porc Epic E | 81 | 0.1288 | A B |
| JQ-1 | 32 | 0.1015 | A B |
| Warwasi NNOO | 92 | 0.0629 | A B |
| Warwasi XXWW | 99 | 0.0531 | A B |
| Porc Epic C | 68 | 0.0298 | A B |
| TH-123B | 113 | 0.0276 | A B |
| JKF-12 | 45 | -0.0462 | A B |
| JKF-1 | 245 | -0.0926 | B |
| Tor Faraj F1 | 232 | -0.1148 | B |
| BS-1 | 30 | -0.1800 | B |

**RCP8:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 64 | 0.1211 | A |
| JKF-1 | 245 | 0.0937 | A |
| JQ-1 | 32 | 0.0152 | A B |
| TH-123B | 113 | -0.0008 | A B |
| Porc Epic E | 81 | -0.0061 | A B |
| BS-1 | 30 | -0.0280 | A B |
| Warwasi NNOO | 92 | -0.0351 | A B |
| Tor Faraj F1 | 232 | -0.0688 | A B |
| Porc Epic C | 68 | -0.0832 | A B |
| JKF-12 | 45 | -0.1304 | A B |
| Warwasi XXWW | 99 | -0.1349 | B |

**RPC9:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 68 | 0.2705 | A |
| Porc Epic E | 81 | 0.1391 | A B |
| 1010-8 | 64 | 0.1225 | A B C |
| TH-123B | 113 | 0.0251 | B C D |
| JQ-1 | 32 | 0.0247 | A B C D |
| JKF-12 | 45 | -0.0031 | A B C D |
| JKF-1 | 245 | -0.0171 | B C D |
| Warwasi XXWW | 99 | -0.0798 | B C D |
| Tor Faraj F1 | 232 | -0.0850 | C D |
| Warwasi NNOO | 92 | -0.1346 | D |
| BS-1 | 30 | -0.2214 | D |

**RPC10:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi XXWW | 99 | 0.1637 | A |
| 1010-8 | 64 | 0.0789 | A B |
| Warwasi NNOO | 92 | 0.0706 | A B |
| Porc Epic E | 81 | 0.0338 | A B |
| TH-123B | 113 | 0.0298 | A B |
| Porc Epic C | 68 | 0.0054 | A B |
| BS-1 | 30 | -0.0122 | A B |
| JKF-12 | 45 | -0.0172 | A B |
| Tor Faraj F1 | 232 | -0.0698 | B |
| JKF-1 | 245 | -0.0868 | B |
| JQ-1 | 32 | -0.1044 | A B |

**RPC11:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 81 | 0.0834 | A B |
| JKF-1 | 245 | 0.0813 | A |
| Porc Epic C | 68 | 0.0433 | A B |
| 1010-8 | 64 | 0.0381 | A B |
| JQ-1 | 32 | -0.0135 | A B |
| Tor Faraj F1 | 232 | -0.0142 | A B |
| Warwasi XXWW | 99 | -0.0281 | A B |
| JKF-12 | 45 | -0.0683 | A B |
| TH-123B | 113 | -0.0734 | B |
| Warwasi NNOO | 92 | -0.0747 | A B |
| BS-1 | 30 | -0.1415 | A B |

Table 7.36. Tukey grouping of ANOVA results for question 5a.

The first component most strongly separates Tor Faraj, which is understandable given the focus on the clear focus on unidirectional-convergent blanks with thin and faceted platforms. The other sites with high scores, particularly Porc Epic C, primarily reflects a prevalence of faceting. JKF-1,

Warwasi NNOO, BS-1 and 123-b have low scores, primarily driven by their dominance of plain platforms, which are typically rather thick platforms.

The second component repeats the familiar distinction between highly reduced (Porc Epic, Warwasi and Tor Faraj) and more primary sites (JKF-12 and TH-123b in particular, 1010-8 and JKF-1 somewhat less). In the case of the present question the analysis clearly correlates cortical platforms and combination scar patterns as attributes associated with the latter. This can be taken as a coarse indication of reduction.

RPC3 divides into several groups. At one pole we find 1010-8, Porc Epic and BS-1. This is driven by a correlation of striking platforms of a medium thickness and radial scar patterns. In contrast Warawsi NNOO, JKF-1, Tor Faraj and JKF-12 lack the focus on radial scar patterns, and there is tendency to thicker platforms, some of which are cortical.

The ANOVA results for RPC 4 are quite evenly spread and the groups defined by the Tukey method overlap considerably. Tor Faraj, Porc Epic E, 1010-8, 123-b and JKF-12 have low mean scores, suggesting the presence of some early stage debitage while other sites, particularly Warwasi NNOO and BS-1 have high scores suggesting an important role for blanks with from proximal scar patterns and dihedral platforms. The reader can refer themselves to Table 7.36 to see the structure of subsequent RPC's. There are clearly a variety of combinations at play and the fact that no component explains more than 13% of the variability highlights the complexity of the situation. As the above components indicate, there is some correlation between particular scar patterns forms of platforms, but as subsequent components show, such relationships are complex and varied.

### 7.18) (5b) How do features reflecting the character of striking platform and dorsal surfaces relate on Levallois blanks?

This repeats 5a but only includes broadly Levallois blanks. The only difference is that this time radial and strongly radial are retained as separate categories, whereas in the previous one they were combined.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (12%, 12%) | **From proximal convergent scar patterns, faceted platforms, relatively thin platforms** | **Plain platforms, relatively thick platforms, narrow blanks** |
| 2 (10%, 22%) | **Plain platforms, relatively thin platforms, elongate flakes** | **From proximal scar patterns, dihedral platforms, relatively thick platforms** |
| 3 (9%, 31%) | **Relatively thick platforms** | **Weakly radial scar patterns** |
| 4 (9%, 40%) | From proximal scar patterns**, strongly radial scar pattern**, **medium relatively thickness platforms**, **elongate blanks** | **Combination scar patterns,** weakly radial scar patterns, **relatively thick platforms, wide blanks** |
| 5 (8%, 48%) | Combination scar patterns, **strongly radial scar patterns, wide blanks** | **From proximal scar patterns, moderately wide blanks** |
| 6 (8%, 56%) | **Bidirectional scar patterns** | **Combination scar patterns, strongly radial scar patterns** |
| 7 (7%, 64%) | **Bidirectional scar patterns, wide blanks** | **Dihedral platforms, thin platforms** |
| 8 (7%, 71%) | **Combination scar patterns, thick platforms** | **Weakly radial scar patterns,** faceted platforms |
| 9 (7%, 78%) | **Strongly radial scar patterns, dihedral platforms, moderately thin platforms** | **Combination scar patterns**, **medium thickness platform** |
| 10 (7%, 84%) | Moderately thin platforms, **moderately narrow blanks** | **Strongly radial scar patterns, elongate blanks** |
| 11 (6%, 90%) | **From proximal scar patterns** | **Weakly radial scar patterns, dihedral platforms** |

Table 7.37. Loading of components.

On the whole, the variation in this sample mirrors that of the complete blank population addressed in 5a. In this case the first component explains an even smaller proportion of the variation. Components 2 and 4 are somewhat different than previously. For RPC2 low scores correlate thin and plain platforms with elongated blanks, in contrast to thick and dihedral platforms on blanks with from proximal scar patterns. For RPC4 the distinction is between platforms of medium flattening correlating with strongly radial scar patterns and elongate blanks, on the one hand, and, on the other hand, a most strongly combination scar patterns, relatively thick platforms and wide blanks. The latter may be interpreted as representing early stage reduction.

RPC1 again demonstrates the extreme differentiation of Tor Faraj from the other sites, for the same reasons as in the previous question. In several cases, such as for RPC 2, 5, and 7 the ANOVA scores are quite tightly clustered so the Tukey Method does not generate any groupings. RPC3

groups 1010-8, JQ-1 and Porc Epic as being characterised by a prevalence of weakly radial scar patterns, in contrast to a greater focus on thick platforms at the other sites.

**RPC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 20 | 0.3356 | A |
| JKF-12 | 20 | 0.2776 | A |
| 1010-8 | 46 | 0.1713 | A |
| Warwasi XXWW | 52 | 0.1404 | A |
| JKF-1 | 86 | 0.1397 | A |
| Warwasi NNOO | 36 | 0.0727 | A |
| Porc Epic E | 29 | -0.0458 | A |
| Porc Epic C | 28 | -0.0617 | A |
| Tor Faraj F1 | 63 | -0.7303 | B |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 46 | 0.1095 | A |
| Warwasi NNOO | 36 | 0.0965 | A |
| Warwasi XXWW | 52 | 0.0779 | A |
| Porc Epic C | 28 | 0.0758 | A |
| JKF-12 | 20 | 0.0051 | A |
| JQ-1 | 20 | 0.0005 | A |
| Tor Faraj F1 | 63 | -0.0571 | A |
| JKF-1 | 86 | -0.0745 | A |
| Porc Epic E | 29 | -0.0922 | A |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 46 | 0.3186 | A |
| JQ-1 | 20 | 0.1521 | A B |
| Porc Epic E | 29 | 0.0538 | A B C |
| Warwasi NNOO | 36 | -0.0077 | B C |
| JKF-1 | 86 | -0.0513 | C |
| Porc Epic C | 28 | -0.0580 | B C |
| JKF-12 | 20 | -0.0785 | B C |
| Tor Faraj F1 | 63 | -0.0849 | C |
| Warwasi XXWW | 52 | -0.2429 | C |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 20 | 0.2603 | A B |
| 1010-8 | 46 | 0.2085 | A |
| JKF-1 | 86 | 0.1347 | A B |
| Tor Faraj F1 | 63 | 0.1006 | A B C |
| JQ-1 | 20 | 0.0955 | A B C D |
| Warwasi XXWW | 52 | -0.0813 | A B C D |
| Porc Epic E | 29 | -0.2182 | B C D |
| Porc Epic C | 28 | -0.2621 | C D |
| Warwasi NNOO | 36 | -0.3119 | D |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 63 | 0.1449 | A |
| Warwasi NNOO | 36 | 0.1445 | A |
| JKF-12 | 20 | 0.0141 | A |
| Warwasi XXWW | 52 | 0.0096 | A |
| JQ-1 | 20 | -0.0120 | A |
| Porc Epic E | 29 | -0.0754 | A |
| Porc Epic C | 28 | -0.0852 | A |
| 1010-8 | 46 | -0.1078 | A |
| JKF-1 | 86 | -0.1306 | A |

**RPC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 20 | 0.1653 | A B C |
| JKF-1 | 86 | 0.1453 | A |
| Porc Epic C | 28 | 0.1375 | A B C |
| Porc Epic E | 29 | 0.0458 | A B C |
| Tor Faraj F1 | 63 | 0.0307 | A B C |
| JQ-1 | 20 | 0.0173 | A B C |
| 1010-8 | 46 | -0.0837 | A B C |
| Warwasi NNOO | 36 | -0.1642 | A B C |
| Warwasi XXWW | 52 | -0.1925 | C |

**RPC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 63 | 0.1633 | A |
| Porc Epic C | 28 | 0.0281 | A |
| Warwasi XXWW | 52 | -0.0128 | A |
| JKF-1 | 86 | -0.0233 | A |
| Warwasi NNOO | 36 | -0.0242 | A |
| 1010-8 | 46 | -0.0291 | A |
| JQ-1 | 20 | -0.0382 | A |
| JKF-12 | 20 | -0.0677 | A |
| Porc Epic E | 29 | -0.1391 | A |

**RPC8:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 29 | 0.2528 | A |
| Porc Epic C | 28 | 0.1910 | A |
| 1010-8 | 46 | 0.1890 | A |
| JQ-1 | 20 | 0.1521 | A B |
| Warwasi XXWW | 52 | 0.0000 | A B |
| Tor Faraj F1 | 63 | -0.0825 | A B |
| Warwasi NNOO | 36 | -0.0984 | A B |
| JKF-12 | 20 | -0.1492 | A B |
| JKF-1 | 86 | -0.1805 | B |

**RPC9:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 20 | 0.2110 | A |
| Warwasi NNOO | 36 | 0.0875 | A |
| JKF-1 | 86 | 0.0336 | A |
| Tor Faraj F1 | 63 | 0.0259 | A |
| Warwasi XXWW | 52 | -0.0175 | A |
| Porc Epic E | 29 | -0.0308 | A |
| JQ-1 | 20 | -0.0636 | A |
| 1010-8 | 46 | -0.1079 | A |
| Porc Epic C | 28 | -0.1580 | A |

**RPC10:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 29 | 0.1163 | A |
| 1010-8 | 46 | 0.0478 | A |
| Tor Faraj F1 | 63 | 0.0443 | A |
| Warwasi XXWW | 52 | 0.0436 | A |
| Porc Epic C | 28 | 0.0428 | A |
| JQ-1 | 20 | 0.0245 | A |
| JKF-12 | 20 | -0.0058 | A |
| JKF-1 | 86 | -0.0933 | A |
| Warwasi NNOO | 36 | -0.1801 | A |

**RPC11:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 46 | 0.1243 | A |
| Porc Epic C | 28 | 0.1148 | A |
| JQ-1 | 20 | 0.0748 | A |
| JKF-1 | 86 | 0.0399 | A |
| Porc Epic E | 29 | 0.0290 | A |
| Tor Faraj F1 | 63 | -0.0729 | A |
| Warwasi NNOO | 36 | -0.0849 | A |
| Warwasi XXWW | 52 | -0.0869 | A |
| JKF-12 | 20 | -0.1437 | A |

Table 7.38. Tukey grouping of ANOVA results.

## 7.19) (6) How did the shaping of the dorsal surface of blanks change with core shape?

A key topic of interest relates to the character of the dorsal surface, most strongly expressed by the dorsal scar pattern, and the extent to which this reflects reduction-intensity related factors. To explore this a correspondence analysis was conducted for complete blanks. The variables used are number of scars over 5mm, dorsal scar pattern (bidirectional, two directions, from left, from right, from proximal, from proximal convergent, radial) and elongation (length/width). This is based on the supposition that the shape of blanks will at least broadly reflect the shape of the core. This idea is supported because this analysis only addresses broadly-Levallois like blanks (i.e. 'Levallois' and 'Indeterminate', with definitely 'non-Levallois' excluded). These blanks are likely to reflect the shape of the debitage surface, and hence of the core.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (18%, 18%) | **From proximal scar patterns,** medium number of scars | **Radial scar patterns**, **Large number of scars** |
| 2 (17%, 34%) | **From proximal scar patterns, wide blanks, low number of scars** | **From proximal convergent scar patterns,** medium number of scars |
| 3 (13%, 48%) | **Bidirectional scar patterns, narrow blanks** | From proximal convergent scar patterns, **medium narrow blanks** |
| 4 (13%, 60%) | **Two directions scar patterns, narrow blanks** | **Radial scar patterns**, medium number of scars |
| 5 (12%, 72%) | **Narrow blanks** | **Bidirectional scar patterns, two directions scar patterns,** medium numbers of scars |
| 6 (11%, 83%) | **Wide blanks, medium number of scars** | **Bidirectional scar patterns, medium narrow blanks, low number of scars** |
| 7 (9%, 93%) | **From proximal scar patterns** | **From proximal convergent scar patterns, wide blanks, low numbers of scars** |
| 8 (7%, 99%) | **Radial scar patterns** | **Large numbers of scars** |

Table 7.39. Loading of components.

RPC1 is primarily driven by a strong distinction between from proximal (or 'unidirectional') and radial scar patterns. This correlates with a greater number of scars for the latter. Here we have the issue that it is difficult to distinguish between the hypothesis that this differentiation reflects reduction intensity or, rather, that it reflects a particular reduction strategy.

For the second component we once again find a distinction between scar patterns, but here there is also a shape differentiation, with from proximal scar patterns correlating with wide blanks. Here then we do see evidence for the changing shape of the core correlating with a particular scar patterns, here narrowing of the core is associated with from proximal convergent scar patterns.

For RPC3 there is no longer a strong distinction based on the number of scars. In general, both bidirectional and from proximal convergent scar patterns are based on a broadly medium number of scars. So here the structure reflects a difference in blank, and hence core, shape. On the one hand are from proximal convergent scar patterns on moderately broad blanks, while on the other are bidirectional scar patterns on narrow blanks. This is understandable relationship as whereas bidirectional cores are typically narrow, those with convergent scar patterns are typically wide at one end. A broadly similar picture in relation to bidirectional cores is found with RPC6.

RPC4 contrasts blanks with 'two directions' scar patterns, which correlate with elongate blanks, and radial scar patterns, which correlate with a medium number of scars. 'Two direction' scar patterns are characteristic of the early stages of reduction, so here the structure implies a distinction between

early cores which are more elongate and later cores, and resultant blanks, where there is a move towards a centripetal scar pattern which is associated with a change to a less elongate structure as reduction proceeds.

For RPC5, the implications are not particularly clear. The structure may broadly imply a distinction between a tendency to laminarity (-), perhaps reflecting deliberate blade production, versus an early stage of reduction (+).

RPC7 contrasts from proximal and from proximal convergent scar patterns, the latter associating with relatively wide blanks. This may suggest a distinction between more unidirectional Levallois and convergent methods.

**RPC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 51 | 0.4294 | A |
| JQ-1 | 21 | 0.2199 | A B |
| JKF-12 | 23 | 0.1526 | A B C |
| JKF-1 | 95 | 0.1356 | A B C |
| Porc Epic E | 34 | 0.0651 | A B C |
| Porc Epic C | 35 | 0.0071 | A B C |
| Warwasi XXWW | 58 | -0.2095 | B C |
| Tor Faraj F1 | 79 | -0.3208 | C |
| Warwasi NNOO | 40 | -0.3522 | C |

**RPC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 79 | 0.2949 | A |
| Porc Epic E | 34 | 0.1683 | A B |
| Porc Epic C | 35 | 0.1382 | A B |
| Warwasi NNOO | 40 | -0.0503 | A B |
| JKF-1 | 95 | -0.0738 | B |
| 1010-8 | 51 | -0.0948 | B |
| Warwasi XXWW | 58 | -0.0981 | B |
| JQ-1 | 21 | -0.2149 | A B |
| JKF-12 | 23 | -0.2601 | B |

**RPC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 79 | 0.1589 | A |
| JKF-1 | 95 | 0.1321 | A |
| Warwasi NNOO | 40 | 0.1235 | A |
| Porc Epic C | 35 | 0.0631 | A B |
| JQ-1 | 21 | 0.0533 | A B |
| JKF-12 | 23 | -0.0584 | A B |
| Porc Epic E | 34 | -0.1089 | A B |
| 1010-8 | 51 | -0.1200 | A B |
| Warwasi XXWW | 58 | -0.3217 | B |

**RPC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 51 | 0.2475 | A |
| Warwasi NNOO | 40 | 0.1551 | A |
| Porc Epic C | 35 | 0.1520 | A |
| Porc Epic E | 34 | 0.1137 | A |
| Warwasi XXWW | 58 | 0.0400 | A B |
| JQ-1 | 21 | 0.0111 | A B |
| Tor Faraj F1 | 79 | -0.0650 | A B |
| JKF-12 | 23 | -0.1236 | A B |
| JKF-1 | 95 | -0.3384 | B |

**RPC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-1 | 95 | 0.1678 | A |
| JKF-12 | 23 | 0.1560 | A B |
| JQ-1 | 21 | 0.0824 | A B |
| Warwasi NNOO | 40 | 0.0747 | A B |
| 1010-8 | 51 | 0.0291 | A B |
| Warwasi XXWW | 58 | -0.0544 | A B |
| Tor Faraj F1 | 79 | -0.0574 | A B |
| Porc Epic C | 35 | -0.1970 | B |
| Porc Epic E | 34 | -0.2622 | B |

**RPC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 40 | 0.2351 | A |
| Warwasi XXWW | 58 | 0.1191 | A B |
| JKF-1 | 95 | 0.0336 | A B |
| JQ-1 | 21 | 0.0114 | A B |
| Porc Epic E | 34 | -0.0378 | A B |
| Tor Faraj F1 | 79 | -0.0947 | A B |
| Porc Epic C | 35 | -0.1179 | A B |
| 1010-8 | 51 | -0.1334 | A B |
| JKF-12 | 23 | -0.2705 | B |

**RPC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 79 | 0.2012 | A |
| JKF-1 | 95 | 0.0796 | A B |
| JKF-12 | 23 | 0.0576 | A B |
| JQ-1 | 21 | 0.0081 | A B |
| 1010-8 | 51 | -0.0091 | A B |
| Porc Epic E | 34 | -0.0198 | A B |
| Porc Epic C | 35 | -0.1186 | A B |
| Warwasi XXWW | 58 | -0.1340 | B |
| Warwasi NNOO | 40 | -0.1788 | B |

**RPC8:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 23 | 0.3284 | A |
| Tor Faraj F1 | 79 | 0.1457 | A B |
| Warwasi XXWW | 58 | 0.0740 | A B C |
| Warwasi NNOO | 40 | -0.0192 | A B C |
| JKF-1 | 95 | -0.0312 | B C |
| Porc Epic C | 35 | -0.0389 | A B C |
| Porc Epic E | 34 | -0.1590 | C |
| 1010-8 | 51 | -0.1808 | C |
| JQ-1 | 21 | -0.1989 | C |

Table 7.40. Tukey grouping of ANOVA results for question 6

Finally, RPC8 contrasts radial scar patterns and blanks with large numbers of scars. This is an interesting correlation as previous components have consistently correlated radial scar patterns with a large number of scars. This might suggest a distinction between radial scar patterns as a feature of reduction intensity (previous examples) and radial scar patterns as a design feature (here), although such a hypothesis remains rather speculative at present.

As can be seen from Table 7.40, on the whole the Tukey Method produces rather simple, if quite overlapping, groupings for this analysis. Sample sizes for Levallois-like blanks at BS-1 and 123-b are here too small, so these assemblages are not included.

For RPC1 we can simplify the heavily overlapping groupings into 3 groups. The first group consists of those with negative mean scores, and consists of Warwasi and Tor Faraj. The middle group consists of Porc Epic, JKF-1, JKF-12 and JQ-1. The final group solely consists of 1010-8. The first group reflects large numbers of unidirectional scar patterns, while the latter reflects the heavily centripetal character of the assemblages. The large middle group reflect a combination of both. The clear distinction of Warwasi and Tor Faraj in this first component should be noted.

The grouping for RPC2 is somewhat confused. If we remove the overlap we can see two groups. The first group consists of Tor Faraj and Porc Epic, while the second group contains all other sites. The former group emphasises from proximal convergent scar patterns on wide blanks, whereas the latter emphasise a unidirectional component associated with narrower blanks.

For RPC3 if we remove the overlap we can again define two groups. The first contains Tor Faraj, JKF-1, Warwasi NNOO, Porc Epic C and JQ-1. The second group contains JKF-12, Porc Epic E, 1010-8 and Warwasi WWXX. The former group emphasises a significant presence of from proximal convergent scar patterns, associated with relatively wider blanks, while the latter is associated with narrow cores and an emphasis on bidirectional scar patterns. The considerable intra-assemblage variability at both Warwasi and Porc Epic should be noted here. In both of these cases the younger assemblages appear to be emphasising from proximal convergent scar patterns. The Tukey grouping of RPC6 connects the Warwasi assemblages, with both showing a focus on bidirectional reduction and quite narrow blanks.

The same procedure of removing the overlap between groups can be applied to the Tukey grouping of RPC4, which gives one group consisting of Tor Faraj, JKF-12 and JKF-1, and another grouping consisting of all remaining sites. The component seems to be grouping these based on the evidence of early stage reduction – as perhaps indicated by two directions scar patterns on relatively narrow

cores – while the other group, with higher scores, are characterised by a greater focus on centripetal removals.

As discussed above, the implications for RPC 5 are not clear. Nor is the grouping of the ANOVA results. Focussing at the extremes of the Tukey grouping, we see Warwasi WWXX, Tor Faraj and Porc Epic. It was suggested above that this correlates with a significant role of blade production in these assemblages. In contrast, the highest scores are those found at Jubbah, but it is unclear what unites them. It is perhaps an indication of their earlier stage of reduction, but this is an ambiguous interpretation.

The results for RPC7 show quite a continuous distribution, with the apparent exception of Tor Faraj which scores highly. This emphasises the significant role for unidirectional convergent reduction here. In contrast other sites are more focussed on unidirectional Levallois, although the Jubbah sites do also score quite highly here.

Finally, for RPC8 there is considerable overlapping in the grouping but we can define three groups. From low to high scores, the first group consists of JQ-1, 1010-8 and Porc Epic E. The second group contains Porc Epic C, JKF-1 and the Warwasi assemblages. The final group consists of Tor Faraj and JKF-12. This seems to reflect that where radial scar patterns are present in the latter two assemblages, they are typically quite simple and with a low number of scars.

**7.20) (7) What is the relationship between reduction intensity and blank morphology?**

The role of reduction intensity in determining the character of lithic morphology has repeatedly emerged in this study as a crucial factor. This question uses Correspondence Analysis on the blank population to attempt explicitly address reduction intensity. The variables used are weight, number of scars >1/3 the length of the blank, % cortex and scar pattern. All complete blanks over 20mm in length are used.

| Component (% variation explained, cumulative %) | - | + |
|---|---|---|
| 1 (15%, 15%) | **Large number of scars, no cortex, radial scar patterns** | **Low numbers of scars, low % cortex, from proximal scar pattern** |
| 2 (13%, 27%) | **Low weight, medium number of scars, no cortex,** from proximal scar patterns | **High weight,** low number of scars, **low % cortex, two directions scars** |
| 3 (11%, 38%) | Low weight**, high number of scars, radial scar patterns** | **Medium number of scars, two directions scars** |
| 4 (10%, 48%) | **Medium weight, from proximal convergent scar patterns** | **Low weight, high weight** |
| 5 (10%, 59%) | Low weight, **high weight, Bidirectional scar patterns** | **Medium weight** |
| 6 (9%, 58%) | **Low weight, radial scar patterns** | **Medium weight, bidirectional scar patterns, from proximal convergent scar patterns** |
| 7 (9%, 77%) | **Low weight, high weight, from proximal convergent scar patterns** | Medium weight, **two directions scar patterns** |
| 8 (8%, 85%) | **Low weight, low number of scars, two directions scar patterns** | High weight, **low % cortex**, |
| 9 (7%, 92%) | **High number of scars, low % cortex** | Medium number of scars |
| 10 (6%, 99%) | **Low weight, from proximal scars** | **Low % cortex, radial scar pattern** |

Table 7.41. Loading of components.

Before describing the structure of each component, some overall comments can be made. The first three components distinguish heavily reduced from less heavily reduced blanks. Subsequently, components 4 to 7 distinguish various combinations of 'medium' and 'not medium' reduction. Finally 8 to 10 reflect varying combinations in slightly strange ways, as the remaining variability is divided up. For instance RPC8 seems to contrast small flakes from early reduction to large flakes from later in reduction, which is clearly a confusing contrast. RPC9 again contrasts reduced and not so reduced. Finally RPC 10 seems to distinguish small from proximal, perhaps 'preparatory' flakes, from radial scar patterns which hear correlates with the presence of some cortex, which may indicate an early stage of reduction.

The first component offers a clear distinction between less and more reduced – with the former being associated with a large number of scars, no cortex and radial scar patterns, and the latter with a low number of scars, low percentage cortex and from proximal scar patterns. Here with have a clear correlation of reduction intensity with particular dorsal face configurations. The second and third components reflect different perspectives on a similar basic structure.

RPC4 strongly correlates from proximal convergent scar patterns with medium weight, perhaps suggesting this is a scar pattern typical of the middle of the reduction cycle. In contrast we find the combination of both low and large weights, which are both 'non-medium'. RPC 5 suggests again

contrasts medium and non-medium, but here suggests that bidirectional scar patterns are a feature of the latter. The strongest correlation of the latter, however, is with high weight. So the component is mostly contrasting less reduced (-) with more reduced (+) blanks.

RPC6 combines elements of the previous two components, and contrasts assemblages with light blanks and radial scar patterns (-, reduced) and those with medium weight and bidirectional and from proximal convergent scar patterns (+, medium reduction). RPC7, in contrast with the loading of earlier components, contrasts correlates from proximal convergent scar patterns (the strongest driver) with both light and heavy blanks. This perhaps suggests that blanks with such components were sometimes produced throughout much of the reduction process. In contrast blanks of medium weight correlate with two direction scar patterns. RPC8 contrasts light blanks with few scars and two direction scar patterns, on the other hand, and heavier blanks with a low % of cortex on the other. Both this and RPC 9 can again be taken as indicating reduced (-) versus less reduced (+). RPC 10 suggests a possible distinction between preparatory and preferential blanks, and so is not considered more here.

Table 7.42 presents the results of grouping of ANOVA's of the components by the Tukey Method. For RPC1 there are three heavily overlapping groups. Removing the overlap we can define three groups. The apparently least reduced, consisting of BS-1, JKF-1 and Tor Faraj have the highest scores. The middle group consists of JKF-12, Warwasi, JSM-1, 123-b and JQ-1. These seem to be characterised by medium levels of reduction in the sense captured by this component. Finally Porc Epic and 1010-8 are suggested to be the more reduced assemblages. At this point it can be noted that in the case of BS-1, which seems rather anomalous, may be explained by the structure of its assemblage which seems to only reflect a part of the reduction process and is dominated by 'preparation' flakes.

The structure just described does not seem particularly intuitive, and we must consider the fact that features such as scar patterns are reflections of both reduction intensity and the desires of the knapper. RPC 2 seems to present the more familiar structure seen in previous questions. Here weight provides a useful way to distinguish intensity of reduction, based on the assumption that

lighter blanks typically represent a more advanced stage of reduction. The Tukey grouping produces a complicated structure. Simplfying somewhat, we might define three groups. The group apparently characterised by being less reduced consists of JKF-12, 123-b, 1010-8 and JKF-1. An intermediary group consists of JQ-1 and Porc Epic E. Finally the most heavily reduced assemblages are Porc Epic C, Tor Faraj, BS-1 and Warwasi.

**PC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 35 | 0.3005 | A |
| JKF-1 | 307 | 0.1388 | A |
| Tor Faraj F1 | 264 | 0.1021 | A |
| JKF-12 | 61 | 0.0997 | A B |
| Warwasi NNOO | 112 | 0.0911 | A B |
| JSM-1 | 24 | 0.0712 | A B C |
| Warwasi XXWW | 129 | -0.0119 | A B C |
| TH-123B | 164 | -0.0174 | A B C |
| JQ-1 | 34 | -0.1348 | A B C |
| Porc Epic C | 85 | -0.2018 | B C |
| Porc Epic E | 95 | -0.2045 | B C |
| 1010-8 | 83 | -0.3009 | C |

**PC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 61 | 0.5798 | A |
| TH-123B | 164 | 0.4972 | A |
| 1010-8 | 83 | 0.3921 | A B |
| JKF-1 | 307 | 0.1842 | C |
| JSM-1 | 24 | 0.0770 | B C D |
| JQ-1 | 34 | -0.0479 | C D |
| Porc Epic E | 95 | -0.1365 | D |
| Porc Epic C | 85 | -0.1931 | D E |
| Tor Faraj F1 | 264 | -0.2397 | D E |
| BS-1 | 35 | -0.2677 | D E F |
| Warwasi XXWW | 129 | -0.3601 | E F |
| Warwasi NNOO | 112 | -0.4700 | F |

**PC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 61 | 0.2363 | A |
| JKF-1 | 307 | 0.1476 | A |
| TH-123B | 164 | 0.1025 | A B |
| Tor Faraj F1 | 264 | 0.0205 | A B C |
| 1010-8 | 83 | -0.0283 | A B C D |
| JQ-1 | 34 | -0.0464 | A B C D E |
| Warwasi NNOO | 112 | -0.0633 | B C D E |
| Warwasi XXWW | 129 | -0.1011 | C D E |
| BS-1 | 35 | -0.1669 | B C D E |
| Porc Epic E | 95 | -0.1870 | C D E |
| Porc Epic C | 85 | -0.3140 | E |
| JSM-1 | 24 | -0.3698 | D E |

**PC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi NNOO | 112 | 0.2997 | A |
| JKF-12 | 61 | 0.2835 | A |
| Warwasi XXWW | 129 | 0.2043 | A B |
| TH-123B | 164 | 0.1160 | A B C |
| BS-1 | 35 | 0.0146 | A B C D |
| 1010-8 | 83 | -0.0150 | B C D |
| Porc Epic E | 95 | -0.0413 | C D |
| JKF-1 | 307 | -0.0823 | D |
| Porc Epic C | 85 | -0.0948 | C D |
| JSM-1 | 24 | -0.1382 | B C D |
| JQ-1 | 34 | -0.1557 | C D |
| Tor Faraj F1 | 264 | -0.2645 | D |

**PC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 85 | 0.1766 | A |
| BS-1 | 35 | 0.1025 | A B |
| JSM-1 | 24 | 0.0929 | A B |
| JKF-12 | 61 | 0.0883 | A B |
| JQ-1 | 34 | 0.0727 | A B |
| Tor Faraj F1 | 264 | 0.0402 | A B |
| TH-123B | 164 | 0.0352 | A B |
| 1010-8 | 83 | 0.0259 | A B |
| Porc Epic E | 95 | -0.0274 | A B |
| JKF-1 | 307 | -0.0346 | B |
| Warwasi NNOO | 112 | -0.1002 | B |
| Warwasi XXWW | 129 | -0.1566 | B |

**PC6:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj F1 | 264 | 0.1462 | A |
| JKF-12 | 61 | 0.1224 | A B |
| JKF-1 | 307 | 0.0820 | A B |
| Warwasi XXWW | 129 | 0.0388 | A B |
| Porc Epic C | 85 | 0.0009 | A B C |
| TH-123B | 164 | -0.0751 | B C |
| BS-1 | 35 | -0.0911 | A B C |
| Porc Epic E | 95 | -0.1236 | B C |
| 1010-8 | 83 | -0.1348 | B C |
| Warwasi NNOO | 112 | -0.1875 | C |
| JSM-1 | 24 | -0.1932 | A B C |
| JQ-1 | 34 | -0.2125 | B C |

**PC7:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 34 | 0.1644 | A B |
| JSM-1 | 24 | 0.1328 | A B |
| BS-1 | 35 | 0.1082 | A B |
| Warwasi XXWW | 129 | 0.1079 | A |
| Porc Epic C | 85 | 0.0929 | A B |
| 1010-8 | 83 | 0.0443 | A B |
| JKF-1 | 307 | 0.0089 | A B |
| Porc Epic E | 95 | 0.0054 | A B |
| TH-123B | 164 | -0.0259 | A B |
| Tor Faraj F1 | 264 | -0.0725 | B C |
| Warwasi NNOO | 112 | -0.0956 | A B C |
| JKF-12 | 61 | -0.2677 | C |

**PC8:**

| site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 83 | 0.2293 | A |
| JSM-1 | 24 | 0.1697 | A B |
| JQ-1 | 34 | 0.0807 | A B C |
| Porc Epic E | 95 | 0.0616 | A B C |
| JKF-12 | 61 | 0.0527 | A B C |
| Porc Epic C | 85 | 0.0083 | A B C |
| JKF-1 | 307 | 0.0074 | B C |
| Tor Faraj F1 | 264 | 0.0048 | B C |
| TH-123B | 164 | 0.0025 | B C |
| BS-1 | 35 | -0.0017 | A B C |
| Warwasi NNOO | 112 | -0.1813 | B C |
| Warwasi XXWW | 129 | -0.1882 | C |

**PC9:**

| site | N | Mean | Grouping |
|---|---|---|---|
| TH-123B | 164 | 0.2217 | A |
| 1010-8 | 83 | 0.1609 | A B |
| JSM-1 | 24 | 0.1562 | A B C D |
| JQ-1 | 34 | 0.1061 | A B C D |
| JKF-12 | 61 | 0.1032 | A B C |
| JKF-1 | 307 | 0.0256 | B C |
| BS-1 | 35 | -0.0059 | A B C D |
| Porc Epic E | 95 | -0.0182 | B C D |
| Warwasi NNOO | 112 | -0.0870 | C D |
| Warwasi XXWW | 129 | -0.0943 | C D |
| Tor Faraj F1 | 264 | -0.1047 | D |
| Porc Epic C | 85 | -0.1092 | C D |

**PC10:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JSM-1 | 24 | 0.2034 | A B C |
| Warwasi NNOO | 112 | 0.1522 | A |
| Porc Epic C | 85 | 0.1464 | A |
| Porc Epic E | 95 | 0.1323 | A |
| Warwasi XXWW | 129 | 0.0799 | A B C |
| BS-1 | 35 | 0.0678 | A B C D |
| JQ-1 | 34 | 0.0412 | A B C D E |
| 1010-8 | 83 | -0.0028 | A B C D E |
| Tor Faraj F1 | 264 | -0.0418 | C D E |
| JKF-1 | 307 | -0.0605 | B C D E |
| TH-123B | 164 | -0.1494 | D E |
| JKF-12 | 61 | -0.2275 | E |

Table 7.42. Tukey groupings of ANOVA results for question 7.

RPC3 seems to combine elements of the previous two components. Here weight (low), number of scars (high) and scar patterns (radial) all correlate negatively indicating a rounded perspective on heavily reduced assemblages. This is contrasted to signs of medium reduction. The grouping is rather complicated. This can be simplified to three groups. Sites with high scores are not heavily reduced. This group consists of JKF-12, JKF-1 and TH-123-b. I would assign Tor Faraj, 1010-8

and JQ-1 to a middling group. Finally the Warwasi and Porc Epic assemblages, BS-1 and JSM-1 are heavily reduced.

RPC 4 seems to focus on a separation of medium-reduction and non-medium reduction. Assemblages relating to the former are Tor Faraj, JQ-1, JSM-1, JKF-1 and Porc Epic. Falling into the latter are 1010-8, BS-1, 123-b, JKF-12 and the Warwasi assemblages.

RPC 5 likewise distinguishes between blanks with a medium reduction (+) and light and heavy reduction and, particularly, bidirectional scar patterns. Here the former consists of Porc Epic C, BS-1, JSM-1, JKF-12, JQ-1, Tor Faraj, 123b and 1010-8. The latter, on the other hand, consists of Porc Epic E, JKF-1, and the Warwasi assemblages.

RPC6 offers a contrast between heavily reduced assemblages and those with medium reduction. The former consist of JQ-1, Warwasi NNOO, 1010-8, Porc Epic E. After a middle group of 123-b, Porc Epic C and Warwasi XXWW, the group with medium reduction consists of JKF-1, JKF-12 and Tor Faraj. JSM-1 and BS-1 are compatible with all three groups, presumably reflecting low sample size.

RPC7 likewise contrasts medium weight (+) and both low and high weight blanks, correlating with from proximal convergent scar patterns. Given the dichotomous character of the latter, it is hard to know how to evaluate it. It seems to be another reflection of 'medium' reduction versus 'non-medium' reduction intensity. The ANOVA results do not really suggests clear grouping, other than that of Tor Faraj, Warwasi NNOO and JKF-12 which share negative scores.

Component 8 returns to a focus on reduced (-) versus not so reduced (+). The former, in particular, consists of the Warwasi assemblages. 1010-8, JSM-1, JQ-1, Porc Epic E and JKF-12 appear as less reduced, with other sites having middling scores.

Finally, RPC 9 offers another contrast between more and less heavily reduced assemblages. The quite complicated structure can be simplified to not very reduced (123-b, 1010-8, JSM-1 and JQ-1), moderately reduced (JKF-12, JKF-1, BS-1, Porc Epic E and Warwasi) and heavily reduce (Tor Faraj and Porc Epic).

The above indicates a rather complicated structure and again we do not see the first and second components explaining a large amount of variability. This reiterates the complicated structure of lithic variability in the assemblages studied.

### 17.21 (8) How does morphology vary when several attributes are considered?

In this final multivariate analysis of blanks we return to the use of Principal Components Analysis. The aim here is to attempt to isolate more nuanced variation in the shape of debitage through using a number of size and shape related variables (technical length, proximal width, width at medial, distal width, thickness at median and platform flattening [platform width/platform thickness]). This is similar to question 2, but here weight is excluded and three width measurements are used to try and tease out variation in shape. The aim is to try and move beyond the basic variation which question 2 focussed on. The analysis only concerns complete 'Levallois'-like blanks. The aim is to focus on variation which is more likely to reflect 'cultural' factors, but as effect is to remove 123-b and JSM-1 from analysis due to their small sample sizes of Levallois debitage.

| Variable | PC1 (56%) | PC2 (19%) | PC3 (14%) | PC4 (6%) | PC5 (3%) | PC6 (2%) |
|---|---|---|---|---|---|---|
| Length (mm) | -0.383 | 0.096 | -0.638 | -0.637 | 0.132 | 0.116 |
| Proximal width (mm) | 0.471 | -0.299 | 0.003 | -0.508 | -0.396 | -0.524 |
| Medial width (mm) | -0.516 | 0.039 | 0.081 | 0.139 | 0.242 | -0.805 |
| Distal width (mm) | 0.343 | 0.247 | -0.720 | 0.488 | -0.109 | -0.228 |
| Thickness (mm) | 0.497 | 0.188 | 0.075 | -0.193 | 0.817 | -0.090 |
| Platform flattening | 0.022 | 0.896 | 0.249 | -0.202 | -0.298 | -0.070 |

Table 7.43. Loading of components.

Here we will only consider the first four components, as the final two explain a very small amount of variation. The first component distinguishes between, on the one hand, blanks which are short, parallel sided and thick and, on the other hand, those which are long, wide and thin.

For the second component the flattening of the platform is by far the dominant driver. Correlating with increasing platform flattening (relatively wide platforms) is a tendency to blanks to get wider at proximal and thinner at distal. The component then distinguishes between blanks which are thin

and convergent and those which are more parallel sided and are thicker with relatively thick platforms.

The third component is most strongly driven by a negative correlation between length and distal width, these inversely correlating with platform flattening. The component then seems to be distinguishing between blanks which are short and convergent with slightly flattened platforms – what could alternatively be described as short points – in contrast to longer and more parallel blanks with relatively thicker platforms.

Finally, RPC4, with its negative correlation of length proximal width, thickness and platform flattening suggests a distinction between long convergent blanks which are thin with somewhat flattened platforms and, conversely, short parallel sided blanks with relatively thicker platforms.

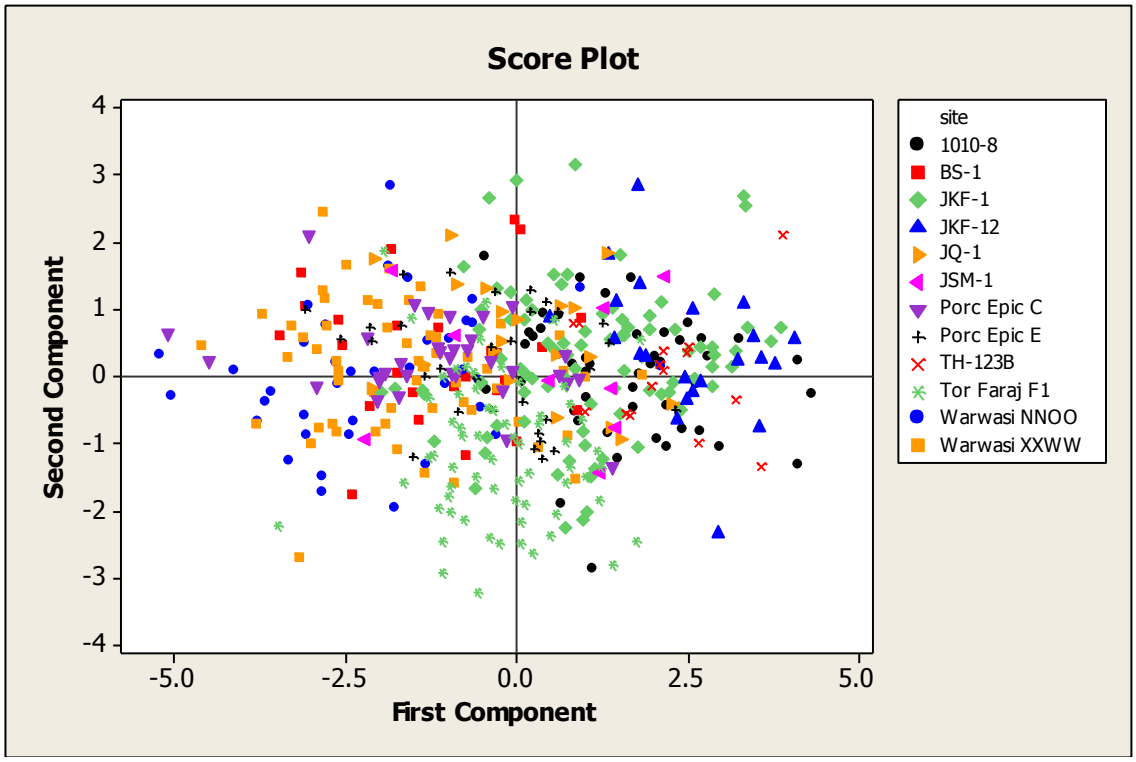



Figure 7.37. Score plot

As shown in Figure 7.44 some interesting grouping emerges from the Tukey grouping of the ANOVA results. For the first component a variety of groups are defined with relatively little overlap. We can suggest 3 basic groups. The group with the highest scores consists of JKF-12,

1010-8 and JKF-1. The intermediary groups consists of JQ-1, Tor Faraj and Porc Epic E. The final group, with the lowest scores, consists of Porc Epic C, BS-1 and Warwasi. The loading of the component (see Table 7.43) reflects a relative scaling of variables. The first group, scoring highly, is characterised then by relatively short, parellel side and thick blanks. The latter group in contrast are longer, wider and thinnner. In this regard then the Jubbah and Nubian assemblages (Figure 7.37 clearly shows the high scorse for 123-b for the first component) are in relative terms short, parallel sided and thick. In contrast the cave and rockshelter sites, as well as BS-1, show a tendency to be relativey longer, wider and thinner. Considering evidence discussed earlier, such as values for blank elongation shown in Table 7.10, this structure is quite understandable.

**PC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JKF-12 | 22 | 2.514 | A |
| 1010-8 | 47 | 1.626 | A B C |
| JKF-1 | 90 | 1.081 | B C |
| JQ-1 | 20 | 0.073 | D |
| Tor Faraj F1 | 65 | -0.239 | D |
| Porc Epic E | 31 | -0.346 | D |
| Porc Epic C | 34 | -1.129 | D E |
| BS-1 | 26 | -1.153 | D E |
| Warwasi XXWW | 58 | -1.621 | E |
| Warwasi NNOO | 38 | -2.050 | E |

**PC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| JQ-1 | 20 | 0.5534 | A |
| JKF-12 | 22 | 0.3914 | A |
| BS-1 | 26 | 0.3268 | A |
| Porc Epic C | 34 | 0.2516 | A |
| JKF-1 | 90 | 0.2468 | A |
| Porc Epic E | 31 | 0.1839 | A |
| Warwasi XXWW | 58 | 0.0868 | A |
| Warwasi NNOO | 38 | 0.0114 | A |
| 1010-8 | 47 | 0.0000 | A |
| Tor Faraj F1 | 65 | -1.1090 | B |

**PC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E | 31 | 0.3992 | A |
| Tor Faraj F1 | 65 | 0.3587 | A |
| Porc Epic C | 34 | 0.1533 | A B |
| JKF-1 | 90 | 0.1190 | A B |
| Warwasi XXWW | 58 | -0.0615 | A B |
| JKF-12 | 22 | -0.1407 | A B |
| Warwasi NNOO | 38 | -0.2168 | A B |
| 1010-8 | 47 | -0.3022 | B |
| BS-1 | 26 | -0.4156 | B |
| JQ-1 | 20 | -0.4866 | B |

**PC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi XXWW | 58 | 0.2288 | A |
| 1010-8 | 47 | 0.1263 | A |
| Tor Faraj F1 | 65 | 0.0422 | A B |
| Porc Epic C | 34 | 0.0257 | A B |
| Warwasi NNOO | 38 | -0.0478 | A B |
| JKF-1 | 90 | -0.0558 | A B |
| JQ-1 | 20 | -0.0667 | A B |
| Porc Epic E | 31 | -0.0770 | A B |
| JKF-12 | 22 | -0.1666 | A B |
| BS-1 | 26 | -0.3985 | B |

**PC5:**

| site | N | Mean | Grouping |
|---|---|---|---|
| BS-1 | 26 | 0.0980 | A B |
| JKF-1 | 90 | 0.0794 | A |
| Porc Epic C | 34 | 0.0733 | A B |
| Warwasi NNOO | 38 | 0.0480 | A B |
| Porc Epic E | 31 | 0.0318 | A B |
| Warwasi XXWW | 58 | -0.0025 | A B |
| JKF-12 | 22 | -0.0066 | A B |
| 1010-8 | 47 | -0.0378 | A B |
| JQ-1 | 20 | -0.0912 | A B |
| Tor Faraj F1 | 65 | -0.1679 | B |

Table 7.44. Tukey grouping of ANOVA results for question 8.

The key feature for PC2 is the distinct grouping of Tor Faraj, which is strongly characterised by its flattened platforms in correlation with convergent blanks. The Tukey Method does not give any other groupings for the other sites, most of which cluster closely together. In this case there appears to be a strong distinction between the Levallois point technology at Tor Faraj and reduction at the other sites.

Two overlapping groups are defined by RPC3. A somewhat arbitrary division between positive and negative scores (the results at either pole being the most secure) gives a high scoring group – Porc Epic, Tor Faraj and JKF-1 – and a low scoring group – Warwasi, JKF-12, 1010-8, BS-1 and JQ-1. This seems to be focussed on the presence of short convergent blanks in the former in contrast to more thick, broadly blade like elements in the latter.

The Tukey grouping for RPC4 forms two almost entirely overlapping groups. There is little variation in mean scores. All that we can say is that those with high scores show something of a tendency to long and convergent blanks, while those with low scores are emphasising an element of variability which consists of short, parallel sided blanks with relatively thicker platforms. The lack of distinct grouping for this component, and low percentage of variation it explains, suggests that the fundamental divisions of size and shape have already been mostly addressed by the previous components.

**17.22) Discussion**

The implications of the morphological and technological variation in debitage described and discussed in this chapter will be integrated with evidence from cores and retouched pieces in the conclusion. For now some basic and fundamental points can be made.

Several factors emerge in relation to the typology of debitage. One is the prevalence of chips/chunks in an assemblage. This offers both insights into the 'quality' of the assemblage (i.e. is it from a well excavated/collected context), as well as other factors such as the taphonomic history of the site. Such pieces must therefore be considered in any evaluation, rather than merely focussing on the aesthetically pleasing elements. Two particular areas of variation are laminarity and the extent of blank convergence. This can be simplified to a typology of blades and points respectively. However, a more nuanced perspective is to see such shape *variation* as part of a range of variability seen in all assemblages. Such factors are more appropriately addressed through quantitative analysis than boxing variation into abstract types. Areas for which typology are in fact traditionally *underestimated*, are with the prevalence of, for instance, core management elements. These give important insights into how core volumes were managed, and they vary in numbers considerably between assemblages.

Most assemblages focus on a local raw material, perhaps supplemented by small amounts of other materials. Porc Epic with its diverse raw material economy is the only real exception here. In this

case local materials such as quartzite and flint are joined by those from perhaps hundreds of kilometres away, particularly obsidian (Pleurdeau 2004).

In terms of uni- and bi-variate measures of size, most show a broadly similar picture. JKF-12 and 123-b are dominated by large debitage. 1010-8 can be described as 'large medium', and JK1-1 as 'low medium' sized. JQ-1 and JSM-1 are a little smaller still, followed by Porc Epic and Tor Faraj, which are quite similar, and finally Warwasi whose debitage is typically the smallest.

In terms of shape variation a somewhat different picture emerges. With the Index of Distal Convergence, for instance, Porc Epic C, BS-1, Tor Faraj and the Warwasi assemblages are on average considerably more convergent (pointed) than the other assemblages.

The character of distal terminations provide an interesting example of the ways in which we can consider lithic variability. For instance, the idea that we can see the role of 'aberrant terminations' from either the perspective of the blank or the core, and that these have rather different implications. The distal terminations also help us to contextualise the character of an assemblage. For instance, JKF-1 has the lowest levels of feather terminations on complete blanks for all of the studied assemblages (see Table 7.13). Does this then indicate a propensity of this raw material type to terminate abruptly? And what effect would this have on a knappers approach to reduction? We might hypothesise, for instance, that the tendency to aberrant terminations might catalyse a focus on unidirectional rather than centripetal reduction, as the latter perhaps comes with a greater risk of a large aberrant terminations obstructing the debitage surface. Such factors are rarely considered, but it is actually from thinking about such attributes that we can contextualise things like variation in shape.

When it comes to cortex, the study offers insights into the variation of the position of cortex. The example of JKF-1 was introduced. Here blanks with cortex on the right lateral are on average heavier, longer and (slightly) thicker than those with cortex on the left lateral (Table 7.19). Such factors may, perhaps, indicate a tendency for removals to be first made from the left lateral of the core (hence preserving cortex on the interior, or right, margin). But the problem with such interpretations is that as cores were rotated, terms like right and left are relative. This is an area in

which refitting would be a considerable aid. This study for now merely suggests that there may be interesting patterning in terms of the position of cortex and that such factors such factors should be considered in future analyses.

Striking platforms show variation in both absolute and relative terms. Variation in relative terms is particularly striking. It was shown that Warwasi and Tor Faraj have high relative platform size (see figure 7.31), indicating the use of relatively small platforms to produce relatively large blanks. Various forms of platform preparation occur. Taking the example of faceting, we see that across assemblages blanks with faceted platforms are on average longer than those in the assemblage without such preparation. Yet there is considerable inter-assemblage variation in such factors. For instance, considering only faceted platforms, relative platform size is almost three times greater at Tor Faraj than at JKF-1.

The scar patterns on the dorsal surface demonstrate both similarities and differences between assemblages. From proximal patterns are the most common in all assemblages. Porc Epic and 1010-8 feature high levels of centripetal reduction, while Tor Faraj has a high proportion of from proximal convergent patterns. The latter scar pattern is often seen as being 'diagnostic' of the Late Levantine Middle Palaeolithic, yet the data clearly shows the fairly high prevalence of it at Porc Epic.

A more detailed evaluation of the implications of the multivariate analyses will be presented in Chapter 9. For now let us just consider some basic points. The analyses seem to indicate that raw material type is not playing a particularly strong role in driving variation. From a theoretical and not merely empiricist perspective, however, the difficulties are clear. Maybe the knappers would have done something different at a site if they had had different raw material.

Through several analyses the most important driver in terms of debitage variability concerns size. Assemblages with small debitage, which is presumed to at least in part represent reduction intensity, share many characteristics with other assemblages with small debitage. In other senses though, the analyses reveal interesting variability which would not be apparent in uni- and bi-variate analyses.

For instance, in some analyses the assemblages from both Porc Epic and Warwasi are very different from each other, indicating a considerable role for intra-assemblage (temporal) variability. In the conclusion chapter the various patterns of similarity and difference in this and the preceding and following chapters will be evaluated to consider overall patterns of similarity and the implications these have for the dispersal of hominin populations.

# Chapter 8: Retouch

## 8.1) Introduction

This final chapter of analysis addresses the retouched component of the lithic assemblages. In contrast to traditional perspectives, which tend to emphasise the typology of retouched stone tools, this research emphasises a dynamic perspective on reduction as a process. The particular approach here is to attempt to explore this from a quantitative rather than qualitative perspective. Despite a tendency to turn away from a focus on retouched tools, the retouched component of assemblages is clearly of importance, and it can be argued that in the reaction against Bordesian perspectives there has been an overcompensation away from analyses of retouch. The approach here is to move away from an over emphasis on retouch typology, and instead to see retouch as an attribute, which can be quantified. Alongside this methodological focus the literature reflects a general movement away from the notion of typology as indicating cultural groups to a focus on factors such as reduction intensity and mobility strategies.

Two key concerns will be addressed in this chapter. Firstly, what kinds of blanks were selected for retouch? And secondly, how does the character and invasiveness of retouch vary? While it is hypothesised that much variation reflects retouch intensity, *sensu* Dibble (e.g. 1987a), and beyond this factors such as variation in mobility strategies, it is suggested that the lack of quantification of retouch means that we have an under-developed sense of variability of retouch. In the present study a simple typology is used, in essence merely as an organisational heuristic. From this foundation a number of attributes relating to retouch are analysed before some Principal Components Analyses tests are presented.

Two other points need to be made here. One is that few retouched artefacts were discovered at Jubbah, so this area, which is pivotal to this thesis, plays less of a role in this chapter than previously. Secondly, the author has a relatively cautious viewpoint on the definition of what counts as intentional retouch, as opposed to natural alterations. As a result the counts presented here may differ quite substantially from those given in previous publications.

## 8.2) Description of retouch and typology

This section will introduce the overall character and typological composition of the various assemblages as a background to the quantified focus of the chapter which follows. As Table 8.1 shows, the percentage of retouch in the assemblages varies considerably. The aim is to show the percentage of retouched artefacts out of the total 'blank population'. For now the broad correlation between the prevalence of retouch and the overall intensity of reduction in an assemblage, as demonstrated by a variety of factors outlined in the previous two chapters, is merely noted.

| | ***Retouched*** | ***Complete retouched (% of total retouched)*** | ***% of total blanks + retouched (all retouched)*** | ***% of total blanks + retouched (complete retouched)*** |
|---|---|---|---|---|
| ***JQ-1*** | 10 | 7 (70) | 11.4% | 8.0% |
| ***JSM-1*** | 4 | 3 (75) | 7.3% | 5.4% |
| ***JKF-1*** | 10 | 8 (80) | 1.3% | 1.1% |
| ***JKF-12*** | 1 | 1 (100) | 1.2% | 1.2% |
| ***Porc Epic layer C*** | 27 | 22 (81) | 15.4% | 12.6% |
| ***Porc Epic layer E***[1] | 52 | 40 (77) | 24.1% | 18.5% |
| ***1010-8***[2] | 25 | | | |
| ***Tor Faraj, floor 1*** | 62 | 35 (56) | 11.1% | 6.3% |
| ***Warwasi NNOO*** | 36 | 18 (50) | 8.5% | 4.3% |
| ***Warwasi WWXX*** | 79 | 44 (56) | 20.5% | 11.4% |
| ***123-B*** | 25 | 25 (100) | 2.9% | 2.9% |

Table 8.1. The frequency and percentages of retouched artefacts in the assemblages studied. 1 - Porc E debitage sampled so this is an underestimate. 2 - the figures for 1010-8 are unclear as a sample was taken for this study and some of the pieces in the British Museum collection marked as retouched are dubious. It is unclear from Marks (1968a, 216) how much is retouched in the sense defined in this study.

### JQ-1

The small assemblage from JQ-1 features a reasonably high proportion of retouched artefacts (see Figure 8.3). These demonstrate a broadly similar character. Table 8.2 shows the basic typology of the retouched component.

| **Type** | **Number** |
|---|---|
| Side retouched | 6 |
| Double side and end retouched | 2 |
| Double side retouched | 1 |
| Retouched point | 1 |

Table 8.2. Typology of retouched artefacts for JQ-1.

**JSM-1**

The small assemblage from JSM-1 features 2 bifaces and 2 other retouched pieces. Given their particular characteristics, and rarity in the assemblages studied, bifaces will not form a large part of the present analysis. One biface (see Figure 8.1) was found on the surface. This could also potentially be classed as  a core-preform. The difficulty in distinguishing between 'cores' and 'bifaces' reflects the difficulties of typological classification. In addition, Levallois cores can be seen as an emergent property of bifacial technology so there will frequently be cases on the line between the two. The other biface was excavated (trench 1, stratum 2) and is broken in half and less clear.

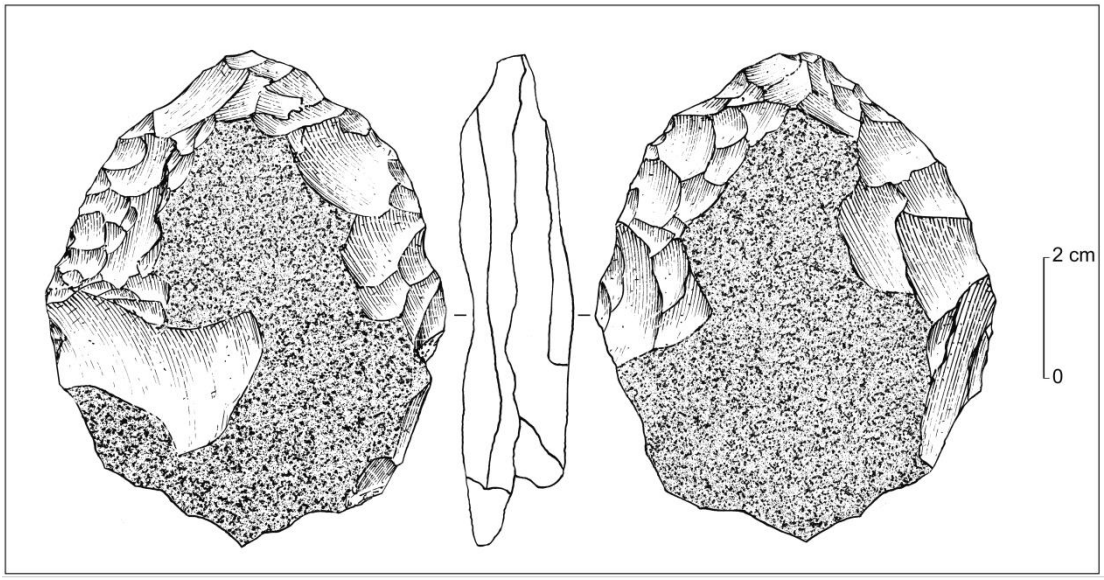



Figure 8.1. Illustration of a biface from JSM-1 (illustration by R. Crassard, from Petraglia *et al.* submitted).

One of the other retouched pieces is a double side and end retouched flake, with a broadly convergent shape, and was found on the surface. The other was excavated (trench 2, stratum 1) and is an end retouched flake.

**JKF-1**

For a reasonably large assemblage, JKF-1 has very low levels of retouch. Even the small number of pieces described typologically in Table 8.3 and shown in Figure 8.4 are not unproblematic, and in some cases may represent use wear/damage. This problem however affects interpretations of retouch in all contexts and a relatively conservative approach was followed. A number of what

superficially resemble 'Mousterian burins' are present, but the absence of features such as negative bulbs and the commonality of longitudinal fractures, means they are seen as fractured, not deliberately burinated, blanks. As with JQ-1, the typology of retouched pieces at JKF-1 is simple, and there is a considerable homogeneity between these pieces, the character of which will be explored through this chapter.

| Type | Number |
|---|---|
| Side and end retouched | 6 |
| Side retouched | 3 |
| Double side and end retouched | 1 |

Table 8.3. Typology of retouched artefacts for JKF-1.

**JKF-12**

A single retouched artefact was collected from the two transects through the site. It is a large (88 mm maximum length x 75 mm maximum width x 42 mm maximum thickness) ferruginous quartzite flake which has been retouched on one side of the dorsal surface

**Porc Epic C**

As shown in Table 8.4 and Figure 8.5 the most significant retouched type in layer C of Porc Epic are retouched points. These are relatively diverse, and include both unifacially and bifacially retouched specimens. Side retouched blanks are the next most common type, followed by a number of diversely retouched pieces. Whereas the points are quite invasively retouched, this is not typically the case for other categories. A single example of both a backed microblade and a burinated blank are also present. These 'precocious' elements are apparently found throughout the sequence, although in low numbers.

| Type | Number |
|---|---|
| Retouched point | 12 |
| Side retouched | 6 |
| End retouched | 3 |
| Double side and end retouched | 2 |
| End backed microblade | 1 |
| Double side retouched | 1 |
| Double side and double end | 1 |
| Burinated | 1 |

Table 8.4. Typology of retouched artefacts for Porc Epic C.

**Porc Epic E**

As shown in Table 8.5 and Figures 8.6 and 8.7, layer E of Porc Epic demonstrates a similar typological composition to layer C. The difference here is the even greater emphasis on lateral (rather than distal) retouching. The single example of a biface (not including small bifacially flaked points) present in the studied layers is shown in Figure 8.7 (number 20). It is an important point that backed lithics are a not insignificant element of the assemblage.

| Type | Number |
|---|---|
| Retouched points | 16 |
| Side retouched | 12 |
| Double side retouched | 10 |
| Side and end retouched | 5 |
| Backed microblade | 4 |
| Double side and end retouched | 3 |
| Backed flake | 1 |
| Biface | 1 |

Table 8.5. Typology of retouched artefacts for Porc Epic E.

**1010-8**

A large number of retouched artefacts are present at 1010-8 (Table 8.6 and Figure 8.8). In the present study a sample of 25 of these was taken to give an indication of the type of technology present at the site.

| Type | Number |
|---|---|
| Side retouched | 8 |
| End retouched | 5 |
| Side and end retouched | 3 |
| Side notched | 3 |
| Double side and end retouched | 1 |
| Double side denticulated | 1 |
| Double side notched | 1 |
| Double side retouched | 1 |
| One side notched, one side retouched | 1 |
| Side retouched and notched | 1 |

Table 8.6. Typology of retouched artefacts for 1010-8.

The typology shows quite a complex structure, with a variety of combinations of retouch and notching. In most cases the lateral margins of the blanks are retouched, but retouch of the distal end is also common. In contrast to the previous sites, notching is clearly a significant aspect of retouch at 1010-8.

**Tor Faraj**

As with the previous assemblages, the author has followed a somewhat more conservative approach to the definition and recognition of retouch than that of previous analyses of Tor Faraj. In many cases it was felt that the very light nibbling of the edges was better seen as use/damage than deliberate retouch. The more convincing examples of retouch are listed in Table 8.7 and shown in Figures 8.9 and 8.10.

| Type | Number |
|---|---|
| End retouched | 14 |
| Side retouched | 13 |
| Burinated | 10 |
| Side denticulated | 5 |
| Side and end retouched | 5 |
| Retouched point | 4 |
| Double side retouched | 4 |
| Double side and end retouched | 2 |
| Side retouched and burinated | 1 |
| Side notched | 1 |
| Double side and end retouched and burinated | 1 |

Table 8.7. Typology of retouched artefacts for Tor Faraj.

In general retouch at Tor Faraj is quite light and applied in a variety of manners to give a diverse typology of retouch. Three points seem of particular importance; the common presence of notching, the presence of a fairly high number of burinated blanks and the prominence of retouch to the distal end of the blank.

**Warwasi NNOO**

Table 8.8 shows the typological breakdown of Warwasi NNOO (see illustrations in Figure 8.11). A small number of notched and burinated lithics are present, but on the whole the assemblage is dominated by laterally retouched blanks. The assemblage is both heavily retouched and quite fragmentary, with a number of broken retouched pieces present.

| Type | Number |
|---|---|
| Double side retouched | 11 |
| Side retouched | 9 |
| Double side and end retouched | 4 |
| Side and end retouched | 3 |
| Side notched | 2 |
| Side retouched and burinated | 2 |
| Burinated | 1 |
| End retouched | 1 |
| Retouched point | 1 |
| Side denticulated | 1 |

Table 8.8. Typology of retouched artefacts for Warwasi NNOO.

**Warwasi WWXX**

While Warwasi demonstrates the broadest typological diversity of the assemblages studied, most individual categories are rare. Notching and burination are again quite unusual. As with NNOO, the assemblage is dominated by flakes and blades with heavily retouched laterals. In this case, however, single side retouch is more common than double side retouch, in contrast to NNOO where the opposite was the case. The typological list for WWXX is shown in Table WWXX and illustrations for WW in Figure 8.12 and XX in Figure 8.13.

| Type | Number |
|---|---|
| Side retouched | 25 |
| Double side retouched | 16 |
| Double side and end retouched | 15 |
| Double side and double end retouched | 6 |
| Side and end retouched | 5 |
| End retouched | 3 |
| Side notched | 2 |
| Burinated | 1 |
| Double side retouched and notched | 1 |
| End notched | 1 |
| Retouched point | 1 |
| Side and double end retouched | 1 |
| Side and end retouched and side notched | 1 |
| Side denticulated | 1 |

Table 8.9. Typology of retouched artefacts for Warwasi WWXX.

**TH-123B**

The site demonstrates a 'mixed' typology, with both lateral and distal retouch, notching and retouched points. The typology is shown in Table 8.10 and illustrations in Figures 8.14 and 8.15.

| Type | Number |
|---|---|
| Side retouched | 7 |
| Retouched point | 4 |
| Side and end retouched | 4 |
| Double side and end retouched | 3 |
| End retouched | 3 |
| Double side and end retouched and side denticulated | 2 |
| Double side retouched | 2 |

Table 8.10. Typology of retouched artefacts for TH-123b.

**Summary of typological variation**

While there are clearly differences between the typological compositions of the assemblages, implying factors such as choice on the part of knappers, it is also clear, as shown graphically in Figure 8.2, that a significant aspect influencing the diversity of retouched lithics relates simply to the number of retouched artefacts present. This must be borne in mind, while this chapter will continue with efforts to explore the nuances of variation in retouch.

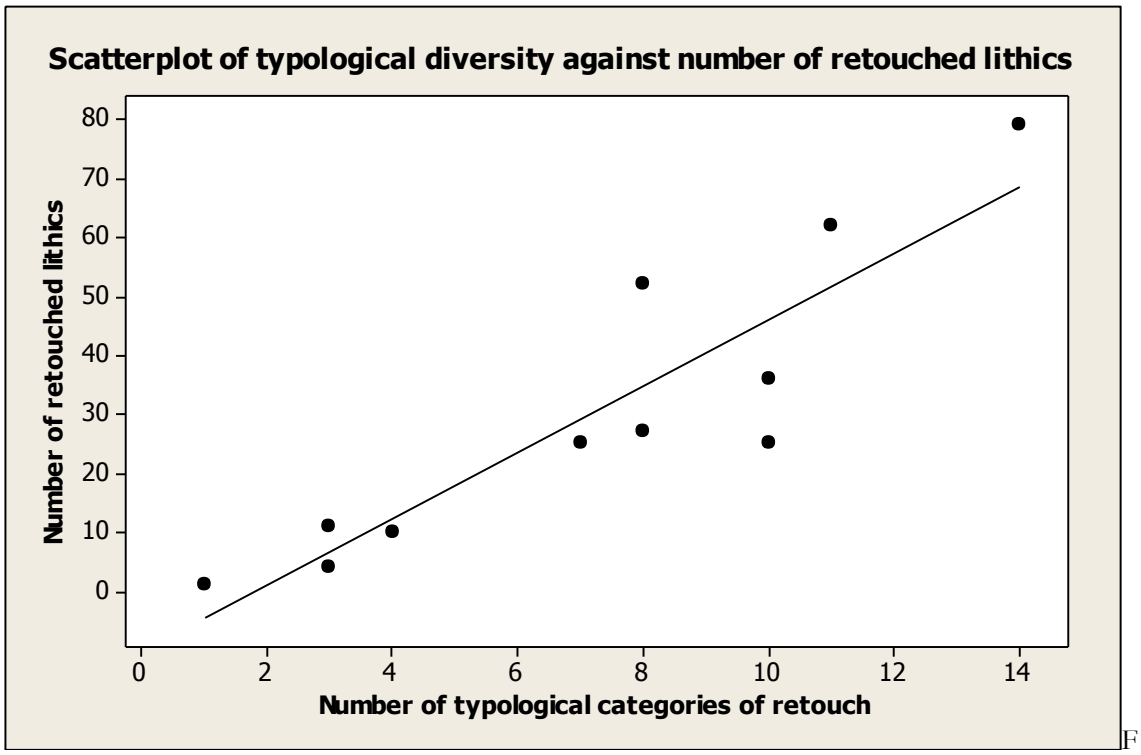



Figure 8.2. Scatterplot of the number of typological categorise of retouch and the number of retouched lithics in an assemblage. R-squared = 81%.

**8.3) Illustrations and photographs of all complete retouched lithics**

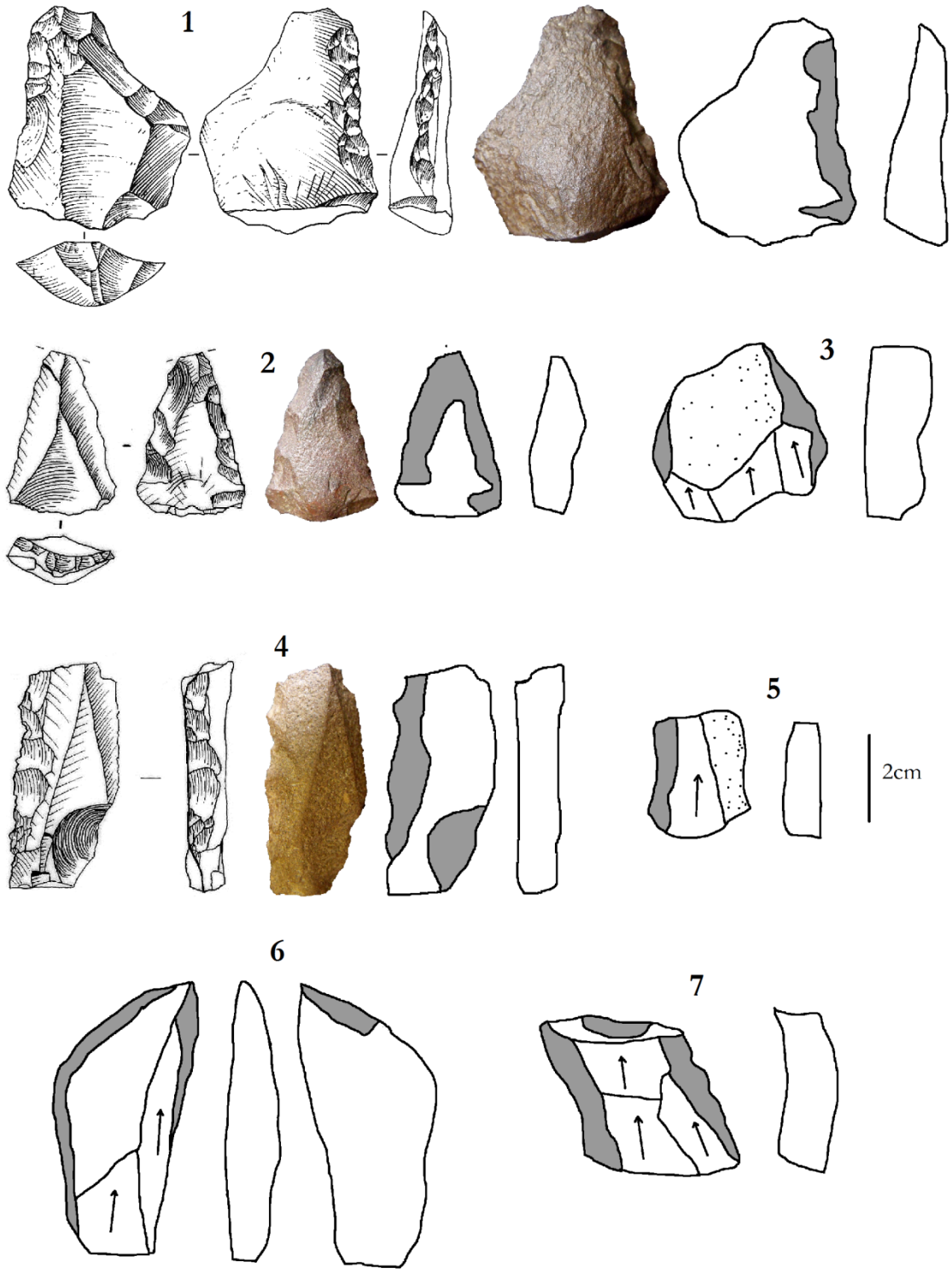



Figure 8.3. Illustrations and photographs of retouched lithics from JQ-1 (illustrations by R. Crassard and G. Devilder).

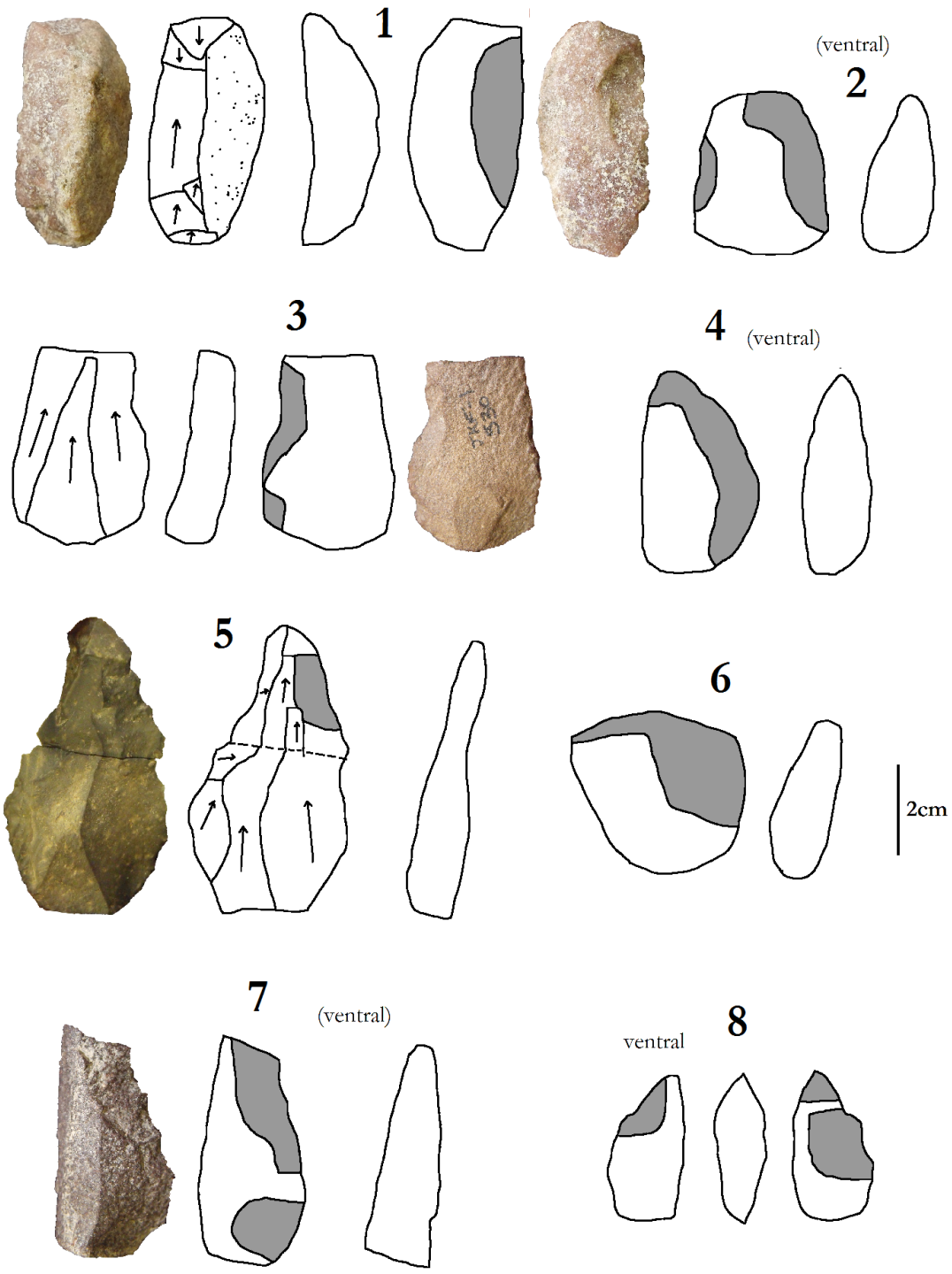



Figure 8.4. Illustrations and photographs of retouched lithics from JKF-1.

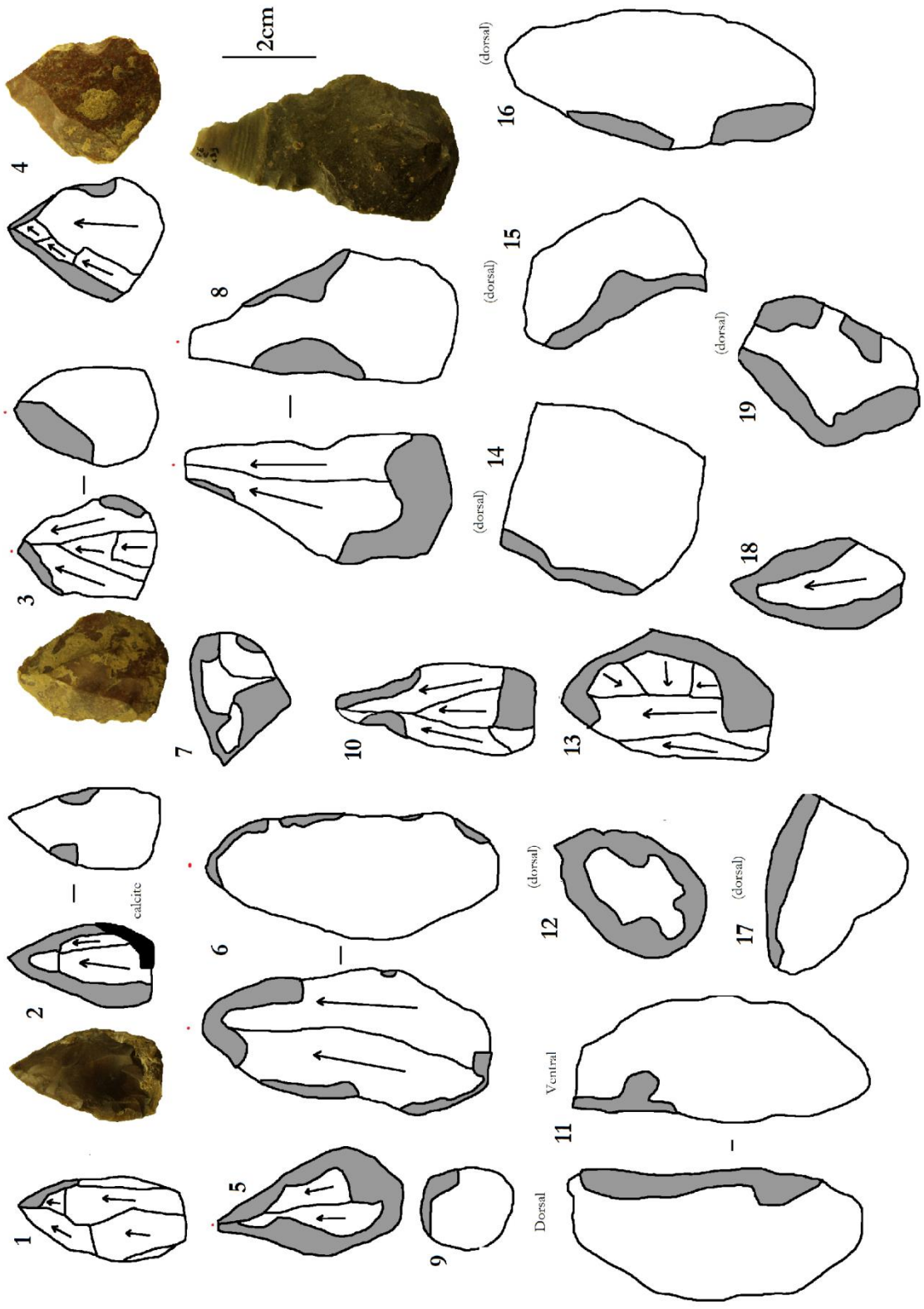



Figure 8.5. Illustrations and photographs of retouched lithics from Porc Epic C.

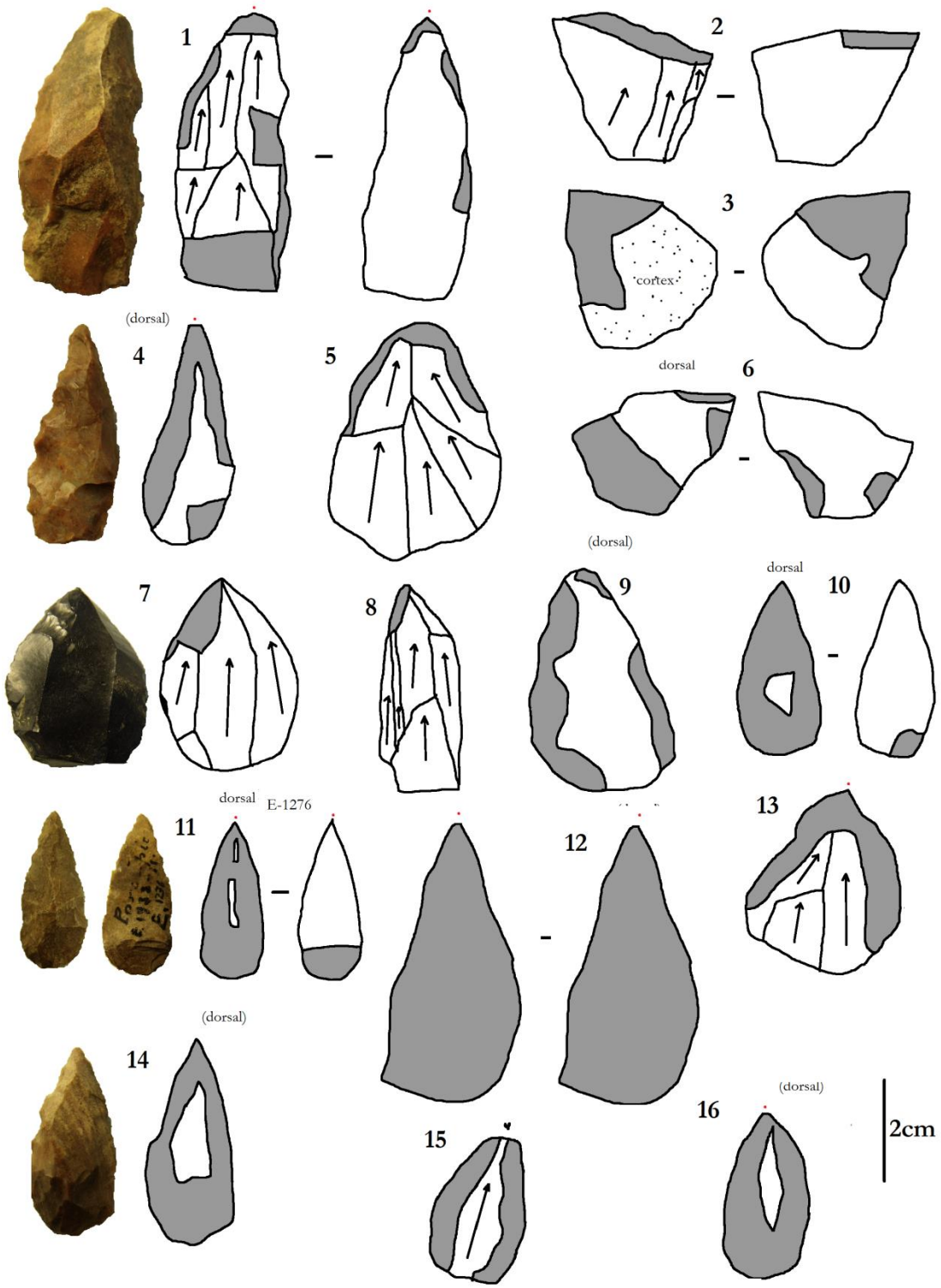



Figure 8.6. Illustrations and photographs of retouched points from Porc Epic E.

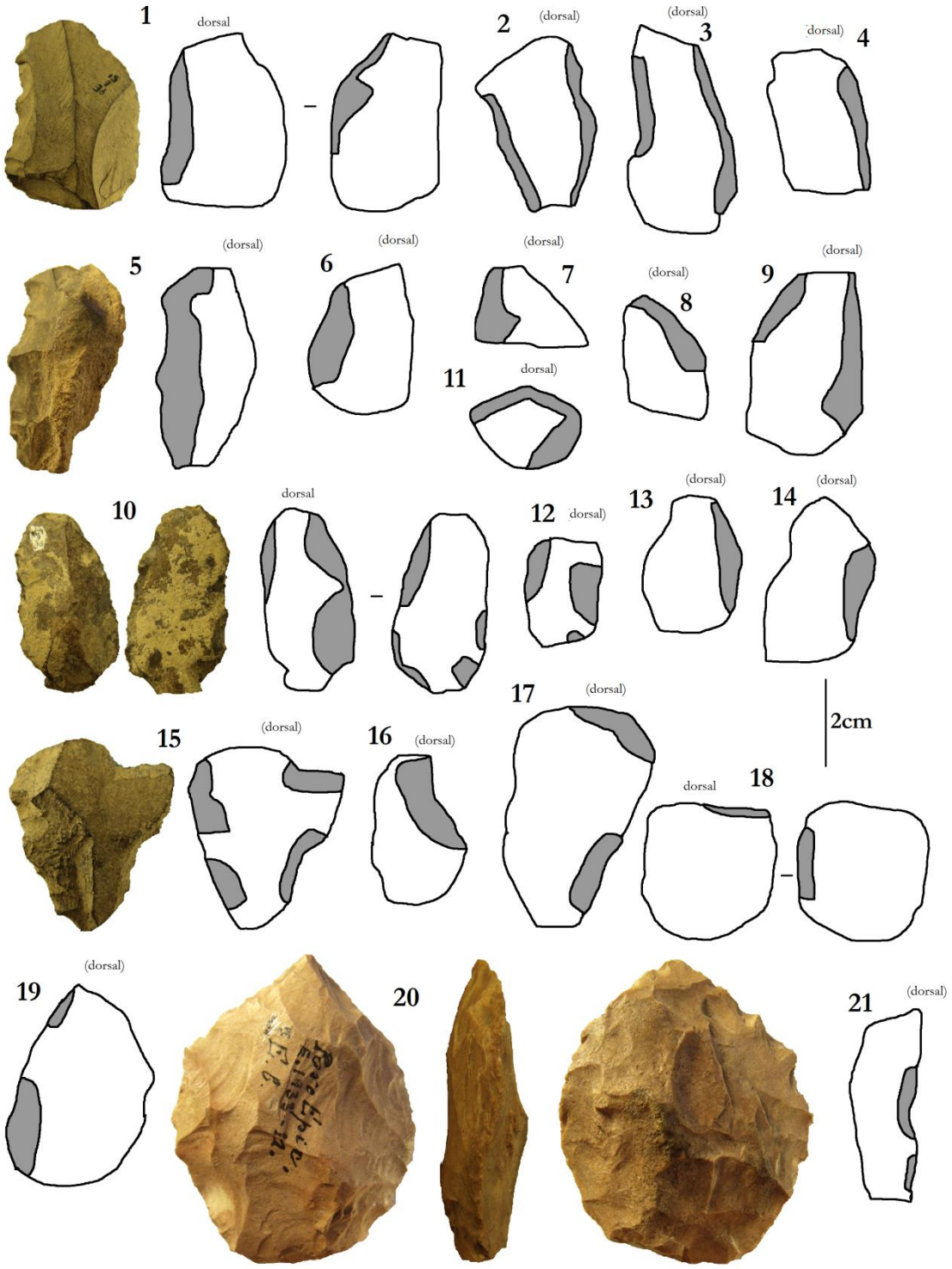



Figure 8.7. Illustrations and photographs of retouched lithics from Porc Epic E.

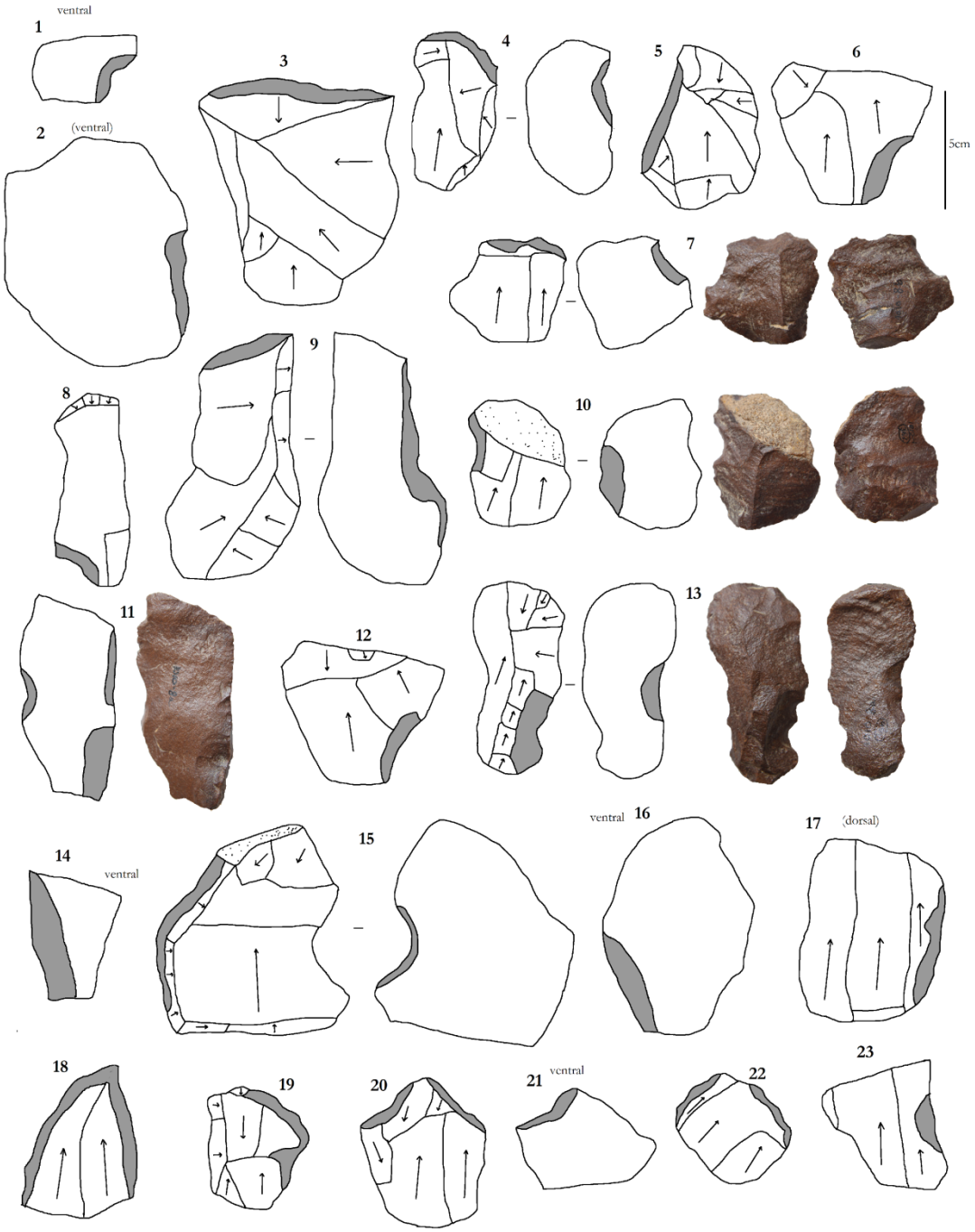



Figure 8.8. Illustrations and photographs of retouched lithics from 1010-8. (Photographs Huw Groucutt, Wendorf Collection, 1010-8, EA76000, copyright the British Musuem).

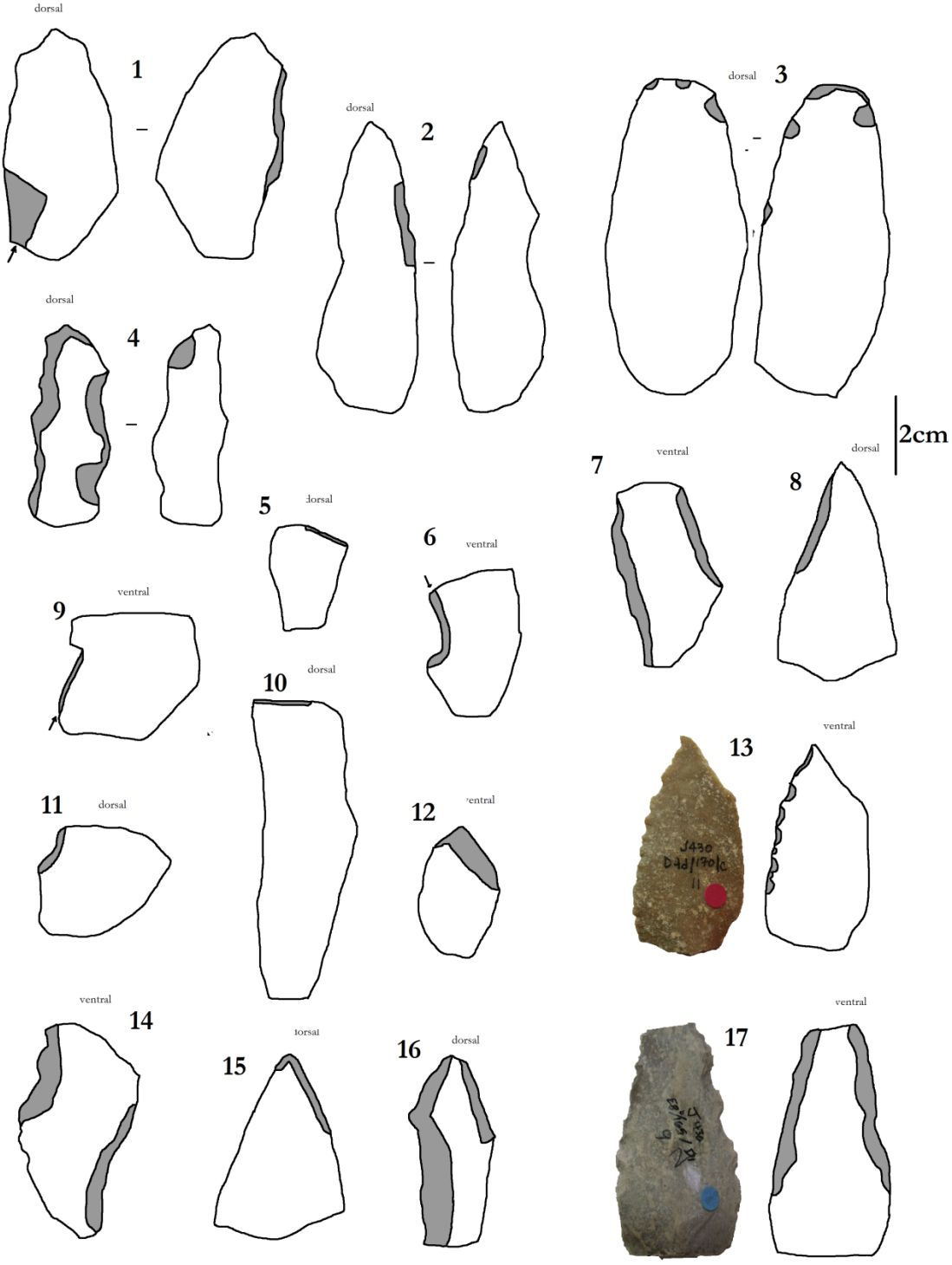



Figure 8.9. Illustrations and photographs of retouched lithics from Tor Faraj.

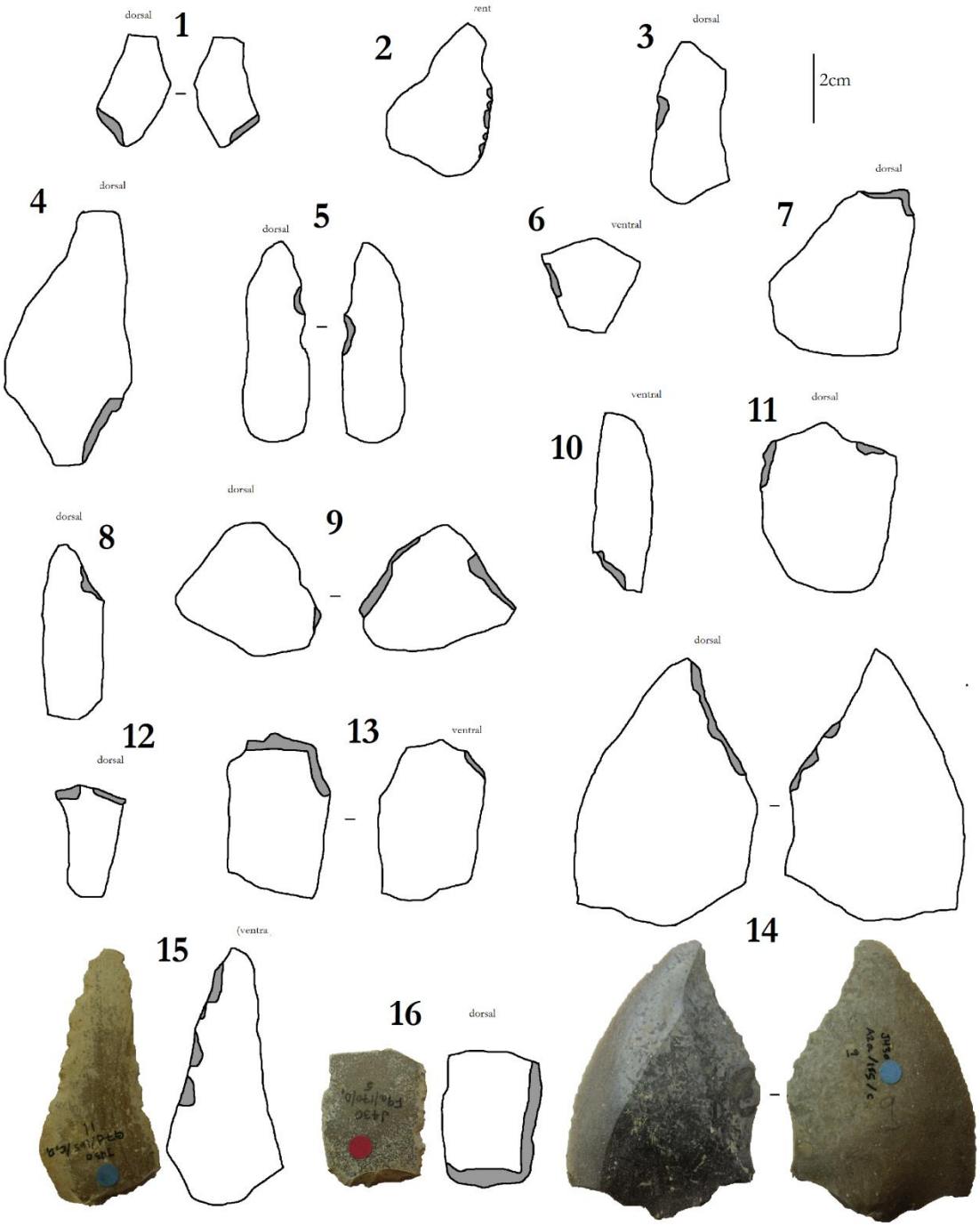



Figure 8.10. Illustrations and photographs of retouched lithics from Tor Faraj.

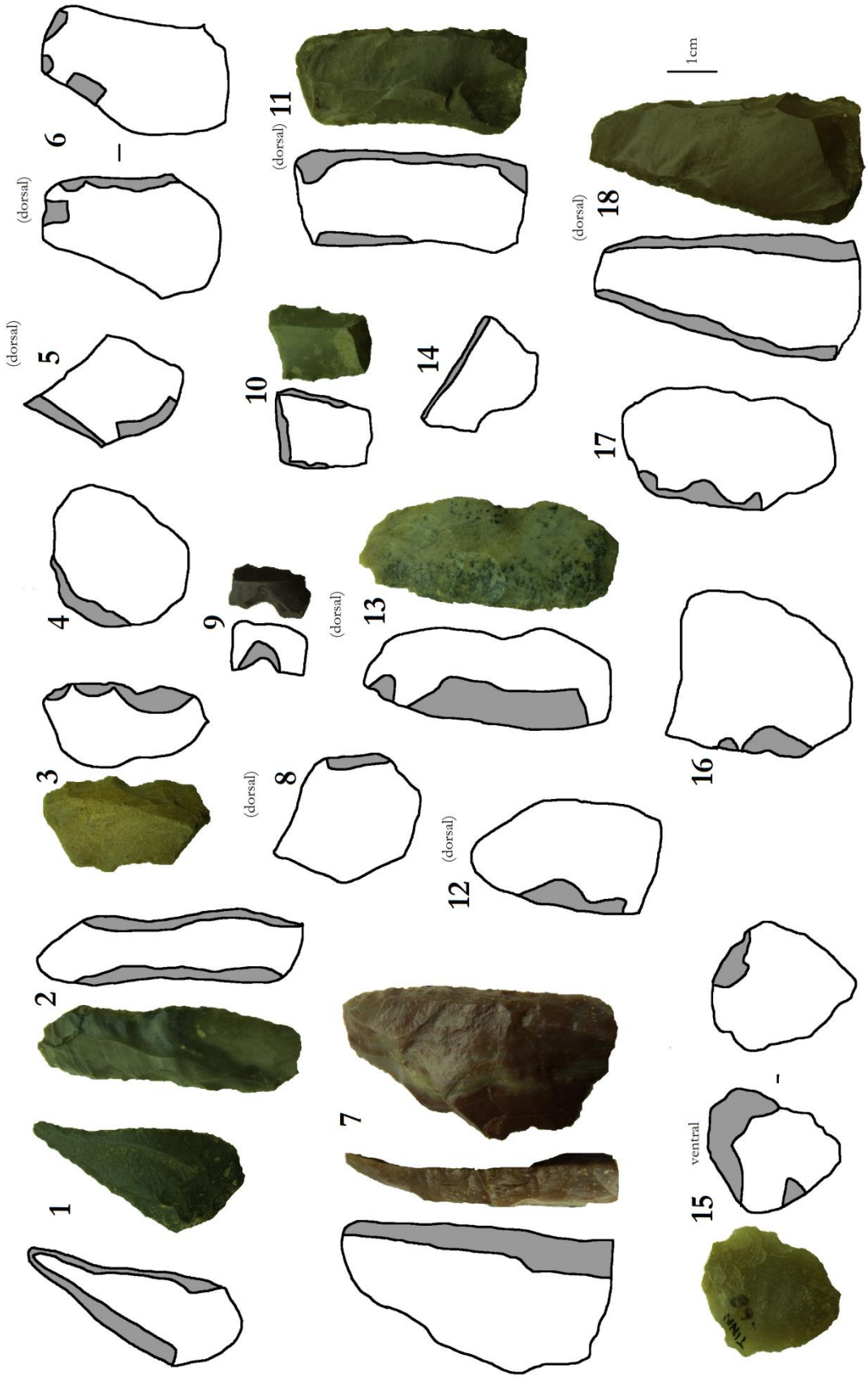



Figure 8.11. Illustrations and photographs of retouched lithics from Warwasi NNOO.




Figure 8.12. Illustrations and photographs of retouched from Warwasi WW.

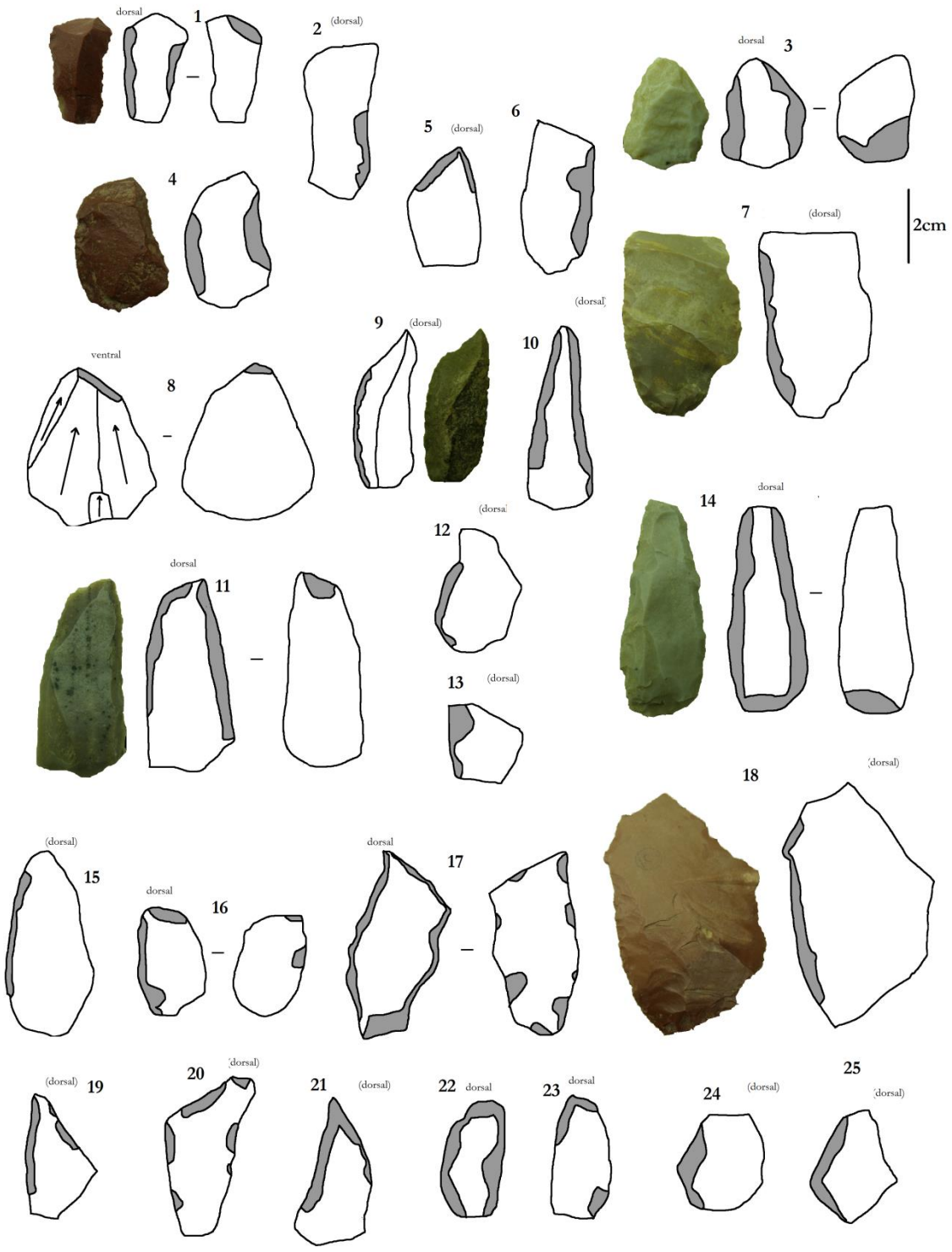



Figure 8.13. Illustrations and photographs of retouched Warwasi XX lithics.

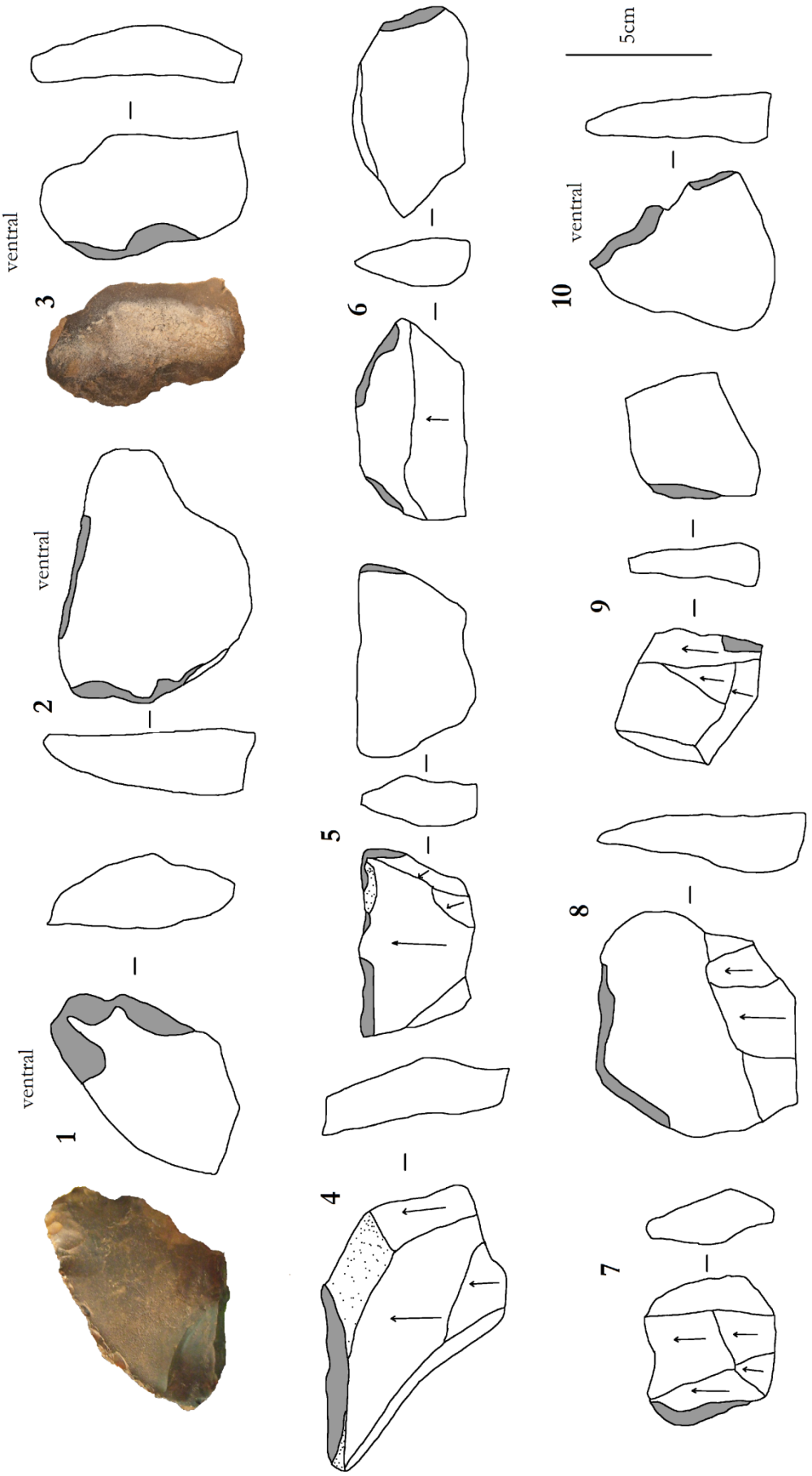



Figure 8.14. Illustrations and photographs of retouched lithics from 123-b.

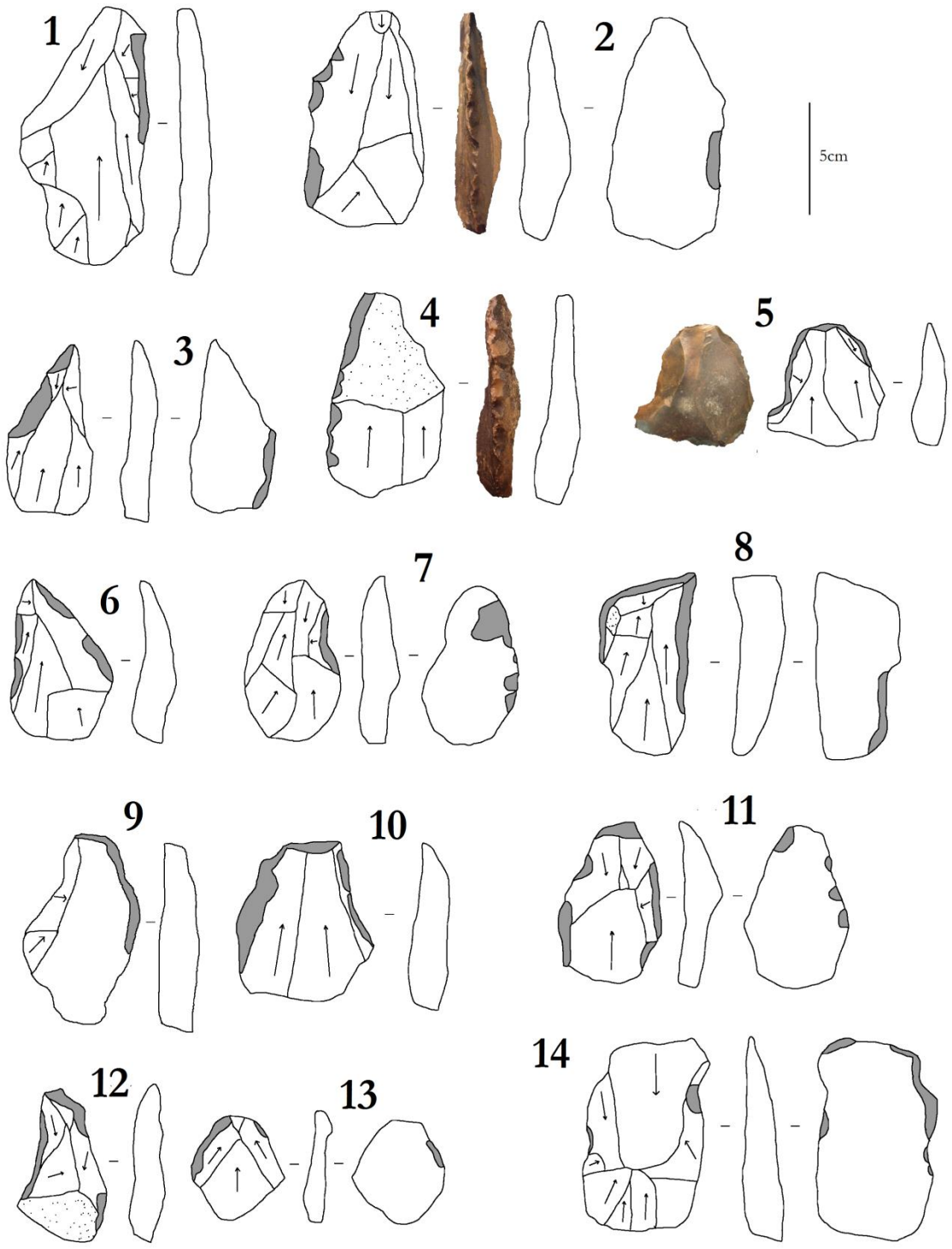



Figure 8.15. Illustrations and photographs of retouched lithics from 123-b.

### 8.4) Raw material composition

Raw material variation offers a number of important insights. Aside from demonstrating choices about which of the types of material retouched on site, diversity offers insights into the constellation of topics revolving around heuristics such as curation and mobility, i.e. were complete retouched pieces imported to a site in contrast to the primary reduction of other (local) raw materials?

| | **Flint** | | **Quartzite** | | **Quartz** | | **Basalt** | | **Indet.** | | **Obsidian** | | **Other fine. grained** | | **Rhyolite** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *JQ-1* | 7 | | 74 | 90 | 14 | | | . | 3 | . | | | | . | 2 | 10 |
| *JSM-1* | 1 | | 93 | 50 | 5 | | | | | 50 | | | | | | |
| *JKF-1* | 1 | | 79 | 30 | 19 | 60 | | | 5 | | | | <1 | | 1 | 10 |
| *JKF-12* | | | 99 | 100 | | | | | | | | | | | <1 | |
| *Porc Epic layer C* | 57 | 63 | 9 | 4 | | | 16 | 4 | 5 | | 12 | 26 | <1 | | | 4 |
| *Porc Epic layer E* | 62 | 62 | 6 | | 1 | | 14 | 6 | 10 | 12 | 17 | 17 | <1 | 2 | | 2 |
| *1010-8* | | | 100 | 100 | | | | | | | | | | | | |
| *Tor Faraj, floor 1* | 100 | 100 | | | | | | | | | | | | | | |
| *Warwasi NNOO* | 100 | 100 | | | | | | | | | | | | | | |
| *Warwasi WW XX* | 100 | 100 | | | | | | | | | | | | | | |
| *123-b* | 100 | 100 | | | | | | | | | | | | | | |

Table 8.11. Comparison of percentages of raw material type for debitage (left columns) and retouched pieces (retouched).

As Table 8.11 shows, in most cases the form of raw material – at least at a broad level and not considering variation within each basic raw material category – of retouched lithics are the same or very similar to those of the general debitage population. In the cases of 1010-8, Warwasi and 123-b the assemblages consist exclusively of one raw material type. An interesting factor to emerge at Jubbah is the dominance of quartz (64% of retouched lithics) at JKF-1. This is in contrast to the debitage, which is dominated by quartzite. This can be taken as indicating a preference for quartz for retouching.

The other key difference of interest is found at Porc Epic. Whereas layer E interestingly demonstrates very similar raw material use for unretouched and retouched components, albeit with slightly less basalt in the latter, layer C demonstrates a relatively high representation of obsidian in the retouched sample, an exotic raw material at the site. This perhaps suggests increased

mobility/raw material transport although given the sample size this is more of an indication than clear proof of something.

### 8.5) Condition/completeness/breakage

Notwithstanding varying conditions of collection and storage, inter-assemblage variation in completeness and patterns of breakage of retouched lithics offers insights into taphonomy and site function.

| | | *Transverse breakage* | | | *Longitudinal breakage* | | |
|---|---|---|---|---|---|---|---|
| | **Complete** | **proximal** | **medial** | **distal** | **right** | **medial** | **left** |
| *JQ-1 upper* | 7 (70) | 2 (20) | | | | | 1 (10) |
| *JSM-1* | 3 (75) | | | 1 (25) | | | |
| *JKF-1* | 8 (80) | | | 2 (20) | | | |
| *JKF-12* | 1 (100) | | | | | | |
| *Porc Epic layer C* | 22 (81) | 2 (7) | | 3 (11) | | | |
| *Porc Epic layer E* | 40 (77) | 5 (10) | | 7 (13) | | | |
| *1010-8* | 22 (88) | 1 (4) | | 1 (4) | 1(4) | | |
| *Tor Faraj, floor 1* | 35 (56) | 6 (10) | 2 (3) | 19 (31) | | | |
| *Warwasi NN + OO* | 18 (50) | 3 (8) | 3 (8) | 12 (33) | | | |
| *Warwasi WW + XX* | 44 (56) | 4 (5) | 4 (5) | 27 (34) | | | |
| *Mudday As Sodh (TH 123b)* | 25 (100) | | | | | | |

Table 8.12. Numbers and percentages of complete and types of broken retouched lithics.

Comparing the values shown in Table 8.12 to the patterns of breakage of debitage outlined in the previous chapter shows that retouched lithics are more commonly found in complete condition than are blanks. This presumably reflects the fact that much breakage occurs during the primary knapping process, after which blanks are selected for retouch. The relative rarity of proximal fragments is broadly similar to that for the debitage. Medial fragments are likewise similarly represented. It is, of course, difficult to tell whether blanks broke before or after being retouched, and this is a distinction of great importance if we wish to illuminate hominin choices in regard to which blanks to retouch. Longitudinally broken retouched lithics are quite rare.

The only category to differ much between retouched and unretouched blanks is the prevalence of distal fragments of the former in some assemblages. These are almost twice as common in the retouched than the unretouched component in the Warwasi assemblages. A similar situation occurs with Tor Faraj. For Porc Epic, however, there are rather less distal fragments for retouched than unretouched. It is unclear to what extent incomplete retouched components were retained from the Porc Epic excavations. As was suggested for the debitage, greater numbers of distal than proximal fragments may reflect the preferential removal of proximal fragments from sites.

**8.6) Cortex**

Aside from variation in the character of retouch, in terms of its position and invasiveness, a key concern is the demonstration of the type of blank chosen for retouch. This section offers the first such analysis, and poses whether blanks with particular proportions of cortical coverage were preferentially chosen.

| | ***0%*** | ***1-25%*** | ***26-50%*** | ***51-75%*** | ***>75%*** |
|---|---|---|---|---|---|
| ***JQ-1 upper*** | 9 (90) | | 1 (10) | | |
| ***JSM-1*** | 2 (50) | | | 2 (50) | |
| ***JKF-1*** | 3 (30) | 1(10) | | 1(10) | 5(50) |
| ***JKF-12*** | 1 (100) | | | | |
| ***Porc Epic layer C*** | 26 (96) | | | | 1 (4) |
| ***Porc Epic layer E*** | 46 (88) | 3 (6) | 2 (4) | 1 (2) | |
| **1010-8** | 21 (84) | 1 (4) | 3 (12) | | |
| ***Tor Faraj, floor 1*** | 54 (87) | 5 (8) | 2 (3) | | 1 (2) |
| ***Warwasi NNOO*** | 33 (92) | | 2 (6) | | 1 (3) |
| ***Warwasi WW XX*** | 72 (91) | 2 (3) | 3 (4) | 1 (1) | 1 (1) |
| ***TH 123b*** | 15 (60) | 7 (28) | 2 (8) | 1 (4) | |

Table 8.13. Breakdown of frequency and percentage of cortex on retouched artefacts.

| | ***% debitage with cortex*** | ***% retouched with cortex*** |
|---|---|---|
| ***JQ-1 upper*** | 32 | 10 |
| ***JSM-1*** | 56 | 50 |
| ***JKF-1*** | 49 | 60 |
| ***JKF-12*** | 71 | 0 |
| ***Porc Epic layer C*** | 14 | 4 |
| ***Porc Epic layer E*** | 17 | 12 |
| 1010-8 | | |
| ***Tor Faraj, floor 1*** | 28 | 13 |
| ***Warwasi NNOO*** | 13 | 9 |
| ***Warwasi WWXX*** | 13 | 9 |
| ***TH 123b*** | 49 | 40 |

Table 8.14. Comparison of frequency of cortex on debitage and retouched lithics.

It does not appear – with the possible exception of the small sample from JKF-1 – that cortical blanks were preferentially chosen. In fact, in all cases except that of JKF-1, a smaller percentage of retouched lithics have cortex than the in the total debitage population. With some partial exceptions discussed below, it appears that the prevalence of cortex on retouched artefacts merely reflects the prevalence of cortical blanks in that particular assemblage. The data then suggests at best a neutral attitude towards the selection of cortical blanks.

Some exceptions to the above generalisations are worthy of remark. The example of JKF-1 is of interest, as this is the only assemblage with a higher percentage of cortical retouched lithics than

cortical debitage. It does then appear that in this case there was a deliberate choice of cortical quartz blanks to retouch. The other interesting change is the difference between the Porc Epic assemblages. While layer E follows the typical relationship described above, layer C's retouched lithics have little cortex. Does this relate to the previously suggested indications of increased mobility/raw material exchange previously discussed?

Table 8.15 describes the position of cortex on retouched flakes. Comparing this data to the comparable figures for unretouched debitage, it appears that the retouched component follows the pattern of the unretouched. This reinforces the view that neither the presence of cortex, nor its particular location, appear to have been a major factor in choosing which blanks to retouch. The common categories in Table 8.15 - particularly distal, left lateral and right lateral are also amongst the most common locations for cortex in the blank population as a whole.

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***JQ-1 upper*** | | | | | | | | | | | | | | | | | 1 | |
| ***JSM-1*** | | | | | | | | | | | | | | | 2 | | | |
| ***JKF-1*** | | 4 | | | | | | | | | 1 | | | | | | 1 | |
| ***JKF-12*** | | | | | | | | | | | | | | | | | | |
| ***Porc Epic C*** | | 1 | | | | | | | | | | | | | | | | |
| ***Porc Epic E*** | | | | | 1 | | | | 1 | | | | | | | | 3 | |
| ***1010-8*** | | | | | 2 | | 1 | | 1 | | | | | | | | | |
| ***Tor Faraj, floor 1*** | 1 | | | | 2 | | 2 | | | 1 | | | | | | | 2 | |
| ***Warwasi NN/OO*** | 1 | | | | | | | | | 1 | | | | | | | 1 | |
| ***Warwasi WW/XX*** | 1 | | | | | | 4 | | | | | | | 1 | | | 1 | |
| ***123-b*** | | 1 | | | 3 | | 2 | | | | 1 | | | | 2 | | | |

Table 8.15. Position of cortex on complete blanks >20mm. 1-all dorsal, 2-platform and all dorsal, 3-both laterals, 4 – both laterals and distal, 5 – distal, 6 – distal and platform, 7 – left lateral, 8 – left lateral and distal, 9 – mesial, 10 – patchy, 11 – platform, 12 – platform and both laterals, 13 – platform and left lateral, 14 – platform and right lateral, 15 – proximal, 16 – proximal and distal, 17 – right lateral, 18 – right lateral and distal.

### 8.7) Distal terminations

The next area which will be examined in relation to the choice of blanks to be retouched is the character of the distal terminations of retouched pieces. The number and percentages of the different termination types are shown in Table 8.16.

| | ***Feather*** | ***Step*** | ***Hinge*** | ***Outrepassé*** | ***Indet*** |
|---|---|---|---|---|---|
| ***JQ-1*** | | 2 (15) | 1 (8) | | 10 (77) |
| ***JSM-1*** | | | | | 2 (100) |
| ***JKF-1*** | 1 (10) | 1 (10) | 1 (10) | | 7 (70) |
| ***JKF-12*** | 1 (100) | | | | |
| ***Porc Epic layer C*** | 11 (41) | | 2 (7) | 1 (4) | 13 (48) |
| ***Porc Epic layer E*** | 20 (38) | 8 (15) | 2 (4) | | 22 (42) |
| ***1010-8*** | 12 (48) | 3 (12) | 1 (4) | | 9 (36) |
| ***Tor Faraj, floor 1*** | 18 (29) | 9 (15) | 5 (8) | 2 (3) | 28 (45) |
| ***Warwasi NN + OO*** | 11 (31) | 3 (8) | 2 (6) | | 20 (56) |
| ***Warwasi WW + XX*** | 28 (35) | 10 (13) | 9 (11) | | 32 (41) |
| ***TH-123b*** | | 1 (4) | 8 (32) | | 16 (64) |

Table 8.16. Number and percentage of distal termination types. Does not including bifaces.

The key feature to note is the very high proportion of indeterminate terminations, reflecting retouch of the distal end, damage or types which do not neatly class. This makes it difficult to say much about the choice of blanks with particular distal terminations for retouch. In some cases – Porc Epic E, 1010-8, Tor Faraj, Warwasi WWXX and 123-b – there is a greater combined percentage of retouched pieces with step and hinge terminations than in the general bank population, but the differences are modest and are not present in the other assemblages. This might indicate a subtle tendency to choose blanks with step and hinge terminations in some assemblages, but such a hypothesis clearly needs to be tested against further evidence in assemblages with less indeterminate distal ends.

### 8.8) Striking platform characteristics

What do the varying manifestations of platform types indicate? Again, it is unfortunate that quite large numbers of platform types are recorded as indeterminate, reflecting factors such as the retouching of the proximal end and crushing/shattering of platforms. Comparing Table 8.17 above to the equivalent table for unretouched debitage reveals some similarities and differences.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assemblage mean plat. size** | 204.4 | 410.4 | 241.9 | | 93.5 | 119.0 | 463.0 | 125.7 | 82.7 | 76.5 | 504.4 |
| **Assemblage mean relative platform size** | 9.2 | 2.8 | 8.9 | | 20.1 | 16.0 | 10.8 | 22.7 | 18.3 | 27.3 | 9.1 |
| **N. plain** | 4 (40) | | 2 (20) | 1 (100) | 6 (22) | 12 (23) | 11 (44) | 8 (13) | 14 (39) | 11 (14) | 2 (8) |
| **Mean size** | 106.0 | | 164.7 | 2649.4 | 53.6 | 76.0 | 344.9 | 65.5 | 52.4 | 47.2 | 588.2 |
| **Mean relative size** | 14.8 | | 21.0 | 2.4 | 24.1 | 28.6 | 14.1 | 39.9 | 22.2 | 42.0 | 8.2 |
| **N. cortical** | | | 5 (50) | | 1 (4) | 1 (2) | 2 (8) | 2 (3) | | | 1 (4) |
| **Mean size** | | | 256.1 | | 41.4 | 128.9 | 562.2 | 208.2 | | | 759.5 |
| **Mean relative size** | | | 5.6 | | 48.3 | 9.4 | 7.4 | 13.2 | | | 5.1 |
| **N. dihedral** | 1 (10) | | | | | 1 (2) | 1 (4) | | 1 (3) | 4 (5) | 3 (12) |
| **Mean size** | 244.3 | | | | | 152.2 | 426.1 | | 122.4 | 123.6 | 359.8 |
| **Mean relative size** | 7.4 | | | | | 8.2 | 5.7 | | 7.1 | 8.1 | 10.1 |
| **N. faceted** | 3 (30) | 1 (50) | 1 (10) | | 12 (44) | 20 (38) | 8 (32) | 16 (26) | 7 (19) | 16 (20) | 14 (56) |
| **Mean size** | 350.9 | 410.4 | 311.4 | | 117.5 | 142.6 | 605.3 | 157.8 | 135.6 | 91.6 | 498.1 |
| **Mean relative size** | 5.3 | 2.8 | 5.0 | | 15.6 | 9.3 | 7.8 | 10.4 | 12.9 | 22.2 | 9.2 |
| **N. missing/indet** | 2 (20) | 1 (50) | 2 (20) | | 8 (30) | 18 (35) | 3 (12) | 36 (58) | 14 (39) | 48 (61) | 5 (20) |

Table 8.17. Platform morphology and associated metric attributes for retouched lithics. All sizes (not relative sizes) in $mm^2$. The first two rows show mean values for the complete retouched assemblage, which is then divided by platform types.

Although JQ-1 is a small assemblage, it is interesting to note the similar figures for platform types for both the retouched and unretouched components. The only difference of note is the greater representation of faceted platforms on retouched pieces (30% versus 14%).

In the case of JKF-1, the major change relates to the substantial representation of cortical platforms in the retouched component (50% versus 7%), and the concomitant reduction in the other categories. This is the only assemblage to have a large frequency of cortical platforms for retouched

blanks. This fits with the earlier observation that cortical blanks were preferentially chosen for retouch at JKF-1.

The Porc Epic assemblages demonstrate a similar structure for the most part, with, for instance, both sharing broadly similar frequencies of faceted platforms both between each other and between their retouched and unretouched components. The only difference in this regard relates to a higher representation of faceted platforms on retouched pieces in comparison to the proportion of faceted blanks in layer C.

Plain platforms are well represented amongst the retouched component of 1010-8, more so, in fact, that in any other assemblage. Faceted blanks were used at the same frequency as they are present in the general blank population.

Tor Faraj is difficult to interpret given its particularly high representation of indeterminate platforms amongst its retouched tools. The same applies to Warwasi WWXX. In both of these cases the number of faceted platforms appears to be about the same, but given that a majority of platform types cannot be identified, care needs to be exercised in interpretation.

Warwasi NNOO has rather fewer indeterminate platforms than WWXX, and demonstrates a very similar structure of unretouched platform types to retouched. In this case then it does not appear that blanks with particular platform types were preferentially selected for retouch.

The other assemblage to demonstrate differences between unretouched and retouched elements is 123-b. Whereas the unretouched component is dominated by plain (40%) and indeterminate (30%) platforms, the retouched component is dominated by faceted platforms (56%), which only made up 15% of the unretouched component. In this case then it does appear that there is a deliberate selection of faceted blanks for retouch.

The mean size of plain platforms is similar for both unetouched and retouched blanks in the Porc Epic assemblages, Tor Faraj and the Warwasi assemblages. In the cases of JQ-1 and JKF-1, plain platforms on retouched pieces are rather larger than on debitage, while at 1010-8 and 123-b the opposite pattern is observed. In terms of relative platform size three groups can be defined. Those

will relatively large platforms (index of <15), consisting of JQ-1, JKF-1 and 123b, those with medium values (17-20), the Porc Epic assemblages and 1010-8, and finally, those with relatively small platforms (large blanks for size of platforms, >20), consisting of Tor Faraj and the Warwasi assemblages. Of note are the closely similar values for the relative size of plain platforms for the Warwasi assemblages, which have rather different mean sizes for unretouched plain platforms. This then suggests selection of blanks with particular relative platform sizes.

With cortical platform sizes, which are not particularly common, the overall picture is that platform sizes are similar for retouched and unretouched. At JKF-1, for instance and where they are relatively common, the mean size of cortical platforms on unretouched blanks is 208.4mm$^2$, while for retouched it is 256.1 mm$^2$ . Relative platform sizes are likewise similar.

Finally, in the case of faceted platforms in the cases of Porc Epic, Tor Faraj, Warawasi WW/XX and 123-b mean values for platform sizes of retouched and unretouched flakes are similar, suggesting the size of the platform was not a particularly important characteristic in choosing which blanks to retouch. In some assemblages though – JQ-1, 1010-8 and Warwasi NNOO – faceted platforms are quite substantially smaller on average for retouched than unretouched blanks. This may indicate selection of blanks with thin proximal ends for retouch in these assemblages.

### 8.9) Dorsal scar patterns

Table 8.18 presents count and percentages of the scar patterns found on retouched blanks.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***JQ-1*** | 5 (50) | | | | | | | | 3 (30) | 1 (10) | | 1 (10) |
| ***JKF-1*** | 1 (10) | 1 (10) | | | | | | 1 (10) | 1 (10) | | | 6 (60) |
| ***Porc Epic C*** | 10 (37) | | | | | | | | 5 (19) | 3 (11) | 3 (11) | 6 (22) |
| ***Porc Epic E*** | 22 (42) | 1 (2) | | | | | 1 (2) | | 1 (2) | 8 (15) | | 19 (37) |
| ***1010-8*** | 9 (36) | 1 (4) | | 1 (4) | | 1 (4) | | 2 (8) | | 4 (16) | 5 (20) | 2 (8) |
| ***Tor Faraj,*** | 32 (52) | 4 (6) | | | | 1 (2) | | | 7 (11) | 1 (2) | | 17 (27) |
| ***Warwasi NNOO*** | 14 (39) | 1 (3) | | | | | 1 (3) | | | | 2 (6) | 18 (50) |
| ***Warwasi XXWW*** | 25 (32) | 11 (14) | | | 1 (1) | | | | | 2 (3) | | 40 (51) |
| ***TH 123b*** | 8 (32) | 8 (32) | 1 (4) | | 1 (4) | | | 1 (4) | 1 (4) | 3 (12) | | 1 (4) |

Table 8.18. Numbers (and percentages) of different dorsal scar patterns for each assemblage. 1 – from proximal, 2 – bidirectional, 3 – from left, 4 – from both laterals, 5 – from distal, 6 – from distal and lateral, 7 – from proximal and from right, 8 – from proximal and from left, 9 – from proximal convergent, 10 – weakly radial, 11 – strongly radial, 12 – indeterminate/cortical.

How do the dorsal scar patterns of retouched blanks compare to those on the unretouched debitage? Only the most common forms of scar pattern will be considered here, given the small sample sizes involved.

From proximal scar patterns are found somewhat higher levels in the retouched than the unretouched component of JQ-1, but not dramatically so. In both cases this is the most common scar pattern. At Porc Epic from proximal scar patterns account for around 40% of scar patterns, on both retouched and unretouched blanks. Likewise unretouched and retouched are broadly similar in this regard at 1010-8, Tor Faraj, Warwasi NNOO and 123b. In Warwasi XXWW, however, although 45% of the blanks have from proximal scar patterns, only 32% of the retouched pieces do.

In the case of bidirectional scar patterns, these are underrepresented in the retouched component of Porc Epic, 1010-8 and Warwasi NNOO. At 1010-8, for instance, they are three times more common on the debitage than on the retouched sample. At Tor Faraj bidirectional scar patterns are found in approximately equal measure on retouched and unretouched pieces. Finally, in the cases of Warwasi XXWW and 123-b bidirectional scar patterns are more common among retouched than

unretouched lithics. In the latter case there are almost three times as great a percentage of bidirectional scar patterns in the retouched material. In this case it seems that in the case of some assemblages bidirectional scar patterns were positively selected for retouch, while in other cases they were avoided.

With from proximal convergent scar patterns the most interesting variation is found at Porc Epic. Here this scar pattern is similarly represented in the unretouched blanks of Layer C (8%) and E (6%). When it comes to the retouched component, however, these figures increase to 19% in layer C and decrease to 2% in layer E. In other assemblages a similar proportion is found in the retouched and unretouched components.

Here weakly and strongly radial scar patterns are considered together. For Warwasi and Tor Faraj radial scar patterns are found at similar (low) levels for both. In the other cases, however, radial scar patterns are less well represented in retouched than in unretouched lithics. For example, in Porc Epic E the figures are 26% and 15% respectively.

Notwithstanding the high levels of indeterminate scar patterns (including fully cortical blanks), which forms a rather higher percentage in most assemblages in the retouched than the unretouched component, it does appear that in general flakes with radial scar patterns were not selected for retouch, while in some cases bidirectionally scared flakes were preferentially chosen, this was not always the case. In other words there is not a simplistic relationship between dorsal scar patterns and the choice of blanks for retouch.

### 8.10) Size and shape variation

This section explores the basic size and shape attributes of retouched lithics, using the same attributes which were used to describe blank variability in Chapter 7. Tables 8.19 to 8.24 present descriptive statistics for complete retouched artefacts, not including bifaces. As with previous categories the aim is to elucidate the character of blanks chosen for retouch. As with blanks, basic description will focus on central tendencies.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010-8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 7 | 1 | 22 | 38 | 22 | 34 | 18 | 43 | 25 |
| **Min.** | 9.7 | 12.8 | 7.1 | | 0.9 | 0.6 | 31.2 | 0.4 | 0.9 | 2 | 17.5 |
| **Max** | 26.7 | 21.8 | 27.1 | | 34.4 | 24.4 | 287.6 | 44.6 | 14.8 | 57.1 | 130 |
| **Mean.** | 19.5 | 17.3 | 20.1 | 191.6 | 11.3 | 9.9 | 91.7 | 14.6 | 7.3 | 10.6 | 65.7 |
| **St dev** | 7.3 | | 6.4 | | 8.9 | 5.8 | 64.7 | 10.0 | 4.0 | 9.9 | 31.2 |
| **25 %** | 10 | | 17.3 | | 4.6 | 5.8 | 52.4 | 6.25 | 3.7 | 5.3 | 43.7 |
| **75 %** | 25.8 | | 23.8 | | 16.2 | 14.6 | 115.7 | 19.8 | 10.5 | 11.9 | 87.1 |
| **Skewness** | -0.6 | | -1.6 | | 1.1 | 0.6 | 2.9 | 1.0 | 0.5 | 3.3 | 0.6 |
| **Kurtosis** | -1.8 | | 3.0 | | 0.7 | -0.3 | 76.3 | 1.1 | -0.5 | 12.9 | -0.7 |

Table 8.19. Weight (g) for complete retouched blanks.

The 'primary' sites, particularly 1010-8 and 123-b, have heavy retouched blanks. The other sites typically have much smaller retouched pieces. The material from Jubbah is typically a little heavier than that of the remaining sites. Compared to unretouched blanks, retouched pieces are, on average, lighter at JQ-1, JK-1 and 123-b, but in most cases, at Porc Epic, Warwasi, 1010-8 and Tor Faraj, retouched pieces are heavier. For example mean weights for unretouched and retouched respectively are 6.1g and 10.6g for Warwasi WWXX, 59.5 and 91.7 g for 1010-8. On the other hand, for JKF-1, the mean unretouched weight is 33.9 g and 20.1g for retouched pieces. The interquartile range for retouched weights is of interest. Not including the 'primary' sites, it is notable that the weight range is typically rather narrow. It appears then that knappers were selecting broadly heavier blanks for retouch, and then within quite a narrow range of around 10-15 grams in most cases. This is shown graphically in Figure 8.16, which compares the figures for 25% and 75% for unretouched and retouched components. The retouched values are typically both larger and less varied. The trend for retouched artefacts to be heavier than the unretouched is seen most strongly in Porc Epic C, 1010-8, Tor Faraj and Warwasi. In all of these cases the 75% value for weight is considerably greater than the equivalent value for unretouched blanks.

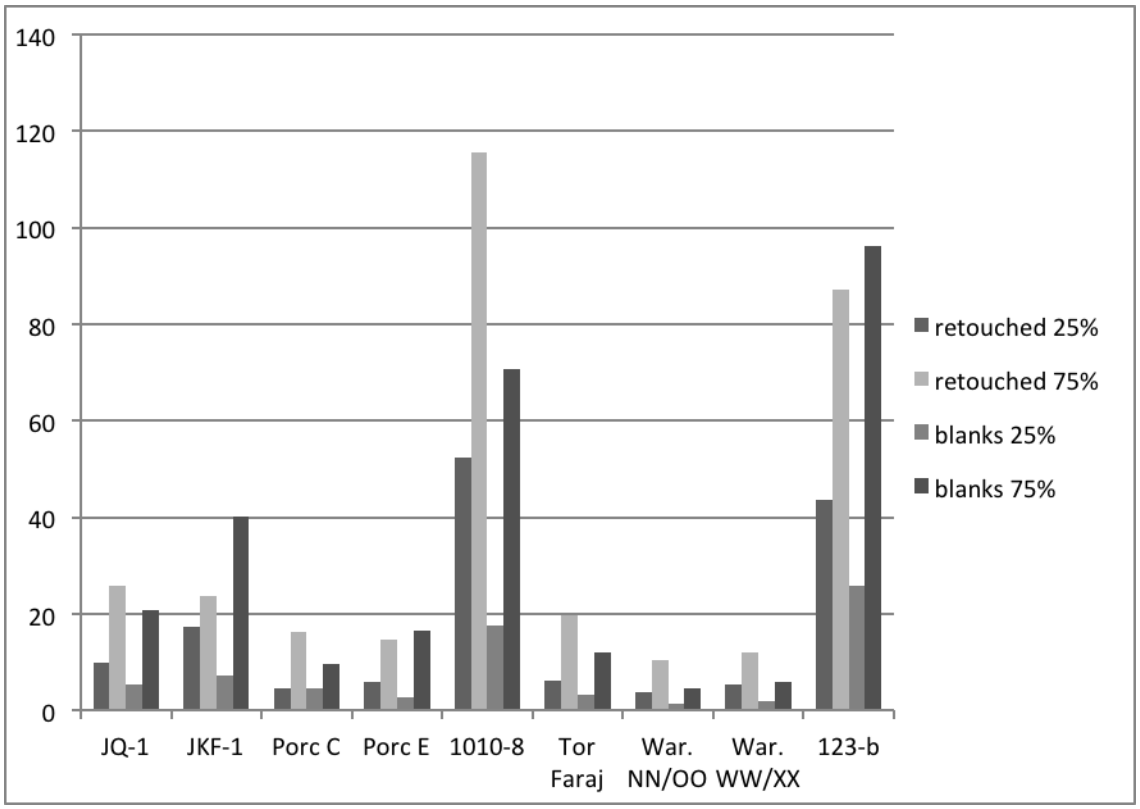


Figure 8.16. Bar chart of interquartile values of weight (g) for complete retouched and unretouched pieces.

| | JQ-1 | JSM-1 | JKF-1 | JKF-12 | Porc C | Porc E | 1010-8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 7 | 1 | 22 | 38 | 22 | 34 | 18 | 43 | 25 |
| **Min.** | 28.1 | 32.1 | 35.2 | | 20.5 | 0.6 | 40.5 | 23.1 | 16.9 | 23.8 | 32.4 |
| **Max** | 66.3 | 41.4 | 69.4 | | 70.4 | 60.29 | 97.8 | 87.9 | 57.8 | 109.4 | 115.8 |
| **Mean.** | 44.4 | 36.7 | 49.0 | 57.5 | 41.7 | 38.6 | 68.0 | 52.2 | 38.0 | 46.6 | 67.8 |
| **St dev** | 13.3 | | 11.2 | | 13.8 | 11.8 | 19.3 | 17.6 | 13.1 | 18.0 | 20.4 |
| **25 %** | 35.0 | | 39.6 | | 32.9 | 32.3 | 50.7 | 37.4 | 28.3 | 33.8 | 55.4 |
| **75 %** | 56.7 | | 54.9 | | 45.8 | 46.2 | 86.7 | 62.4 | 47.6 | 56.2 | 80.0 |
| **Skewness** | 0.6 | | 0.9 | | 0.6 | -0.8 | 0.2 | -0.7 | 0.0 | 1.7 | 0.3 |
| **Kurtosis** | -0.5 | | 1.1 | | 0.0 | 1.8 | -1.5 | 49.3 | -1.0 | 4.2 | 0.1 |

Table 8.20. Technical length (mm) for complete retouched blanks.

A similar picture emerges in relation to the length of retouched blanks. In all assemblages the mean length is greater for retouched blanks. Aside from 1010-8 and 123-b, we can observe a considerable similarity between the lengths of retouched pieces in the different assemblages. For JQ-1, JKF-1, Porc Epic, 1010-8, Tor Faraj and Warwasi the mean lengths for retouched pieces varies from 39 mm to 52mm, with the 25% range varying from 32 to 40 mm, indicating a strongly convergent range for the acceptable lower length of blanks to be retouched, and the 75 % from 46 to 62mm, and here the upper range is strongly increased by Tor Faraj. These values that blanks selected for retouch were both long and typically fell within a narrow range of variability.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 7 | 1 | 22 | 38 | 22 | 34 | 18 | 43 | 25 |
| **Min.** | 18.1 | 24.9 | 16.1 | | 10.6 | 7.8 | 29.4 | 3.2 | 7.9 | 12.5 | 27.4 |
| **Max** | 36.4 | 39.1 | 41.0 | | 39.5 | 34.4 | 80.0 | 46.3 | 31.8 | 40.7 | 82.6 |
| **Mean.** | 26.8 | 34.0 | 27.1 | 62.8 | 24.1 | 22.6 | 48.2 | 26.5 | 21.7 | 23.3 | 48.2 |
| **St dev** | 6.4 | | 7.9 | | 6.4 | 2.5 | 14.3 | 9.0 | 5.7 | 5.6 | 13.3 |
| **25 %** | 21.3 | | 21.3 | | 18.8 | 17.3 | 36.8 | 19.6 | 16.9 | 20.1 | 38.1 |
| **75 %** | 32.6 | | 31.2 | | 28.5 | 28.5 | 56.1 | 33.9 | 25.4 | 26.4 | 56.1 |
| **Skewness** | 0.2 | | 0.6 | | 0.4 | -0.3 | 0.9 | -0.2 | -0.6 | 0.8 | 1.0 |
| **Kurtosis** | -0.7 | | 1.1 | | 0.6 | -0.4 | 0.1 | 0.22 | 0.7 | 1.1 | 0.5 |

Table 8.21. Width at mid-point (mm) for complete retouched blanks.

A similar situation exists in regards to the width of retouched blanks as was described above for length, but while the means for width are greater for retouched than unretouched blanks in all assemblages, they are less significantly greater than was the case for length. Once again the relative homogeneity, across assemblages can be noted. In most cases around 10mm separates the interquartile values indicating strong selection for particular widths. In the case of Warwasi WWXX this is particularly clear, and this in the assemblage with the largest sample size of complete retouched pieces. Here the 25% value is 20.1mm, the mean 23.3mm and the 75% 26.4 mm. This narrow range of variability clearly indicates the selection criteria applied by knappers.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 7 | 1 | 22 | 38 | 22 | 34 | 18 | 43 | 25 |
| **Min.** | 7.98 | 10.9 | 8.3 | | 2.4 | 2.9 | 9.1 | 3.9 | 3.0 | 2.9 | 6.7 |
| **Max** | 11.7 | 12.7 | 15.4 | | 15.6 | 14.3 | 28.4 | 14.1 | 13.4 | 16.7 | 21.2 |
| **Mean.** | 10.3 | 11.8 | 11.6 | 29.6 | 8.2 | 8.1 | 15.7 | 7.7 | 6.7 | 6.7 | 13.6 |
| **St dev** | 1.4 | | 2.4 | | 3.4 | 2.5 | 4.7 | 2.6 | 2.4 | 2.4 | 3.7 |
| **25 %** | 9.2 | | 9.2 | | 5.5 | 6.3 | 12.5 | 5.3 | 4.8 | 5.3 | 10.5 |
| **75 %** | 11.5 | | 13.4 | | 10.3 | 9.9 | 18.3 | 9.1 | 7.7 | 7.7 | 16.4 |
| **Skewness** | -0.8 | | 0.2 | | 0.7 | 0.3 | 0.8 | 0.6 | 1.1 | 1.9 | 0.1 |
| **Kurtosis** | -0.4 | | -0.4 | | 7.5 | 0.0 | 1.0 | -0.2 | 2.3 | 6.6 | -0.6 |

Table 8.22. Thickness at medial (mm) for complete retouched blanks.

Thickness again repeats the pattern described above. With the exception of 123-b, the retouched component is on average thicker than the unretouched in all assemblages. There is once again considerable homogeneity here, as shown below in Figure 8.17. The values for JQ-1 and JKF-1 are a little larger than the other, more heavily reduced, assemblages (although the similarity of the Jubbah material to each other can be noted). Of these – Porc Epic, Tor Faraj and Warwasi - there is a remarkable similarity in the variability of the thickness of retouched pieces. Mean values range from 6.7 mm to 8.2 mm, a remarkably narrow variability. Values for 25 and 75 percentiles vary

from 4.8 to 6.3 mm and 7.7 to 10.3 mm respectively. The remarkable internal consistency of Porc Epic and Warwasi is also clear.

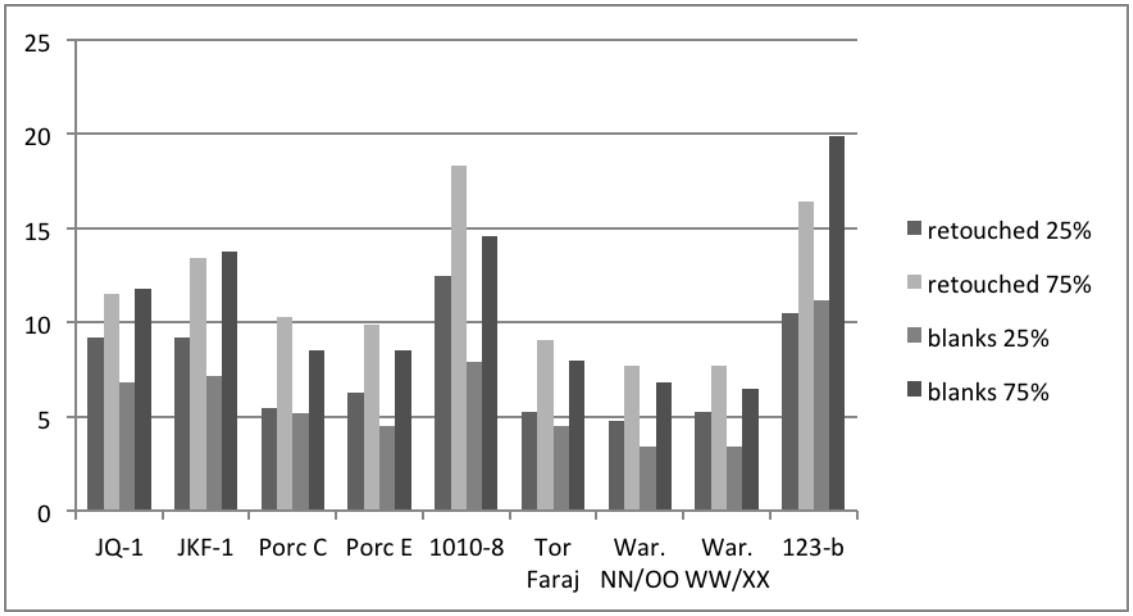


Figure 8.17. Bar charts of interquartile values of thickness (mm) values for retouched and unretouched pieces.

Tables 8.23 and 8.24 provide information on the length of the margins of retouched blanks. This attribute was not collected on unretouched blanks due to time constraints, but to do so is definitely a worthwhile endeavour. If retouch is largely about rejuvenating the usability of an edge then clearly the length of available edge on a blank in in theory an important concern in selecting blanks for retouch.

In terms of the length of the margins for complete blanks, remarkable homogeneity is again clear. With the exception of JKF-12 and 123-b, the mean values for all assemblages fall within the range of 102-135 mm.

| | **JQ-1** | **JSM -1** | **JKF -1** | **JKF -12** | **Porc C** | **Porc E** | **1010 -8** | **Tor Faraj** | **War. NNOO** | **War. WWXX** | **123- b** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 8 | 1 | 19 | 37 | 20 | 35 | 20 | 44 | 25 |
| **Min.** | 88 | 110 | 82 | | 59 | 50 | 151 | 51 | 50 | 68 | 132 |
| **Max** | 162 | 120 | 175 | | 163 | 153 | 303 | 214 | 142 | 240 | 288 |
| **Mean.** | 129 | 115 | 130. 6 | 240 | 109. 0 | 106. 5 | 211. 5 | 135.4 | 102.0 | 122.2 | 213. 8 |
| **St dev** | 22.6 | | 26.9 | | 29.5 | 23.1 | 50.4 | 37.9 | 26.0 | 35.2 | 46.2 |
| **25 %** | 100 | | 117 | | 87.5 | 89 | 171 | 107 | 85 | 95.3 | 180 |
| **75 %** | 140 | | 147 | | 123 | 118 | 236 | 164 | 122 | 139.3 | 261 |
| **Skewness** | -0.3 | | -0.2 | | 0.6 | -0.2 | 0.8 | 0.2 | -0.4 | 1.6 | 0.2 |
| **Kurtosis** | -0.5 | | 1.4 | | -0.2 | 0.0 | -0.6 | -0.2 | -0.5 | 3.8 | -1.1 |

Table 8.23. Length of margins (mm) for complete retouched blanks.

It is of interest that the length of margins for broken retouched blanks is remarkably similar to that of complete specimens. This may suggest that in many cases the retouch was carried out after the breakage of the blank. To test such propositions detailed microscopy studies are needed. If large numbers of the breaks occurred after retouch we might expect rather different values for the length of the margins on these pieces. For a prehistoric retoucher of course it would matter little if the lithic they were knapping was a complete blank or not, if it met perceived metrical requirements.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010-8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 10 | 2 | 10 | 1 | 23 | 47 | 23 | 62 | 35 | 78 | 25 |
| **Min.** | 93 | 110 | 82 | | 59 | 43 | 126 | 51 | 50 | 58 | 132 |
| **Max** | 162 | 120 | 175 | | 163 | 153 | 303 | 214 | 159 | 240 | 288 |
| **Mean.** | 125.9 | 115 | 131.7 | 240 | 105.9 | 104.2 | 205.8 | 129.3 | 97.9 | 109.2 | 213.8 |
| **St dev** | 23.0 | | 26.6 | | 274 | 24.3 | 50.8 | 36.3 | 29.9 | 36 | 46.2 |
| **25 %** | 100 | | 114 | | 88 | 85 | 168 | 99 | 74 | 83 | 180 |
| **75 %** | 142 | | 153 | | 119 | 118 | 236 | 153 | 119 | 128 | 261 |
| **Skewness** | -0.1 | | -0.2 | | 0.9 | -0.3 | 0.8 | -.2 | 0.3 | 1.4 | 0.2 |
| **Kurtosis** | -1.1 | | -0.4 | | 0.4 | 0.1 | -0.2 | -0.5 | -0.7 | 3.1 | -1.1 |

Table 8.24. Length of margins (mm) for all retouched blanks.

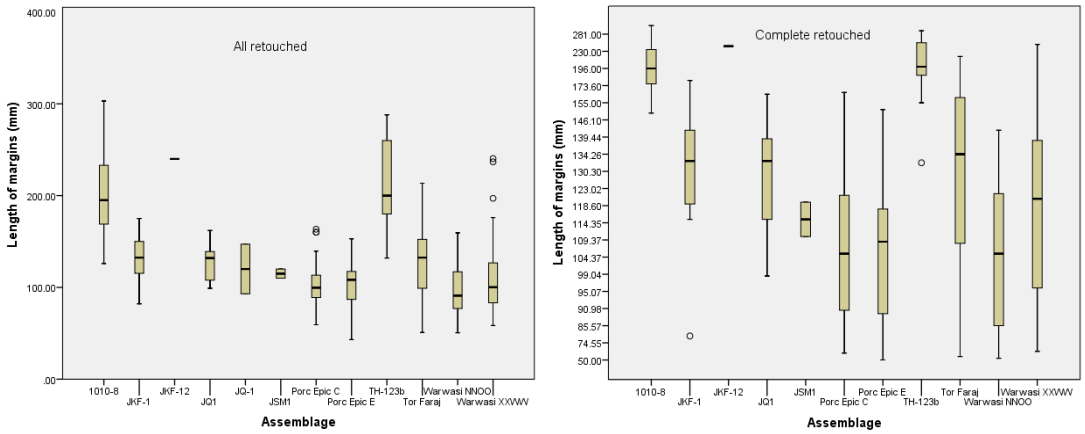



Figure 8.18. Boxplots of length of margins (mm) for all retouched pieces (left) and complete retouched pieces(right).

**8.11) Position of retouch**

Having considered the types of blanks which are retouched, we will now address the character of retouch itself, beginning with where on the blanks retouch was applied in the different assemblages.

| | ***Dorsal only*** | ***Ventral only*** | ***Both*** | ***Indet*** |
|---|---|---|---|---|
| ***JQ-1*** | 6 (60) | 3 (30) | 1 (10) | / |
| ***JSM-1*** | 2 (100) | / | / | / |
| ***JKF-1*** | 1 (10) | 7 (70) | 2 (20) | / |
| ***JKF-12*** | 1 (100) | / | / | |
| ***Porc Epic layer C*** | 19 (70) | 2 (7) | 5 (19) | 1 (4) |
| ***Porc Epic layer E*** | 34 (65) | 2 (4) | 9 (17) | 6 (12) |
| **1010-8** | 12 (48) | 8 (32) | 5 (20) | / |
| ***Tor Faraj, floor 1*** | 28 (45) | 19 (31) | 15 (24) | / |
| ***Warwasi NN + OO*** | 28 (78) | 1 (3) | 7 (19) | / |
| ***Warwasi WW + XX*** | 57 (72) | 4 (5) | 18 (23) | / |
| ***TH 123b*** | 10 (40) | 4 (16) | 10 (40) | 1 (4) |

Table 8.25. The face(s) retouched for all retouched pieces.

As shown in Table 8.25, there exists considerable diversity in which face, or faces, were retouched. In the cases of Porc Epic and Warwasi (in particular) retouch of the dorsal surface only was dominant, occurring in 65 to 78% of cases, while in a further 17-23% of cases both faces were retouched. Retouch of the ventral surface is unusual in these cases. On the other hand at JQ-1, JKF-1, 1010-8 and Tor Faraj retouch of the ventral surface is common, typically at around 31% but reaching 70% in the small sample from JKF-1. These assemblages also feature a high proportion of blanks with retouch on both faces. In these sites then, with the exception of JQ-1, a majority of examples include retouch on the ventral surface, either alone or in combination with the dorsal surface. At 123-b limited retouch exclusively on the ventral surface does occur, but most retouch is found either only on the dorsal surface or, equally commonly, on both surfaces.

Given the apparent similarity in terms of metric attributes of blanks chosen for retouch discussed previously, it seems hard to see a purely 'functional' basis for these differences in which face(s) were retouched. This can be hypothesised to represent a genuine 'cultural' difference, although what exactly it means is unclear and, clearly, it is something which could repeatedly appear and reappear so does not constitute a good 'phylogenetic' marker.

Figure 8.19 shows a more detailed perspective on the distribution of retouch on artefacts. It divides the dorsal and ventral faces into the segments defined by Clarkson (2002). The percentages refer to

the total percentage of examples in which that sector is retouched out of the cumulative number of retouched segments for that assemblage.

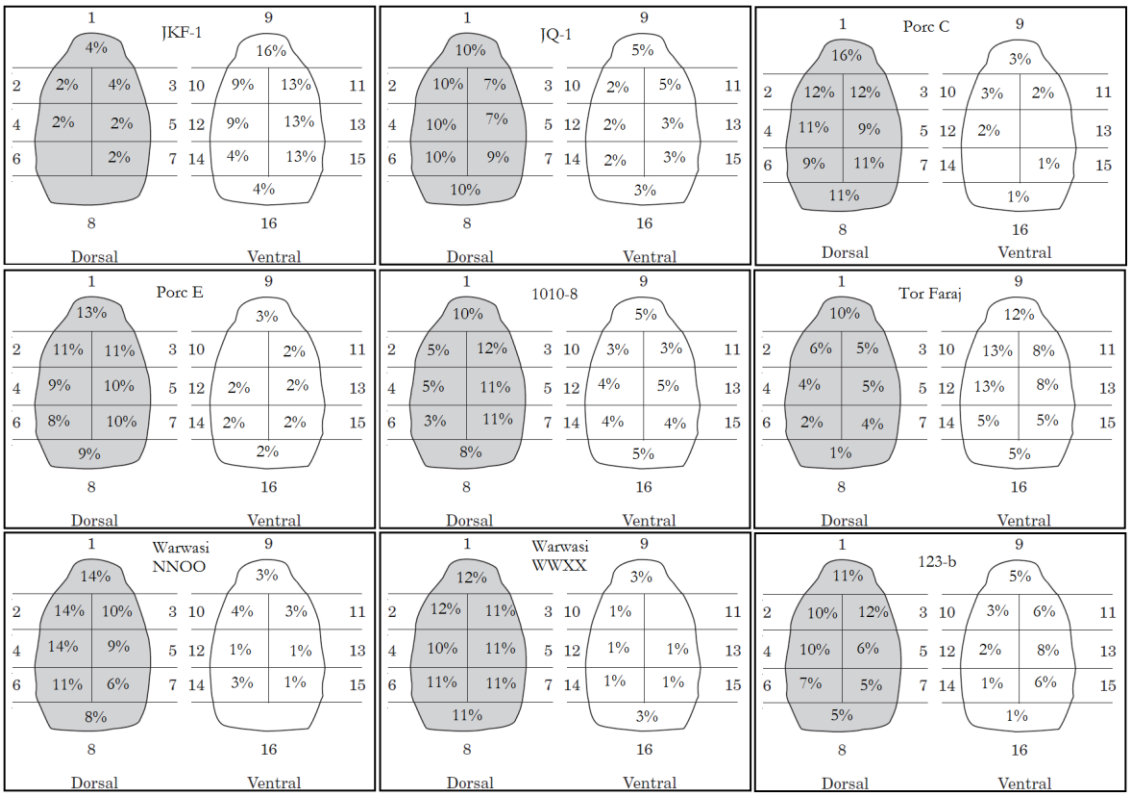


Figure 8.19. Position of retouch on complete blanks. Shows percentage of retouch of each segment according to the total number of retouched segments in that assemblage.

Give the small sample sizes involved, particularly in the case of Jubbah, and the effects that even one or two pieces will have on the percentages shown in Figure 8.19, we must be careful not to over interpret the distribution of retouch. Nevertheless, differences between assemblages are clearly suggested.

In the case of JKF-1 there is not much retouch on the dorsal surface, it is mostly on the ventral surface and here particularly focussed distally and on the left (NB: here and subsequently all references to left and right refer to a perspective of the blank with the dorsal upwards and proximal towards the viewer, so right on the ventral surface in the figure above is described here as left). JQ-1 does not have much ventral retouch, and what there is is quite evenly spread. Retouch is focussed on the dorsal side and is here also quite evenly spread. In the case of Porc Epic C there is again not much retouch on the ventral surface. On the dorsal surface retouch is for the most part quite

evenly spread. Layer E is similar to Layer C, except that in the latter there is something of a tendency to retouching the distal portion of the dorsal face. 1010-8 features a moderate and even spread of retouch on the ventral surface, while most retouch is on the dorsal and is focussed on the right lateral and distal. At Tor Faraj the moderate amount of retouch is focused towards the distal end. Most retouch is on the ventral surface, and is here focussed on the right lateral and distal, but the left is also quite commonly retouched. Warwasi NNOO has a small and even distribution of retouch on the ventral surface. Most retouch is dorsally with a weak tendency to the left and distal. Warwasi WWXX is similar, but the tendency to the left and distal on the dorsal is weaker, and there is less retouch on the ventral. Finally, at 123-b there are moderate levels of retouch on the ventral, with a clear emphasis on the left lateral. On the dorsal surface retouch is quite evenly distributed.

The above description suggests quite complex patterns of variation. Combining the retouch on the distal and ventral lateral margins suggests three groups (see Figure 8.20). At JKF-1, JQ-1 and Warwasi NNOO there is a focus on the left lateral margin for retouch. Conversely at 1010-8, Tor Faraj and 123-b the focus is on the right margin. Finally the Porc Epic assemblages and Warwasi WWXX feature essentially the same levels of retouch on either margin.

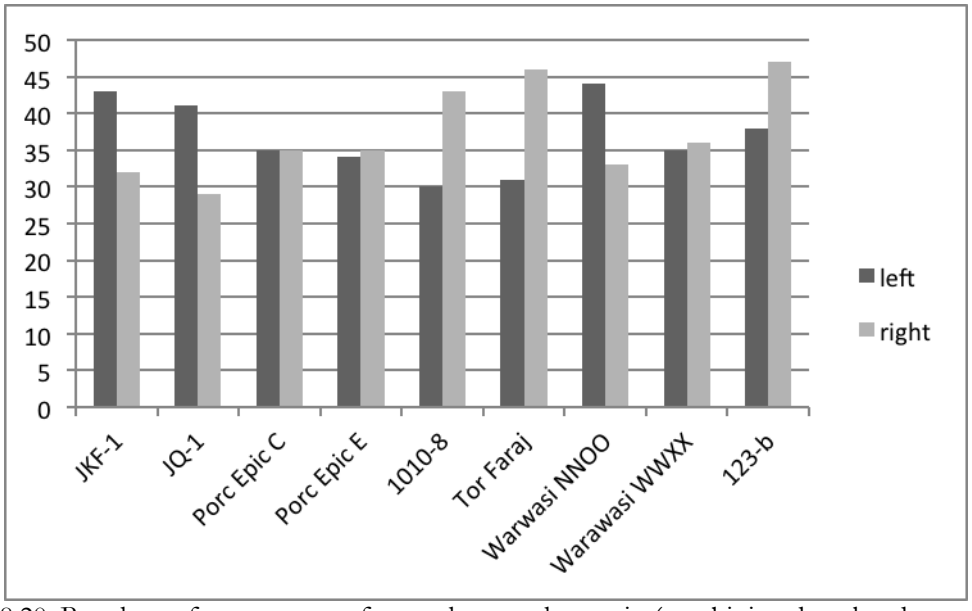



Figure 8.20. Bar chart of percentages of retouch on each margin (combining dorsal and ventral surfaces). Graph does not include retouch at proximal or distal ends.

**8.12) Invasiveness of retouch**

As discussed earlier, several measures have been proposed to quantify the extent or 'invasiveness' of retouch. The three techniques employed in this study are discussed below, followed by an index which unites the three (the General Reduction Index, GRI) as each of the individual measures reflects a slightly different focus and the GRI aims to give an easily comparable figure for the extent of retouch in an assemblage.

**Geometric Index of Unifacial Retouch (GIUR)**

Tables 8.26 and 8.27 show GIUR values for all retouched pieces and all complete retouched pieces respectively.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 6 | 1 | 1 | 1 | 20 | 31 | 13 | 36 | 32 | 62 | 16 |
| **Min.** | 0.38 | | | | 0.38 | 0.44 | 0.20 | 0.56 | 0.62 | 0.71 | 0.5 |
| **Max** | 0.38 | | | | 0.44 | 0.52 | 0.35 | 0.62 | 0.71 | 0.94 | 0.55 |
| **Mean** | 0.38 | 0.38 | 0.86 | 0.37 | 0.41 | 0.47 | 0.30 | 0.60 | 0.67 | 0.81 | 0.54 |
| **St dev** | 0.0 | | | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| **25 %** | 0.38 | | | | 0.39 | 0.44 | 0.21 | 0.58 | 0.65 | 0.74 | 0.52 |
| **75 %** | 0.38 | | | | 0.42 | 0.50 | 0.32 | 0.61 | 0.68 | 0.85 | 0.55 |
| **Skewness** | 0.4 | | | | 0.0 | 0.1 | -0.7 | -0.4 | 0.0 | 0.3 | 0.4 |
| **Kurtosis** | -1.8 | | | | -1.2 | -1.5 | -1.1 | -1.2 | -0.8 | -1.0 | -1.5 |

Table 8.26. GIUR values for all retouched pieces.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 1 | 1 | 1 | 1 | 13 | 22 | 13 | 24 | 23 | 31 | 16 |
| **Min.** | | | | | 0.38 | 0.44 | 0.20 | 0.56 | 0.62 | 0.72 | 0.5 |
| **Max** | | | | | 0.44 | 0.52 | 0.35 | 0.62 | 0.71 | 0.94 | 0.55 |
| **Mean** | 0.38 | 0.38 | 0.86 | 0.37 | 0.41 | 0.48 | 0.30 | 0.60 | 0.67 | 0.80 | 0.54 |
| **St dev** | | | | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| **25 %** | | | | | 0.39 | 0.45 | 0.21 | 0.58 | 0.65 | 0.75 | 0.52 |
| **75 %** | | | | | 0.43 | 0.50 | 0.32 | 0.61 | 0.68 | 0.83 | 0.55 |
| **Skewness** | | | | | -0.4 | 0.0 | -0.7 | -0.3 | 0.3 | 0.62 | 0.4 |
| **Kurtosis** | | | | | -1.1 | -1.6 | -1.1 | -1.2 | -0.7 | -0.66 | -1.5 |

Table 8.27. GIUR values for complete retouched pieces.

The first point to note is the extreme similarity of the two sets of data above. Take, for instance, Warwasi WWXX. Looking at the GIUR of complete retouched pieces halves the sample size, but the mean only changes by 0.01, as do both the interquartile ranges. This perhaps suggests that GIUR is quite a robust measure, and that sample size problems are perhaps not critical in this regard. This assertion is supported by the typically rather small range of intra-assemblage variability, which is also of interest in terms of understanding the intention of the knappers. This does not seem to simplistically reflect, say, raw material factors as in the case of Warwasi and Porc Epic the

two assemblages at both sites are quite different from each other, but both have a small range of variability. As shown in figure there are clear and dramatic differences in GIUR values. Comparing Porc Epic and Warwasi, both seemingly heavily reduced and retouched assemblages, shows much higher GIUR values are found at Warwasi. Interestingly, the values for GIUR seem to be low in Africa and Arabia and higher in the Levant and Iran.

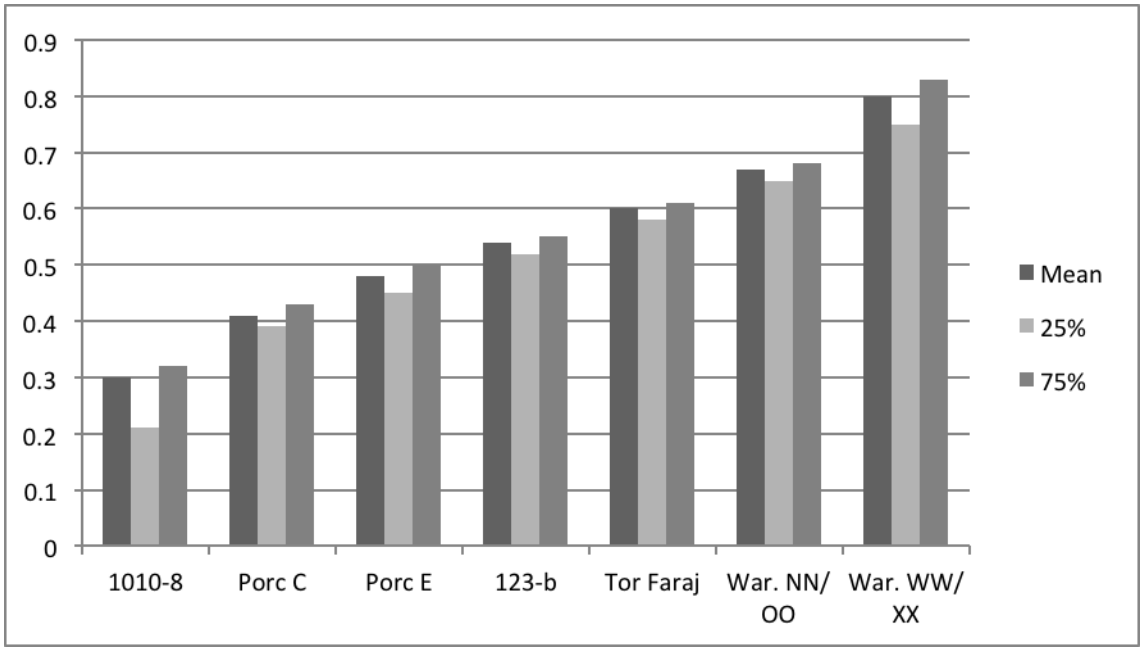


Figure 8.21. Bar chart of interquartile and mean values for Geometric Index of Unifacial Retouch.

**Index of Invasiveness**

The Index of Invasiveness (II) reflects 'horizontal' retouch, in contrast to the vertical focus of GIUR. It has the advantage that is can be applied to blanks retouched on both surfaces, but it can only be applied to complete flakes.

| | JQ-1 | JSM -1 | JKF-1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 8 | 1 | 20 | 35 | 21 | 29 | 16 | 40 | 22 |
| **Min.** | 0.22 | 0.06 | 0.09 | | 0.06 | 0.06 | 0.03 | 0.03 | 0.09 | 0.03 | 0.09 |
| **Max** | 0.53 | 0.44 | 0.53 | | 0.53 | 0.84 | 0.28 | 0.41 | 0.35 | 0.69 | 0.44 |
| **Mean** | 0.40 | 0.25 | 0.30 | 0.13 | 0.29 | 0.33 | 0.15 | 0.13 | 0.20 | 0.27 | 0.19 |
| **St dev** | 0.1 | 0.3 | 0.1 | | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.1 |
| **25 %** | 0.31 | | 0.22 | | 0.19 | 0.22 | 0.09 | 0.06 | 0.125 | 0.19 | 0.13 |
| **75 %** | 0.50 | | 0.44 | | 0.43 | 0.47 | 0.20 | 0.19 | 0.25 | 0.34 | 0.25 |
| **Skewness** | 0.2 | | 0.0 | | 0.2 | 0.8 | 0.3 | 1.4 | 0.2 | 0.9 | 1.1 |
| **Kurtosis** | -2.4 | | -0.3 | | -1.1 | 0.8 | -0.8 | 2.0 | -1.0 | 0.6 | 1.1 |

Table 8.28. Index of Invasiveness values for complete retouched pieces.

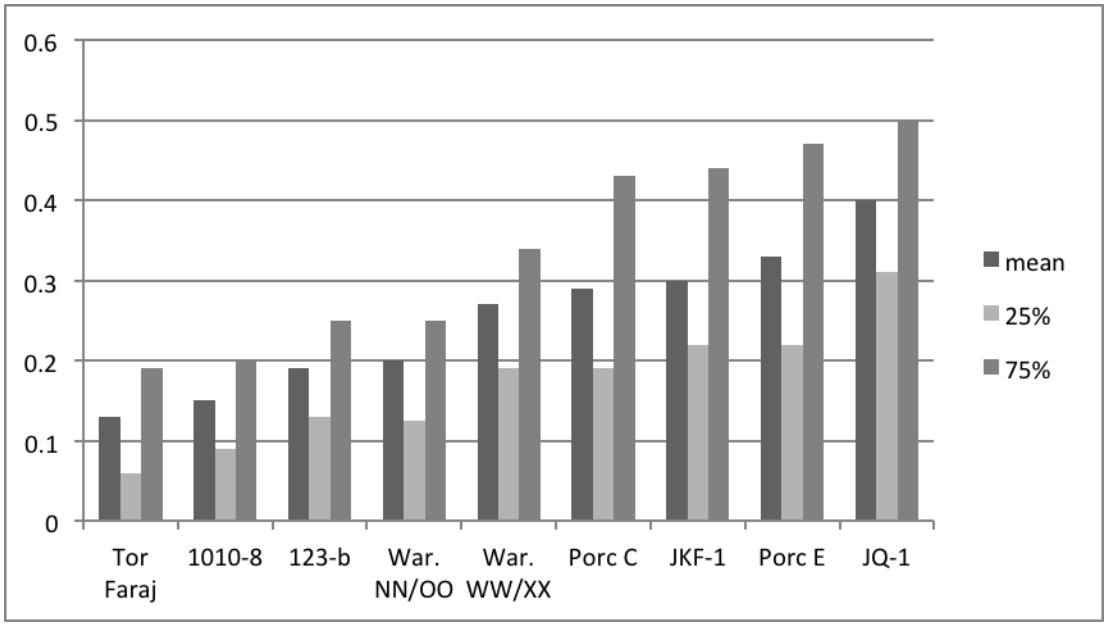



Figure 8.22. Bar chart of Index of Invasiveness mean and interquartile range.

As Table 8.28 and Figure 8.22 show, the II results also demonstrate intra-assemblage homogeneity, and quite substantial inter-assemblage heterogeneity. The results are almost inverse to those of the GIUR. While 1010-8 is still low in both, and here it is joined by the other primary assemblage of 123-b, Tor Faraj which has a high GIUR score has the lowest II score and Warwasi is in the Middle. Pork Epic, JKF-1 and JQ-1 have the highest scores for II.

Figures 8.23 and 8.24 compare the Index of Invasiveness and GIUR values for specimens which have both recordings. They show that while there is an overall correlation between the two

measures, but that it is a broad relationship, with an R squared value of 19.5%. However as figure shows, the relationship varies considerably between assemblages, in some cases having only a weak correlation.

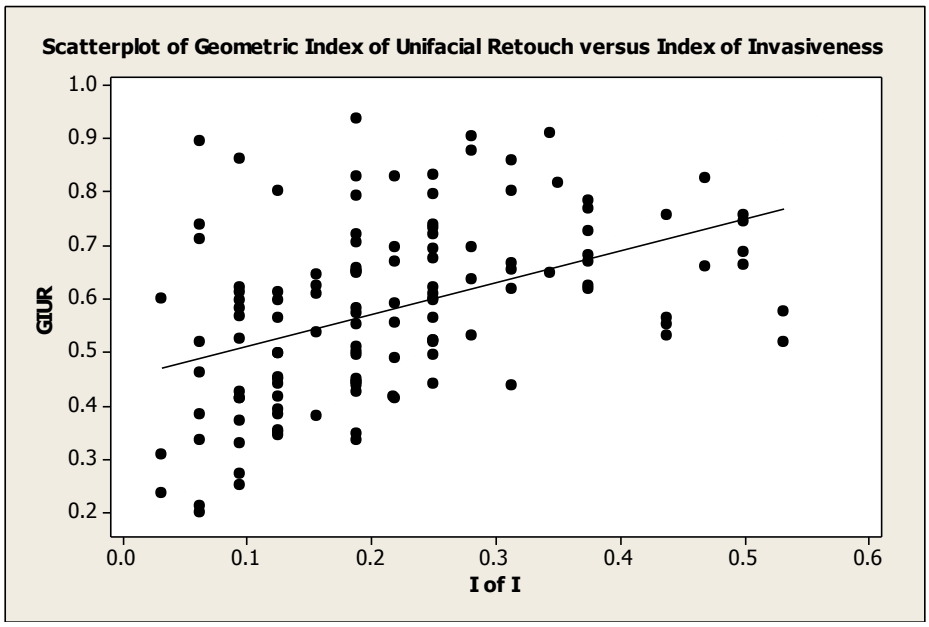



Figure 8.23 Scatterplot of the Index of Invasiveness vs. Geometric Index of Unifacial Retouch for all assemblages. One outlier removed.

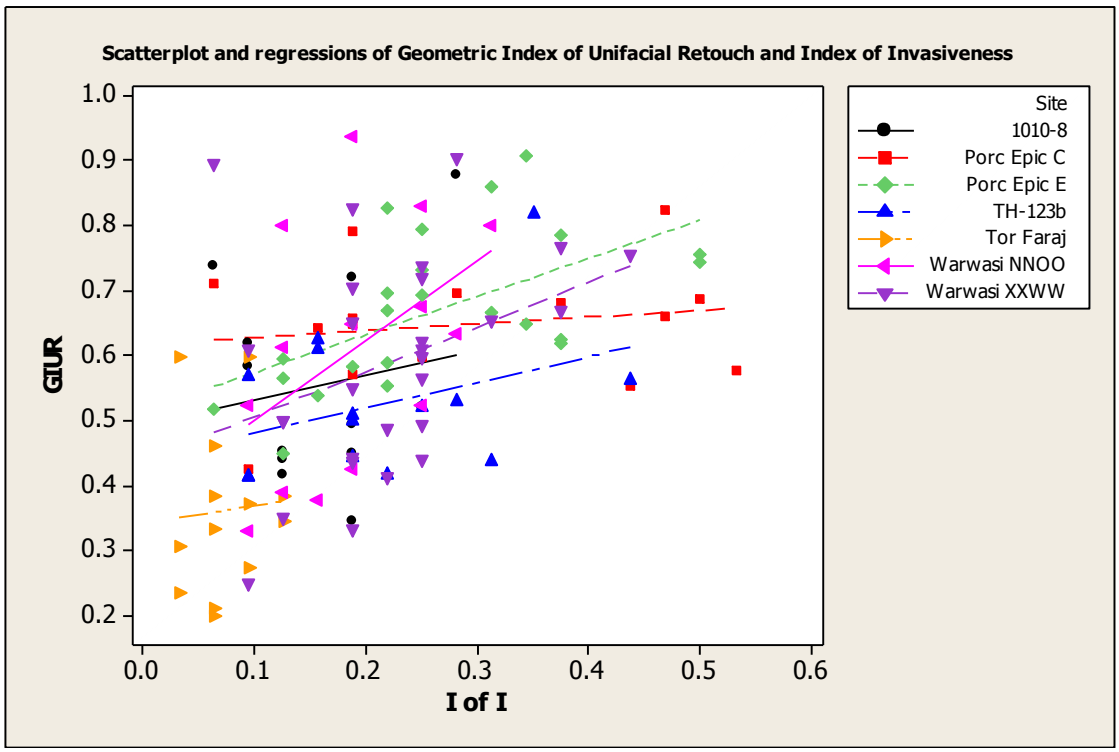



Figure 8.24. Scatterplot of Index of Invasiveness vs. Geometric Index of Unifacial Retouch with regression lines for individual assemblages. One outlier removed (Porc Epic E).

**Percentage of margins retouched**

The final measure employed to characterise the extent of retouch is the comparison of the length of the margin retouched to the total length of the margins. In contrast to the previous two measurements which reflect the interaction of retouch and the morphology of the shape, this is a simple measure which recognises the importance of cutting edge and its re-sharpening in lithic technology. An advantage of this measure is that it can be applied in almost all situations and is not sensitive to factors such as variation in flake shape. The results are shown in Tables 8.29 and 8.30.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 10 | 2 | 10 | 1 | 23 | 46 | 23 | 60 | 35 | 78 | 25 |
| **Min.** | 21.0 | 25.6 | 11.0 | | 11.2 | 9.1 | 13.1 | 5.3 | 12.1 | 5.1 | 18.1 |
| **Max** | 61.7 | 36.4 | 55.7 | | 100 | 100 | 75.0 | 86.0 | 81.5 | 100 | 84.1 |
| **Mean** | 35.8 | 31.0 | 42.6 | 24.4 | 50.6 | 51.0 | 30.2 | 23.0 | 47.0 | 48.7 | 41.1 |
| **St dev** | 13.4 | | 14.0 | | 27.7 | 25.6 | 14.0 | 16.3 | 21.3 | 25.2 | 14.7 |
| **25 %** | 25.2 | | 31.8 | | 25.2 | 29.5 | 18.5 | 12.0 | 30.3 | 26.9 | 28.3 |
| **75 %** | 46.8 | | 51.5 | | 73.5 | 71.9 | 37.1 | 29.6 | 69.9 | 66.2 | 48.2 |
| **Skewness** | 0.9 | | -1.5 | | 0.3 | 0.6 | 1.4 | 1.7 | 0.1 | 0.3 | 1.1 |
| **Kurtosis** | -0.1 | | 1.8 | | -1.1 | -0.7 | 3.5 | 3.3 | -1.3 | -1.0 | 1.9 |

Table 8.29. Descriptive statistics for percentage of edge retouched for all retouched specimens.

| | JQ-1 | JSM -1 | JKF -1 | JKF -12 | Porc C | Porc E | 1010 -8 | Tor Faraj | War. NNOO | War. WWXX | 123-b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **N.** | 7 | 2 | 9 | 1 | 19 | 36 | 20 | 35 | 18 | 44 | 25 |
| **Min.** | 21.0 | 25.6 | 11.0 | | 15.7 | 9.1 | 13.1 | 6.1 | 12.1 | 5.1 | 18.1 |
| **Max** | 61.7 | 36.4 | 55.7 | | 100 | 100 | 75 | 86.0 | 81.5 | 100 | 84.1 |
| **Mean** | 37.9 | 31.0 | 39.2 | 24.4 | 54.0 | 53.0 | 30.9 | 23.1 | 42.2 | 51.6 | 41.1 |
| **St dev** | 15.3 | | 15.5 | | 26.2 | 27.6 | 14.5 | 17.1 | 22.3 | 26.6 | 14.7 |
| **25 %** | 26.1 | | 27.1 | | 31.1 | 30.4 | 19.0 | 11.8 | 26.6 | 29.5 | 28.3 |
| **75 %** | 52.2 | | 52.3 | | 73.5 | 78.5 | 37.3 | 29.7 | 64.1 | 76.0 | 48.2 |
| **Skewness** | 0.6 | | -0.7 | | 0.2 | 0.4 | 1.4 | 1.9 | 0.5 | 0.2 | 1.1 |
| **Kurtosis** | -1.3 | | -0.6 | | -0.9 | -1.0 | 3.3 | 4.4 | -0.8 | -1.1 | 1.9 |

Table 8.30. Descriptive statistics for percentage of edge retouched for complete retouched specimens.

As an experiment the values for both complete and incomplete examples are shown. It is again significant that the values are typically rather similar. This may suggest that retouching of blanks after their breakage was more common in these assemblages than breakage after retouch. For the most part, around 30-50% of margins on a blank were typically retouched. Tor Faraj has low values and gives an interesting example of the problems of comparing the measures of retouch. Its low score here and in Index of Invasiveness, but quite high GIUR indicate that while retouch was not extensive horizontally or in terms of the blanks margins, when conducted it was vertically invasive.

Here aside from Tor Faraj, JKF-1 and JQ-1 have low scores, 123-b is in the middle, and Warwasi and Porc Epic have high scores.

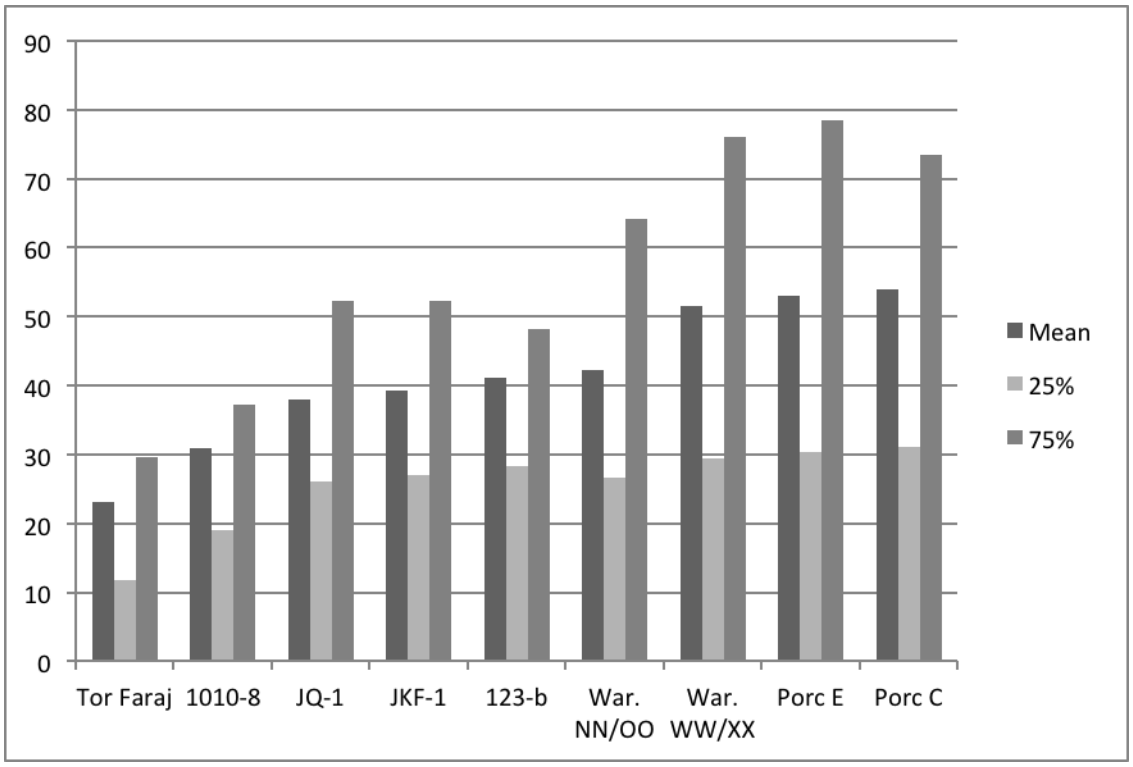


Figure 8.25. Bar chart of mean and interquartile values for percentage of margins retouched.

**8.13) Comparing measures of retouch**

The above three techniques reveal quite different results for the extent/invasiveness of retouch. Figure 8.26 compares the mean scores for each test for each assemblage with a combined score (General Reduction Index [GRI]) which is an average of the three tests. A problem with the GRI is that because only complete specimens (for II) with all measures recorded are included, there seems to be a tendency for slightly escalated figures in comparison to the individual indices, but the exercise is conducted as an experiment to see if there is a utility in such an index.

Figure 8.26 shows the broad agreement between measures to evaluate the extent of retouch. For the sites with good sample sizes we can divided between the lightly retouched Tor Faraj, 1010-8

and 123-b and the more heavily retouched Porc Epic and Warwasi. This pattern, for the most part, correlates with the extent of reduction of sites seen in earlier chapters, with the exception of Tor Faraj which might be expected to be more retouched.

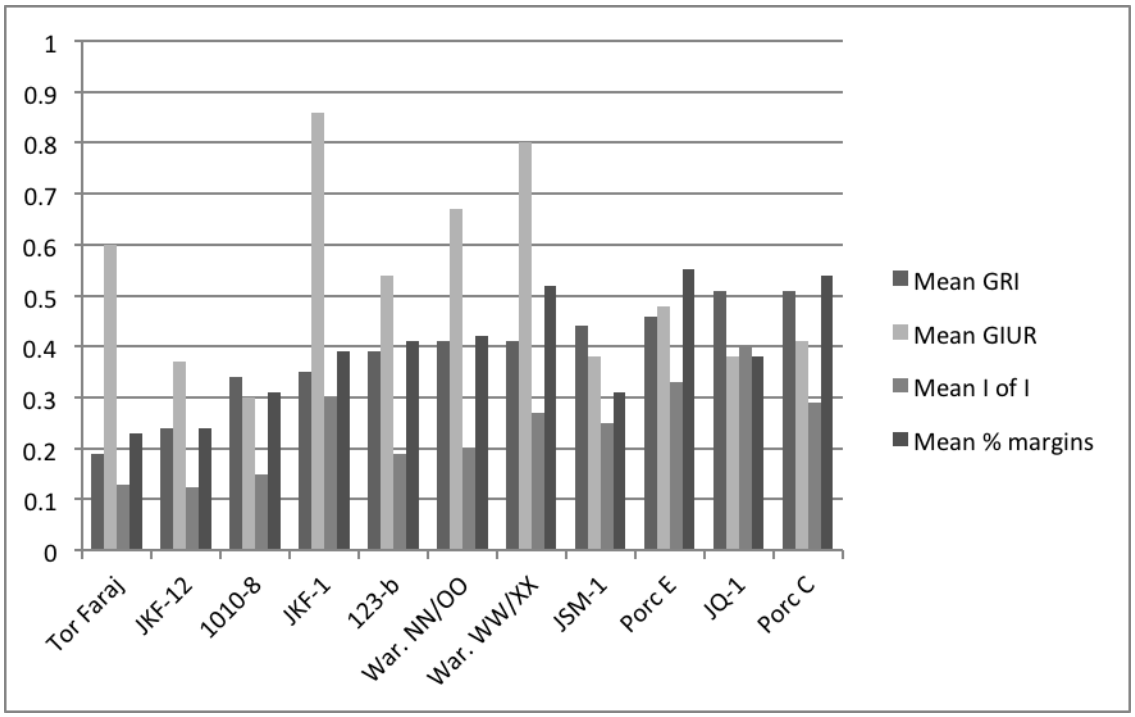



Figure 8.26. Bar chart comparing measures of retouch for complete retouched lithics. % retouched is divided by 100 for comparability. General reduction Index = (GIUR + IofI + % margin retouched)/3.

**8.14) Notching and burination**

Most of this chapter focuses on 'normal' retouch, which is seen as typically representing a combination of rejuvenating an edge and shaping the tool. Other forms of retouch are, however, present. In the case of Porc Epic small numbers of backed microliths are present. However, the main alternative forms of retouch in the studied assemblages are what are termed here notching and burination. These are conceived of as methods of retouch, and not necessarily related to the creation of a particular 'tools', such as a 'burin'. Burination is seen as primarily a means of removing an edge, and the presence of retouch/heavy use wear on several burin spalls supports such a 'retouch' interpretation. Picin *et al.* (2011) show how a typology of notching can be developed, and a similar approach could be applied to burin forms. The present aim is merely to offer some discussion of notching and burination in the studied assemblages.

The first point to note is that these forms of retouch are only present in certain assemblages, and then often only in low numbers. Porc Epic is dominated by 'normal' retouch, with a single example of a burinated piece in the studied layers. In the case of Warwasi low levels of notching and burination are present in both layers studied. At 123-b a small amount of notching is present. The two assemblages of particular interest are 1010-8, which is heavily notched, and Tor Faraj, in which both burination and notching are well represented. The meaning of these patterns of variation is unclear, but presumably reflects a combination of functional factors and a cultural context in which these forms of technology were known.

Firstly, let us consider notches. Basic information on notches is presented in Table 8.31. Given the small sample sizes it is hard to be definitive about variation in them. Aside from 1010-8 and Tor Faraj they are typically quite rare. The significance of variation in their location is unclear. At 1010-8 and Tor Faraj they are mostly on the right lateral, while at Warwasi they are (only slightly) more common on the left. Clearly substantially augmented sample sizes are needed, but there is clearly considerable variation in the character and location of notching.

| Assemblage | n. notches | Notch locations | Comments |
|---|---|---|---|
| **1010-8** | 15 | Left – 1<br>Right – 4<br>Both/other - 3 | Virtually all notches 'complex', a mixture of single and denticulated. |
| **Tor Faraj** | 22 | Left – 2<br>Right – 4<br>Both/other - 1 | Typically in the form of 'denticulates'. Mostly simple notches, but some complex |
| **Warwasi NNOO** | 7 | Left – 3<br>Right –1<br>Both/other - 0 | A mixture of simple and complex, single and multiple. |
| **Warwasi WWXX** | 7 | Left – 3<br>Right – 2<br>Both/other - 1 | A mixture of simple and complex, mostly single. |
| **123-b** | 3 | Left – 1<br>Right – 0<br>Both/other - 1 | Most 'notches' in assemblage appear natural, a small number are convincing. |

Table 8.31. Basic information on notches in the assemblage studies.

Burins are only found in any number at Tor Faraj. Here in several cases multiple burin spalls have been removed on the same piece. Figure 8.27 shows the length of burinations in the different assemblages. While the examples from Porc Epic and Warwasi have a similar size range, mostly clustering around 10mm, those from Tor Faraj are mostly rather larger. As with notches, it is felt that considerable progress can be made with the quantification of burins. However, as with notches, the small samples present in the assemblages studied means they are not here studied in detail.

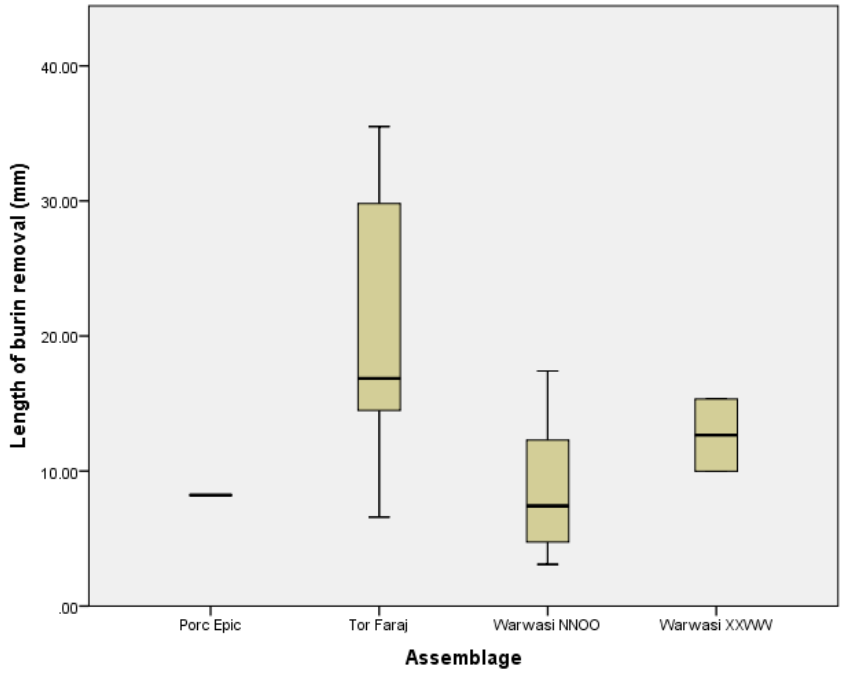



Figure 8.27. Box plots of lengths of burin removals (mm).

**Multivariate analyses of retouched lithics**

Due to the small sample sizes of retouched lithics available the approach taken here is to conduct a small number of multivariate analyses focussing on basic questions of artefact size and shape.

### 8.15) (1a.) How does morphology and retouch intensity of retouched blanks vary within and between assemblages?

A Principal Components Analysis was conducted on all retouched pieces. The sample includes broken specimens, for the reason previously mentioned that it is often unclear if they broke before or after retouch. Question 1b will only address complete retouched pieces. The variables used here are the number of scars over 5mm, the maximum dimension, maximum width, maximum thickness and % margins retouched. This aims to give a general overview of morphology and the % margins retouched is used as a measure of retouch and is used because it is an attribute available for more specimens, as II only applies to complete specimens and GIUR only to dorsal retouch.

| Variable | PC1 (50%) | PC2 (20%) | PC3 (16%) | PC4 (8%) | PC5 (4%) |
|---|---|---|---|---|---|
| N. scars >5mm | 0.315 | 0.309 | -0.886 | 0.137 | -0.043 |
| Maximum dimension (mm) | 0.555 | -0.034 | 0.066 | -0.588 | 0.583 |
| Maximum width (mm) | 0.570 | -0.079 | 0.181 | -0.202 | -0.771 |
| Maximum thickness (mm) | 0.513 | -0.183 | 0.226 | 0.768 | 0.250 |
| % margins retouched | -0.065 | -0.929 | -0.357 | -0.067 | -0.019 |

Table 8.32. Loading of principal components and percentage of variation explained.

The first component explains 50% of the variability and reflects size – with a positive correlation of maximum, dimension, width and thickness, in particular, as well as the number of scars. The second component (20%), in contrast, reflects retouch intensity and is very strongly driven by the percentage of the margin retouched. High scores for PC2 mean little retouch, and this weakly correlates with greater thickness. Against this are the number of scars, which makes sense as we would typically expect less reduced pieces to have more scars. The third component (16%) is primarily driven by a negative correlation of the number of scars and the percentage of the margin retouched. This variable seems to reflect a combination of retouch intensity, here primarily from the perspective of the number of scars, in inverse correlation with size variables, but also saying something about the character of primary reduction (as a large determinant of the number of scars). PC4 (8% of variability) emphasises the shape of the retouched pieces. High scores reflect pieces

which are long, narrow and thin, while low scores equate with those which are short, wide and thick.

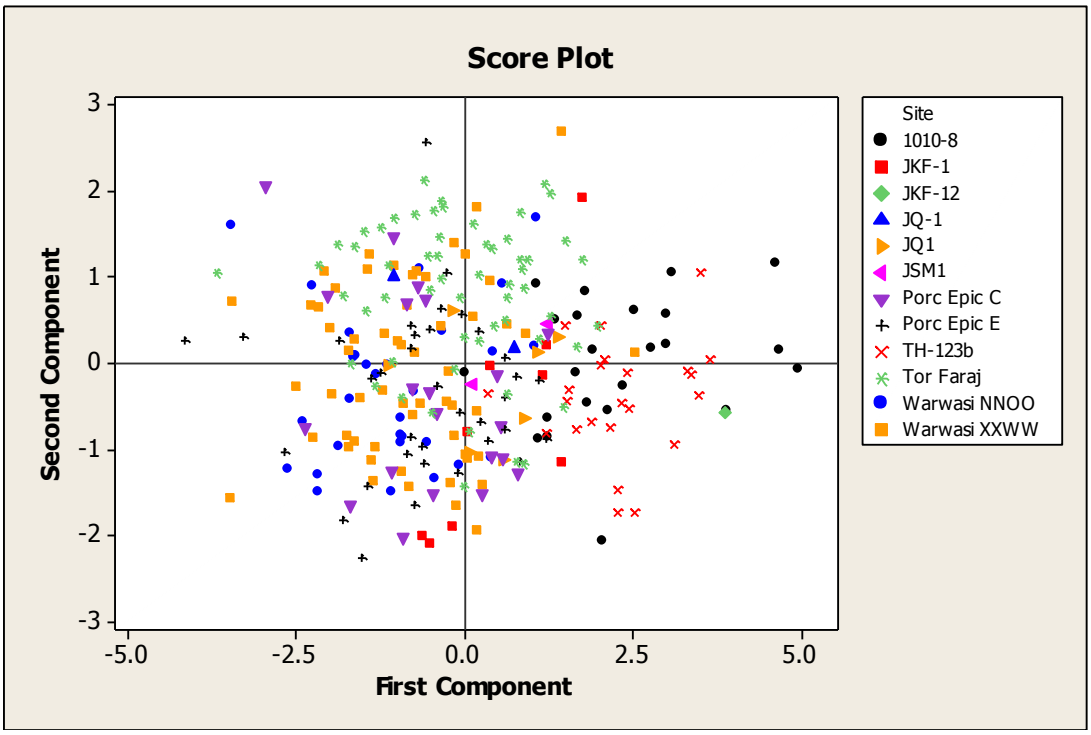



Figure 8.28. Score plot of first and second components.

**PC1:**

| Site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 23 | 2.356 | A |
| TH-123b | 23 | 2.298 | A |
| Tor Faraj | 58 | -0.085 | B |
| Porc Epic C | 21 | -0.569 | B C |
| Porc Epic E | 35 | -0.600 | B C |
| Warwasi XXWW | 58 | -0.838 | C |
| Warwasi NNOO | 31 | -1.062 | C |

**PC2:**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj | 58 | 0.8066 | A |
| 1010-8 | 23 | 0.0165 | B |
| Warwasi XXWW | 58 | -0.0485 | B |
| Warwasi NNOO | 31 | -0.2683 | B |
| Porc Epic C | 21 | -0.3414 | B |
| Porc Epic E | 35 | -0.3519 | B |
| TH-123b | 23 | -0.4215 | B |

**PC3:**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj | 58 | 0.3492 | A |
| 1010-8 | 23 | 0.3222 | A |
| TH-123b | 23 | 0.0344 | A B |
| Porc Epic E | 35 | -0.1311 | A B |
| Warwasi NNOO | 31 | -0.1515 | A B |
| Warwasi XXWW | 58 | -0.3485 | B |
| Porc Epic C | 21 | -0.4444 | B |

**PC4:**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic C | 21 | 0.2628 | A |
| 1010-8 | 23 | 0.1772 | A B |
| Porc Epic E | 35 | 0.1406 | A B |
| Warwasi NNOO | 31 | 0.0029 | A B |
| Warwasi XXWW | 58 | -0.0304 | A B |
| TH-123b | 23 | -0.1806 | A B |
| Tor Faraj | 58 | -0.2521 | B |

Table 8.33. Tukey grouping of ANOVA results for each principal component.

The ANOVA of PC1 demonstrates a grouping repeatedly demonstrated through this thesis, from the large and primary sites of 1010-8 and 123-b through to the small and reduced Warwasi assemblages. Results from the second component broadly repeat observations earlier in this chapter that Tor Faraj typically has a low percentage of its margins retouched. The particularly low (heavily retouched) scores for 123-b are perhaps a little surprising, but this reflects the contribution of a low number of scars here.

These first two components then, which explain 70% of the variability, reflect essentially the size of blanks chosen for retouch – which supports the structure of size variability found overall in the blank populations – and the intensity of retouch, hence most sites have quite a broad spread on the second component reflecting intra-assemblage variability in retouch intensity.

PC3 divides the Warwasi and Porc Epic assemblages – and it should be noted how the Warwasi assemblages fall *within* the variability of Porc Epic – which are small and heavily reduced and have a large number of scars from Tor Faraj and 1010-8 in particular which have less retouch and fewer scars. The moderate score of 123-b reflects the longitudinal flaking characteristic of this assemblage which gives it quite a low number of scars.

Finally, the ANOVA of PC4 defines two large and overlapping groups. Porc Epic and 1010-8, in particular, are characterised according to this as having retouched pieces which are relatively short, wide and thick. In contrast Warwasi, 123-b and Tor Faraj, the latter in particular, emphasise long, narrow and thick pieces. Such characteristics may not be immediately obvious when comparing individual attributes), but the benefit of PCA is that it shows the combination of these factors and shape clustering which transcends individual variables. Although, of course, the orthogonal characteristics of PCA must be remembered and a considerable element of shape variability may have been subsumed in earlier variables.

### 8.16) (1b.) How does morphology and retouch intensity of complete retouched blanks vary within and between assemblages?

This repeats question 1a, but excludes broken retouched pieces. As shown in Table 8.34 and Figure 8.29, the loadings of each component and the plot of PC1 and PC2 reveal a closely similar structure to that seen in question 1a, despite the considerably reduced sample size in this case. The loadings of the components are almost identical, as is the percentage of variance explained by each component (in this case 50.3%, 20.4%, 16.4%, and 8.4% respectively for RPC1-4.

| Variable | PC1 (49%) | PC2 (21%) | PC3 (16%) | PC4 (8%) | PC5 (5%) |
|---|---|---|---|---|---|
| N. scars >5mm | 0.290 | 0.460 | -0.826 | 0.148 | 0.014 |
| Maximum dimension (mm) | 0.556 | -0.047 | 0.048 | -0.623 | -0.546 |
| Maximum width (mm) | 0.576 | -0.092 | 0.136 | -0.156 | 0.785 |
| Maximum thickness (mm) | 0.518 | -0.233 | 0.181 | 0.758 | -0.290 |
| % margins retouched | -0.087 | 0.852 | 0.510 | 0.071 | -0.036 |

Table 8.34. Loading of principal components and percentage of variation explained.

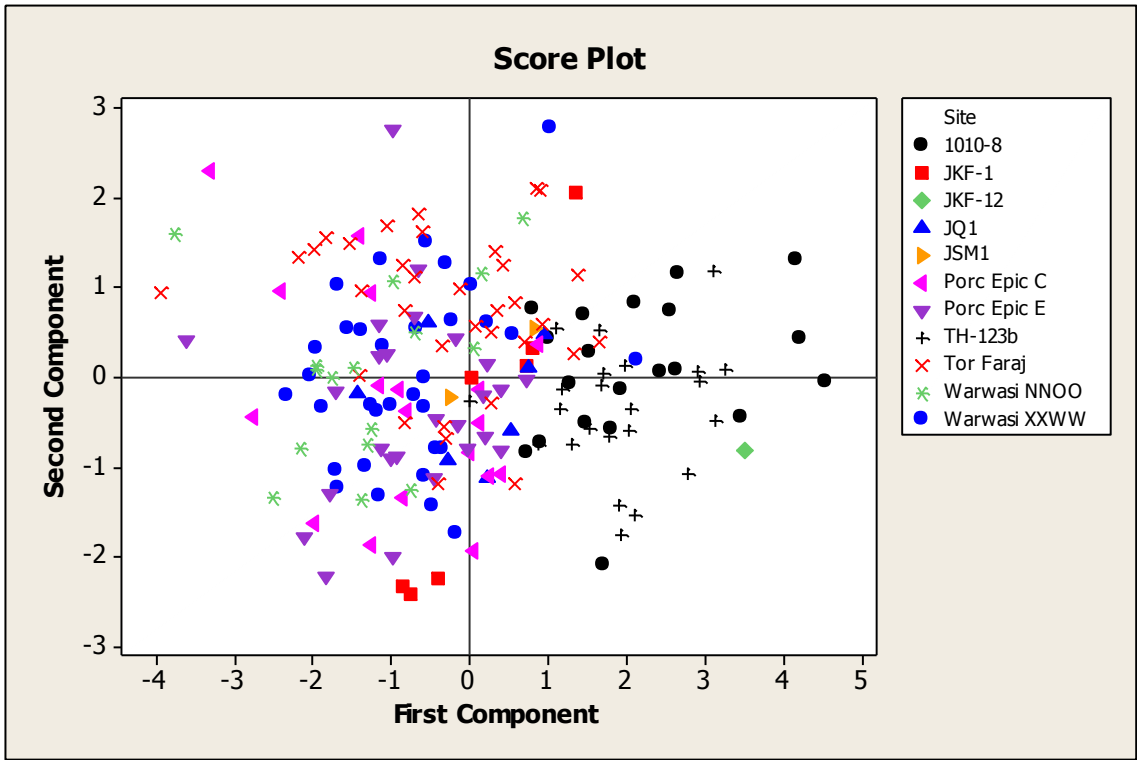



Figure 8.29. Score plot for first and second component.

As the structure of each component seems to be essentially the same as for the previous question, I will not repeat the description of them here. Likewise the results of the ANOVA's, shown below, demonstrate in all cases the same structure as for 1a. The structure for PC1 and PC3 are slightly simplified and the scores for PC4 are inverted due a to slight difference in algorithm, but as a mirror image the structure is identical. These results then support those of 1a in characterising the structure of the retouched component of these assemblages. It is important to observe that at this basic level of analysis of morphology and retouch as indicated by the percentage of margin retouched, whether large numbers of broken retouched pieces are included or not makes little

difference to the structure of variability. This again may support the idea that many of the pieces were retouched after the blank broke.

**PC1**

| Site | N | Mean | Grouping |
|---|---|---|---|
| 1010-8 | 20 | 2.176 | A |
| TH-123b | 23 | 1.921 | A |
| Tor Faraj | 34 | -0.308 | B |
| Porc Epic E | 26 | -0.758 | B |
| Warwasi XXWW | 33 | -0.782 | B |

**PC2**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj | 34 | 0.7445 | A |
| 1010-8 | 20 | 0.0726 | A B |
| Warwasi XXWW | 33 | 0.0215 | B |
| Porc Epic E | 26 | -0.3096 | B |
| TH-123b | 23 | -0.3612 | B |

**PC3**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj | 34 | 0.5948 | A |
| 1010-8 | 20 | 0.1188 | A B |
| TH-123b | 23 | -0.0479 | B |
| Porc Epic E | 26 | -0.2046 | B |
| Warwasi XXWW | 33 | -0.4276 | B |

**PC4**

| Site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj | 34 | 0.2628 | A |
| TH-123b | 23 | 0.2076 | A B |
| Warwasi XXWW | 33 | 0.1469 | A B |
| Porc Epic E | 26 | -0.1972 | B |
| 1010-8 | 20 | -0.2087 | A B |

Table 8.35. Tukey grouping of ANOVA results for each principal component.

## 8.17) (2.) How do retouched pieces compare to unretouched blanks in basic morphology?

This question uses Principal Components Analysis to address the selection of particular blanks for retouch from the overall blank population. It only uses three assemblages – those with the greatest numbers of retouched artefacts, Porc Epic E, Tor Faraj floor 1, and Warwasi WWXX. These three nevertheless give a good geographical spread (Ethiopia, Jordan and Iran) and the exercise should be seen as experimental analysis. Only complete blanks are included, and the variables, chosen to emphasise basic morphological variability, are technical length, proximal width, medial width, distal width and thickness at medial.

| Variable | PC1 (49%) | PC2 (21%) | PC3 (16%) | PC4 (8%) | PC5 (5%) |
|---|---|---|---|---|---|
| Technical length (mm) | 0.378 | 0.584 | 0.349 | 0.612 | -0.136 |
| Proximal width (mm) | 0.495 | 0.097 | -0.661 | -0.141 | -0.538 |
| Medial width (mm) | 0.562 | -0.149 | -0.249 | 0.108 | 0.767 |
| Distal width (mm) | 0.261 | -0.790 | 0.255 | 0.378 | -0.315 |
| Thickness at medial | 0.478 | 0.044 | 0.561 | -0.671 | -0.066 |

Table 8.36. Loading of principal components and percentage of variation explained.

The first component (52% of variability) reflects size. All variables positively correlate, and high scores equal large size. PC2 (22%) reflects a difference in shape between lithics which are long and broadly parallel sided (high scores) and those which are short with convergent margins (the latter indicated by the strong contribution of distal width to the component). The third component

(13%) reflects a different form of shape, distinguishing between  shot, thin lithics with expanding margins (low scores) and long and thick flakes with converging margins (high scores). Finally PC4 (9%) primarily divides short and thick lithics (low scores) from those which are long and thin (high scores), this component perhaps emphasising the laminarity of an assemblage. This appears to be an extremely promising structure, as the components reflect firstly size and then three different aspects on shape.

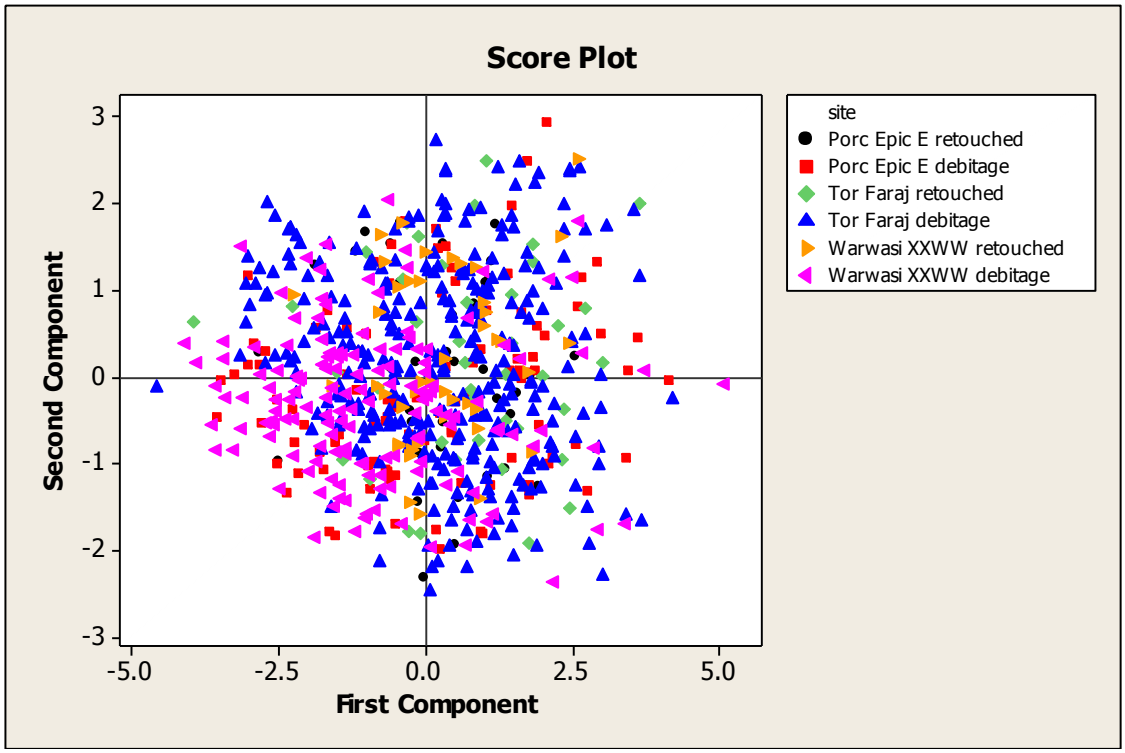


Figure 8.30. Score plot for the first and second component.

The score plot is quite difficult to interpret due to the number of points on it. However, a much clearer picture comes from the ANOVA's of the components. The first component reveals exactly the structure which has been suggested earlier. In all cases, the retouched component is typically larger than the unretouched debitage. Aside from this main observation, the ANOVA highlights the small size of the debitage at Warwasi XXWW and the considerably larger size of the retouched component here. These points aside, no dramatic differences between the sites emerge and the retouched tools from the sites have roughly similar mean scores.

**PC1:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj retouched | 42 | 0.691 | A |
| Porc Epic E retouched | 38 | 0.282 | A |
| Warwasi XXWW retouched | 44 | 0.257 | A |
| Tor Faraj debitage | 315 | 0.239 | A |
| Porc Epic E debitage | 105 | 0.035 | A |
| Warwasi XXWW debitage | 151 | -0.862 | B |

**PC2:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Warwasi XXWW retouched | 44 | 0.230 | A |
| Tor Faraj retouched | 42 | 0.152 | A B |
| Tor Faraj debitage | 315 | 0.137 | A |
| Porc Epic E retouched | 38 | 0.066 | A B |
| Porc Epic E debitage | 105 | -0.144 | A B |
| Warwasi XXWW debitage | 151 | -0.311 | B |

**PC3:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Porc Epic E retouched | 38 | 0.2634 | A |
| Warwasi XXWW retouched | 44 | 0.2514 | A |
| Tor Faraj retouched | 42 | 0.2248 | A |
| Porc Epic E debitage | 105 | 0.0702 | A |
| Tor Faraj debitage | 315 | -0.0779 | A |
| Warwasi XXWW debitage | 151 | -0.0885 | A |

**PC4:**

| site | N | Mean | Grouping |
|---|---|---|---|
| Tor Faraj retouched | 42 | 0.1463 | A |
| Tor Faraj debitage | 315 | 0.0919 | A |
| Warwasi XXWW retouched | 44 | 0.0803 | A |
| Warwasi XXWW debitage | 151 | -0.0554 | A |
| Porc Epic E debitage | 105 | -0.1086 | A |
| Porc Epic E retouched | 38 | -0.4961 | B |

Table 8.37. ANOVA results for each principal component.

With the second component, the first point we can make is that in the case of Tor Faraj and Porc Epic the retouched component of each site is very similar in shape to the unretouched debitage of that site. The fact that retouched and unretouched are very similar morphologically in this regard, and this component is the most important *shape* related variable after the simple *size* focus of PC1 – suggests that retouch was applied to blanks representative of that assemblage. On the other hand the fact that the debitage and retouched components of Warwasi WWXX are at opposite ends of diversity for this component suggests a rather different pattern. It might be taken as indicating the importation of retouched pieces (or large blanks which could be retouched) and cores for the product of small blanks, or the systematic retouch of larger blanks.

The ANOVA of PC3 does not reveal any discreet, and statistically firm, groupings. It is however clear that the retouched components group closely together and that the debitage has low scores and forms another group. In this case, then, the division is between retouched and unretouched, in a pattern not seemingly varying much between assemblages. The difference reflects the prevalence of short and thin lithics in the debitage of these assemblages, which we might label 'preparation flakes' In contrast the retouched material is dominated by long and thin pieces with converging laterals.

With PC4 we return to a structure guided by 'assemblage integrity', in that the retouched part of one assemblage is more similar to the debitage of that assemblage than to the retouched component of another assemblage. The two parts of Tor Faraj are quite similar, reflecting both being characterised by length and thinness. Warwasi occupies a middling position, where the

debitage tends towards the short and thin and the retouched towards the long and thin. Porc Epic follows a rather different trend to these two other assemblages and here the debitage, while still scoring lowly, has a considerably higher score than the retouched component which is only one lower than the debitage in this assemblage. While the component emphasises a general tendency for Porc Epic lithics to be short and thick, this is a tendency particularly pronounced in the retouched component.

**8.18) Discussion**

Let us briefly consider some of the major points and themes which have emerged in this chapter. The significance of these observations will be returned to in Chapter 9.

On the overall picture and on the types of blanks chosen for retouch several basic points emerge. Firstly, there are major differences in the percentages of retouch between assemblages. This includes those within a single site. In the case of Warwasi, for instance, the quantified view taken here demonstrates that one assemblage is almost three times more commonly retouched than the other.

When factors such as raw material type and cortical coverage are considered it does not appear that in general there are clear and consistent selection criteria for particular blanks to retouch. In a broad, and univariate sense, it appears that blanks were chosen for retouch from the general blank population and factors such as the amount of position of cortex do not seem to be important. In some other areas, however, the situation is more ambiguous. The example of distal terminations is a clear case. There may be a slight tendency towards a dominance of hinge and step fractures, but this is difficult to evaluate as a high number of examples have indeterminate terminations. Given small sample sizes in most cases, this makes the evaluation of particular, individual attributes of retouched pieces somewhat difficult. Where there do appear to be selection criteria for particular attributes, these are found in a complicated and overlapping manner. For example, in the case of 123-b retouched pieces have a considerably higher rate of bidirectional scars than the general

debitage does, but the opposite pattern, at a ratio of around 1:3 is found at the other Nubian Complex site of 1010-8.

When size related attributes, rather than specific morphological and technological features, are examined it is clear that there is a selection for larger blanks to retouch. However, beyond this simple observation by quantification we can make further points such as the demonstration that retouched pieces often fall within narrow ranges of size variability. Weights, for instance, typically cluster around 10-15 grams. This applies to several categories.

It is suggested based on similarities in both the length of the margins and the percentage of the margins retouched for both broken and unbroken pieces, that many of these pieces were broken before retouch. This is something which needs to be explored by microscopic and refitting studies.

In regards to the position and character of retouch a number of observations can be made. In regards to which side of the blank was retouched, and which margin was emphasised, there is clearly variability between assemblages, but the meaning of this is unclear. Is there, for example, significance in the high levels of ventral retouch at Tor Faraj, 1010-8 and (remembering small sample sizes) at Jubbah? The different measures of retouch at least broadly correlate and support a mostly coherent picture of which assemblages are most retouched.

The small number of multivariate statistics conducted demonstrate the power and potential of these methods. The primary drivers of variability are size related, reiterating the individual attributes described earlier. These emphasise the selection of large blanks for retouch. Beyond this the analyses clarify the underlying patterns of shape variability which cannot be isolated by qualitative approaches of uni/bivariate analyses. In question 2 a particularly interesting example of this was observed, when it was shown that while the debitage and retouched components of Tor Faraj and Porc Epic are rather similar, suggesting a close relationship in each case, while at Warwasi WWXX a rather different pattern applied. Here a large difference exists between the shape of the blanks and the retouched pieces, perhaps suggesting factors such as the import of complete retouched or large blanks, or other such practices which offer insights into mobility and provisioning strategies.

# Chapter 9: Discussion and conclusions

## 9.1) Introduction

This concluding chapter brings together the data presented in this thesis and considers how it relates to the questions posed in Chapter 1. The first section summarises the implications of the lithic assemblages at Jubbah and how these contribute to our picture of the Arabian Middle Palaeolithic. Following this the variation identified in Chapters 6, 7, and 8 is summarised and discussed. The concluding section then brings together these two areas to consider how the evidence presented relates to hypotheses on dispersals.

## 9.2) Summary of discoveries at Jubbah and the emerging picture of the Arabian Middle Palaeolithic

With the development of the 'southern dispersal' hypothesis in its variant forms, the character of the Upper Pleistocene hominin occupation of Arabia assumed a critical importance in testing theories on dispersals out of Africa, as well as possible movements of Neanderthals from the north. While hominin palaeontological evidence remains elusive, significant advances have been made in terms of understanding the palaeoenvironmental and archaeological records of Upper Pleistocene Arabia. A summary of knowledge and hypotheses on the Arabian Middle Palaeolithic is given in Table 9.1.

As a result of the discoveries at Jubbah discussed in this thesis, Arabia now has three geographic areas which appear to demonstrate distinct change through time in the Middle Palaeolithic. Firstly, at Jebel Faya an MIS 5 assemblage, which the discoverers claim is of 'African' character, is overlain by distinctive and seemingly unique assemblages (A and B) which appear to demonstrate an autochthonous trajectory (or trajectories) (Armitage *et al.* 2011). The limited information available on the Jebel Faya assemblages makes comparative analysis at present difficult. Some support for Armitage *et al.'s* (2011) narrative may be found in assemblages in the surrounding area where sites feature a combination of façonnage technology and centripetal Levallois reduction (e.g. Scott-Jackson *et al.* 2009; Wahida *et al.* 2009).

In southern Arabia, most clearly articulated in Dhofar (Rose 2006; Rose and Usik 2009; Rose *et al.* 2011; Usik *et al.* in press), a rather different sequence is found. Widespread 'classic Nubian' assemblages occur as surface sites. In their one known buried (fluvial) context they date to ~107 ka. From this we might hypothesise a middle/early MIS 5 chronology for this industry. Assemblages assigned by Usik *et al.* (in press) to the 'Mudayyan' both share many features with the classic Nubian, but also show distinctive developments, such as a flattening of the debitage surface. On geomorphological grounds (i.e. they are consistently closer to eroding flint sources than are classic Nubian sites) and in terms of patination (they are consistently less weathered than classic Nubian material), the Mudayyan assemblages are clearly younger than the classic Nubian, but so far this is a purely relative chronology. Younger still, both for the same reasons as above and because material has been found in excavated and dated contexts, is the 'Leptolithic'. In Dhofar the oldest absolute age estimates for this industry are terminal Pleistocene (Hilbert *et al.* 2012), but it has been argued that similar assemblages in this area are likely to be much older (Rose and Usik 2009). It can be argued that the assemblage at SD-1 in Yemen shares a broadly similar suite of traits to the 'Leptolithic', both using the narrow side of a core to produce simple blades and points (Delagnes *et al.* 2012, in press). It may be that similarities between SD-1 and 'Leptolithic' assemblages represent convergent evolution in a broadly similar environment. On the other hand if the similarities represent a cultural connection, this gives the southern Arabian blade tradition a heritage of at least 55 ka.

| | Jubbah | Dhofar | Jebel Faya |
|---|---|---|---|
| **Pre MIS-5** | (JQ-1). Levallois technology present. Diverse raw materials. | ? | ? (Assemblage D). Not yet described. |
| **Early /mid MIS 5** | (JSM-1). Very homogenous preferential Levallois with centripetal preparation. Bifacial technology. | (various sites, only one with a minimum date) 'Classic Nubian' dominated by Nubian core reduction, emphasising 'Type 1' methods, that is the formation of a median distal ridge by distal divergent preparatory removals. Other methods present including non-Levallois single platform and bidirectional cores. Limited retouch. Where present, retouch mostly on lateral margins. Bifacial reduction absent. | (Assemblage C). Both large bifaces and smaller bifacial foliates. Limited evidence for Levallois technology, mostly from a few apparently carefully prepared blanks. Varied retouched component. Mostly local flint. Assemblage is regarded as being a 'workshop'. |
| **Late MIS 5** | (JKF-1). Cores change as reduction proceeds from unidirectional Levallois through bidirectional and unidirectional convergent Levallois to more centripetal methods. Also non-Levallois reduction. Raw materials dominated by quartzite and quartz.<br>(JQ-1). Assemblage dominated by centripetal reduction of quartzite. Cores mostly recurrent centripetal Levallois and discoidal. Retouched component includes a retouched point, other examples emphasise retouch on the lateral margins. | ? (various sites) Mudayyan ('micro-Nubian') not absolutely dated, but younger than classic Nubian in terms of consistent patination and geomorphological factors, but could be MIS 3?. Nubian technology, but on small cores. There is tendency to flattened debitage surfaces, less pronounced distal ridges and more acute striking platforms. Alongside Nubian Levallois cores there is a greater focus on non-Levallois bidirectional cores. No bifacial technology. | ? (perhaps assemblage B, see below) |
| **Post MIS 5** | ? | 'Leptolithic'. Broadly similar technology present at SD-1, Yemen dating to ~55 ka. Key feature of these assemblages is the hard hammer production of simple blades and elongated points from the narrow faces of cores with little platform preparation. In contrast to the lateral and distal convexity of Levallois cores, the blade assemblages of southern Arabia are dominated by cores with flat debitage surface. In terms of retouch, the assemblages are typologically varied and a façonnage component exists in at least some contexts. | (Assemblage B [~100-40ka], could be MIS 5a, hypothesised here to be early MIS 3). Diverse core forms, apparently non-Levallois. Flat debitage surfaces. Apparent tendency towards convergent shape for blanks. No bifacial technology. Mostly local flint.<br>Assemblage A (~40ka). Reduction mostly of orthogonal multiplatform cores. Nothing Levallois or bifacial. All local flint |

Table 9.1. Summary of important characteristics of the Arabian Middle Palaeolithic in key areas. After Armitage *et al.* (2011), Rose *et al.* (2011), Delagnes *et al.* (2012), Hilbert *et al.* (2012). Petraglia *et al.* (2011; 2012), Usik *et al.* (in press), this thesis.

The discoveries at Jubbah discussed in this thesis add a completely new dimension to discussions on the Middle Palaeolithic demography of Arabia. Based on palaeoenvironmental considerations, it is likely that refugial areas will be found in southern Arabia. The absence of clearly post-MIS 5 evidence at Jubbah may support the idea that the aridification of northern and interior Arabia led to

a population contraction into areas such as the Yemeni highlands. Jubbah, an interior palaeolake in northern Arabia, is situated in an important area to understand dispersals into the peninsula.

The discovery of material dating to MIS 7 at JQ-1 makes this the oldest well-dated assemblage in Arabia. Although currently too small to describe firmly the character of reduction at the site, the assemblage demonstrates the existence of Levallois technology in Arabia in MIS 7 and with the diverse raw materials represented might indicate extensive mobility across the landscape. Subsequent excavations will seek to enlarge the number of lithics in this low-density assemblage. Occurring at a time close to the apparent origin of *Homo sapiens*, and not much younger than the earliest Middle Palaeolithic in the Levant or the Middle Stone Age in Africa this discovery firmly situates Arabia as an important area in the origin of both *Homo sapiens* as a species, i.e. ~300-200ka, and of the origin and diversification of the Middle Palaeolithic.

At JSM-1 the assemblage is hypothesised to represent a single phase of occupation in early to mid MIS 5. The assemblage is extremely homogenous in its characteristics. A distinctive yellow siliceous quartzite seam close to the site is the presumed source for the raw material. This was prepared in a centripetal manner and preferential blanks were removed from faceted platforms. Alongside this a façonnage component is present, most clearly represented by the one complete biface in Figure 8.1. In terms of its combination of centripetal Levallois reduction and bifacial technology the assemblage shares broad similarities with the African MSA. However, the form of raw material at the site may be influencing the morphology of the products here. The narrow seam used puts limits on the kind of reduction which could be carried out. On the other hand, the relatively good quality of this raw material may have meant that knappers could carry out reduction sequences they were unable to perform on other raw material types.

The JKF-1 assemblage is by far the largest found at Jubbah. The range of lithics, from fairly large cores, through a diversity of debitage products and core management elements, to some small and heavily reduced cores indicates that an extensive part of reduction took place on site. The two ages of grains present in the sediments are taken as indicating burrowing/vegetation activity in MIS 3. The age of the older population of grains at ~87 ka is taken to indicate the age of the occupation.

The presence of a single, thin layer of lithics in a single stratum and the apparent similarity of reduction throughout the assemblage is taken to indicate that the site represents a fairly short lived occupation. Future excavations at the site will enlarge the sample and a study of refitting will be conducted to complement the attribute analysis conducted here.

The JKF-1 assemblage seems to strongly support a relationship between morphological and technological features and the intensity of reduction. The earlier stages of reduction were largely unidirectional, bidirectional and unidirectional convergent. There, are, however complications to this generality, as the existence of some large flakes with centripetal scar patterns demonstrate. Convexity was largely maintained through the use of débordant elements. The existence of fairly well formed convergent blanks (points) shows that unidirectional convergent reduction was an important part of the reduction process at the site. This, however, occurs in proportions more similar to that seen at Porc Epic (Ethiopia) than in the late Levantine Middle Palaeolithic (such as at Tor Faraj, Jordan). As JKF-1 cores became smaller they became increasingly centripetal.

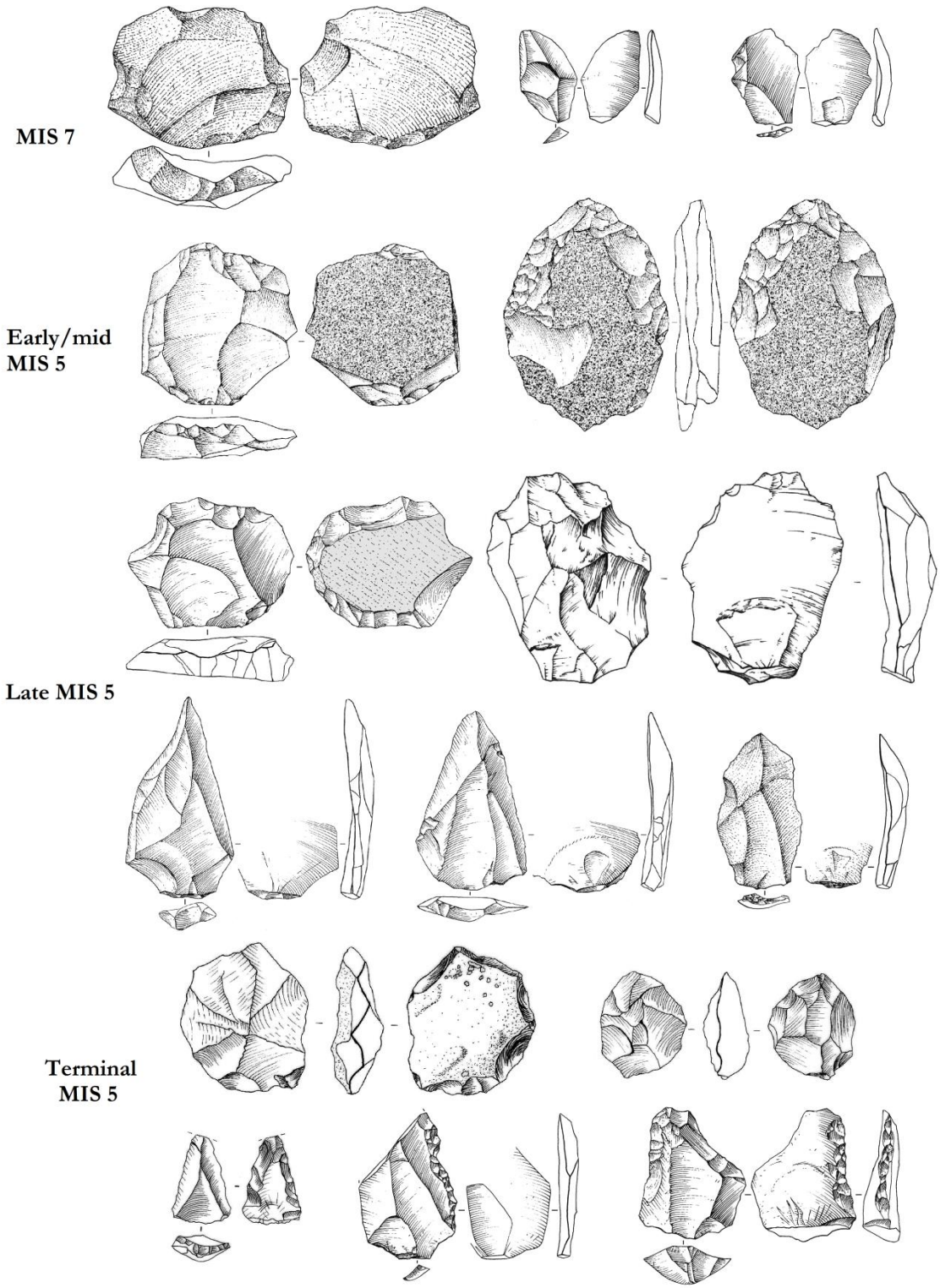



Figure 9.1. Summary of chronological variability at Jubbah (figures from Petraglia *et al.* 2011, 2012; this thesis). NB: not to scale.

Alongside quartzite, small quartz pebbles were also reduced at JKF-1. There seems to be a different, and consistent, reduction strategy for quartz. Cores at the early stage of reduction are classified as single platform cores, and demonstrate lithic technical investment. In some cases reduction proceeded beyond a few removals and the morphology developed a bidirectional and centripetal character. In a volumetric sense several quartz cores can be regarded as Levallois.

Small numbers of other lithics of raw materials are found. Despite their small numbers these offer possibly important insights into the character of the site. A few small pieces of flint are present, but this material is most importantly represented by a single, more or less pointed blank with a finely faceted platform. In terms of rhyolite this is most clearly represented by a single core and a somewhat convergent blank which appears to have snapped when retouch was attempted.

The goals of knapping at JKF-1 seems to have been the production of large Levallois blanks, Levallois points and small flakes. The latter were probably for more immediate use, while, it is hypothesised, the former two were made to be taken away into the wider landscape. Even during periods of greater precipitation, the An Nafud area was probably semi-arid, and so heavily seasonal. The character of the JKF-1 assemblage, the focus on Levallois reduction and limited retouch, can be taken as indications that the aim was the production of large blanks while the group was close to a raw material source, much of which was then removed. As with JSM-1, the character of raw material is an important consideration in understanding the nature of the JKF-1 assemblage. As we saw in chapter 7, JKF-1 has the highest numbers of non-feather terminations of all the assemblages analysed in this study. This is taken as indicating the rather poor quality of the raw material. Of course, to the skilled knappers of the Middle Palaeolithic, who were probably well aware of other raw materials such as flint which is found in the assemblage, these raw material deficiencies would also have been clear.

When we consider the typo-technological features of the assemblage we must consider these raw material factors as well as the likely position of Jubbah as part of a seasonal mobility strategy. Take the production of points. This can be seen in terms of ancestry, adaptation or raw material limitations. Both the African and Levantine MSA and MP records indicate that point production

was an important part of the cultural traditions of these areas. Dispersing populations might then have brought these techniques of reduction with them, but point production can also be seen in 'adaptive' terms, particularly in semi-arid regions where seasonal ambushing of migratory species may have been an important part of survival. To these issues the evidently quite low raw material quality at Jubbah adds a third consideration. It may be that knappers adapted to the brittle raw material by making their reduction primarily longitudinally, rather than centripetally, focussed. In other words they controlled convexity primary through the removal of débordant elements. A centripetal approach risked obstructing the debitage surface with aberrant terminations. If the aim was primarily to produce large blanks which could be carried into the landscape, which implies the prediction that we should find heavily used and probably retouched blanks elsewhere, then a focus on unidirectional, bidirectional and unidirectional convergent reduction was logical. When we see that several factors influence features such as the shape of blanks produced in an assemblage, it is clearly the case that we must avoid simplistic comparisons with other assemblages. The morpho-technological features of any assemblage must always be understood in the specific context of that site.

The need to contextualise technological features can also be applied to the 'Nubian Complex' assemblages of southern Arabia. These can be taken as indicating dispersals from north-eastern Africa (Rose *et al.* 2011), but the possibility of independent innovation must not be completely rejected. If we consider the 'Nubian technique' of median distal ridge preparation as a 'design' feature, one which produces strong distal ends to blanks, then it is clearly a technology which would be advantageous in certain environments. In particular, we can imagine a situation where groups who were moving into areas poor in raw materials, such as an ameliorated Rub' al Khali, carrying strong blanks would be an economising strategy to transport useable raw material. It is easy to imagine how the centripetal and bidirectional preparation of Levallois cores would periodically produce a median distal ridge, in effect by coincidence. When struck opposite this ridge this morphology might produce a 'backing up' of force and a strong preferential blank. At JKF-12, for instance, which is discussed below, a single Nubian like core was collected. Observant knappers might notice the benefits of this technique and increasingly rely on it in their reduction. Analogous

convergent evolution has been suggested for 'tanged' lithics in the mid-latitude arid belt (Scerri 2012, in press), in this case probably relating to equifinality in ways of hafting lithics. The underlying point is that in a strict sense it is problematic to use broadly 'adaptive' features to indicate population dispersals. The strongest evidence for dispersal would come from a spatially and temporally broadly continuous, or at least not data points separated by thousands of kilometres, distribution of idiosyncratic features. The Nubian Complex is, in a sense, somewhat idiosyncratic, but it is hardly impossible to imagine the reinvention of the Nubian technique and more chronometric dates are urgently needed.

Returning to Jubbah, the JKF-12 assemblage is hypothesised to represent the raw material source for JKF-1. The assemblage demonstrates a focus on unidirectional Levallois reduction, trending towards convergent removals. This is interpreted as representing an initial shaping of the cores, some of which were subsequently moved to JKF-1 and reduction continued. JKF-12 demonstrates a flexible approach to knapping and adaptation to particular raw material characteristics. The presence of a single Nubian-like core in the assemblage is interesting, but it is unclear if this is an isolated specimen, or whether more such types will be found.

At JQ-1 the younger assemblage appears to relate to the MIS 5a palaeosol dated to ~75 ka. The core technology at the site is fairly homogenous and consists of small and heavily reduced cores, characterised by different forms of centripetal reduction. Alongside these cores the assemblage consists mostly of small flakes, as well as several larger flakes of a Levallois preferential character with centripetal preparation. Compared to other assemblages at Jubbah the JQ-1 assemblage is quite heavily retouched. While mostly quartzite, both flint and rhyolite are also present in the assemblage. What does this suite of characteristics indicate? Two hypotheses can be advanced. The limited sources of good raw material in the immediate vicinity of JQ-1 may have meant that cores began as small raw material packages, this explaining their diminutive character. On other hand, the fairly homogenous and exhausted character of the cores, the high levels of retouch, and presence of some apparently more 'exotic' raw materials may suggest a different scenario. These features may indicate that the assemblage actually in part represents material carried by groups arriving at Jubbah

from the wider landscape. The higher levels of retouch matching the prediction made from the JKF-1 assemblage that such pieces would be found elsewhere. Of course, the reality may be that a mixture of these two hypotheses is responsible for the character of the assemblage. As Figure 9.2 shows, the cores at JQ-1 exist at the lower end of a continuum of a size relationship which extends through JKF-1 to JKF-12. This relationship may be primarily driven by reduction intensity, but also may relate to the physical properties of reduction of this type of raw material. Given that the JQ-1 cores are typically flaked on all surfaces, their diminutive size is here taken to indicate extensive reduction is perhaps a more important factor than initially diminutive raw material size.

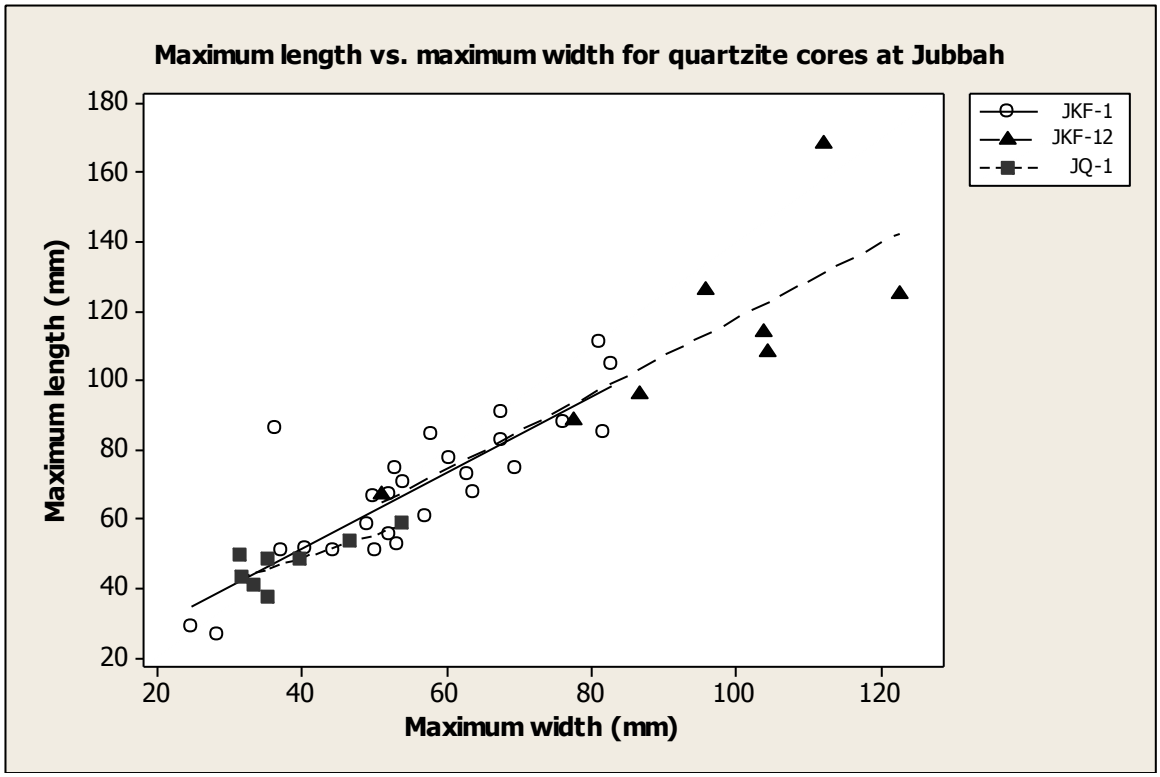



Figure 9.2. Comparison of maximum length and maximum width for quartzite cores at JKF-1, JKF-12, and JQ-1.

If the JQ-1 and JKF-1 assemblages do indicate different aspects of hunter-gatherer mobility, in which seasonality was probably important, this helps us to contextualise the raw material variability seen at Jubbah. At JSM-1, JKF-1 and JQ-1 small amounts of flint are found, while at the latter two rhyolite is present. Neither of these materials is known to occur in the immediate area. In the case of JKF-1, the exotic raw materials include a core and two convergent blanks. Does this offer an insight into part of a lithic 'kit' which was carried to Jubbah and abandoned when a raw material

source was identified? The presence of apparently exotic raw materials at Jubbah may indicate highly mobile populations as we might expect in semi-arid conditions.

### 9.3) Summary of core analysis

The detailed analysis of lithic variability in the assemblages studied began with core technology. It does appear to the author that genuine typological distinctions can be made between forms of cores, but the analysis clearly demonstrates that such distinctions largely correlate with variation in size and reduction intensity. The apparent 'reality' of typological distinctions stands in contrast to the results for blanks and retouched pieces, where most variation appears to be more continuous. This character of cores reflects the fact that the core forms an integrated system for the production of blanks, and that the physical properties of conchoidal fracture underlie different typologies, of which there are not an unlimited number. Levallois reduction, for instance, reflects an attempt to produce relatively long, wide and thin blanks. In contrast discoidal reduction reflects a way of producing more blanks, but such blanks are smaller, often thicker and less standardised.

| Site | Summary of changes to core morphology and technology with reduction |
|---|---|
| **JKF-1** | Large cores are Levallois, medium sized are single platform and discoidal, small are multiplatform, bidirectional, radial and amorphous. Apparent trend for reduction to be unidirectional in its early phases, moving through bidirectional and unidirectional convergent and ending in diverse smaller centripetal cores. |
| **JKF-12** | Most cores are Levallois. Dominant trend is for large cores to be recurrent unidirectional Levallois, while unidirectional convergent, Nubian Type-1 like, and preferential Levallois with centripetal preparation are smaller. Multiplatform cores reflect a flexible approach to reduction such as the use of a large flake as a core. |
| **JSM-1** | Core technology very homogenous. Dominated by removal of broadly ovoid preferential blanks from centripetally prepared and faceted Levallois cores. The underside of the cores is heavily cortical. Other cores convincingly appear as pre-cores for this type of reduction which have been abandoned before the removal of a preferential blank. |
| **JQ-1** | All cores are small and broadly similar in dimensions, and features such as the number of scars. The suggested distinctions between discoidal and Levallois types reflects a flexibility on the part of the knappers to adapt to different morphologies of raw material. |
| **123-b** | There appear to be two distinct reduction trajectories. The dominant one is Levallois and is dominated by Nubian Levallois reduction. This began with the preparation of the median distal ridge and subsequent decortification of the core. Pointed blanks were then struck from faceted striking platforms. Some examples were subsequently prepared for further Levallois removals, but cores on site were not reduced to exhaustion. The Nubian reduction technique here seems to be extremely standardised. The other reductions strategy consists of relatively small numbers of non-Levallois unidirectional and bidirectional cores with flat debitage surfaces. |
| **Porc Epic C** | Most cores heavily reduced so only offer a partial insight into reduction (most cores abandoned when about 40mm in maximum dimension and 15-20 mm thick). While all cores are small, the larger ones tend to be Levallois, while smaller cores include Levallois types, but also discoidal and amorphous cores. Size and technological differences are subtle due to extensive reduction, differences reflecting raw material variation and the element of contingency in the reduction process |
| **Porc Epic E** | Most cores heavily reduced so only partial insight into reduction. Broadly similar characteristics to layer C, but fewer amorphous and discoidal cores in E. Levallois and single platform cores typically larger than amorphous and multiplatform cores. |
| **1010-8** | Larger cores are Nubian Type-1 and preferential Levallois with centripetal preparation while smaller examples are bidirectional Levallois. |
| **Tor Faraj** | Cores on flakes come in a range of sizes. A few centripetally prepared Levallois cores are present, and these are slightly larger than other core types. Most Levallois cores, however, cluster closely in size being ~40-50mm long and ~20 to 40mm wide. The variation in core morphology is here taken as suggesting that reduction was dominated by unidirectional convergent Levallois reduction until the core was too small for this to continue, or the debitage surface was obstructed by aberrant terminations or the loss of convexity. At this point reduction shifted from a longitudinal focus to one emphasising removals from all margins of the core. Consequently the distinction between types is primarily marked by differences in width rather than length. The first step in the move away from unidirectional convergent Levallois cores was to make removals from secondary, distal, striking platforms, producing bidirectional Levallois cores. Where reduction proceeded beyond a Levallois phase it did so in a rather informal manner, producing multiplatform and, particularly, amorphous cores. |
| **Warwasi WWXX** | Both Warwasi assemblages are dominated by cores on flakes and small, heavily reduced and rather amorphous cores. There is some indication that reduction trends from single platform, via bidirectional to discoidal cores. Levallois cores typically slightly larger (particularly wider) than other core types, as well as having more cortex and more scars. |
| **Warwasi NNOO** | While broadly similar to WWXX, the main difference is the greater number of discoidal cores in this layer. This, as well as other indications such as the complete absence of cortex from all cores, can be taken as indications of greater reduction intensity. In NNOO the larger cores are multiplatform and Levallois, while the smaller cores are cores on fakes (which are typically smaller than those from WWXX), single platform, bidirectional and discoidal cores. |

Table 9.2. Summary of core variability in the various assemblages, in relation to hypotheses on how morphological variability relates to reduction intensity and abandonment thresholds.

There has been a tendency to suggest that cores were reduced in a particular manner throughout their use-life, despite arguments to the contrary (e.g. Bordes 1961, 89). At times this is stated explicitly, at other times it is more implicit. At both Porc Epic and Jebel Faya, for instance, the presence of blades has been interpreted as indicating a specific 'blade reduction strategy' (Pleurdeau

2005; Armitage *et al.* 2011). The results in this thesis strongly suggest that the character of cores in large part reflects the intensity of their reduction. Hypotheses on how this varied on a site by site basis are presented in Table 9.2. In heavily reduced assemblages the cores can give a rather misleading impression of the character of reduction. At Warwasi, for instance, the morphological characteristics of the blanks – such as frequently faceted platforms and a tendency to laminarity – are rather at odds with the rather amorphous discoidal cores which dominate the assemblage (after cores on flakes). Combining the blank and core data suggests that much of the reduction was probably more unidirectional Levallois-like, switching to discoidal reduction at a late stage. In the case of Tor Faraj the data was interpreted as suggesting a reduction process focussed on unidirectional convergent Levallois reduction, but with a transformation to fairly ad-hoc reduction forming amorphous cores when Levallois cores became too small or the knapper lost control of the convexity of the debitage surface.

The form of cores is argued to largely indicate reduction intensity and discard thresholds. In most assemblages the earlier stage of reduction was Levallois, shifting to more diverse and opportunistic approaches as the size of the core decreased. It seems clear that there are significant differences even at the level of a fairly coarse typology of Levallois methods, Nubian, recurrent methods, etc., but these differences must be understood within a dynamic framework which recognises the fundamental importance of reduction intensity.

Multivariate statistics were applied to morphological and technological characteristics of cores. A summary of the results of these analyses is given in Table 9.3. The essential character of the results is that much of the variation is ordered in terms of size and reduction intensity. We therefore find the repeated clustering of Warwasi, Porc Epic and Tor Faraj. While the cores in these assemblages demonstrate a clear equifinality in terms of characteristics such as size, as we have seen they also demonstrate quite distinctive typological characters. The small cores at these sites are characterised as discoidal at Warwasi, preferential Levallois with centripetal preparation and recurrent centripetal Levallois at Porc Epic and unidirectional convergent Levallois and amorphous at Tor Farj. This differentiation suggests that future quantified studies will be able to advance and clarify the nature

of variation between such assemblages, while the present analysis has focussed on a clarification of the broad picture of variation across a large area. Likewise, the example of variation in 'convergence' of core shape, that is a relatively narrow distal end, indicates that while size variation is critical, even a coarse level of analysis highlights differences in shape.

The analysis of variation in cores across Arabia, and of the Arabian material to that from the comparative sites in surrounding regions, quantifies the apparent character of Arabian sites as often being 'primary' sites, associated with raw material sources and not heavily reduced. This recognition has different implications. In part, it probably reflects a genuine character of the Arabian record, the relatively arid environment leading to low population density and with aridification large areas were probably almost devoid of hominin populations. The sites largely reflect hominin raw material procurement, with the products then being removed and scattered across the landscape. Given this, it is not surprising that the lithics have a rather different character to those in caves and rock shelters which appear to represent repeated visits to the same site, extensive reduction and the performance of a variety of activities on site. Nevertheless, the example of JQ-1 indicates that sites with apparently heavily reduced cores can be found in Arabia. This may, in part, reflect a bias in past surveys towards large and obvious assemblages, but also as was suggested the character of the JQ-1 assemblage may indicate the role of palaeolakes such as Jubbah in the mobility strategies of Middle Palaeolithic hominins.

| **Question** | **Summary of results** | **Groupings** |
|---|---|---|
| *[1] What is the relationship between raw material type and the technological character and intensity of core reduction?* | Raw material does not seem to play a particular strong role in determining morphology, with the partial exception of quartz. The problem of course is that the data does not include what could not be done with certain materials, so likely underestimates the role of raw material variability. | The analysis essentially separates assemblages with large cores (123-b, JKF-12, 1010-8) from those with small cores (JKF-1 quartz, Warwasi, Porc Epic and Tor Faraj). JSM-1 trends towards the former. JKF-1 quartzite is divided between the small group and the large group. Subsequent components driving by various combinations of size and typological related features.<br>For those with large enough sample sizes:<br>**(PC1**, decreasing size): **1** – 123-b, **2** – JKF-1 quartzite, **3** – Warwasi NNOO, Porc Epic E, Tor Faraj, **4** – Porc Epic C, JKF-1 quartz. |

| | | |
|---|---|---|
| *[2]How does morphology vary in non-Levallois cores?* | Mostly driven by reduction intensity, indicated by % cortex and number of scars. which is related to a change in shape (more reduced cores are less flattened). Second component strongly driven by a shape difference, between more and less elongated cores. Size structure is the dominant factor. | Look at group centroids and overall tendencies (considering the wide spread of results, ignoring some which are extremely spread or <2 cores) produces 4 groups of particular interest. 1) Porc Epic C and E and Warwasi NNOO (heavily reduced, medium elongation), 2) 123-b and Tor Faraj (medium reduction, low elongation), 3) JKF-1 quartzite (quite heavily reduced, elongate), 4) JKF-1 quartz (not heavily reduced, elongate). |
| *[3]How does morphology vary in preferential Levallois cores?* | This PCA strongly divides the sample based firstly on size and secondly on distal convergence. Size separates the heavily reduced assemblages from the more primary sites. 123-b emerges as strongly convergent in shape, whereas most others are more parallel/ovoid. Porc Epic, in particular, and Tor Faraj slightly, have a few cores which are more convergent but in these most are squat. | (**PC1,** increasing size), Porc Epic, Tor Faraj, Warwasi, JSM-1, JKF-1, 1010-8, 123-b, JKF-12.<br><br>(**PC2,** increasing convergence), JKF12, JKF-1, 1010-8, JSM-1, Porc Epic C, Warwasi WWXX, Tor Faraj, Warwasi NNOO, Porc Epic E, 123-b |
| 4. *How does reduction intensity impact core morphology?* | Results distinguish between retouch intensity from a variety of perspectives, PC1 gives an overall summary of reduction, emphasising in particular the inverse correlation between the % cortex and the number of scars. PC2 emphasises the number of aberrant terminations, while PC3 focusses on, in particular, changing shape (more reduced cores being less elongate. The first component, in particular correlate increasing reduction with the basic structure encountered in several analyses. The subsequent component emphasising numbers of terminations is perhaps less successful, because the number of aberrant terminations can express either extensive reduction or poor quality materials. | (**PC1,** decreasing % cortex and elongation, more scars and non-feather terminations), JSM-1, 1010-8, JKF-1, 123-b, JKF-12, Warwasi WWXX, Tor Faraj, Porc Epic, Warwasi NNOO.<br><br>**(PC2**, decreasing % cortex, elongation and number of aberrant terminations), Warwasi WWXX, 123-b, JKF-12, Tor Faraj, JKF-1, Porc Epic C, JSM-1, Warwasi NNOO, Porc Epic E, JQ-1, 1010-8. |
| *5. What is the morphological variability of Arabian cores?* | This analysis supports earlier comments that size and reduction intensity are the major features driving core variability. In a broad sense the relationship between the first two components distinguishes between sites like JQ-1, JSM-1 and 210-65 and, where cores are small, mostly quite heavily reduced and not elongate, and those like 217-42, 123-b, JKF-12, 210-32, 201-60, 216-205, where cores are large, less heavily reduced and more cortical. Analysis supports the status of many Arabian sites as primary 'workshops', basic variation dose not seem to be geographical or chronological (in far as the latter can be told). | (**PC1**, increasing % cortex, decreasing elongation, weight, thickness and number of scars) JKF-12, 123-b, 210-232, 217-42, 216-205, 201-60, JQ-1, 210-165, JSM-1, JKF-1, 201-61.<br>**(PC2**, increasing % cortex, elongation, weight, thickness and decreasing number of scars), JQ-1, 210-165, JSM-1, JKF-1, 217-42, 123-B, JKF-12, 210-232, 201-60, 216-205, 201-61. |
| *6. How do Arabian cores compare to non-Arabian cores in general morphology?* | Overall Arabian cores are less and not heavily reduced, although the example of JQ-1 is something of an exception. So while the analysis clusters together Arabian sites as being less reduced than those in surrounding areas, this may in part reflect a sampling bias, and/or something real in the demography of Pleistocene Arabia.<br>Second component shows some of the problems with such analysis, low scars seem to | (NB: groupings based on ANOVA mean scores, not Tukey grouping)<br>**(PC1,** increasingly small and less cortical [more reduced] cores), **1 –** 210-232, 216-205, JKF-12, 201-60, 123-b, 201-61, 217-42, **2** - JKF-1, JSM-1, 210-165, Warwasi WWXX, JQ-1, **3** - Tor Faraj, Warwasni NNOO and Porc Epic.<br>(**PC2**, increasingly small, cortical and decreasing numbers of scars), **1** - JKF-12, 123-B, JQ-1, Warwasi NNOO, 210-232, Porc Epic E, 217-42, |

| | | |
|---|---|---|
| | equate to both cores which are not reduced much and on small pebbles (such as JKF-1 quartz) and small cores where the reduction technique leads to the presence of relatively few scars (Tor Faraj). Not clear that the two are being conflated in a meaningful way. | 1010-8, JKF-1 quartzite, Porc Epic C, **2** - Tor Faraj, Warwasi WWXX, 216-205, 201-60, 210-165, JSM-1, JKF-1 quartz, 201-61. |

Table 9.3. Summary of multivariate analyses of cores.

**9.4) Summary of blank analysis**

Virtually all Palaeolithic assemblages are dominated by unretouched blanks. This factor alones means that they have a central position in understanding different ways in which hominins reduced a core. At a basic level, all of the assemblages studied are dominated by flakes. However, a laminar element is also important, being prominent at Porc Epic layer C, Tor Faraj and Warwasi. Increasing laminarity is argued to reflect a more longitudinal focus to core reduction, rather than necessitating the idea of specific 'blade reduction strategies'. In this sense both variance in laminarity and in the proportion of 'points' in an assemblage reflecting varying combinations of features reflecting a broadly similar underlying approach to reduction. Some assemblages emphasise convergent debitage, some less so. This recognition, demonstrated in Chapter 7, offers further support to a quantified method to compare nuanced differences in morphological and technological characteristics of lithic assemblages.

The quantification of blank variability led to some observations which do not appear to have been previously emphasised. For instance, across assemblages a tendency for distal fragments to be more heavily represented than proximal fragments was observed. It was suggested that this may represent the removal of more voluminous proximal fragments for retouch, but in reality the meaning of such patterns remain unclear. These patterns can only be observed by quantifying whole assemblages. Likewise, variance in laminarity is poorly manifested in qualitative accounts. Previous analyses do not appear to have emphasised the substantial intrasite differences in laminarity at both Porc Epic and Warwasi, for instance.

Variation in striking platform types is also something which can easily be quantified. A key factor to emerge is that the Warwasi and Tor Faraj assemblages, in contrast to the African and Arabian

material, have high values for relative platform size (large blanks from small platforms). This only emerges by systematic measuring of striking platforms and blank dimensions and subsequent statistical analysis. This is not particularly complicated, but does necessitate a focus on the assemblage as the unit of analysis. Whereas the Jubbah assemblages for the most part show similar proportions of platform preparation, the analysis once again revealed the considerable differences between assemblages in both the Porc Epic and Warwasi sequences. At Warwasi there is significantly less faceting in the younger layers, while at Porc epic there is a fairly large increase in the proportion of faceted and dihedral platforms in the younger layer. Such observations show that it is critical to have good temporal control of assemblages in order to understand dispersals, and that suggestions of homogeneity in the East African MSA and Zagros Middle Palaeolithic are wrong. Considering such change at these sites, we can imagine dramatic change in a context of dispersals where populations encountered different raw materials, demographic conditions were different, and so on. The example of the SD-1 platforms, which Delagnes *et al.* (2012) suggest were not elaborately faceted because they could not be elaborately faceted due to raw material characteristics, is another excellent example of the need to consider such attributes in theoretical and not empiricist terms.

Chapter 7 demonstrated that variation in shape characteristics are apparent even when whole blank populations, and not merely selected elements assigned to the 'Levallois' category, are considered. It was also shown that significant elements of shape variation are associated with size variation. Consequently the most heavily reduced assemblages have the most elongate blanks (Warwasi, Porc Epic and Tor Faraj). Likewise, the heavily reduced assemblages also have the most convergent (pointed) debitage.

| Question | Summary of results | Examples of groupings |
|---|---|---|
| *[1] How is variability in blank size structured?* | Raw material does not seem to play a large role in relation to size variability. Various components divide large and small blanks from different perspectives. After initial dominance of size variation, shape variation is also significant. | (**RPC1,** decreasing size) **1** – JKF-12, **2** – 1010-8, 123-b, **3** – JKF-1, JQ-1, **4** – JSM-1, Porc Epic, Tor Faraj, BS-1, **5** – Warwasi.<br>(**RPC4,** increasing convergence as well as a trend towards use of flint) **1** – JQ-1, JKF-12, JKF-1, BS-1, JSM-1, 1010-8, **2** – Porc Epic E, Warwasi NNOO, Porc Epic C, **3** – Warwasi WWXX, 123-b, Tor Faraj.<br>**(RPC 6**, decreasing convergence and trend towards use of quartzite) **1** – 123-b, **2** – Tor Faraj, Warwasi WWXX, **3 –** Warwasi NNOO, Porc Epic C, JSM-1, **4** – JQ-1, JKF-12, 1010-8, JKF-1, **5** – Porc Epic E, BS-1. |
| *[2a] What is the character of morphological variability for blanks >20mm long?* | Divides sample firstly by a basic distinction between blanks which are heavy, long, wide and thin and those which are light, short, narrow and thick. The second component emphasis platform flattening. The third component addresses another element of blank shape compared to PC1. Seems like a successful analysis which highlights both size and shape. | **(PC1**, increasing weight, length, width, but thinner) **1** – Warwasi, **2** – BS-1, Porc Epic, JSM-1, **3** – Tor Faraj, JQ-1, JKF-1, **4** - 1010-8, 123-b, **5** – JKF-12.<br>**(PC2,** increasing platform flattening) **1** – Porc Epic E, 123-b, JKF-1, JQ-1. **2** – JSM-1, Warwasi NNOO, JKF-12, Porc Epic C, BS-1, **3** – Warwasi WWXX, 1010-8, Tor Faraj.<br>**(PC3**, decreasing laminarity) **1** – Tor Faraj, Porc Epic, Warwasi WWXX, **2** – 1010-8, Warwasi NNOO, 123-b, JKF-12, JQ-1, **3** – JKF-1, BS-1, JSM-1. |
| *[2b] What is the character of morphological variability for blanks 30-60mm long?* | Reveals a similar, but slightly different and more nuanced structure to the above. The first component seems to emphasise laminarity more than previously. | (**PC1,** decreasing laminarity) **1** – Warwasi, **2** – Porc Epic, Tor Faraj, **3** – JKF-1, 1010-8, **4** – 123-b, JKF-12<br>**(PC2,** decreasing platform flattening) **1** – Tor Faraj, 1010-8, Porc Epic C, Warwasi, **2** – JKF-12, Porc Epic E, 123-b, JKF-1.<br>**(PC3,** increasingly small, but gracile blanks) **1** – JKF-1, JKF-12, 1010-8, 123-b, Warwasi NNOO, **2** – Warwasi WWXX, Porc Epic C, Tor Faraj, Porc Epic E. |
| *[3] How were knappers utilising striking platforms to control blank length?* | Shows correlation between platform preparation (dihedral and faceted platforms) and relatively long blanks. But complicated relationship between variables. For instance, PC1 correlates overall platform preparation with relative length, while PC3 divides assemblages with a significant number of dihedral terminations from those lacking these, but having faceted platforms. | **(RPC1**, decreasing numbers of dihedral and faceted platforms and decreasing relative length), **1** – Porc Epic C, Warwasi, Tor Faraj, **2** – Porc Epic E, 1010-8, BS-1, JSM-1, JKF-1, **3** – JQ-1, 123-B, JKF-12.<br>**(RPC3,** increasing numbers of faceted platforms, decreasing numbers of dihedral and decreasing relative length), **1** - Porc Epic C, Warwasi, Tor Faraj, **2** – Porc Epic E, 1010-8, BS-1, JSM-1, JKF-1, JQ-1. |
| *[4] How were knappers utilising platforms to control blank width?* | Shows correlation between platform preparation (particularly dihedral platforms, as well as faceted platforms) and wide blanks. | **(RPC1,** decreasing relative width and number of dihedral and faceted platforms and increasing numbers of cortical platforms), **1** – JKF-12, 123-b, **2** – JQ-1, JKF-1, JSM-1, **3** –1010-8, BS-1, **4** – Warwasi NNOO, Porc Epic E, Warwasi WWXX, Tor Faraj, Porc Epic C.<br>(**RPC4**, decreasing relative width, more plain and dihedral platforms, smaller numbers of faceted platforms and step terminations). **1** – Porc Epic E, JKF-12, **2** – 1010-8, 123-b, Porc Epic C, Tor Faraj, **3** – JQ-1, JSM-1, Warwasi WWXX, JKF-1, **4** – Warwasi NNOO, BS-1. |
| *[5a] How do* | This analysis shows a variety of correlations | (**RPC1,** increasingly relatively thick platform, |

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| *features reflecting the character of striking platforms and dorsal surfaces relate for all complete blanks?* | between aspects of striking platform morphology and dorsal surface features. As with previous Correspondence Analyses here, the problem is that each component explains a fairly small percentage of the variation so the analyses reveals a variety of different, and often broadly contradictory, results. Tendency for from proximal convergent and radial scrap patterns to be associated with prepared platforms and relatively thinner blanks. But the diversity of the components indicate there is not a simplistic relationship between striking platform features and blank characteristics, they merely create tendencies in certain directions. | fewer faceted platforms and from proximal convergent scar patterns), **1** – Tor Faraj, 1010-8, Porc Epic C, **2** – Porc Epic E, Warwasi WWXX, JKF-12, **3** – JQ-1, JKF-1, Warwasi NNOO, BS-1, 123-b.<br>(**RPC2,** increasingly relatively thin platforms and narrow blanks, fewer cortical platforms and combination scar patterns), **1** – JKF-12, 123-b, 1010-8, **2** – JKF-1, JQ-1, BS-1, **3** – Porc Epic C, Warwasi WWXX, Porc Epic E, Warwasi NNOO, Tor Faraj.<br>(**RPC3**, increasingly relatively thin platforms, fewer centripetal scar patterns and fewer cortical platforms) **1** – 1010-8, Porc Epic, **2** – BS-1, JQ-1, Warwasi WWXX, 123-b, Warwasi NNOO, **3** – JKF-1, Tor Faraj, JKF-12.<br>(**RPC9**, increasingly wide blanks, fewer dihedral platforms, more plain platforms and radial scar patterns) **1** – Porc Epic, 1010-8, **2** – 123-b, JQ-1, JKF-12, JKF-1, **3** – Warwasi WWXX, Tor Faraj, **4** – Warwasi NNOO, BS-1 |
| *[5b] How do features reflecting the character of striking platforms and dorsal surfaces relate for Levallois blanks?* | For the most part this is similarly structured to the results for 5a and each component explains a similar proportion of variability. It is interesting that despite the significantly reduced sample and focus on seemingly 'predetermined' debitage, a similar relationship between platforms and dorsal surfaces remains. | (**RPC1,** increasingly relatively thin platforms, more faceted platforms and from proximal convergent scar patterns, fewer plain platforms) **1 –** JQ-1, JKF-12, 1010-8, Warwasi WWXX, JKF-1, Warwasi NNOO, Porc Epic, **2** – Tor Faraj.<br>(**RPC4** particularly driven by increasing numbers of strongly radial scar patterns, relatively thinner platforms and increasingly elongate blanks, fewer combination scar patterns), **1** – JKF-12, 1010-8, JKF-1, **2** – Tor Faraj, JQ-1, Warwasi WWXX, **3** – Porc Epic, Warwasi NNOO. |
| *[6] How did the shaping of the dorsal surface change with the shape of the core for Levallois blanks?* | Assuming that blank shape at least in large part reflects core shape, this question sought to correlate the shape and number of scars on blanks with particular scar patterns. Various different correlations are demonstrated. | **(RPC1** decreasing number of scars and number of radial scar patterns) **1** – 1010-8, JQ-1, **2** – JKF-12, JKF-1, Porc Epic **3** – Warwasi WWXX, Tor Faraj, Warwasi NNOO.<br>**(RPC2** (decreasing number of scars and number of from proximal convergent scar patterns) **1** – Tor Faraj, Porc Epic, **2** – Warwasi NNOO, JKF-1, 1010-8, Warwasi WWXX, JQ-1, JKF-12.<br>**(RPC5** (decrease in number of bidirectional and two directions scar patterns and an increasing tendency to laminarity) **1** – JKF-1, JKF-12, JQ-1, Warwasi NNOO, 1010-8, **2** – Warwasi WWXX, Tor Faraj, Porc Epic. |
| *[7] What is the relationship between the intensity of reduction and the morphology of the blank?* | The role of reduction intensity has been mentioned repeatedly. This question attempted an explicit analysis of the role of this on blank morphology. Produced, in a way, different results than expected. Highlighted difficulties though, e.g. using number of scars to indicate reduction intensity may be flawed because large blanks often have higher numbers of scars. | **RPC1** (increasingly reduced [more scars, less cortex, radial scar patterns]) **1** – BS-1, JKF-1, Tor Faraj, JKF-12, Warwasi NNOO**, 2** – JSM-1, Warwasi WWXX, 123-b, **3** – JQ-1, Porc Epic, 1010-8.<br>**RPC3** (increasingly reduced) **1** – JKF-12, JKF-1, 123-b, **2** – Tor Faraj, 1010-8, JQ-1, Warwasi, BS-1, Porc Epic E, **3** – Porc Epic C, JSM-1.<br>**RPC6** (increasingly reduced and tendency to radial scar patterns with reduction in bidirectional and from proximal convergent scar patterns) **1** – Tor Faraj, JKF-12, JKF-1, Warwasi WWXX, Porc Epic C, **2** – 123-b, BS-1, Porc |

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| | | Epic E, 1010-8, Warwasi NNOO, JSM-1, JQ-1. |
| *[8] How does morphology of Levallois blanks vary when several attributes are considered?* | As the Correspondence Analyses produced rather complicated results it was decided to include a further Principal Components Analysis in this study. More variables were used and only Levallois-like blanks included to try and emphasise shape variation. Comparing the results to those of question 2 shows broad similarity, but also that this current question appears to offer more nuanced insights into shape variability between assemblages. | **(PC1,** increasingly long, wide and thin blanks) **1** – JKF-12, **2** – 1010-8, JKF-1, **3** – JQ-1, Tor Faraj, Porc Epic, BS-1, **4** – Warwasi. **(PC2**, increasingly flat platforms and convergent margins) **1** – JQ-1, JKF-12, BS-1, Porc Epic C, JKF-1, Porc Epic E, Warwasi, 1010-8, **2** – Tor Faraj. **(PC3,** increasingly short and convergent margins) **1** – Porc Epic E, Tor Faraj, Porc Epic C, JKF-1, **2** – Warwasi WWXX, JKF-12, Warwasi NNOO, 1010-8, BS-1, JQ-1. |

Table 9.4. Summary of multivariate analyses of blanks, with pertinent examples of groupings (interpretation of Tukey method clustering).

In terms of the multivariate analysis, a considerable number of results were generated from a large volume of data. This does not suggest clear and repetitive patterns of similarity and difference, but does in general group assemblages together based on size, which in large part reflects reduction intensity. As has been suggested at several points, such data must be interpreted to be meaningful. While blank features do not seem to simplistically correlate with particular raw material characteristics (question 1), two factors need to be remembered. Firstly, rare raw materials (those forming less than 5% of the category) were not included in the analysis as primary variables, so the analysis only focuses on the major categories of raw material. Secondly, as the JKF-1 distal termination argument indicates, such analyses tell us nothing about what knappers would have done differently with different raw material. Nevertheless, the analysis perhaps indicates that accounts emphasising the primary role of raw material form in morphological variability are over-stated. At a basic level size related factors are the dominant driver of variability, indicating that, on average, debitage decreases in size in the following groups: 1.) JKF-12, 123-b, 2.) 1010-8, 3.) JKF-1, 4.) JSM-1, JQ-1. 5.) Porc Epic, Tor Faraj, Warwasi. The former represent raw material procurement sites where primary reduction was conducted and cores not extensively reduced, while the latter represent more intensively occupied sites with heavily reduced assemblages.

Several analyses (particularly questions 2 and 8) highlight that the group of Warwasi, Porc Epic and Tor Faraj share important features of shape as well of size, particularly in terms of their relative laminarity. This supports the earlier observation of co-variance of laminarity and size.

The situation is rather more complex in terms of the implications for the shape of the margins, particularly in terms of convergence. For example, in the first question the Jubbah assemblages group together as being characterised by non-convergent blank margins, while Porc Epic and Warwasi have moderately convergent margins, and Warwasi WWXX, 123-b and Tor Faraj are the most convergent. Clearly this does not correlate with the basic size related structure which has repeatedly been demonstrated. The trouble with such analyses is that as the dominant components are driven by size, a significant element of shape variability is subsumed within the initial components. Emphasis on shape in subsequent components may then give a rather misleading perspective. It can, however, be noted that for question 1, components 4 and 6 tell broadly similar stories in terms of convergence.

Likewise, the relationship between features of the striking platform and of the dorsal surface and overall morphology of blanks is complex. Question 2 suggests that Tor Faraj, 1010-8 and Warwasi have flat (relatively wide) platforms, while the Jubbah assemblages, Porc Epic E, 123-b have rather thicker (relatively) platforms. A broadly similar structure in this regard is shown for both all debitage (2a) and only for Levallois debitage (2b). This is an interesting example of intrasite differences, with the younger Porc Epic material demonstrating considerably greater platform flattening compared to the older assemblage. Question 3 demonstrates that the Warwasi, Tor Faraj and Porc Epic assemblages have high numbers of faceted platforms correlating with relatively long blanks, the opposite pattern is found at 123-b and JKF-12, with the Jubbah localities falling in between. However, when features of the dorsal surface are emphasised (question 5) we find a rather different picture again. In this case there is quite a dramatic difference between the analysis of all debitage and that of only Levallois debitage. Space prevents a thorough description of each analysis, but the overall picture is one of some repeated correlations, particularly in terms of the more and less reduced assemblages respectively, but also, within this, quite considerable variability.

**9.5) Summary of retouch analysis**

The analysis of retouched tools focussed on the character of blanks selected for retouch and the character of retouch applied. In both senses the value of a quantified approach was again demonstrated.

The significant temporal variation at both Porc Epic and Warwasi once again warns against treating the lithic technology at such sites as homogenous. In both these cases there is a considerable decrease in the percentage of blanks retouched, almost a threefold decrease in the case of Warwasi. Such observations are of basic and fundamental importance in understanding the role of retouch in an assemblage, yet relative proportions of retouch in an assemblage receive little attention in traditional accounts, in contrast to absolute counts. While there are typologically distinctive elements of retouch in certain spatial and temporal contexts, it was demonstrated that diversity in retouch types is correlated with the number of retouched types present in an assemblage.

Confirming earlier accounts of Arabian assemblages, both the Jubbah assemblages and 123-b have little retouch. For such reasons, as well as small sample sizes at other sites, multivariate analysis played less of a role in relation to the retouched component than had originally been planned. Some important observations emerged from univariate and bivariate analyses. Bifacial technology was rare throughout, its slight presence at Jubbah perhaps suggesting, generously, connections to African sites. On the whole, however, variation is more one of scale and different emphasis. The Arabian, African and Iranian material emphasise lateral retouch, whereas at Tor Faraj the emphasis is on distal retouch. The presence and prominence and notching and burination seem to cross cut temporal and spatial divisions. These types of retouch may relate to specific functional activities, but can also be seen as culturally transmitted forms of retouch. Burination, for instance, can often be seen as a way of removing a damaged edge, rather than being a technique to make a specific 'tool' type called a burin. In general, the material analysed in this study gave little impression of the existence of discreet 'tool' types. Most retouch appears to relate to edge rejuvenation, combined with possible elements of fairly subtle shaping of the piece to a desired morphology.

The data seems to indicate that blanks chosen for retouch were those of a particular size and shape. Some interesting patterns of homogeneity can be observed, in terms of features such as the length of the margins. It can be argued that such factors reflect functional requirements, either relating to the hafting of the lithics or in relation to the needs of hand held use. In many cases retouched artefacts, in an admittedly subjective sense, fit comfortably into the hand and can be held firmly.

The study has demonstrated variation in factors such as the face(s) retouched. But what does this mean? Does the occurrence of high levels of retouch on the ventral retouch in Oman, Saudi Arabia, Jordan and Sudan imply population dispersals? It is suggested that it probably does not, but is this pattern merely coincidence, or does it reflect functional factors of some sort relating to semi-arid environments? No easy answers are posed to such questions, but it is only be reporting and quantifying such information that hypotheses can be developed. The same applies to the emphasis on particular lateral margins for retouch.

This study has demonstrated that different techniques for measuring the extent or invasiveness of retouch produce quite different results. Different measures have previously been compared experimentally, but not at this scale against real archaeological data. It is suggested that the different measures of retouch reflect quite different things, but also that these differences reflect real patterns of variation in the archaeological record. For example, the African and Arabian assemblages typically have low Geometric Index of Unifacial Retouch scores, while Tor Faraj and Warwasi are much higher. Future studies should use several measures of retouch intensity to allow a robust characterisation of spatial and temporal variation.

The results of the multivariate analyses on the retouched component are presented in Table 9.5. Overall, it suffices to say that typically blanks chosen for retouch both resemble those in the assemblage in which they are found and trend towards being towards the larger end of size distribution for that assemblage. Similarities between retouched and unretouched components at the sites also extends to shape similarities. The analyses revealed that Warwasi WWXX showed a rather anomalous pattern in comparison to the other assemblages. Here the retouched and unretouched blanks are rather different in character. While the debitage is typically very small,

reflecting the heavy reduction of cores transported into the mountains, the retouched pieces are large. This structure can be taken as indicating a strategy whereby hominins carried both cores for the production of small blanks and large, often laminar, blanks which could be heavily retouched. The demonstration of such a pattern shows how quantified and multivariate analysis of retouch can offer considerable insights into understanding lithic technology. In terms of the primary aims of this thesis, however, the analyses primarily show that Arabian sites have low levels of retouch and the character of retouch appears to be context specific. Retouch, then, does not seem to say much in terms of dispersals patterns.

| Question | Summary of results | Groupings |
|---|---|---|
| *[1a] How does morphology and retouch intensity of retouched blanks vary within and between assemblages?* | The major source of variation is size related, while subsequent components emphasise retouch intensity and shape. The analysis seems to discriminate between assemblages quite effectively and offers a good basic description of variation in the retouched component. On the whole the pattern of retouch intensity mirrors that seen early for reduction intensity, but with some differences, for instance the high scores for length of margin retouched for 123-b might not have been expected. PC4 emphasises the retouch of laminar blanks, but with such results the orthogonal characteristics of PCA must be remembered and many blade-proportioned retouched pieces may have been accounted for by earlier components. | **(PC1**, decreasing size) **1** – 1010-8, 123b, **2** – Tor Faraj, **3** – Porc Epic, Warwasi.<br><br>(**PC2,** increasing percentage of margins retouched) **1 –** Tor Faraj, **2** – 1010-8, Warwasi, Porc Epic, 123-b.<br><br>**(PC4,** increasing long, narrow and thin) **1** – Porc Porc C, 1010-8, Porc Epic E, Warwasi NNOO, **2** – Warwasi WWXX, 123-b, Tor Faraj. |
| *[1b] How does morphology and retouch intensity of complete retouched blanks vary within and between assemblages?* | Interestingly the results for this question, despite the reduced sample sizes and exclusion of broken pieces, are similar to those for 1a. This can be taken as indicating the retouch of branks after they were broken, rather than before. | **(PC1**, decreasing size) **1** – 1010-8, 123-b, **2** – Tor Faraj, Porc Epic E, Warwasi WWXX.<br><br>**(PC2,** increasing percentage of margins retouched) **1** – Tor Faraj, 1010-8, **2** – Warwasi WWXX, Porc Epic E, 123-b. |
| *[2] How do retouched pieces compare to unretouched blanks in basic morphology?* | This question used data from the three sites with the biggest samples of retouched artefacts. The results are very interesting. The main source of variation is size related, and shows that while the size of retouched blanks relates to the size of unretouched blanks in that assemblage, in all cases retouched pieces were typically larger than unretouched. The second component shows that In the case of Porc Epic E and Tor Faraj, the shape of the retouched blanks are very similar to the unretouched. However, here Warwasi WWXX shows a rather different pattern, with retouched and unretouched components being the most different of all the samples analysed. | **(PC1,** decreasing size) **1** – Tor Faraj retouched, Porc Epic E retouched, Warwasi WWXX retouched, Tor Faraj debitage, Porc Epic E debitage, **2** - Warwasi WWXX debitage.<br><br>**(PC2,** decreasing length and increasing distal convergence) **1** – Warwasi WWXX, Tor Faraj retouched, Tor Faraj debitage, Porc Epic E retouched **2** – Porc Epic E debitage, Warwasi WWXX debitage. |

Table 9.5. Summary of multivariate analyses of retouched blanks with pertinent examples of groupings (interpretation of Tukey method clustering).

**9.6) Conclusions**

This thesis aimed to test hypotheses and models for Upper Pleistocene dispersals, particularly in terms of the dispersal of *Homo sapiens* out of Africa, but also in terms of the movements of other populations such as Neanderthals. The large amount of data analysed provides information on the behaviour of Palaeolithic hominins, but the data does not speak for itself and the call for a 'theoretical' and not simply 'empiricist' view has repeatedly been raised.

The character of lithic technology always represents a compromise between 'culture', of which dispersals are a significant aspect, and 'adaptation'. The evidence presented suggests that rather than explicating dispersals through simplistic correlations between lithics which look vaguely similar, quantification and multivariate analysis can offer a far richer view. It was demonstrated, for instance, that an important element of typological variation in cores relates, seemingly quite directly, to reduction intensity. Likewise, the diversity of retouched tool typology correlates with the number of retouched blanks which are present. Such considerations are critical, yet have played little role in traditional accounts. From such data flows the demonstration that simplistic articulations of lithic evidence and hypotheses on dispersals are likely to be illusive.

The position of Arabia in the process of Upper Pleistocene hominin dispersals has been considered both 'directly' and 'indirectly'. In terms of the latter a detailed interregional comparative analysis was conducted to situate the Arabian evidence. Let us consider, for example, the observation that Arabian Middle Palaeolithic sites typically have little retouch (e.g. Petraglia and Alsharekh 2003; Rose *et al.* 2011; Delagnes *et al.* 2012), which this thesis demonstrates is also broadly true at Jubbah, although the small assemblage from JQ-1 is quite heavily retouched. The analysis showed that in the cases of both Warwasi and Porc Epic the younger assemblages in both cases have considerably reduced percentages of retouched artefacts, in the former case decreasing from 20.5% of the assemblage in WWXX to 8.5% in NNOO. Considering such changes within a single site, it is easy to imagine that the paucity of retouch in Arabia reflects similar factors to those which led to lower levels of retouch in the younger Ethiopian and Iranian samples. These changes presumably relate to a constellation of factors involving factors such as mobility strategies and demographic changes,

both in large part reflecting environmental conditions. Porc Epic and Warwasi also demonstrated significant changes through time in factors such as laminarity and the frequency of prepared platforms. These factors emphasise that entities such as the 'East African MSA' are not static for tens of thousands of years. Claims to the contrary say more about research methodologies than reality. Dispersals will be most firmly elucidated by theorising how the material culture of a particular population would change in a different environment, with different raw materials, and so on. Attempts to simply draw arrows on maps between things which look superficially alike are unlikely to produce meaningful results.

This thesis has sought to both synthesise existing knowledge on the Arabian Middle Palaeolithic and to present new evidence from the locality of Jubbah. From this a number of points emerge in relation to the dispersal and adaptation of populations. It has become clear that the Arabian record does not support simplistic correlations with surrounding regions. We therefore find 'Nubian' sites in southern Arabian which are 'more Nubian' than those in Nubia (i.e. a greater percentage of their cores represent the Nubian Technique of core reduction) and as research progresses in southern Arabia, from western Yemen to the Oman and the UAE, an expanding body of evidence suggests autochthonous trajectories in southern Arabia represented by lithic technology unlike that known from elsewhere in surrounding countries. In that sense the hypothesis of the *Tabla Rasa* put forward to develop research in Arabia (Rose 2006) appears to have been firmly falsified, at least for a large part of the Upper Pleistocene.

The evidence presented here reinforces the complexity of population movements in MIS 5. It seems that several dispersals into Arabia occurred and indeed dispersal is more likely to have had the characteristics of a 'process' than an 'event'. The analysis also highlights the importance of interior and northern Arabia. Alongside recent discoveries near Riyadh (Crassard and Hilbert, submitted), Jubbah shows the importance and high promise of interior Arabia, particularly in contexts like palaeolakes. In contrast to areas such as Oman where years of research have found almost no *in situ* Palaeolithic archaeology, two short seasons at Jubbah have identified several stratified sites. This presumably relates to differential geomorphological processes and geological

characteristics. In contrast to southern Arabia, no clear evidence for post-MIS 5 occupation has been found at Jubbah, and from the literature review does not seem to be present in central and northern Arabia, although as with most claims about Arabia this needs to be verified by further research.

This archaeological narrative fits logically with the emerging palaeoenvironmental evidence which highlights a dramatic increase in precipitation in MIS 5, allowing populations to move widely into, within and out of Arabia, and at least one smaller wet phase in MIS 3, which was perhaps insufficient to allow interregional movements, but did allow refugial populations to expand across southern Arabia

What does the nature of lithic technology at Jubbah indicate on when and from where populations dispersed? The best evidence dates to MIS 5a, while the dates and technology at JSM-1 are taken as indicating an earlier (MIS 5e?) occupation. On palaeoenvironmental grounds it is hypothesised that Jubbah was not occupied on a long term basis, but in an episodic fashion as the region saw periodic climatic amelioration. In terms of chronology, if the date of ~87 ka for JKF-1 is accurate, it is significant that this is before there is any clear evidence for Neanderthals in areas such as the Levant (e.g. Shea 2007, 2008), where it seems *Homo sapiens* were the only species in the area for at least ten thousand more years after the occupation of JKF-1. While acknowledging the paucity of our knowledge about hominin population dynamics in areas such as Iraq and Iran, it is felt that the evidence at Jubbah is most parsimoniously interpreted as representing dispersals from Africa. This is supported by the correlation of dates at Jubbah with periods of climatic amelioration when the deserts of the Saharo-Arabian belt contracted significantly, as well as the technological features of the Jubbah assemblages. The presence of a bifacial component in Arabian assemblages has been argued to orientate the record to Africa (e.g. Armitage *et al.* 2011; Groucutt and Petraglia 2012, in press) and a small amount of bifacial technology is present at Jubbah. Some of the particular characteristics seen at Warwasi and Tor Faraj, such as the use of small platforms to make large blanks and the particularly low number of centripetal scar patterns and low numbers of scars (question 6 of chapter 7) are not seen in the Arabian assemblages.

The Levallois reduction strategies at Jubbah are, in a sense somewhat 'generalised', and this appears to reflect a combination of factors, from the position of Jubbah in an arid environment where the aim of reduction was to produce a diverse tool kit of points and large flakes to carry into the wider landscape, to the raw material properties. At JKF-1 the raw material used appears to have had a propensity to aberrant terminations. This is interpreted as catalysing a focus on broadly unidirectional Levallois, with convexity maintained through the removal of core management elements. While the product of triangular blanks, some classifiable as Levallois points, was an important aspect of reduction at JKF-1, it was so in levels more comparable to those found in African MSA contexts than to the almost complete focus on unidirectional-convergent reduction seen at Tor Faraj and other Levantine Late Middle Palaeolithic assemblages. It was seen that at Tor Faraj that point production was continued even as cores became extremely diminutive. In contrast, at JKF-1 point production was focussed on the middle phase of reduction and can be related both to the physical properties of knapping the particular raw material used and as an adaptive response in a semi-arid environment. While further comparative research is needed to firmly compare the Jubbah material, the evidence considered here is sufficient to hypothesise that it demonstrates several dispersals from Africa into Arabia in MIS 5.

It is acknowledged that poor chronological control of many of the assemblages studied is a problem, and that the paucity of excavated and dated sites makes the demonstration of gaps in occupation difficult to firmly identify. The analysis was orientated around two major hypotheses, firstly that hominins dispersed into Arabia from Africa in MIS 5 or, secondly, from north of Arabia in MIS 3. There are of course many other possibilities than these, and as a result no firm conclusions can be stated on dispersals at present. While it is felt that the major Middle Palaeolithic dispersals into Arabia probably were from Africa in MIS 5, both on certain features of lithic technology and parsimoniously in terms of palaeoenvironmental circumstances, it is acknowledged that this may be shown to be false. The major outcome of this thesis is a problematization of simple connections between forms of lithic technology and population dispersal.

Returning to the various models for Upper Pleistocene dispersals outlined in Table 1.1, what does the evidence outlined in this thesis suggest in terms of testing the numerous hypotheses which have been advanced? The paucity of Upper Palaeolithic material analogous to that found in the Levant has been noted (e.g. Maher 2009). Combined with the increasing evidence for autochthonous late Middle Palaeolithic cultural trajectories giving rise to the southern Arabian blade tradition and the general aridity of this time, although nuanced by the sub-pluvial of early MIS 3, the evidence does not support the Upper Palaeolithic model. Similar issues affect the Microlithic model. The steep coastal shelf of southern Arabia make this an idea area to test the predictions of the Microlithic model, and so far no evidence has been found which would support such the model. The Two-stage model makes less specific hypotheses on the kinds of lithics we would expect to find in Arabia, but the paucity of evidence for MIS 3 dispersals into Arabia means that it is probably only the earlier of the two hypothesised dispersals which may have occurred. The timing of the above three models, which were in large part premised on genetic evidence, has largely been undermined by recent estimates of mutation rates (Scally and Durbin 2012). The congruence of archaeological, genetic and environmental evidences indicates that major dispersals into Arabia did not occur post-MIS 5.

In light of the above it is felt that the 'Middle Palaeolithic' model is the most parsimonious framework at present for understanding dispersals into Arabia. Within such a framework numerous options are possible, including on: 1) the route – Sinai and/or Bab al Mandab, 2) – the timing, e.g. multiple, MIS 5e, MIS 5a, etc. The Neanderthal dispersal model is not presently supported by evidence in Arabia, but the discovery of fossil material could change this and the model remains possible. The main reason it is not felt to be likely on present evidence is that the Arabian sites occur thousands of years before Neanderthals were present in the putative source area to the north. Neanderthals in the Levant, ignoring the poorly understood Tabun C1 fossil, appear to be a post-MIS 5 phenomenon where Palearctic conditions connected the Levant and further north in Eurasia and palaeoenvironmental conditions are seen as having made dispersal into Arabia from the north problematic. As this thesis has, however, demonstrated and as discussed further below, lithic evidence alone does not simplistically support or refute particular models. The evidence from lithics

has emerged as being extremely complex, and this complexity must be situated with other categories of evidence to cast light on dispersal processes.

Returning to the questions posed in Chapter 1 the key findings of this thesis can be summarised as follows:

1) The research suggests that variability in lithic technology displays quantifiable and behaviourally significant patterning. The implications of this variability are, however, not self-evident and a variety of factors need to be considered before lithic evidence can be used to make dispersal hypotheses. Aspects of lithic technology such as reduction intensity and size need to be factored into analyses; robust comparisons should address assemblages which are similar in these senses in order to highlight cultural differences. A variety of factors have been shown to influence lithic technology. In the case of Jubbah, for instance, both raw material features and the role of the palaeolake in the mobility strategies of Middle Palaeolithic hominins have been highlighted. In the case of Warwasi WWXX the disjuncture between features of the debitage and retouched blanks can be interpreted in terms of 'provisioning the individual'. The significant intrasite differences at Porc Epic and Warwasi reveal the complexity of the situation. Further research through long sequences with associated environmental evidence can help to explicate the factors explaining change through time. Comparing assemblages at similar stages of reduction will help to differentiate between the difference factors influencing lithic variability, including the putatively cultural.

2) The character of the Arabian Upper Pleistocene Middle Palaeolithic can, in simple terms, be expressed as consisting of two components: a.) diverse MIS 5 assemblages with a variety of Levallois methods, some assemblages contain bifacial technology; b.) Post MIS-5 assemblages are diverse, but share some features such as a move away from Levallois technology, with its lateral and distal convexity on cores, to the use of flat debitage surfaces and a paucity of elaborate platform preparation. The diversity of MIS 5 assemblages is

becoming increasingly evident, and it is clear that at Jebel Faya, in Dhofar and at Jubbah quite different reduction strategies are present at this time.

3) The Middle Palaeolithic assemblages of Arabia are not straightforwardly analogous with either the African Middle Stone Age or assemblages to the north of Arabia. It is clear that significant intra-site and intra-regional variation makes sweeping statements on regional similarities and differences at best rather premature. Never the less it is felt that in broad terms, and parsimoniously with biogeography and palaeoenvironmental change, the Arabian record does more closely correlate with Africa than elsewhere. Some of the specific features of assemblages such as Warwasi and Tor Faraj, such as the relative platform sizes and frequencies of centripetal reduction, have not been seen on the Arabian assemblages studied. In typological terms the use of centripetal Levallois and bifacial reduction in Arabia are features similar to those found in many African MSA contexts. The similarities are, however, not particularly striking and diverse interpretations of the Arabian Middle Palaeolithic are still possible.

4) The quantification of retouch broadly supports the 'resharpening model' in contrast to the notion that desired 'tool' 'types' were produced. Variation in the intensity and location of retouch were noted, with for instance the Warwasi and Tor Faraj assemblages being characterised by 'steep' retouch (i.e. high scores for the Geometric Index of Unifacial Retouch). The overall picture is that in contrast to notions of discreet tool types, variation in retouch provides insights into functional and demographic variability, and that there is probably a considerable element of contingency. The study of the debitage is argued to be the key to the robust understanding of reductions sequences.

5) The quantified approach taken here shows that much variability cross-cuts traditional divisions. Small and heavily reduced assemblages repeatedly cluster together, as do large and less reduced assemblages. While certain typological distinctions do seem to be notable in particular contexts, in particular retouched points at Porc Epic, thin Levallois points with 'Concorde' profiles and finely faceted striking platforms at Tor Faraj, and Nubian

cores at 123-b, on the whole the statistical analyses suggest a considerable amount of equifinality. This suggests that future analyses should seek to compare assemblages with similar intensities of reduction, otherwise variation in reduction intensity largely overrides putatively 'cultural' factors.

This thesis has carried out the first quantified interregional comparison of Middle Palaeolithic technology in Northeast Africa, Arabia, the Levant and Iran and reports the first detailed analyses of lithic technology from interior Arabia. Further research critically needs to expand survey and excavation across poorly understood areas of Arabia, and in particular in the vicinity of palaeolakes and palaeorivers. The quantified approach of this thesis has shown the potential of such methods, but also that considerable variation relates to factors such as reduction intensity. The firm resolution of debates on the dispersal of hominin populations in the Upper Pleistocene requires both empirical advances, particularly the excavation of more dated sites across Arabia and neighbouring countries, but also the development of a robust theoretical framework in which to understand such discoveries. Similar 'types' of sites (e.g. raw procurement localities, occupation sites, etc.) in different regions need to be compared and the role of the specific character and context of sites more firmly factored into lithic analyses if we are to use lithic evidence to robustly test hypotheses on population dispersals.

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