LATE EARLIER STONE AGE SITES IN THE MAPUNGUBWE NATIONAL PARK, SOUTH AFRICA: A TECHNOLOGICAL STUDY

Helen Kempson

A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Science.

Johannesburg, 2007

DECLARATION

I declare that this dissertation is my own, unaided work, except where otherwise acknowledged. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Signed this ______ day of _______________ 2007

____

Helen Kempson

ABSTRACT

Dr K. Kuman initiated the Limpopo research programme that at present is based on excavations conducted at three sites, Hackthorne, Kudu Koppie and Keratic Koppie. They are situated atop a remnant of an ancient Miocene terrace, approximately 4km from the present day course of the Limpopo River in the Mapungubwe National Park. A broad range of stone tool types is represented in the area, with mostly Earlier and Middle Stone Age artefacts found on the higher ground and Later Stone Age pieces found primarily on the Limpopo's floodplain. One of the obstacles to understanding the archaeology of the region is the widespread episodic deflation that occurred here during arid periods of the Pleistocene, which had an impact on stratified sequences in the Stone Age. While all three sites have been subject to deflation, Hackthorne and Keratic Koppie are single component sites. Kudu Koppie, however, preserves some stratigraphy and provides a means of comparing and assessing the single component assemblages which have undergone varying degrees of mixing. It was therefore vital to establish a pattern of change through time at Kudu Koppie, with a sequence of late Earlier, Middle and Later Stone Age deposits, using a combination of strategies including typology, technological analysis and a study of raw material exploitation. These data suggest that Hackthorne is primarily a late Earlier Stone Age (ESA) assemblage with some Middle Stone Age (MSA) mixing, while Keratic Koppie preserves an ESA assemblage with a more significant MSA component. The ESA component is further argued to be a final post-Acheulean industry with a major component of woodworking tools, suggesting it may be a local variant of the Sangoan Industrial Complex.

ACKNOWLEDGEMENTS

Thank you to everybody that assisted me in this research, especially to Kevin Miller for his patience and support, and to my family for their encouragement. Thank you also to a number of students, most notably Geeske Langejans, for their assistance and understanding, to Sam Dymond and Luca Pollarolo for their illustrations, and to my supervisor, Dr K. Kuman, for her guidance and interest in this project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Only a small number of Earlier Stone Age (ESA) sites has been found preserved in good contexts in South Africa (Klein 2000). Excavations by Dr Kathleen Kuman in the Mapungubwe National Park aim at broadening our knowledge of the ESA record, as well as our understanding of the archaeology of the mid to late Pleistocene. The larger research question is to describe the contexts of the sites and to reconstruct as far as possible the pre-Later Stone Age cultural phases and periods of occupation in the research area.

Southern African climates oscillated significantly with glacial/interglacial cycles at higher latitudes (Tyson & Partridge 2000), and during arid periods of the Pleistocene, associated with glacial conditions (Barham 2001), people living in the Stone Age may have chosen to move to more habitable regions north of the research area, a behaviour that seems to be reflected as gaps in the archaeological record for these times (Kuman *et al.* 2005a). This project will contribute to answering this question, especially by identifying different cultural phases represented.

A large number of artefacts are scattered over the surface of the research area. These include ESA types, such as simple core types, bifaces and occasional unifaces, as well as some pieces more typical of the MSA (Kuman *et al.* 2005a). Excavations also recovered artefacts that bear more similarity to industries that are transitional between the ESA and MSA, particularly to those found just north of the Limpopo in Zimbabwe (Cooke 1966). This would most likely place the archaeology of these sites at approximately 300 kyr (Kuman *et al.* 2005a).

This research is based on excavations at three open air sites, Hackthorne, Kudu Koppie and Keratic Koppie (Figs. 1.1 & 1.2) that occur within a short distance of each other (maximum 2.5km) in the Mapungubwe National Park, Limpopo Province. All three sites have been deflated, and Hackthorne and Keratic Koppie are both single component sites. At these two sites artefacts occur throughout the deposit, but the majority of pieces concentrate on the substrate due to deflation.

The situation at Kudu Koppie is quite different and while deflation has occurred stratigraphy can still clearly be identified and these layers preserve a cultural sequence. This sequence is of great value and provides a means of establishing how assemblages in the area changed through time and where the single component sites fit into the Kudu Koppie sequence.

All three excavations have produced a variety of tool types and artefacts including, amongst other types, handaxes, cleavers, picks, prepared cores, flakes with faceted platforms, and retouched pieces dominated by denticulates. The bifaces imply that the earliest occupation of these sites was during the ESA, either in the Acheulean or in the post-Acheulean Sangoan industry, which contains fewer bifaces relative to picks and heavy- and light-duty denticulated and notched scrapers. However, there are a few pieces (such as retouched points) that seem to fit more comfortably within the MSA.

Apart from the larger tool types such as bifaces and picks, some Sangoan and Sangoan-Lumpemban Complex assemblages may appear extremely similar to early MSA assemblages. This complicates the picture in the Limpopo, as assemblages may be either Sangoan-like or a mixture of Acheulean and MSA artefacts. At Kudu Koppie a Sangoan-like assemblage, containing a small number of bifaces and picks, has been recovered from the unmixed basal level of the deposit, overlain by an MSA assemblage (with some possible LSA contamination only in its uppermost level). The basal layer consists of pebble-sized koppie-derived sandstone matrix, but the ESA artifacts continue to occur with decreasing depth as the deposit transforms to a coarser-sized matrix in the top levels of the unit. MSA artifacts are then contained above this zone within a coarser matrix of koppie rubble, which is clast-supported. The two assemblages considered in this dissertation therefore comprise a final ESA unit and an MSA unit. The artefactual layers are consistent across the site (now excavated over more than $10m^{2}$), but stratigraphic details of other squares are still under study due to the complexity of deposit formation around the koppie, as well to the influence of deflation.

Although the unstratified Hackthorne assemblage approaches the Kudu Koppie sample in size, it appears to be an activity-related assemblage probably focused on hunting and butchery (Kuman *et al.* 2005b) and has fewer formal tools to assist assessment of the industry, although some ESA types are present. In some ways it resembles what C.K. Cooke (1966) described as the Charaman Industry in Zimbabwe where assemblages appeared to be transitional between late ESA and MSA. Cooke (1968) considered the Charaman to follow the Sangoan as the final expression of the ESA; it is however not resolved if there is sufficient reason to distinguish the Sangoan and Charaman as two separate industries. The transition from ESA to MSA is complex and will be discussed in more detail in Chapter 2. Keratic Koppie also contains some ESA pieces but these occur along with some more finely made pieces, such as well made prepared cores of crypto-crystalline material and a finely made denticulate on a large flake. Thus the preliminary impressions to be tested for the two unstratified sites by comparison with Kudu Koppie are that Hackthorne may represent an older assemblage than Keratic Koppie, while on the basis of formal tools and core types, Keratic Koppie appears to have the greater likelihood of mixing of cultural phases.

Analysis and comparison among the sites will be done using a combined technological and typological approach, contrasting the ESA and MSA assemblages. The aim of this research is to determine if deflation may have led to the mixing of cultural phases at Hackthorne and Keratic Koppie, or if these sites appear mostly unmixed, in which case they will be assessed as Acheulean, Sangoan-like, or MSA.

As the raw materials used at all three sites are very similar, an analysis of raw materials and flaking strategies will further assist in clarifying the cultural phases and possible degree of mixing present at the sites.

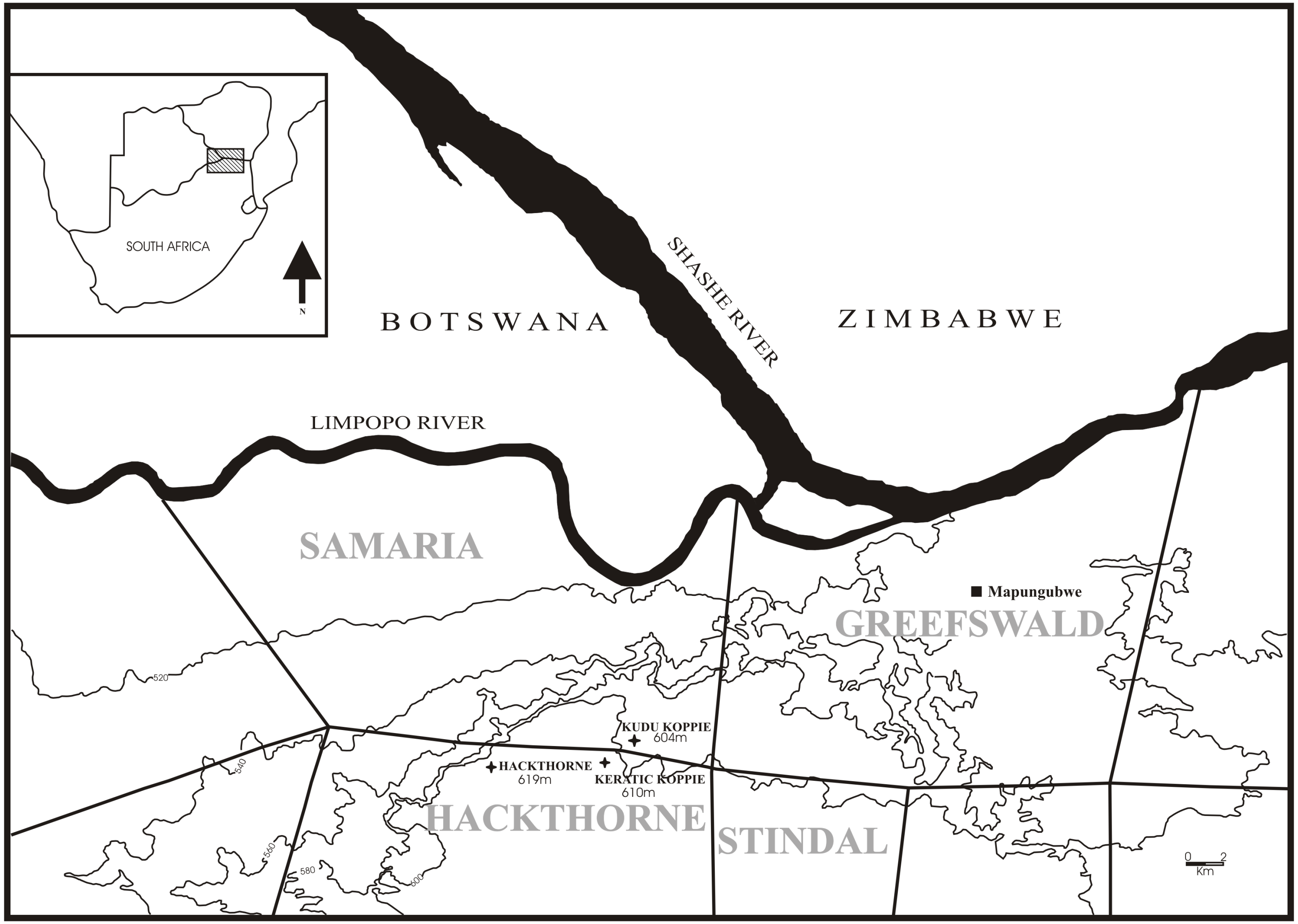


Fig. 1.1 Location of the study area. Drawn by M. Kekana, after Kuman *et al.* 2005b.

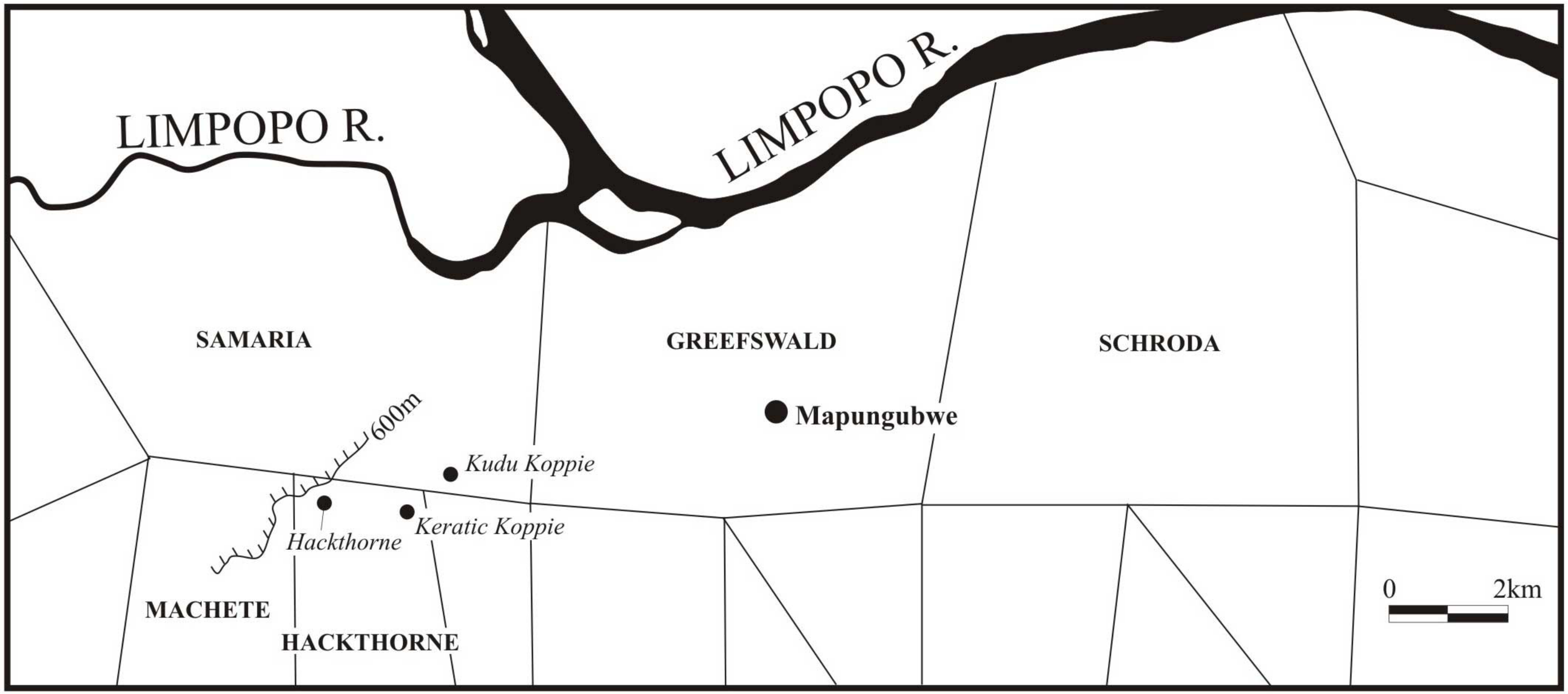


Fig. 1.2. Detail of the escarpment area, showing the location of the escarpment (hatched line) formed by an ancient aggrading terrace of the Limpopo River. From Kuman *et al.* 2005b.

CHAPTER 2

THE STONE AGE CULTURAL SEQUENCE

The assemblages to be evaluated fit within the later Earlier Stone Age and the Middle Stone Age periods, and this section therefore discusses the relevant industries, beginning with the Acheulean. The rate of change seen in the lithics of the Acheulean is slow (Klein 2000), but by the later Acheulean, knappers were familiar with a more extensive range of options which become more refined in the MSA, such as the prepared core technique (*ibid.*) and blade production (Barham 2000a, Beaumont & Vogel 2006). The transition from the end of the Acheulean to the MSA is complex and controversial and has been described as the most important event to occur in the later Middle Pleistocene (Tryon 2006). Traditionally the disappearance of handaxes and cleavers has defined the MSA in South Africa. In other words, when the large cutting tools of the Acheulean seem to be replaced with points of bone or stone, industries are attributed to the MSA. However, early MSA sites are very rare and this paucity of information tends to exaggerate the differences between the Acheulean and the MSA (*ibid*).

In the past, a number of researchers have recognized industries that are 'transitional' between the ESA and MSA. At the 1955 Panafrican Congress the term 'First Intermediate Period' was adopted to describe this transition period between the ESA and MSA (McBrearty 1988). The term was then dropped at the Burg Wartenstein symposium of 1965 due to insufficient field evidence (*ibid*). However, a number of researchers still support the argument for transitional industries, and these are discussed in the sections below.

Therefore while the ESA with bifaces generally gives way to an MSA without bifaces, in some areas 'transitional' industries' defined as the Sangoan and Fauresmith have been recognized. This 'transitional' status has meant that the Sangoan is frequently referred to as a final ESA industry (Clark 1959), but some researchers consider it to represent the early MSA (Davies 1976, Van Peer *et al.* 2003). Van Riet Lowe (1947) placed the Fauresmith at the end of the ESA, while Beaumont & Vogel (2006) define the Fauresmith as the MSA, arguing that it is older than 500,000 years old. More recently a number of researchers have again been researching these industries (e.g., M. Chazan, F. Rheinhardt), and they argue that while they are problematic, they do in fact exist (McBrearty 1988). Although no good dates are available for the Sangoan, it seems to appear at approximately 300,000 years ago and is associated with the appearance of more evolved hominids (McBrearty 1988, White *et al.* 2003). The variation seen in artefacts at this time is complex and although the terms Sangoan and Fauresmith are the traditional industry names for this period, actually pigeonholing assemblages within these industries is difficult.

THE LATER ACHEULEAN

The origin and subsequent dispersion of the Acheulean Tradition lies in sub-Saharan Africa with the oldest assemblages dating to approximately 1.65 million years ago (Roche 1995). The Acheulean is broadly divided into the early and later Acheulean, with the later Acheulean commencing at about 1 mya (Klein 2000).

The early Acheulean is characterised by less standardised handaxes that are both heavier and thicker (Volman 1984). Older bifaces also tend to have fewer scars and deeper scar beds than later examples (*ibid*). Later Acheulean handaxes show a greater degree of standardization of shape (Volman 1984) and a high degree of technological competence (Kuman 2007). Although some late Acheulean bifaces can be as crude as early types, many are generally thinner, more symmetrical and more trimmed than earlier bifaces (Klein 2000). Some researchers recognize a middle Acheulean which, when compared with earlier types, show more regularity of shape and are increasingly flatter in section (Kuman 2007). The middle Acheulean would then probably be broadly contemporaneous with the Acheulean Bed IV at Olduvai Gorge and the Olorgesailie members older than 0.6 Ma (*ibid*).

The Acheulean is characterized by a wide range of variability in morphology and relative frequency of artifact types, rather than a simple progression from more crude to more refined industries (Volman 1984). It has been argued that the distribution and variability of handaxes provide evidence for social learning (Wynn 1995), but McNabb *et al.* (2004) argue that strong social learning appears absent for bifaces from the Cave of Hearths, which mainly reflect the best means of producing a sharp cutting edge. However, elements of specific and preconceived designs (Semaw 1997) do first appear in the Acheulean production of handaxes.

Acheulean knappers were also familiar with prepared core flaking methods, such as the Victoria West prepared core method (Kuman 2001), the Levallois technique (Klein 2000) and blade production (Barham 2000a).

The earliest dated occurrence of the Levallois technique is at Gesher Benot Ya'aqov (Goren Inbar 1992), which has been dated to approximately 780kya (Goren-Inbar *et al.* 2000). The technique is present in all Upper Acheulean assemblages and absent from all Earlier Acheulean assemblages along the Jordan River in Israel (Goren-Inbar 1992). In level II-6 the Levallois technique and Kombewa technique occur together, with the Levallois technique being used for the manufacture of flakes and the Kombewa technique used to produce large flakes for the manufacture of handaxes and cleavers (Goren-Inbar *et al.* 1994). While sites in North, East and South Africa report the use of the Victoria West and Levallois techniques, these are usually not well dated or described and so the origin in time and space of these prepared core techniques is unknown (Goren-Inbar 1992).

Sites which preserve Acheulean assemblages are widely dispersed, covering all of Africa as well as parts of Europe and Asia. The distribution of artefacts may reveal a pattern of land use by hominids (Potts 1989) though the function of specific tool types, such as handaxes, remains unresolved. At Olorgesailie, assemblages associated with floodplains and/or lake margins tend to contain a very small handaxe component, with most bifaces associated with channel deposits (Potts 1989). Potts (1989) argues that the high number of handaxes recovered in these channel deposits reflect the function of the area as a place of manufacture. While artefacts may reflect spatial patterning of tool use and discard, its significance in terms of foraging and land use during the Acheulean is not clear (Potts 1989).

In southern Africa, the majority of assemblages is in poor context and typically occurs as open air sites (Volman 1984). They frequently lack organic remains or palaeoenvironmental data, and temporal relationships between sites are usually absent (*ibid*). This makes it difficult to make statements about occupation in a region, or to draw comparisons between sites (*ibid*). Acheulean cave sites are rare, possibly because so few cave deposits of suitable age have survived to the present (Klein 2000), but four later Acheulean sites are Wonderwerk Cave, Olieboompoort, Cave of Hearths and Montagu Cave (Mitchell 2002).

As the South African landscape has been subjected to extensive planation and erosion, the distribution of Acheulean sites may only reflect those areas where artefacts were preserved in sediment traps and may not represent a true pattern of land use (Klein 2000, Kuman 2003). Klein (2000) suggests that the distribution of sites is limited to areas located near standing water. Sites that occur near gravels or raw materials are also more likely to leave sufficient artefacts to be visible in the archaeological record (Kuman 2003). It is probable therefore that a combination of factors leads to site formation and preservation, including proximity to water, a nearby source of gravels, and a sediment trap to preserve the site (*ibid*).

Determining a date for the end of the Acheulean is problematic, and McBrearty and Brooks (2000) have placed the appearance of the MSA at between 250-300ka. This date is well supported by the MSA assemblage at Florisbad, the earliest yet identified MSA site in southern Africa, with a date of 259,000 ± 35,000 (Grün *et al.* 1996).

THE ESA TO MSA TRANSITION

INTRODUCTION

As discussed above, the Acheulean in South Africa is usually replaced by MSA industries, but in some regions of Africa, the MSA is preceded by assemblages of the Sangoan Industry (McBrearty 1988, 1991) or the Fauresmith (Sampson 1974). Also, where the Sangoan and Acheulean occur together in a stratified deposit, the Sangoan is always younger (Cooke 1968, Volman 1984, Clark 2001a), and at a small number of stratified sites in Africa, the Sangoan Industry has been found to lie between Acheulean and Middle Stone Age deposits (McBrearty 1991). Dated beds within the Kapthurin Formation in Kenya show that in that country the transition from Acheulean to MSA technological adaptations were in place before 285kya (Tryon & McBrearty 2002). Significantly, various industrial traditions are interstratified at Kapthurin, including Acheulean, Sangoan, MSA and possibly Fauresmith components. The transition period was therefore not a simple, unidirectional change. New research on the Sangoan (McBrearty 1988, Van Peer *et al.* 2003, Rots & Van Peer 2006) and the Fauresmith (Beaumont & Vogel 2006) increasingly suggest that there is no abrupt or simple replacement of the ESA by the MSA. The industries are poorly understood (*ibid*) but appear to represent a varied transition phase between the Earlier and Middle Stone Ages.

THE FAURESMITH

This industry was first collected as surface assemblages from areas surrounding Kimberley in South Africa and described by Goodwin in 1926. Characterized by the co-occurrence of small handaxes and the prepared core method of flake production, the Fauresmith was thought to originate at 250-190 kyr BP by Beaumont (1990a). Beaumont has now revised this date to approximately 510 kyr (inferred).

The industry is interpreted as a period of transition between the ESA and MSA and particularly as an adaptation to coping with open grasslands (Tryon & McBrearty 2002), with the scraper and blade component of these assemblages interpreted by Clark (1959) as reflecting an increased emphasis on butchery and hide processing. Van Riet Lowe in 1947 referred to it as the 'culminating phase of the Earlier Stone Age," as well as "the transition from core to flake treatment". Originally defined as a southern African adaptation, Humphreys (1970) felt the concept had "...become spread from Cape to Kenya.", but that the criteria used in assigning assemblages to this industry had never been made clear.

The Fauresmith is well represented at a number of sites in the former Northern Cape, Natal and Orange Free State, and collections have been most discussed by Beaumont (1990a,b). At Nooitgedacht (Northern Cape), it includes refined prepared cores, coarse blades, convergent points and a few handaxes which are mainly small. A similar assemblage has been found at Roseberry Plain 1, which also includes single platform cores and rare, long laterally retouched points. Bifaces are almost all small and often show S-twist edges. At Kathu Pan, Stratum 4a preserves a Fauresmith assemblage, again characterized by points and blades, and it includes side-scrapers made on flakes and rare, refined handaxes. At Rooidam, Strata 3-8 produced a Fauresmith assemblage of over 19000 excavated pieces. Small handaxes were recovered along with a small number of cleavers, blades and convergent points. Core types included prepared cores and single platform cores. Fock (1968) argued that the artefacts appeared to belong to the Fauresmith on typological grounds, and particularly because handaxes were quite broad relative to length.

A metrical analysis revealed that Northern Cape Fauresmith handaxes are relatively thicker than the Acheulean handaxes at Wonderwerk Cave (Beaumont 1990a). Beaumont (1990a) suggests that this may be a useful marker for distinguishing between Acheulean and

Fauresmith handaxes, as size may be affected by the raw materials locally available, and plan-form seems not to change significantly.

In 1933 Rev. Edward Paterson forwarded a collection to Van Riet Lowe, found at the St. Augustine Mission near Nqutu in Natal. The entire collection was made of indurated shale (hornfels) and closely resembled the Fauresmith. The collection contained small, slender bifaced handaxes and small cleavers on end- and side-struck flakes, as well as flakes with facetted platforms, prepared cores, slightly trimmed points, and scrapers (Van Riet Lowe 1947). While it has been suggested that the Fauresmith is a form of Acheulean resulting from the use of hornfels (Humphreys 1970), Fauresmith artefacts have been produced in the same forms using a variety of raw material types (Beaumont & Vogel 2006).

In 1990 Beaumont (1990a) suggested that Fauresmith sites spanned a time period from *ca* 250-190 kyr BP, but after further work at Wonderwerk Cave, Beaumont and Vogel (2006) proposed a much earlier date. They subdivided the industry into early, middle and late Fauresmith, dating the middle Fauresmith levels at ~480-510 kyr (inferred age), with the late Fauresmith levels dating to 276-286 kyr. The lowest levels (MUs 5-9) preserve a very small assemblage that has been described as containing artefacts that seem to be largely or entirely Acheulean in nature with possible early Fauresmith artefacts. Near the bottom of the deposit MU7 has been dated to ~780kyr.

Behaviours associated with this industry at Wonderwerk Cave (Beaumont & Vogel 2006) include:

1) Mobiliary art – slabs, usually incised with well-spaced parallel curved lines, extending as far back as ~500 kya.
2) Exotic minerals – scatters of unmodified stones, such as small chalcedony pebbles and quartz crystals. The nearest source of chalcedony pebbles is 45km from the site.
3) Pigments – the collection of haematite pieces found throughout most of the levels.
4) Bedding material – a 0.4m layer of humified vegetation was found, interpreted as providing a bedding area in excess of $50m^2$ and providing direct evidence of regional home base organization by 400 kyr.
5) Use of fire – found throughout the sequence, mainly seen in heat fractures on artefacts and phytolith rich ash lenses. An extensive ash sheet from the oldest levels contains hundreds of charred-calcined large mammal bone fragments and is taken to indicate that meat was roasted.

THE SANGOAN

The Sangoan was first collected and described by Wayland and Smith (1923) from the type site of Sango Bay on Lake Victoria in Uganda. This original Sangoan assemblage is a surface collection and so problems arise in trying to define the characteristics of an industry based on a selected assemblage. Generally Sangoan assemblages show fewer hand-axes, cleavers and knives than the Acheulean, and although they have about the same heavy-duty tool component, small scrapers dominate at many Sangoan sites from central African geological and surface contexts, possibly due to their selected nature (Sampson 1974). As mentioned previously, few dates are available but the transition to the Sangoan had occurred in Kenya by 285kya (Tryon & McBrearty 2002).

Sampson (1974) wrote that no large primary context sample was available to precisely define the Sangoan, and consequently any collection containing crude handaxes and cleavers with abundant picks, choppers and core axes, and made on coarse-grained rocks, was claimed to be Sangoan. At this time, the only useful Sangoan sample was seen to come from Kalambo Falls, but only recently has this industry been published in detail by Clark (2001).

Often occurring above later Acheulean assemblages, as at Kalambo Falls, the Sangoan industry appears less refined. Clark (1950:89) states that:

> ' …the Sangoan exhibits a degree of crudity which, to the writer, is very difficult to explain, except by supposing either a migration of a new ethnic group, or more probably a complete revolution of technique forced upon the remnants of the Chelles-Acheul population as a result of the changed climatic conditions.'

Clark (1959) has long argued that the First Intermediate industries (Fauresmith & Sangoan) provide the first evidence for broad, regional adaptations in sub-Saharan Africa, with the Acheulean well suited to open environments, and the Sangoan representing an adaptation to wooded regions. Clark sees changing climates as providing a stimulus to change, forcing hominids to adapt to regional environments and creating regional specializations. Large cutting tools such as handaxes, cleavers and knives are often associated with butchering and tools such as core axes, picks, choppers and scrapers are more often associated with woodworking (Sampson 1974). The change in emphasis in tool types during the Sangoan may therefore support the argument that the Sangoan was adapted to more wooded environments, but the argument is based largely on geographic associations.

Traditionally the Sangoan Industrial Complex is associated with currently forested areas of sub-Saharan Africa, often occurring in regions in which the Acheulean is not present (Volman 1981). However, environmental reconstructions have shown that a number of Sangoan sites were not necessarily wooded during the period of occupation. Pollen recovered from Sangoan levels at Kalambo Falls suggests a more open environment prevailed at times (Taylor *et al.* 2001), and faunal remains of large equids recovered from the Sangoan site of Simbi in Kenya suggest an element of open grassland nearby (McBrearty 1991). Barham (2001) has shown that climate change in the Middle Palaeolithic has affected the distribution of human populations as forest boundaries shift with glacial and interglacial events. In much of central Africa heavy rainfall would have leached tropical soils of nutrients and created forests producing low quality foraging and a shortage of animal protein for hominid populations. A reduction in rainfall during the drier glacials would have led to the expansion of drier woodlands that were nutritionally more productive, supporting more animal biomass (Barham 2001). Therefore the woodworking emphasis in Sangoan assemblages need not necessarily be correlated with dense tropical forest. Patterns of hominid habitation were probably in constant flux in response to changing environments, though the transition to the MSA may represent expansion into a wider range of environments that included the more challenging forested areas.

Dating of sites is also problematic. Sangoan collections are beyond the range of radiocarbon dating, and possibly too young to use the Potassium Argon method (McBrearty 1991). Chronological relationships between sites are also unclear. For example, Gombe Point in Kinshasa is recognized as the type sequence for the Zaire basin (McBrearty 1991). First excavated in 1925, the site preserves a succession of post-Acheulean industries. However, excavations carried out in 1973 and 1974 suggest that the cultural sequence there has been substantially disturbed by bioturbation (Cahen & Moeyersons 1977). In other parts of Africa, the relevant terminal ESA assemblages are disturbed in a different way--i.e., through deflation, with the Charama Plateau of Zimbabwe the best known example.

However, Sangoan assemblages have been recovered from some viable archaeological contexts at various sites and have contributed to what we know of the Sangoan at present. These sites include Kalambo Falls in Zambia (Clark 2001b), Pomongwe and Bambata Caves, Zimbabwe (Cooke 1968), Muguruk, Kenya (McBrearty 1988, 1991), and Sai Island, Sudan (Van Peer *et al.* 2003). Extensive surface collections of artefacts by Davies may possibly belong to the Sangoan Industry and are discussed later, but these have not been excavated. These sites are discussed below:

KALAMBO FALLS, ZAMBIA

Clark (2001b) recognizes the Chipeta Industry as the local expression of the Sangoan at Kalambo Falls, where it occurs in rubble lines and channel fills. Despite this, artefacts are most often only slightly abraded or fresh and it is assumed they had not moved far from their original position. No lanceolate or foliate points were recovered in the Sangoan deposits, but these do occur in the two overlying Lupemban industries, the Siszya and Nakisasa, which Clark considers to be part of the MSA. In the older of these two, the Nakisasa, handaxes still occur as well as cleavers, although these are rare. In the Siszya industry, handaxes and cleavers are absent and lanceolate points are more commonly found.

In the Sangoan level (the Chipeta Industry, Site B horizon IV), Roe (2001) describes the changeover from Acheulean types to Sangoan types as "too sudden and too sweeping" to be the last stage in a gradual process of change. He suggests that the change in large cutting tools at Kalambo Falls is primarily due to a change in function and notes that there does not appear to be any return to an Acheulean stage once the Sangoan stage occurs. This may however be more a function of a punctuated record at Kalambo Falls.

Clark (2001b) recognizes the transition from later Acheulean to Sangoan in the following ways:

- Handaxes and core axes appear different as the soft hammer technique used on large primary flakes gives way to hard hammer flaking of cobbles and angular blocks.
- Sangoan core axes are heavier than the Acheulean bifaces.
- The Sangoan core-axe appears far more crude than the more refined Acheulean handaxes.
- Prepared Core Technology is absent.

MUGURUK, KENYA

McBrearty (1988, 1991) has excavated an *in situ* Sangoan-Lupemban site at Muguruk, Kenya. Here the industry is defined as Sangoan-Lupemban Complex, in contrast with Kalambo Falls where Sangoan and Lupemban appear to be distinct industries in time. The Sangoan-Lupemban is represented by the Ojolla Industry and is followed by an MSA called the Pundo Makwar Industry (discussed later, along with the Lupemban, in the MSA section). This site is important because a Sangoan assemblage can now be compared with the MSA industry which lies above it, and with other Sangoan-Lupemban collections. Only a small sample was recovered, but it does broaden our understanding of the frequency of types represented.

A breakdown of formal tool types (Table 2.1) shows that a high proportion of large bifacial and heavy-duty tools occur relative to light-duty tools (McBrearty 1988). This was unexpected, as at Kalambo Falls the light-duty component of the assemblage was more significant, and at Mwanganda (Malawi) the percentage of light-duty tools was even higher (McBrearty 1988). However, the sample of 56 formal tools on which these comparisons are based is limited, and activity differences could be the explanation.

	Number	**Percent**
Large bifacial tools	13	23.2
Heavy-duty tools	10	17.9
Light-duty tools	33	58.9
Total	56	100.0

Table. 2.1 Proportion of bifacial, heavy-duty and light-duty tools from the Ojolla industry (Sangoan-Lupemban) at Muguruk, Kenya. After McBrearty 1988.

Bifacial retouch is common at 41% of the assemblage, and bifacially retouched flakes grade into bifaces (*ibid*). Of the twenty cores recovered from Muguruk, 90% are radial forms. Levallois cores are a subcategory of radial cores and constitute 50% of these (McBrearty 1988). McBrearty also notes that despite the differences between the Sangoan-Lupemban and MSA industries at Muguruk, the method of flake production remained virtually unchanged between the two industries, with the majority of cores being radially flaked in both. This site is also significant because it shows that Levallois cores can be found in the Sangoan-Lupemban Complex, but they are not found in the Sangoan assemblages of Kalambo Falls.

SAI ISLAND, SUDAN

At Sai Island in northern Sudan, a stratified site of Sangoan overlying Acheulean has been reported, and on the basis of preliminary OSL dates, the Sangoan level has been dated to roughly 220-180 kya (Van Peer *et al.* 2003). Van Peer *et al.* refer here to the Sangoan as part of the MSA and report relatively sophisticated behaviours, including what they interpret as symbolic behaviour--quartzite cobbles were selected for grinding vegetal material, and shaped mortars and chert nodules were used to grind yellow and ochre pigments. However, as Rots and Van Peer (2006) later argue that the core-axes are hafted, the ochre may not have had a symbolic use but may instead have been used to strengthen mastic in the hafting process (Wadley *et al.* 2004).

Core axes are well represented in the deposit and are the qualifying reason for attributing this assemblage to the Sangoan Industrial Complex (Rots & Van Peer 2006). Flaking strategies are mostly discoidal, and Levallois cores are present but rare. Handaxes are rare and a range of tool types occurs that have been made on flakes.

Wear analysis was carried out on 48 core axes with interesting results (Rots & Van Peer 2006). It appears that core axes were manufactured for hafting, and that these hafted tools were used in a percussion motion on a moderately hard to hard material. The working edge was found to be too blunt for woodworking, and processing plant foods seems unlikely unless the tool came into contact with a hard surface during this process. Rots & Van Peer (2006) suggest that the most likely use of these tools was for the subsurface exploitation of lithic raw materials, plant foods or iron oxides.

BAMBATA & POMONGWE CAVES, ZIMBABWE

The term "Proto-Stillbay" was used by Jones (1940) to describe an industry excavated from the base of Bambata Cave in Zimbabwe, considered to be a 'direct derivative' of the Rhodesian Sangoan (Clark 1950). Although the assemblage included handaxes, ovates and other large tools (Armstrong 1931), Jones felt that these were only later carried into the cave, and he proceeded to publish only the small tools, for which he proposed the term Proto-Stillbay. Based on surface assemblages from Khami, the Charama Plateau and Cranmore farm, Cooke (1966) felt he could show that the Proto-Stillbay was not a valid industry, and that the large tools excavated at Pomongwe cave were an integral part of the assemblage Jones had called Proto-Stillbay. Cooke (1966) therefore proposed either the term developed Sangoan or Charaman to represent this industry, preferring the latter. However, most Charaman sites are open-air sites and Volman (1984) has questioned the reliability of these assemblages.

In a comparison made by Sampson (1974), the Charaman seems to contain fewer picks, handaxes, hammers, anvils and choppers than the Sangoan, and it also contains more points and scrapers. Cooke recognizes two important trends in Charaman assemblages (Table 2.2):

- Pygmy picks are prevalent.
- Handaxes are rare except in diminutive form, and they appear instead to be replaced by large points.

Cooke describes these points as bifaces, or pygmy handaxes, and unifacial flake tools. Prepared cores, listed as tortoise cores, also form part of the assemblage.

While it was common at times in the past to determine tool type percentages as a means of comparing industries, biases in sample size, activity differences represented in assemblages, and the variable attribution of pieces to a certain type make this technique unreliable. It does however have some use, for instance in highlighting the relative reduction seen in large cutting tools such as handaxes, which is often noted in the literature. A further instance where this approach may be useful is in comparing the relative abundance of pygmy picks and diminutive handaxes or large points, where this data is available.

	Mafungabusi Sangoan (Gwelan)	Charama Proto-Stillbay (Charaman)	Cranmore Proto-Stillbay (Charaman)	Khami Proto-Stillbay (Charaman)	Pomongwe Stillbay Bambata
Picks	23.8%	15.3%	16.1%	12.2%	0.0%
Handaxes	12.3%	1.0%	1.0%	1.0%	0.0%
Points	6.3%	17.1%	21.0%	22.2%	14.2%
Scrapers	32.6%	47.2%	42.0%	46.6%	32.1%
Utilized blades	6.7	8.3%	9.9%	10.0%	29.6%
Other tools	18.%	11.1%	10.0%	8.0%	24.1%
	100%	100%	100%	100%	100%

Table 2.2 Percentage of tool types found at sites in Zimbabwe, attributed to the Sangoan, final Sangoan (Charaman) and MSA (Bambata). After Cooke (1966) and based on a small sample, size unknown.

NATAL COAST, SOUTH AFRICA

Oliver Davies (1976) has made collections of what he calls 'Sangoan' artefacts along the Natal coast, mostly retrieved as surface collections from the coastal dunes. However, he states that whilst these and other collections may be descended from the Central African Sangoan Industry, no territorial continuity is evident and they do not closely resemble the Central African Sangoan. He feels that the 'Sangoan' in Zimbabwe developed from the true Sangoan towards the Charaman and not the Lupemban and that the 'Sangoan' in KwaZulu Natal may have been a parallel but unrelated response to ecological conditions there (Davies 1976). Davies therefore proposed the term Tugela industry be used, as first suggested by Cramb, for these collections (Davies 1976). It is interesting to note that Clark (1950) felt that the Natal Coast Sangoan or Tugela Industry was undoubtedly an "intimate part" of the Sangoan Complex.

Dr Kathy Kuman and a few of her students, including myself, visited the Red Sands along the KwaZulu-Natal coast in September 2006 where Davies worked, as well as their continuation along the Eastern Cape Pondoland coast. From surface collections it appears that Sangoan-like artefacts are present in the area for over 21 km distance along the coast dunes, though not in a primary context (Kuman 2006). It seems that the artefacts derive from one or more horizons that have been eroded, with the artefacts concentrated onto more resistant surfaces through deflation. It is quite possible that in some of the areas mixing of ESA and MSA artefacts has occurred. Sangoan-like artefacts can be seen in the heavy-duty component of the material, with many picks and rough handaxes observed, and a prepared core element is present which could belong to either the ESA or MSA periods (*ibid*). Davies felt the artefacts dated to the last interglacial. Should artefacts be found in better contexts at some time in the future, it is likely that these will be OSL-dated.

SUMMARY OF ISSUES RELEVANT TO THE SANGOAN

The Sangoan industry is poorly understood for a number of reasons. Very few excavated assemblages have been collected from reliable contexts, and many collections were either selected or recovered from geological contexts (McBrearty 1991). The Sango Bay type site was itself a surface collection (McBrearty 1998) and does not provide an adequate sample for comparison. It has variously been suggested that the Sangoan is a raw material expression of the Acheulean / MSA (Isaac 1982), that the term is not helpful and should be discarded (Cahen

1978), that the industry might represent an adaptation to a more wooded environment (Clark 1959), or that alternatively it may reflect the new abilities of archaic *Homo sapiens* (McBrearty 1991). McBrearty (1991) feels that while our understanding of what the Sangoan represents is flawed, the concept of the Sangoan is nonetheless valid.

As is apparent, the transition between the ESA and MSA--and the Sangoan's place in this debate--is complex, and only further research will clarify both the time period during which such a transition occurred and its diagnostic characteristics. The issue of regional variation is important and needs to be addressed. At Kalambo Falls for instance prepared cores are absent, while at various other sites in Zimbabwe and Kenya, prepared cores form a part of Sangoan-related assemblages. At present it is impossible to determine if this can be attributed to regional variation or change through time, or potentially to neither of these possibilities. The lack of good dates makes understanding the chronological relationships amongst sites even more difficult to assess (McBrearty 1991).

Complicating the period further is the Lupemban Industry, often assigned to the MSA. The type site of this industry is situated on the Lupemba stream in Zaire, just north of the Angolan border, and is characterized by the addition of lanceolate or foliate points to typical Sangoan types (McBrearty 1998). In addition to Zaire, the Lupemban occurs in Uganda, Angola and Western Kenya, but most assemblages are unreliable and come from either ambiguous or poorly documented stratigraphic contexts (*ibid*).

Isaac (1982) feels that the difference between the Sangoan and Lupemban industries cannot at present be differentiated either typologically or using stratigraphic data. For this reason he suggests that the two industries should be grouped using the term Sangoan-Lupemban. McBrearty (1988) has followed the same approach for the sites of Muguruk and Simbi in Kenya, despite the fact that lanceolate points have been recovered at Muguruk and not at Simbi. Significantly, at present, no development of a Sangoan to Lupemban sequence is represented in Kenya (*ibid*).

It would therefore appear that at minimum the Sangoan can be defined as an industry that contains a small number of handaxes and in some regions cleavers, while picks are also present. While core-axes are seen as the typical Sangoan heavy duty tool type, these tools have variously been classed as picks (McBrearty 1988), scrapers or handaxes (Cormack 1995). Although prepared cores are absent from Kalambo Falls, they form part of most other assemblages attributed to the Sangoan by Van Peer, McBrearty, and Cooke. Radial flaking methods also seem to be important at these sites, and light duty tools generally dominate these assemblages, though percentages vary. What separates the Sangoan from the later Acheulean and the Fauresmith is its crude appearance.

THE SUGGESTED NATURE OF THE SANGOAN IN SOUTHERN AFRICA

Due to the proximity of the northern Limpopo Province sites to Zimbabwe it might be expected that a Sangoan industry here may look similar to those recovered in these neighbouring regions. Two types of industry have been described, the Sangoan by Clark, and the 'end' of the Sangoan (named the Charaman) by Cooke. There are slight differences between the two, and both may occur together.

1. The Sangoan must contain a relatively small element of heavy duty bifacial tools similar to those occurring in the Acheulean. Therefore a small component of handaxes, cleavers, choppers and/or knives must be represented, in contrast with a greater prominence of these types in the Acheulean.
2. Picks are generally very well represented, though in the terminal Sangoan (Charaman) their numbers drop and they are dominated by diminutive forms, which Cooke called pygmy picks.
3. Heavy duty scrapers or core scrapers are usually represented.
4. Prepared cores may be present in both the Sangoan and terminal Sangoan.
5. A wide range of handaxes occurs in the Sangoan of Zimbabwe, though these tend to be dominated by diminutive or small handaxes in the terminal Sangoan.
6. Handaxes, cleavers, picks and core-axes are often large and crude, made on coarser grained rocks.
7. The terminal Sangoan may contain a large percentage of scrapers and points.
8. Core-axes are the most diagnostic of the Sangoan industry, but these have frequently been mislabeled as picks, handaxes and core scrapers, and so they are difficult to use as a marker for the Sangoan.

TRANSITION TO THE MIDDLE STONE AGE

While Goodwin (1948) proposed the terms Earlier, Middle and Later Stone Age, he acknowledged some of the problems researchers experienced in allocating assemblages to one of these three ages. As these divisions are generalisations, overlaps between periods should be expected to occur. But while certain techniques might first appear in a previous period, it is only when these new techniques, and importantly, new aims, become dominant in an assemblage and replace previous techniques that a new period of the Stone Age is represented (*ibid*). Following this approach, Goodwin recognized the handaxe as the type-tool of the Acheulean, and Levallois technology, particularly for producing triangular points and lance-heads, as the markers of the MSA.

The degree of variability in Middle Pleistocene assemblages makes it difficult to identify the earliest MSA occurrences. It appears that dates for the late Acheulean and early MSA cluster between 200-300,000 years ago, although the Acheulean seems to have been replaced by 200 ka (McBrearty & Brooks 2000). In South Africa, the earliest MSA assemblage is dated at Florisbad, at 259,000 ± 35,000 years ago (Grün *et al.* 1996).

To the north, Barham (2000a) defines a conservative date range for the Lupemban in Zambia at 170-270 ka based on Uranium Series dating, but he suggests this industry may extend as far back as 400 ka. Little is known of the ESA-MSA archaeology of Zimbabwe, but in southern Zimbabwe, the local expression of the late Sangoan is the Charaman, for which there are no valid dates. Following this are the first known MSA assemblages which fall within the Bambata Industry (Barham 2000a).

Volman (1984) feels that south of the Limpopo River the only widespread and convenient marker for distinguishing the MSA from the ESA is the absence of large cutting tools. However, this change may only reflect the declining importance of these tools, until the point is reached at which they were no longer being manufactured. It is possible that this decreasing reliance upon large cutting tools may be seen in the Charaman (late Sangoan) assemblages from Zimbabwe, where the percentage of handaxes and cleavers is significantly lower than during the early Sangoan, and even heavy-duty tools become rare in the Charaman (Volman 1984).

Volman's (1984) earliest MSA assemblages in South Africa date back to at least Oxygen Isotope Stage 6 (i.e., >128,000 years) and are characterised by very little formal retouch. Flakes are small and broad, with few faceted platforms. Although prepared cores occur, there is a high proportion of cores for the production of flakes with intersecting flake scars. Retouched points are absent, and scraper retouch is rare. Denticulates seem to represent the well-retouched component of the formal tools, with minimal, denticulate-like retouch most common. Volman's assemblages are dominated by sites well south of the Limpopo River, with emphasis on the southern Cape, and these traits are but one regional expression of the earlier MSA in Africa.

FLORISBAD, SOUTH AFRICA

At Florisbad in the Free State, 7m of deposit preserve an MSA sequence that appears to begin with the early MSA (Kuman *et al.* 1999). The basal levels date to 279,000 ± 47,000 years (Grün *et al.* 1996). Few artefacts were recovered from the earliest levels and they are not very informative, although the assemblage contains some informal flake tools and prepared core technology. Bifaces are absent, and multiple platform cores and small broad flakes are common. The early MSA is also different in use of raw materials and shows relatively less use of prepared core technology than succeeding levels.

KLASIES RIVER MOUTH, SOUTH AFRICA

Using the Klasies River Mouth material, Singer and Wymer (1982) divided the MSA sequence there into MSA I, MSA II, Howieson's Poort, MSA III and MSA IV. Wurz (2002) carried out a technological study of these sub-stages of the MSA, looking at the change in principal core-reduction strategies. According to this work there is little or no selection of non-local raw materials in the MSA I substage, primarily using pyramidal cores and flat Levallois cores for blade production. However, the site dates to no older than 125,000 years ago, with a probable age for the base of the deposit at about 115,000 years ago (Wurz 2002). Therefore Klasies River Mouth is younger than the earliest MSA in South Africa, which is better represented at Florisbad.

MUGURUK, KENYA

As previously noted core reduction at Muguruk remained similar throughout the Sangoan-Lupemban and MSA of Kenya. McBrearty (1988) sees the real change between the Sangoan and the MSA in two ways:

1. Large bifacial tools are absent in the MSA.
2. There is a change in technique of small tool manufacture. During the Sangoan, small flake tools tend to have a high degree of edge retouch (72%), and retouch is more commonly bifacial (66.7%). During the MSA the extent of edge retouch drops (41%) and retouch is more commonly from the dorsal surface only (64%).

TWIN RIVERS, ZAMBIA

At Twin Rivers, Zambia, Clark and Brown (2001) dated an early MSA stone tool assemblage by $^{230}\mathrm{Th}/^{234}\mathrm{U}$ to 230ka (Barham & Smart 1996). They assign the material to the Lupemban Industrial Complex, which they divided chronologically into the Lower Lupemban, Upper Lupemban and Lupembo-Tshitolian. Large cutting tools, picks and core axes extend well into the Lupemban sequence, although these tend to become more refined and better shaped with time (Table 2.3). The assemblages from these levels also include a variety of backed tools, lanceolates, tranchets and bifacial points (Barham 2000a).

Barham (2000b) argues that the lithic technology of the Lupemban is adapted to closed canopy forest habitats, specifically including composite tools that enabled foragers to exploit tropical resources, such as primates hunted in the forest canopy. Barham (2000a) suggests that the variety of backed tools found in the Lupemban levels represents a behavioural adaptation to exploit these specific resources, as hafted composite tools such as tranchet flakes may have facilitated the arboreal hunting of primates, and hafted lanceolates may have been used to hunt large terrestrial game such as elephant and hippo. He suggests this may have developed along with increasing social complexity to guard against starvation and reproductive isolation.

<table>
<tr><th></th><th>Lower Lupemban</th><th>Upper Lupemban</th><th>Lupembo-Tshitolian</th></tr>
<tr><td>Light-duty tools</td><td>Small retouched tools, various scrapers & utilized pieces</td><td>?</td><td rowspan="3">1) Bifacial technology retained.
2) Increased use of Levallois method.
3) Larger tools become smaller & more refined.
4) More variability in tool types, including more denticulates.</td></tr>
<tr><td>Large cutting tools</td><td>Handaxes & lanceolates</td><td>Large, refined foliate lanceolates</td></tr>
<tr><td>Heavy-duty tools</td><td>Picks & core axes</td><td>Well shaped core axes</td></tr>
</table>

Table 2.3. Change through time in the Lupemban sequence at Twin Rivers. Data from Clark & Brown (2001).

SUMMARY

While the Acheulean remained a relatively static industry throughout much of its existence, the later Acheulean is relatively dynamic. Prepared core technology and blade production have their greatest development in this time period. However, the transition from the final Acheulean to early MSA industries is one of increasing complexity. This can be seen in the first evidence for regional diversity in Africa, with contrasts between industries from South Africa, Zambia and East Africa, and more controversially in the first evidence for symbolic behaviour suggested in the processing of ochre.

This increased complexity also obscures the timing and nature of change, which is not a simple progression towards a single new industry, but which instead produced a range of industries (Fauresmith, Sangoan, Lupemban, and other early MSA industries) adapted to exploiting resources in changing environments ranging from open grasslands to closed canopy forests. The ability to create new industries and thereby to colonize new habitats is probably due to the appearance of a more evolved hominid. Therefore understanding this transition period will require far more research, as suggested by McBrearty above. At present, the existing sites provide some understanding of the late ESA to MSA transition (Table 2.4), which will undoubtedly be refined with future research and improved dating.

	Kalambo Falls Chipeta Industry Sangoan (Site B)	**Muguruk** Ojolla Industry Sangoan-Lupemban	**Charama** Charaman Late Sangoan	**Kalambo Falls** Nakisasa Industry Earlier Lupemban	**Kalambo Falls** Siszya Industry Later Lupemban	**Muguruk** Pundo Makwar MSA
Handaxes	Present	Present	Present	Present	Absent	Absent
Cleavers	Present	Absent	Present	Present – rare	Absent	Absent
Picks	Present	Present	Present	Present	Absent	Present – very rare
Core axes	Present	Present but called picks	Absent	Present	Present	Absent
Core scrapers	Present	Absent	Absent	Present	Present	Absent
Lanceolates	Absent	Present	Absent	Present	Present	Absent
Levallois cores	Absent	Present	Present	Present	Present	Present

Table 2.4 The presence or absence of certain tool and core types as far as can be established for the above sites.

CHAPTER 3

THE EXCAVATED SITES

All three excavations are of open-air sites that occur in the Mapungubwe National Park, a semi-arid region that is prone to drought, and one that has been significantly affected by temperature fluctuations in the Pleistocene (Kuman *et al*. 2005b). This landscape has been deflated, probably a number of times, and is currently capped by late Pleistocene and Holocene age sands (*ibid*).

The sites are distributed across a terrace remnant that is 3km long and probably formed in the Tertiary, with these sediments being cemented by calcrete, probably in the Miocene (de Wit 1996, de Wit *et al.* 2000). The palaeo-Limpopo River was also once a much larger river with a substantial catchment area that may have had its headwaters in Angola, and possibly included the Okavango system (de Wit *et al*. 2000). As a result a wide range of cobbles and pebbles of various raw materials occur in the river terrace, which formed as the palaeo-Limpopo became much reduced in size during the Miocene (*ibid*). All three of the sites are located within a few kilometers of the present course of the Limpopo River.

Gravels within the terrace include quartz, quartzite, sandstone, rhyolite, chert and chalcedony with some banded ironstone and dolerite, and provided the toolmakers with a ready source of raw materials (Kuman *et al*. 2005b). The calcrete surface of the terrace is today covered by aeolian sand derived from the local Clarens Formation sandstones (Bordy & Cantuneanu 2002). The landscape is mostly of sandstone with numerous dolerite dykes exposed at the surface. Where the dolerite intrusions can be seen in the landscape bands of sandstone at the margins of these dykes have been metamorphosed and formed quartzite. Sandstone, quartzite and dolerite are therefore freely available in local outcrops.

HACKTHORNE

The first site to be excavated was Hackthorne (Site 2229AB231, 22°13′47″S, 29°18′56″E), in 2001. The site (Figs. 3.3 & 3.4) is situated on top of the ancient terrace of the Limpopo River, which now lies 20-30m above the surrounding landscape and 4km from the present course of the Limpopo River (Kuman *et al*. 2005b).

The excavation is located approximately 20m from the edge of the terrace. Humic acid produced by vegetation has created deep solution pockets in the calcrete and due to this the thickness of sand covering the site varies quite dramatically in accordance with the irregular calcrete surface below (*ibid*). The sand is unstratified and artefacts tend to concentrate on the calcrete substrate. An OSL sample (Jacobs & Collett 2005) taken from one of these solution pits provided an age of 15.8±1.1ka, showing that even the oldest sediments at the site are young relative to the antiquity of the artefacts recovered (Kuman *et al*. 2005b).

A total of 8899 pieces has been recovered from the main Hackthorne excavation. The majority of pieces recovered are small flaking debris (less than 20mm), with only 3051 (34.28%) of the assemblage being 20mm or larger (Table 3.1). The assemblage is therefore complete with only a fraction of the smallest component of flaking debris absent due to runoff at the edge of the terrace (Gibbon 2002; Kuman *et al*. 2005b). Although close to the edge of the escarpment, the surface is quite flat and so very little runoff of the smaller pieces occurred, except for the material under 10mm which may have washed off in heavy rains. This proportion of small flaking debris indicates that actual knapping occurred at the site, rather than the further reduction of cores initially reduced elsewhere, or the production of various tool types (Schick & Toth 1994, Delagnes *et al.* 2006). Also, the sieves used at this site were 4mm mesh, not the 2mm mesh size more regularly used, as regular checking through the 2mm sieve recovered very few small chips (Kuman, pers. com).

	≤ 10mm	>10mm & <20mm	≥ 20mm	**TOTAL**
Number of pieces	2146	3702	3051	**8899**
Percentage of assemblage	24.11%	41.6%	34.28%	**100%**

Table 3.1 Number of artefacts and size distribution at Hackthorne.

KERATIC KOPPIE

The site (Figs 3.5 & 3.6) (Site 2229AB407, 22° 13′51.9″S, 29° 19′48.3″E) is located adjacent to a koppie and unstratified sands (Fig. 3.7) overlie the sandstone bedrock. Deflation has concentrated the artefacts in the bottom 30cm of a 2m layer of sand. Three squares of 1mx1m were excavated to a depth of approximately 2m. All of the flaking debris appears to be present (Table 3.2), with one third of the artefacts being ≤10mm (again a 4mm mesh sieve was used) and a third of the pieces greater than 10mm but less than 20mm. This is due to koppies acting as sediment traps as windblown sands build up against the outcrops. At some locations in the area sediments have built up in excess of 5m of depth (Kuman *et al*. 2005b). It also indicates that actual flaking was taking place at the site and that the flaking was not for the production of tools for immediate use such as at a butchery site. The decaying sandstone bedrock may also have trapped the smaller flaking debris, and as the area is quite flat, resulted in the absence of runoff of smaller pieces. A number of refitting pieces has also been recovered, but as only three 1mx1m squares have been excavated the number of refits is probably artificially low. Together this suggests that although the site is deflated there is good preservation of the assemblage as a whole.

Three OSL samples were taken, but only one of these returned a valid date. Samples one and two were taken from the upper levels of the excavation, but had very high overdispersion rates. Sample three was taken from near the base of the deposit and produced an age of 23.3±1.1ka (Jacobs & Collett 2005).

	≤ 10mm	>10mm & <20mm	≥ 20mm	**TOTAL**
Number of pieces	1086	1006	883	**2975**
Percentage of assemblage	36.50%	33.81%%	29.68%%	**100%**

Table 3.2 Number of artefacts and size distribution at Keratic Koppie.

KUDU KOPPIE

The site (Site 2229AB415, 22° 13′40.5″S, 29° 20′21.6″S) is located at the base of a large sandstone outcrop or koppie (Figs 3.7 & 3.8). It overlies sandstone bedrock but the Miocene terrace deposits lie within about 2km of the koppie. Although the site has been deflated, at least four stratigraphic levels can be seen in the deposit exposed in square 3S2E (Fig. 3.1). Depths are in cm below datum (BD), with datum lying at 5 cm above surface. The depths at which these layers occur at the site varies between squares, but is as discussed below for this square:

Layer 1: The basal level (156-174 cm BD) lying directly on the sandstone bedrock is a closely packed lag deposit that contains ESA pieces (Kuman *et al*. 2005b). It is so heavily weathered that the sandstone rubble exfoliated from the koppie is reduced to a small particle size (Kuman in press).

Layer 2: A layer of larger-size sandstone rubble (105-156 cm BD) also derived from weathering of the koppie, is a largely clast-supported deposit. This layer contains ESA material at the base and grades into MSA higher up. The contact between MSA and ESA is present at level 121-126 cm BD, with some mixing of the two industries evident in this horizon.

Layer 3: A layer of gravelly sand and small sandstone clasts (96-106 cm BD) containing MSA artefacts.

Layer 4: A fine sand level (91-96 cm BD) containing MSA pieces, representing the uppermost MSA horizon. There does not seem to be any mixing of characteristic MSA with overlying LSA pieces in this sand level, but some minor mixing cannot be ruled out as deflation and bioturbation are common.

These four stratigraphic units contain the MSA and ESA samples. Not considered in this thesis is the remainder of the sand unit, from 91 cm BD to surface, which contains some sporadic LSA material. In the top level of this sand, a few artefacts and pottery are present that are characteristic of the contact period between hunter gatherers and Iron Age people who entered the area approximately 2000 years ago (Kuman *et al.* 2005b). Very few artefacts occur in this sand layer.

Artefacts are distributed throughout the levels (Fig.3.2), although it is clear that deflation episodes have produced a concentration of artefacts on the bedrock surface (layer 1), as well as on top of the sandstone rubble (layer 2). This concentration is partly due to deflation, but it cannot be explained without assuming that the site was frequently visited. Only two squares have been excavated to the sandstone bedrock (3S2E & 3S3E) and it is data from square 3S2E only that is included in this study, though some artefacts from other squares have been discussed and illustrated. In total

20867 pieces (Table 3.3) have been recovered from square 3S2E, with three quarters of this being small flaking debris. The site has not been winnowed of the smaller material and is well preserved with a number of refitting pieces.

Two OSL samples were taken for dating. The sample taken from the sand levels of the main excavation at 41cm below the surface did not produce a valid date because of a high overdispersion rate. The second sample was taken from a test pit and produced an age of 15.0±0.8ka (Jacobs & Collett 2005).

WEST WALL
1.74M

4) Sandy layer, containing sporadic LSA artefacts down to level 91-96.

3) Layer of poorly sorted gravelly sand containing MSA pieces, corresponding closest to levels 96-106.

2) Rocky layer containing MSA pieces with ESA at the base, corresponding closest to levels 106-156.

1) Lag deposit at base containing ESA pieces, begins at level 156-161.

Fig.3.1 View of the stratigraphy of the west wall of square 3S2E.

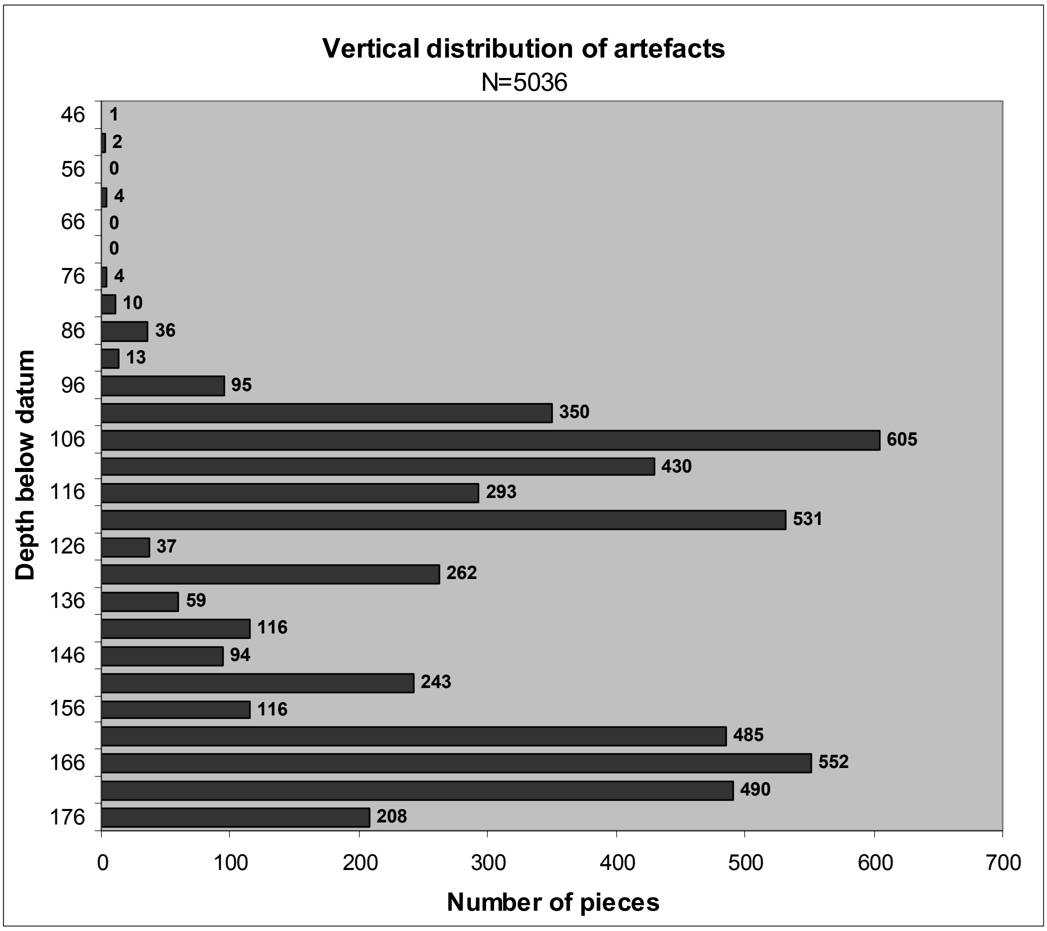


Fig.3.2. Distribution of artefacts equal to or larger than 20mm maximum length at Kudu Koppie, by 5cm levels.

For the purposes of this study, the ESA assemblage (Table 3.4) and MSA assemblage (Table 3.5) will be separated so as to characterize the two industries and record how the change through time in the region occurs. The ESA assemblage (KK1) (Table 3.4) encompasses the levels from the base of the deposit, or level 171-176cm below datum (which lies at 5 cm above surface), to include the level 126-131cm below datum. The next 5cm spit, 121-126cm, is a zone of contact between the ESA and MSA where the two industries cannot be readily separated, and it is included in the MSA assemblage (KK2) (Table 3.5), which includes material up to level 96cm below datum. The composition of the entire Kudu Koppie assemblage, as well as KK1 and KK2, is as below (Table 3.3 to Table 3.5).

Flaking debris is well represented for both assemblages at Kudu Koppie, showing that the site was regularly used for tool manufacture and that even in the MSA levels raw materials were transported to the site rather than complete tools being brought in and merely re-sharpened.

	≤ 10mm	>10mm & <20mm	≥ 20mm	**TOTAL**
Number of pieces	6605	9184	5087	**20867**
Percentage of assemblage	31.65%	44.01%	24.37%	**100%**

Table 3.3 Total number of artefacts and size distribution at Kudu Koppie, square 3S2E, for both ESA and MSA levels (96 below datum to bedrock).

	≤ 10mm	>10mm & <20mm	≥ 20mm	**TOTAL**
Number of pieces	3211	4317	2662	**10190**
Percentage of assemblage	31.51%	42.36%	26.12%	**100%**

Table 3.4 Sample KK1: number of artefacts and size distribution at Kudu Koppie, square 3S2E ESA levels, 126 cm below datum to bedrock.

	≤ 10mm	>10mm & <20mm	≥ 20mm	**TOTAL**
Number of pieces	3394	4867	2425	**10686**
Percentage of assemblage	31.76%	45.54%	22.69%	**100%**

Table 3.5 Sample KK2: number of artefacts and size distribution at Kudu Koppie, square 3S2E MSA levels, 96cm to 126cm below datum.

Fig. 3.3 Excavations at the Hackthorne site. The mounds in the center are calcrete.

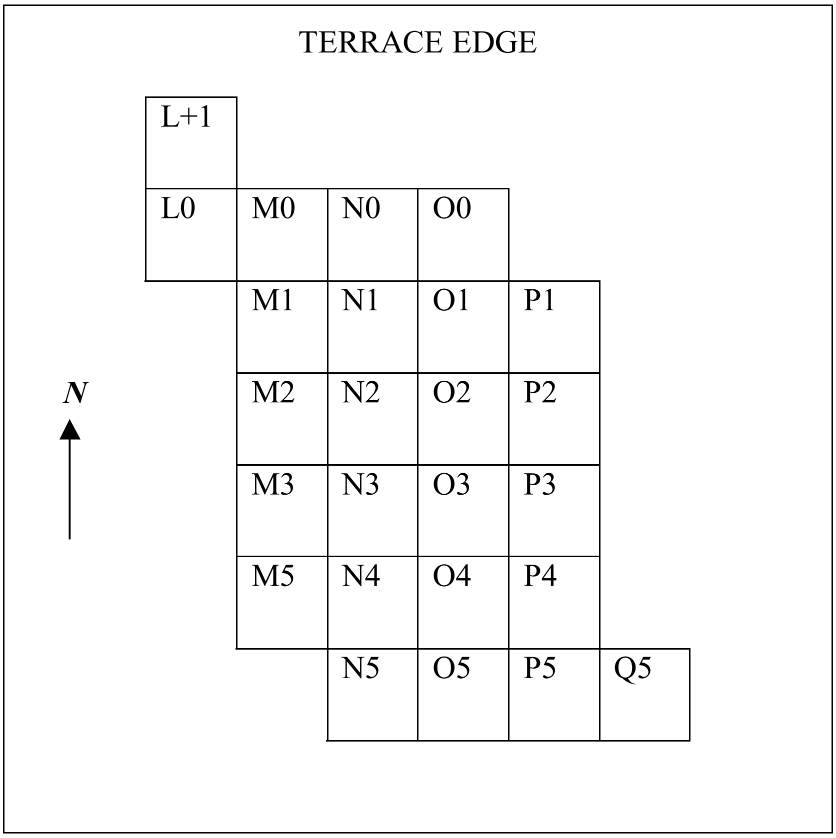


Fig. 3.4 Plan view of the Hackthorne excavations (excluding geological trench).

Fig. 3.5 Photo of the Keratic Koppie excavations.

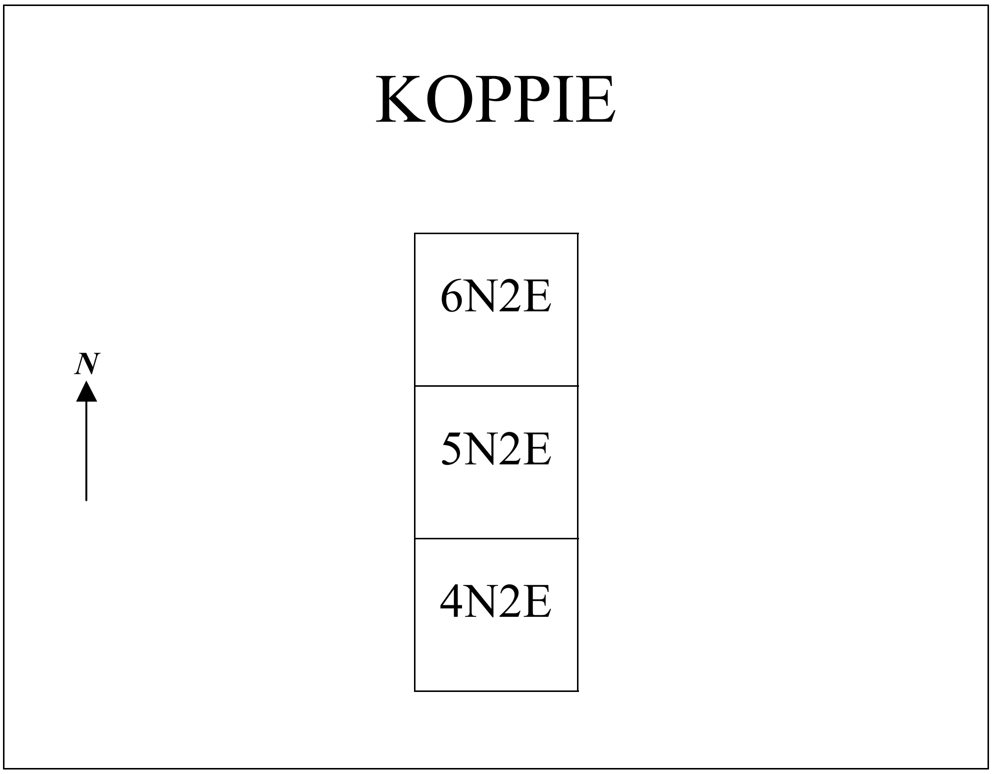


Fig. 3.6 Plan view of the Keratic Koppie excavations.

Fig. 3.7 Excavations at Kudu Koppie (under the canopy) are close to the base of the sandstone koppie.

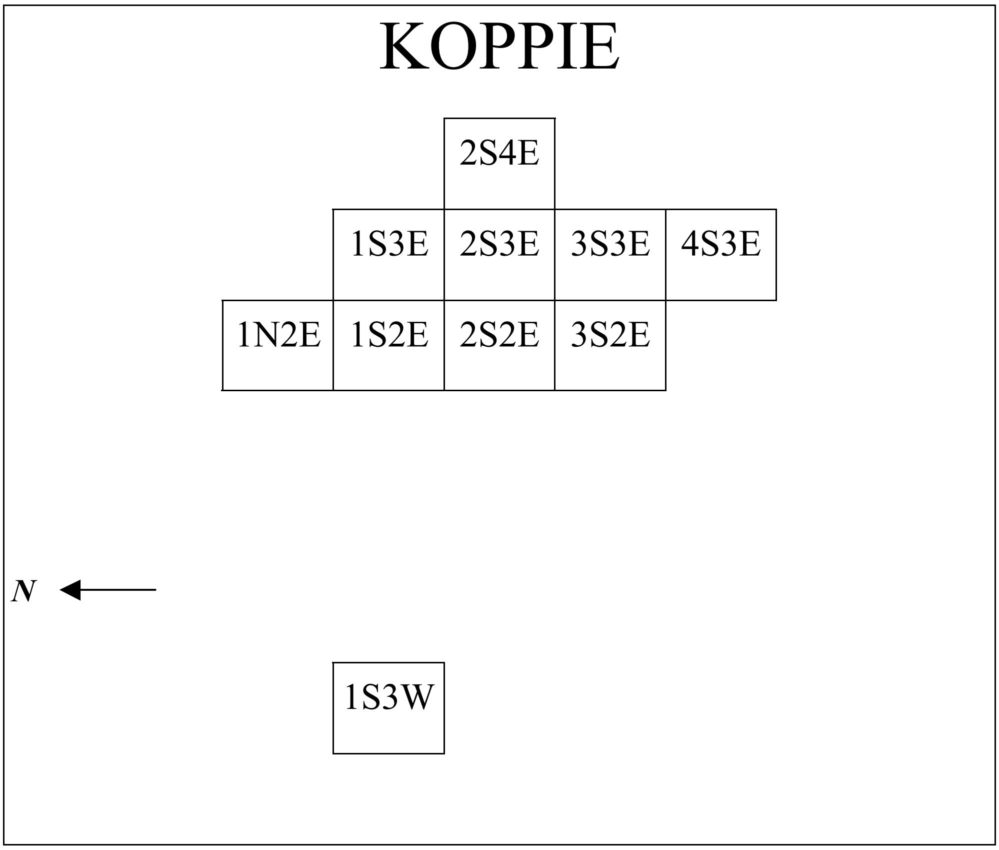


Fig. 3.8 Plan view of the Kudu Koppie excavations, excluding test pits.

METHODS

TYPOLOGICAL CLASSIFICATION

All pieces in the assemblages were defined typologically according to the types described below.

DEBITAGE

All pieces less than 20mm: Small Flaking debris.

Complete flakes: Flakes equal to or larger than 20mm that have either no damage or limited damage.

Incomplete flakes: Flakes equal to or larger than 20mm in maximum length that are broken but still retain all or most of the striking platform.

Split flakes: Flakes equal to or larger than 20mm in maximum length that have broken perpendicular to the striking platform and through the bulb.

Flake Fragments: Broken pieces of flake that do not have a striking platform and that are equal to or larger than 20mm.

Chunks: Pieces equal to or larger than 20mm that are usually thicker and more angular in nature, produced in the knapping process.

Bipolar flakes /chunks: Flakes removed from a bipolar core, and chunks of either flakes or of the core itself.

CORE TYPES

Core fragments: Broken pieces of a core.

Casual cores: Cores from which only one or two flakes have been removed.

Chopper cores: Cores worked unifacially or bifacially, with flake scars usually adjacent to one another.

Radial cores: Either unifacial or bifacial cores where flakes are struck from the perimeter of the core towards the centre of the piece. This type includes cores that might be described as sub-radial, where the flaking pattern is not entirely circular, often due to a lack of suitable angles on the core.

Prepared cores: Cores that have been prepared for the removal of one or more flakes of predetermined shape. Cores are asymmetrical and prepared flakes are removed at an angle more or less parallel to the plane of intersection of the two asymmetrical halves. Platforms are not always prepared. The core may be shaped for the removal of a single (preferential) flake, or for the removal of multiple flakes (recurrent).

Irregular cores: Cores with only a few removals and forming no particular pattern, often on a flat piece, unlike polyhedral cores.

Polyhedral cores: Cores having more than two striking platforms, removed in no particular pattern.

Blade cores: Cores from which the majority of removals have blade-like dimensions.

Single platform cores: Cores where flakes have been removed from one face or platform only. These differ from unifacial chopper cores as the angle of removals is steeper in these cores than in chopper cores.

Bipolar cores: Cores which have been created with the bipolar method of flaking between a hammer and an anvil, and where a significant portion of the core remains.

<u>LIGHT-DUTY RETOUCHED PIECES</u>

Miscellaneous retouched pieces: Pieces with minimal and discontinuous retouch.

Broken retouched pieces: Part of a broken retouched piece.

Retouched flakes: Flakes with more than minimal or discontinuous retouch which cannot be readily assigned to a more formal type (e.g. a scraper or denticulate, etc.)

Denticulated /notched scrapers: Pieces that have one or more relatively steep retouched edge, and where the retouch produces a serrated edge and/or notched working area.

Denticulates: Pieces with retouch that produces a serrated working edge, less steep than that of a scraper edge, presumably for use in a cutting motion.

Cutting tools: Pieces that exhibit either some bifacial retouch or use wear. The edge is not steep enough to be considered a scraper and a cutting action is implied.

HEAVY-DUTY TOOLS / RETOUCHED PIECES

Handaxes: Bifaces and unifaces flaked to produce a sharp distal end and cutting edges.

Cleavers: Bifaces with a sharp distal cutting edge at right angles or slightly oblique to the long axis of the piece.

Picks: Shaped tools that appear similar to core axes and handaxes, but with the emphasis of shaping / retouch at the tip of the piece to produce a strong pointed end. These may be bifacial or unifacial.

Core axes: Shaped tools that may appear similar to handaxes or picks, but which are rough, heavy tools that have an emphasis on the tip and a heavy butt that usually shows little retouch.

Core scrapers / heavy-duty scrapers: Blocks, chunks or recycled cores that have steep retouch along one or more edges.

Knives: Tools that usually show bifacial use wear along one edge, with the opposing edge either naturally blunt or roughly backed by the tool-makers.

Choppers: Bifacial or unifacial core tools with contiguous removals that are distinguished from chopper-cores by the appearance of crushing or use wear on the edge of the tool shaped by either unifacial or bifacial removals.

Small bifaces: Bifaces that are small and often grading in size to a point. They may be equivalent to pygmy picks if the emphasis is on the tip, or knives if one side is blunt (usually naturally).

Uniface: Unifacially flaked pieces with a flat, cleaver like tip and denticulated scraper edge.

TECHNOLOGICAL ANALYSIS

Following the typological analysis, all complete flakes equal or larger than 20mm in maximum length were studied. Where possible the technological traits described below were noted for each assemblage.

FLAKE ATTRIBUTES

RAW MATERIALS

The assemblages were sorted into the raw material types presented below. A wide variety of raw materials was used at the sites. This results from the variety of river pebbles and cobbles available in the terrace deposits, as well as certain materials that occurred naturally in the landscape. The categories are as follows:

Banded Ironstone: This rock is a combination of ironstone and chert which occur in layers or bands to form banded ironstone. This only occurs as river cobbles and pebbles.

Crypto-crystalline rocks: This includes a range of materials such as chert and chalcedony, which only occur as river cobbles and pebbles, with the exception of an extremely poor quality brecciated chert that occurs naturally in the landscape as veins.

Dolerite: This is a fine-grained basaltic rock (Rapp & Hill 1998). This resource could be exploited directly from the various dykes in the area or collected as weathered blocks as they eroded naturally.

Quartz: Quarts tends to fracture conchoidally as well as along flaws and crystal lattices (Schick & Toth 1994). All quartz occurs in the form of river cobbles or pebbles.

Quartzite: A wide range of quartzites occur of varying colour and texture and are available both in the form of river cobbles and pebbles, as well as at natural outcrops.

Rhyolite: Rhyolite is a fine-grained volcanic rock (Rapp & Hill 1998), with a crypto-crystalline or microcrystalline structure (Nockolds *et al.* 1978). This rock only occurs in the form of river cobbles and pebbles.

Other: This category includes pieces that occur in small numbers, such as gneiss, sandstone, shale, and pieces of unknown type. It also includes friable quartzite; (quartzites with very coarse grains, or where these grains are not well fused).

LENGTH

The maximum length of each piece was measured and recorded in mm.

TECHNOLOGICAL LENGTH AND WIDTH

For complete flakes, the platform was aligned horizontally and the technological length was measured as the distance from the platform to the most distal point of the flake on a line perpendicular to the horizontal axis. The width of the piece was then taken as the maximum distance perpendicular to the length.

STRIKING PLATFORM FACETS

The number of facets on a flake platform was counted where a facet or plane extended across the entire thickness of the platform. Small scars that did not cross the entire platform were considered to represent flaking of the platform to remove irregularities of the surface that would interfere with flake removal and were not included in the count. The categories used were as follows:

Number of facets	
0	Cortical
1	Plain
2	Dihedral
3	Faceted
4 or more facets	Multi-faceted
Thin	Breadth of the platform is thin

PLATFORM ANGLE:

This is the angle formed where the platform and ventral surface meet. Completely cortical platforms were not measured. This angle was not measured where platform shatter was noted, or where the shape of the piece was a problem, such as a very prominent bulb or a twisting flake.

FLAKING AXIS

With the long axis of the flake aligned on the vertical axis, the position of the striking platform is determined as:

- End-struck: platform is proximal, in line with the long axis.
- Side-struck: platform is lateral, perpendicular to the long axis.
- Corner-struck: platform is intermediate between proximal and lateral positions.

FLAKE TYPE

The presence or absence of cortex and its placement (Fig. 3.9) on the flake was noted in order to categorize flakes, where possible, into the six types recognized by Toth (1982). Toth replicated the various core types from Koobi Fora and used this data to predict the proportion of each flake type that will typically be produced in a complete assemblage (Table 3.6).

	I	II	III	IV	V	VI
Number	7	15	26	17	93	21
Percentage	4	8	17	19	52	12

Table 3.6. Experimental work done by Toth produced data suggesting the proportion of flake types 1.6 that would be expected in a complete assemblage.

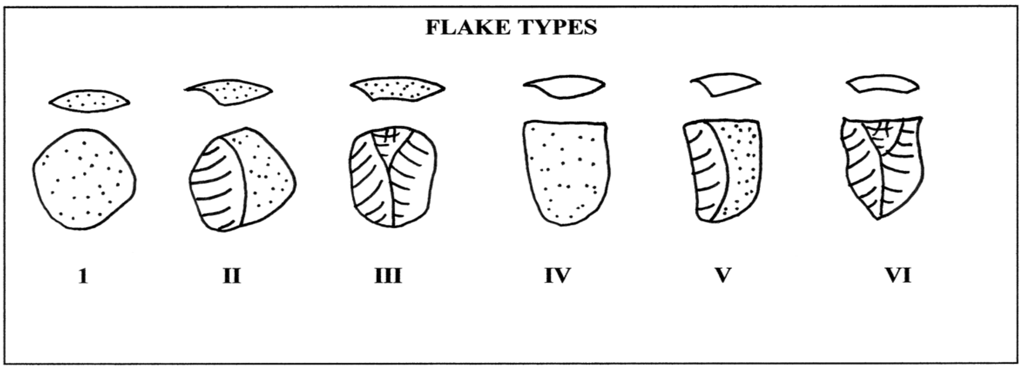


Figure 3.9. Flake types (after Toth 1982)

Type 1: Entirely cortical on platform and dorsal surface.
Type 2: Cortical platform and partly cortical dorsal surface.
Type 3: Cortical platform with no cortex on the dorsal surface.
Type 4: No cortex on the platform, with the entire dorsal surface cortical.
Type 5: No cortex on the platform, with a partly cortical dorsal surface.
Type 6: No cortex on the platform or dorsal surface.

TERMINATIONS:

Four types of termination were recognized. These were identified using the descriptions of Whittaker (1997) and Andrefsky (2000).

Feather: The flake separates from the core smoothly, resulting in a sharp, feathered edge (Whittaker 1997, Fig. 3.10).

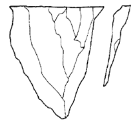


Figure 3.10. Feather termination (after Andrefsky 2000)

Step: Flakes that snap or shatter during removal, forming an angle with the ventral surface at approximately 90º, have step terminations (Andrefsky 2000, Fig. 3.11).

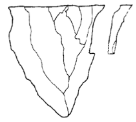


Figure 3.11. Step termination (after Andrefsky 2000)

Hinge: The fracture surface turns upward, resulting in a hinge at the distal end of the flake on the ventral face (Whittaker 1997, Fig. 3.12).

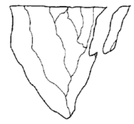


Figure 3.12. Hinge termination (after Andrefsky 2000)

Overshoot: When the force and crack initiated by impact passes into the core the flake continues further and removes part of the end of the core (Whittaker 1997, Fig. 3.13).

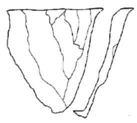


Figure 3.13. Overshoot termination (after Andrefsky 2000)

Variables affecting the type of flake termination include the friability of the raw material, the size and shape of the flake, the hammer used, the angle and location of applied force, the striking platform as well as flaws within the core (Andrefsky 2000). Flake terminations comment on both the skill of the knapper and the quality of raw materials. Flakes with feathered terminations are the most desirable flakes, although Wurz (2002) has noted the use of overshot flakes to produce lateral and distal convexities on cores.

CHAPTER 4

RESULTS: TYPOLOGY & TECHNOLOGY

The result of a typological analysis, as well as the results of the technological analysis of complete flakes, is presented here. Late ESA, post-Acheulean assemblages that have been published as Sangoan or Sangoan-like consist of small numbers of typical Acheulean bifaces and cleavers combined with larger proportions of picks, pygmy picks, heavy and light duty scrapers, and sometimes unifaces. The results of the typology and technology study also suggested that the ESA component is for the moment more suitably placed within the Sangoan, therefore where figures and captions refer to the ESA or Sangoan, these terms are interchangeable for these earlier levels. Therefore the term Sangoan has been used in the figures.

TYPOLOGICAL ANALYSIS

The typological composition of the four assemblages is provided below by site. Core types and formal tools (including utilized flakes) are also listed in more detail. As far as possible unifacial or bifacial flaking has been noted for both radial and chopper cores. For prepared cores the recurrent or preferential methods of removal have been listed, along with the categories of recurrent centripetal, unidirectional or bidirectional.

The percentage of tools in each assemblage is the percentage relative to all pieces equal to or larger than 20mm. Light-duty tools are those made on flakes or chunks which do not exceed 100mm in maximum dimension. Heavy-duty tools are predominantly core tools, but where flake tools are over 100mm in maximum length, these are referred to as heavy-duty tools. These criteria are similar to the typology used at Kalambo Falls, where heavy duty tools are most often 100mm or more in length and light duty tools are generally less than 100mm in length (Clark & Kleindienst 2001).

<u>HACKTHORNE</u>

This assemblage (Table 4.1) includes 8899 pieces in total. Of this, 5848 pieces (66%) are less than 20mm. The remainder of the assemblage consists of 3051 pieces, and 34

(1.11%) of these are formal tools or utilized flakes. There are 666 complete flakes from which data were collected where technological attributes were reasonably clear. Cores of various types (Fig 4.2) form 4.49% (N=137) of pieces equal to or greater than 20mm. Manuports are not listed for this site as river gravels are situated near the Hackthorne site, but natural stones were recorded if they were at least 40mm in length as they may have been brought into the site.

ASSEMBLAGE COMPOSITION: HACKTHORNE			
DEBITAGE:	**8456**	**CORES:**	**137**
Flaking debris < 10mm	2146	Irregular cores	12
Flaking debris ≥ 10mm & < 20mm	3702	Bipolar cores & core remains	10
Complete flakes	666	Blade cores	0
Incomplete flakes	451	Casual cores	16
Split flakes	109	Chopper cores	22
Core trimming flakes	51	Polyhedral cores	12
Kombewa flakes	9	Prepared cores	10
Flake fragments	580	Radial cores	28
Bipolar flakes	12	Single platform cores	9
Bipolar chunks and fragments	27	Core fragments	18
Chunks	703		
OTHER:			
Hammerstones	11		
Natural stones / cobbles and pebbles	251		
Split cobbles/pebbles	10		
Formal tools	34		
TOTAL	**8899**		

Table 4.1. Assemblage composition of the Hackthorne assemblage, including flaking debris. All material is ≥20mm except for flaking debris.

FORMAL TOOLS (1.11% OF ASSEMBLAGE)			
LIGHT-DUTY TOOLS (44.1%):	**15**	**HEAVY-DUTY TOOLS (55.8%):**	**19**
Denticulated/notched scraper	9	Handaxe	1
Denticulate	4	Pick	2
Broken retouched piece	2	Pygmy pick	3
		Pick?	1
		Large denticulated/notched scraper	9
		Large scraper	1
		Uniface	1
		Cleaver	1
		Large denticulate	1

Table 4.2 Formal tool types at Hackthorne.

HACKTHORNE			
CORE TYPE	**TOTAL**	**RAW MATERIAL**	**COMMENT**
Irregular	12	Banded Ironstone 9.0% Crypto-crystalline 36.36% Quartz 36.36% Quartzite 18.18%	-
Blade	0	-	-
Casual	16	Banded Ironstone 10.0% Quartz 25.0% Quartzite 35% Rhyolite 13.33%	-
Chopper	22	Banded Ironstone 9.0% Crypto-crystalline 25.0% Quartz 35.0% Quartzite 20.0% Rhyolite 10%	1 Unclear 21 Bifacial
Polyhedral	12	Crypto-crystalline 16.66% Quartz 41.66% Quartzite 41.66%	-
Prepared	10	Banded Ironstone 11.1% Quartz 22.2% Quartzite 33.3% Rhyolite 33.3%	3 Recurrent centripetal 1 Recurrent unipolar 2 Recurrent bidirectional 1 Recurrent? 3 Preferential
Radial	28	Crypto-crystalline 11.1% Quartz 40.7% Quartzite 33.3% Rhyolite 7.4% Other 7.4%	18 Unifacial 10 Bifacial
Single platform	9	Banded Ironstone 11.1% Crypto-crystalline 22.2% Quartz 33.3% Quartzite 33.3%	-

Table 4.3 Core types at Hackthorne including raw material selection.

Formal tools (Table 4.2) include one handaxe (Fig. 4.4) and one cleaver (Fig. 4.3), but various pick-like types are more common at Hackthorne (Fig. 4.4), particularly the small, pointed pieces called pygmy picks. These are small core tools (40mm, 61.2mm and 60mm) with retouch concentrated at the tip to produce a pointed end. Denticulates and denticulated/notched scraper types (Figs. 4.3 & 4.7) form the majority of light-duty tools, with about half of these occurring as pointed forms. A number of these scrapers on pointed shaped flakes look very similar to the points listed by Cooke for the Charaman. Heavy-duty tools form roughly 56% of the formal tools with light-duty tools at about 44%.

With the exception of blade cores which only occur in the KK-2 (MSA) assemblage, Hackthorne has all the core types found across the four assemblages (Table 4.3). Casual cores form 14.6% of the assemblage and this is higher than at any other site (KRK=9.6%, KK-MSA=1.2%, KK-ESA=3.7%), and chopper cores are also well represented (20%).

Chopper cores are bifacial and occur in all rock types but dolerite, which is practically absent from the site. Of the radial cores, the majority is unifacial (64.2%) and shows no preference in terms of raw material selection. Prepared cores are made primarily on quartz, quartzite and rhyolite (Fig. 4.2). Recurrent methods of reduction are more popular, with only 3 of the 10 prepared cores (or 30%) showing preferential flake removals. Recurrent centripetal (N=3, 30%) as well as recurrent unipolar (N=1, 10%) and recurrent bidirectional (N=2, 20%) therefore together account for the majority of prepared core types.

As expected, the majority of chopper cores is made using cobbles and pebbles. However, for prepared and radial cores, the tendency is towards using split cobbles or pebbles, or using thick cortical flakes. Some pieces occur on rocks that have been split or flaked using the bipolar method, showing that this was a technique used for producing a range of core types.

KERATIC KOPPIE

Keratic Koppie is a relatively small assemblage (Table 4.4) and includes 2975 pieces in total. Of this, 2092 pieces (70.3%) are less than 20mm. The remainder of the assemblage consists of 883 pieces, and 9 (1.01%) of these are formal tools or utilized flakes. Data were collected where possible from 136 complete flakes. Of pieces equal to or greater than 20mm, cores form 6.9% (N=61). Natural stones (N=86) consist almost exclusively of chunks of poor quality crypto-crystalline rock. These pieces often have scars which appear very similar to flake scars but in my opinion these are most probably natural. There is however evidence that this raw material type has been used for flaking at the site.

In this small sample there is no preference evident for any tool type (Table 4.5). Heavy-duty tools (Figs. 4.5 & 4.11) include one cleaver, a pick, a core axe, a uniface and one large denticulate. Light-duty tools comprise two utilized flakes, one denticulate and one denticulated/notched scraper. Heavy-duty tools are slightly more numerous at 55% (N=5) than light-duty tools at 45% (N=4), but the sample is too small for this to be considered significant.

ASSEMBLAGE COMPOSITION: KERATIC KOPPIE			
DEBITAGE:	**2770**	**CORES:**	**61**
Flaking debris < 10mm	1086	Irregular cores	10
Flaking debris ≥ 10mm & < 20mm	1006	Bipolar cores & core remains	4
Complete flakes	136	Blade cores	0
Incomplete flakes	137	Casual cores	5
Split flakes	34	Chopper cores	6
Core trimming flakes	6	Polyhedral cores	8
Kombewa flakes	0	Prepared cores	4
Flake fragments	160	Radial cores	16
Bipolar flakes	33	Single platform cores	3
Bipolar chunks and fragments	0	Core fragments	5
Chunks	172		
OTHER:			
Hammerstones	4		
Manuports	45		
Natural stones	86		
Formal tools	9		
TOTAL	**2975**		

Table 4.4. Assemblage composition of the Keratic Koppie assemblage, including flaking debris.

FORMAL TOOLS (1.01% OF ASSEMBLAGE)			
LIGHT-DUTY TOOLS (44.4%):	**4**	**HEAVY-DUTY TOOLS (55.5%):**	**5**
Denticulated/notched scrapers	1	Pick	1
Denticulate	1	Cleaver	1
Utilized flake	2	Denticulate	1
		Core axe	1
		Uniface	1

Table 4.5 Formal tool types at Keratic Koppie.

This assemblage has the highest incidence of irregular cores (Table 4.6) at 19.2% (N=10). Radial cores are also more numerous than in any other assemblage (N=16, 30.7%), as are polyhedral cores (N=8, 15.3%). Chopper cores and prepared cores form a smaller part of this assemblage than any other.

Irregular cores are produced equally on crypto-crystalline, quartzite and rhyolite blanks, and are therefore made primarily on fine-grained rocks, while radial cores are of quartz and quartzite, and are mostly bifacial.

KERATIC KOPPIE			
CORE TYPE	**TOTAL**	**RAW MATERIAL**	**COMMENT**
Irregular	10	Crypto-crystalline 37.5% Quartzite 37.5% Rhyolite 37.5	-
Blade	0		-
Casual	5	Crypto-crystalline 40% Quartz 40.0% Quartzite 20%	-
Chopper	6	Quartz 16.6% Quartzite 83.3%	2 Unifacial 1 Bifacial 3 Unclear
Polyhedral	8	Crypto-crystalline 25.0% Dolerite 12.5% Quartzite 62.5%	-
Prepared	4	Crypto-crystalline 75.0% Quartz 25%	3 Recurrent centripetal 1 Unclear
Radial	16	Quartz 12.5% Quartzite 75.0% Other 6.25%	4 Unifacial 9 Bifacial 3 Unclear
Single platform	3	Quartz 33.3% Rhyolite 66.6%	-

Table 4.6 Core types at Keratic Koppie including raw material selection.

Chopper cores are quite small in number but occur as unifacial and bifacial types. They are made of quartz and quartzite only and occur on cobble fragments, cobbles or split cobbles. Prepared cores are almost exclusively recurrent centripetal and made on crypto-crystalline rocks (Fig. 4.6). As the cores are exhausted and quite flat, blank types are unclear, but the undersides are largely cortical, so split cobbles or cortical flakes were probably used.

KUDU KOPPIE
THE ESA LEVELS

The ESA assemblage from Square 3S2E of Kudu Koppie is 10190 pieces in total (Table 4.7). Of this, 7528 pieces (74%) are less than 20mm. The remainder of the assemblage consists of 2662 pieces, and 90 (3.4%) of these are formal tools or utilized flakes. Data were collected where possible from 167 complete flakes. Of pieces equal to or greater than 20mm, cores form 4.88% (N=130).

ASSEMBLAGE COMPOSITION: KUDU KOPPIE: ESA LEVELS			
DEBITAGE:	**9883**	**CORES:**	**130**
Flaking debris < 10mm	3211	Irregular cores	13
Flaking debris ≥ 10mm & < 20mm	4317	Bipolar cores & core remains	10
Complete flakes	167	Blade cores	0
Incomplete flakes	461	Casual cores	4
Split flakes	59	Chopper cores	26
Core trimming flakes	10	Polyhedral cores	15
Kombewa flakes	3	Prepared cores	13
Flake fragments	647	Radial cores	26
Bipolar flakes	1	Single platform cores	11
Bipolar chunks and fragments	4	Core fragments	12
Chunks	1003		
OTHER:			
Hammerstones	11		
Manuports	70		
Natural stone pieces	6		
Heavy & light-duty tools	90		
TOTAL	**10190**		

Table 4.7. Composition of the ESA levels at Kudu Koppie.

This assemblage is quite diverse (Table 4.8). Heavy-duty tools include various heavy scraper types, denticulates, picks (Fig. 4.9), choppers, a core axe and a knife. Denticulated/notched scrapers (Fig. 4.10) make up the majority of light-duty tools. Miscellaneous and broken retouched pieces are also common, although a range of scrapers, denticulates, cutting tools and retouched flakes also occur. Light-duty tools are more numerous at 77% (N=69) of tools with heavy-duty tools at 23% (N=21).

FORMAL TOOLS (3.4% OF ASSEMBLAGE)			
LIGHT-DUTY TOOLS (77%):	**69**	**HEAVY-DUTY TOOLS (23%):**	**21**
Denticulated/notched scrapers	34	Heavy-duty scrapers & core scrapers	8
Scrapers	4	Denticulates	3
Scraper & burin	1	Denticulate + denticulated scraper	1
Denticulates	4	Scraper + possible broken pick	1
Retouched flakes	4	Pick	3
Cutting tools	3	Chopper	2
Miscellaneous retouched pieces	13	Core axe	1
Broken retouched pieces	6	Knife (naturally backed)	2

Table 4.8. Light and heavy-duty tools from the ESA levels of Kudu Koppie.

KUDU KOPPIE: ESA LEVELS			
CORE TYPE	**TOTAL**	**RAW MATERIAL**	**COMMENT**
Irregular	13	Crypto-crystalline 25.0% Quartz 8.3% Quartzite 50.0% Rhyolite 16.6%	-
Blade	0		-
Casual	4	Dolerite 25.0% Quartz 50.0% Quartzite 25.0%	-
Chopper	26	Banded Ironstone 6.2% Crypto-crystalline 6.2% Quartz 26.9% Quartzite 46.1% Rhyolite 7.6% Other 7.6%	5 Unifacial 16 Bifacial 4 Unknown
Polyhedral	15	Dolerite 6.6% Quartz 26.6% Quartzite 60.0% Other6.6%	-
Prepared	13	Banded Ironstone 7.6% Crypto-crystalline 7.6% Dolerite 21.4% Quartz 15.3% Quartzite 30.7% Rhyolite 7.6% Other 7.6%	7 Preferential 3 Recurrent centripetal 1 bidirectional 2 Unknown
Radial	26	Banded Ironstone 3.8% Crypto-crystalline 7.6% Quartz 23.0% Quartzite 53.8% Rhyolite 7.6% Other 3.8%	12 Unifacial 14 Bifacial
Single platform	11	Crypto-crystalline 9.1% Quartz 45.4% Quartzite 36.3% Other 9.1%	-

Table 4.9. Details of cores from the ESA levels of Kudu Koppie.

Chopper cores and radial cores both form 24% (N=26 for each) of this assemblage (Table 4.9 & Fig. 4.6). Chopper cores are also more numerous in this assemblage than any other, as are single platform cores at 10.1% (N=11). Chopper cores are mostly bifacial (61.5%) and show no tendency towards raw material selection. Radial cores are almost equally unifacial or bifacial and are made on equally diverse rock types.

Prepared cores are made on a wider range of rock types than any other core type, and the majority of prepared cores is produced for preferential flake removals (N=7, 64% of cores with an evident pattern). Casual cores form the smallest part of the assemblage (3.7%, N=4), and the only assemblage with a smaller casual core component is the KK-MSA assemblage. This core type is also made on the smallest number of rock types, i.e. dolerite, quartz and quartzite. This assemblage shows little or no selection of raw material types and relatively little diversity in blank form, with the majority of cores being made on cobbles/pebbles or chunks.

THE MSA LEVELS

This is the largest of the four assemblages (Table 4.10). Of 10686 pieces 8261 (77.3%) are less than 20mm. The remainder of the assemblage consists of 2425 pieces, and 45 (1.86%) of these are formal tools or utilized flakes. Data were collected where possible from 279 complete flakes. Of pieces equal to or greater than 20mm, cores form 3.5% (N=85).

Light-duty tools dominate this assemblage (Table 4.11 & Fig. 4.11). The majority of these is denticulated/notched scrapers, and denticulates. No new tool types are represented, with the exception of the tip of a retouched point. Heavy-duty tools include only two large scrapers, one of which has a pick-like end. Light-duty tools are more numerous at 95.67% (N=43) of tools with heavy-duty tools at 4.4% (N=2).

ASSEMBLAGE COMPOSITION: KUDU KOPPIE MSA LEVELS			
DEBITAGE:	**10526**	**CORES:**	**85**
Flaking debris < 10mm	3394	Irregular cores	7
Flaking debris ≥ 10mm & < 20mm	4867	Bipolar cores & core remains	4
Complete flakes	279	Blade cores	8
Incomplete flakes	459	Casual cores	1
Split flakes	73	Chopper cores	11
Core trimming flakes	13	Polyhedral cores	4
Kombewa flakes	1	Prepared cores	34
Flake fragments	1008	Radial cores	10
Bipolar flakes	9	Single platform cores	2
Bipolar chunks and fragments	5	Core fragments	4
hunks	418		
OTHER:			
Hammerstones	4		
Manuports	26		
Natural stone pieces	0		
Heavy & light-duty tools	45		
TOTAL	**10686**		

Table 4.10. Composition of the MSA levels at Kudu Koppie.

TOOLS (1.86% OF ASSEMBLAGE):			
LIGHT-DUTY TOOLS (95.6%):	**43**	**HEAVY-DUTY TOOLS (4.4%):**	**2**
Denticulated/notched scrapers	24	Heavy-duty scrapers & core scrapers	1
Denticulates	5	Core scraper with pick end	1
Retouched flakes	2		
Cutting tools	1		
Miscellaneous retouched pieces	7		
Broken retouched pieces	3		
Tip of denticulated point	1		

Table 4.11. Light and heavy-duty tools from the MSA levels of Kudu Koppie.

The most notable aspect of cores in this assemblage (Table 4.12) is the production of blade cores (10.3%, N=8), and the high number of prepared cores (45.4%, N=35). Blade cores are made on fine-grained rocks only, with 75% (N=6) on crypto-crystalline rocks, and 25% (N=2) on rhyolite. Prepared cores are almost equally preferential or recurrent centripetal, with two recurrent unidirectional cores. The use of quartz for prepared cores drops to 5.8% (N=2), although the use of quartzite increases slightly, and forms the most important raw material source for prepared cores (35.2%, N=12). There is however a strong increase in the use of crypto-crystalline and rhyolite for these core types.

KUDU KOPPIE: MSA LEVELS			
CORE TYPE	**TOTAL**	**RAW MATERIAL**	**COMMENT**
Irregular	7	Crypto-crystalline 14.2% Quartz 57.1% Quartzite 14.2% Rhyolite 14.2%	-
Blade	8	Crypto-crystalline 75.0% Rhyolite 25.0%	-
Casual	1	Crypto-crystalline 100%	-
Chopper	11	Banded Ironstone 27.2% Crypto-crystalline 18.1% Quartz 9.1% Quartzite 27.2% Rhyolite 9.1% Other 9.1	1 Unifacial 10 Bifacial
Polyhedral	4	Quartz 25.0% Quartzite 50.0% Rhyolite 25.0%	-
Prepared	34	Banded Ironstone 5.8% Crypto-crystalline 17.6% Dolerite 11.7% Quartz 5.8% Quartzite 35.2% Rhyolite 23.5%	14 Preferential 12 Recurrent centripetal 2 Unidirectional 6 Unclear
Radial	10	Crypto-crystalline 10.0% Dolerite 10.0% Quartz 20.0% Quartzite 40.0% Rhyolite 20.0%	2 Unifacial 8 Bifacial
Single platform	2	Quartz 50.0% Quartzite 50.0%	-

Table 4.12. Details of cores from the MSA levels of Kudu Koppie.

Casual cores are restricted to one crypto-crystalline core, and single platform cores are equally rare (N=2), made on quartz and quartzite rocks. Radial cores (11.6%, N=9) are relatively unimportant when compared to the other three assemblages (Ht= 25%, KRK=30.7%, KK-Sangoan=24.0%). Chopper cores and radial cores are both almost exclusively bifacial, and neither shows a tendency towards raw material selection. Blade and prepared cores therefore show a tendency to be made on fine-grained rocks for these more complex core types, while the remainder of core types shows very little selection.

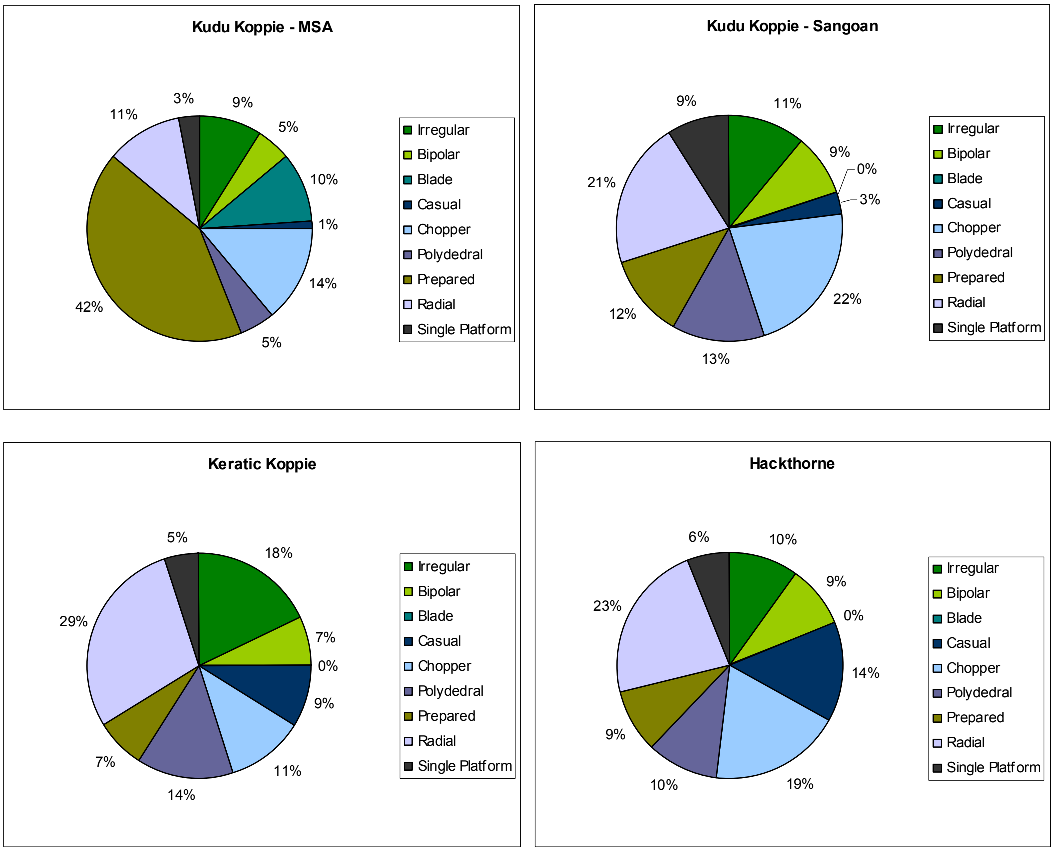


Fig.4.1 Comparison of core types, including bipolar cores, as produced in all four assemblages.

DISCUSSION

A comparison of core types among the three sites and four assemblages (Fig. 4.1) shows that the KK-MSA assemblage is the most different. This can be seen in the presence of blade cores (10%) and very high use of prepared cores (42%) in the assemblage. This comes at the expense of radial cores, casual cores and polyhedral cores in particular. With the exception of blade and prepared cores, all core types in the KK-MSA assemblage occur in smaller percentages than in any of the other three assemblages. The other three assemblages all show a more generalized pattern of core reduction, although with slight differences in the emphasis on certain core types used in each of these assemblages. This contrasts quite sharply with the strategy of core reduction used for the KK-MSA assemblage.

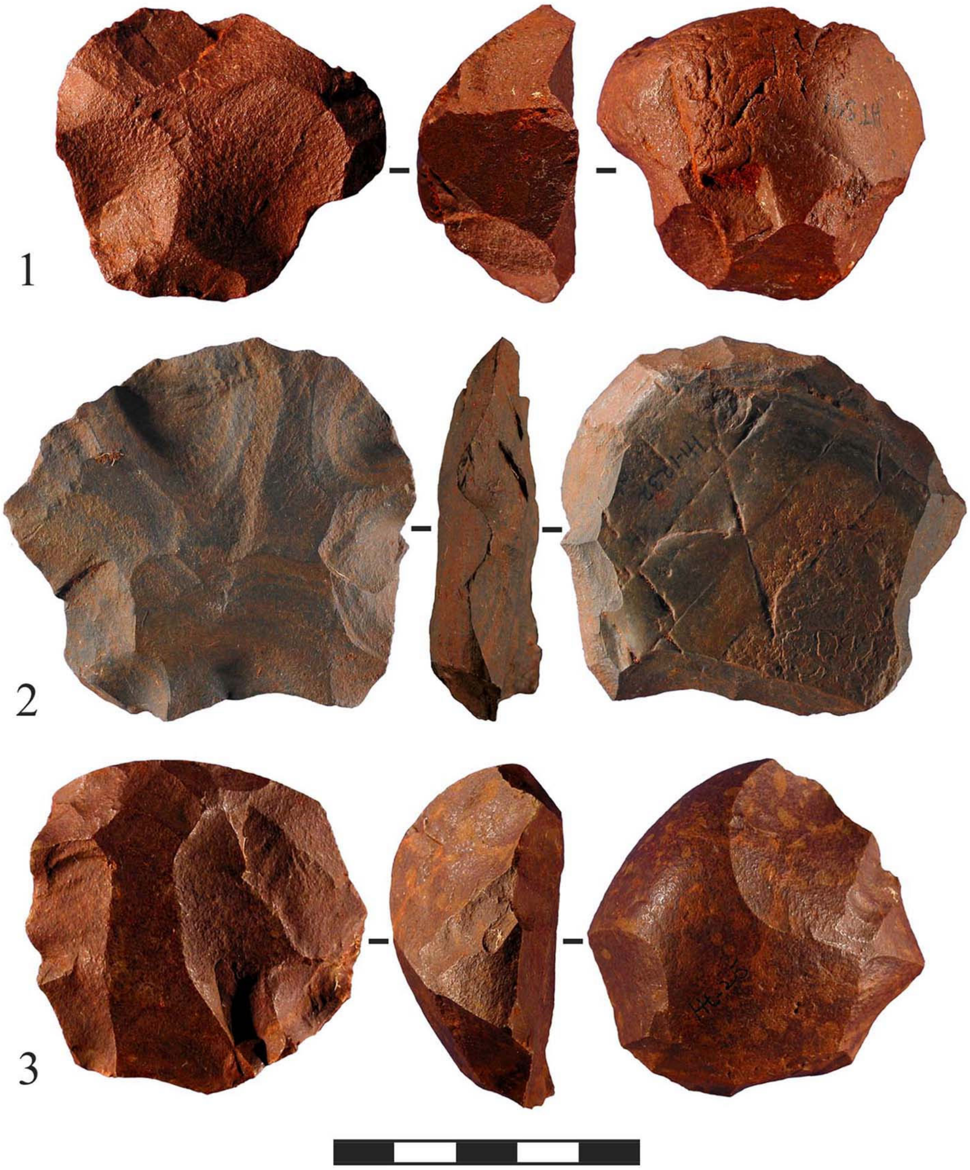


Fig. 4.2. Prepared cores from Hackthorne: 1) Recurrent centripetal core in quartzite, 2) Recurrent bidirectional core in banded ironstone, 3) Unidirectional prepared core in Rhyolite. From Kuman *et al*. 2005.

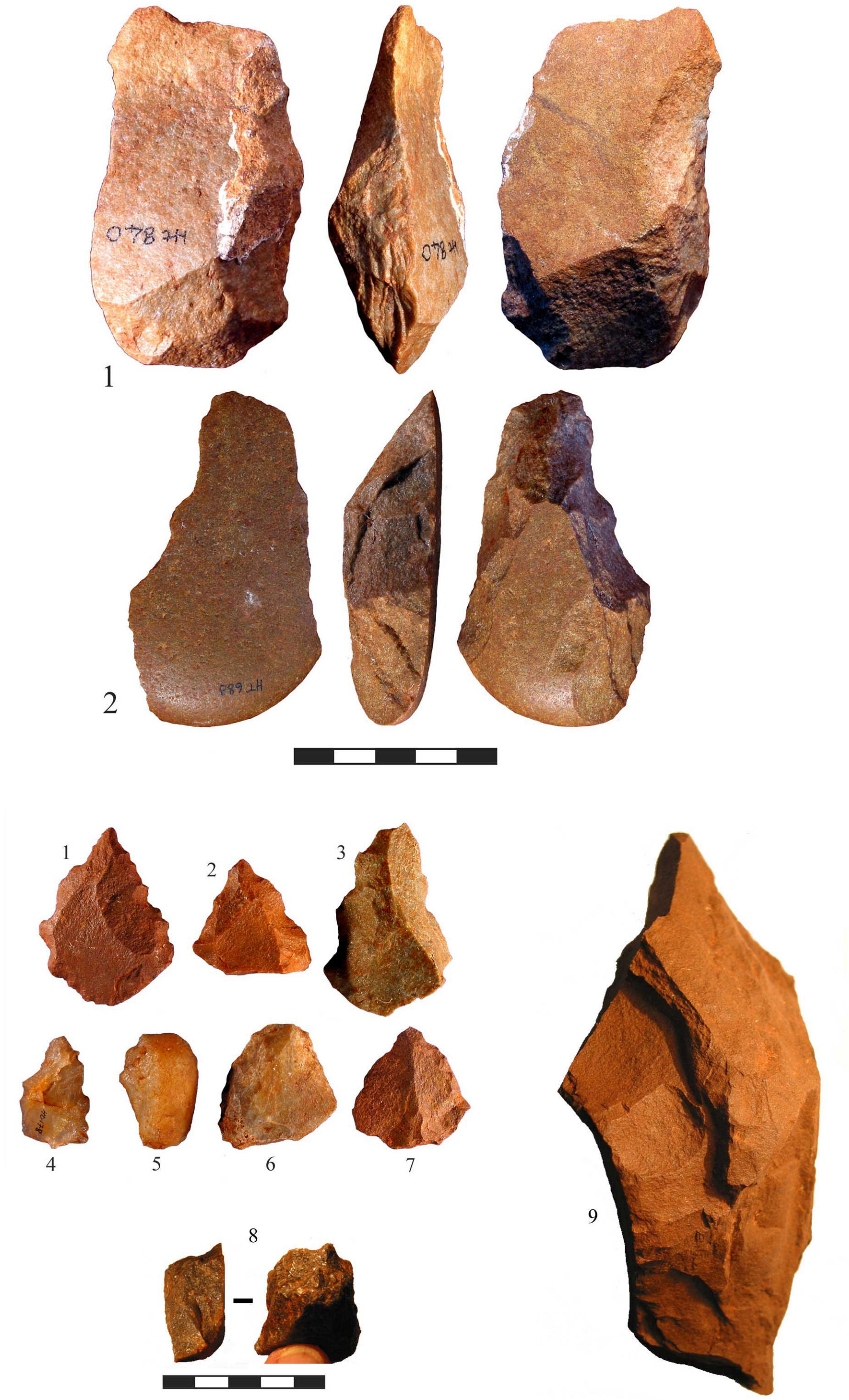


Fig. 4.3. Retouched tools from Hackthorne. Top: 1) Cleaver, 2) Uniface (see Fig. 4.7 number 1). Bottom: 1-8) light-duty denticulated/notched scrapers, 9) heavy-duty scraper made on a core, retouched at bottom left. From Kuman *et al.* 2005b.

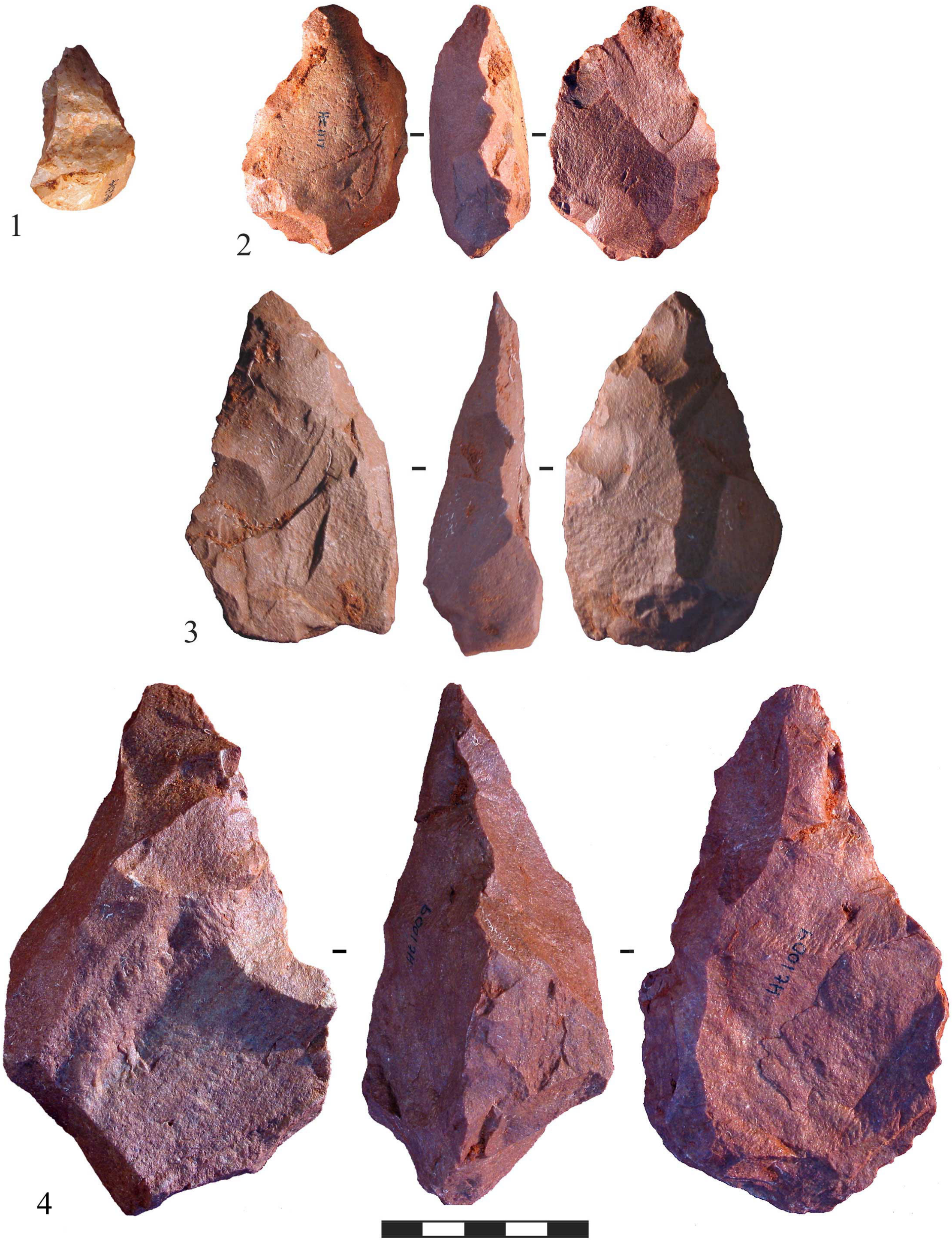


Fig. 4.4. Tools from Hackthorne. 1-2) Small bifaces or pygmy picks. 3) Handaxe (small and grading to a point in size) 4) Pick. From Kuman *et al.* 2005b.

Fig. 4.5 Large tools from Keratic Koppie. Left: a uniface. Right: a cleaver. From Kuman *et al.* 2005b.

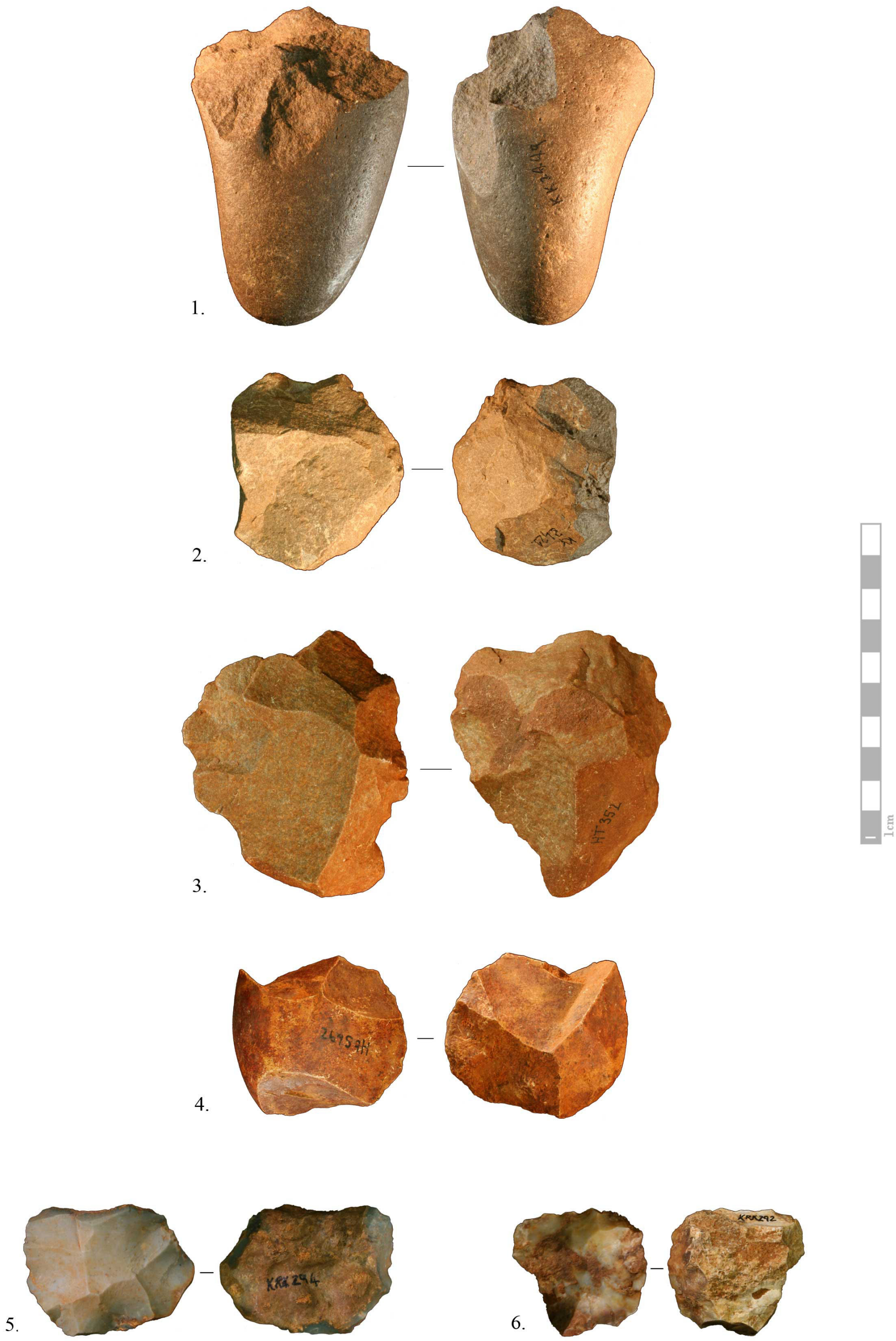


Fig. 4.6 1) Bifacial chopper core (quartzite) from the ESA levels of Kudu Koppie 2) Preferential prepared core (quartzite) form the ESA levels of Kudu Koppie 3) Bifacial radial core (quartzite) from Hackthorne 4) Bifacial radial core (rhyolite) from Hackthorne 5) Centripetal prepared core (crypto-crystalline) from Keratic Koppie 6) Centripetal prepared core (crypto-crystalline) from Keratic Koppie.

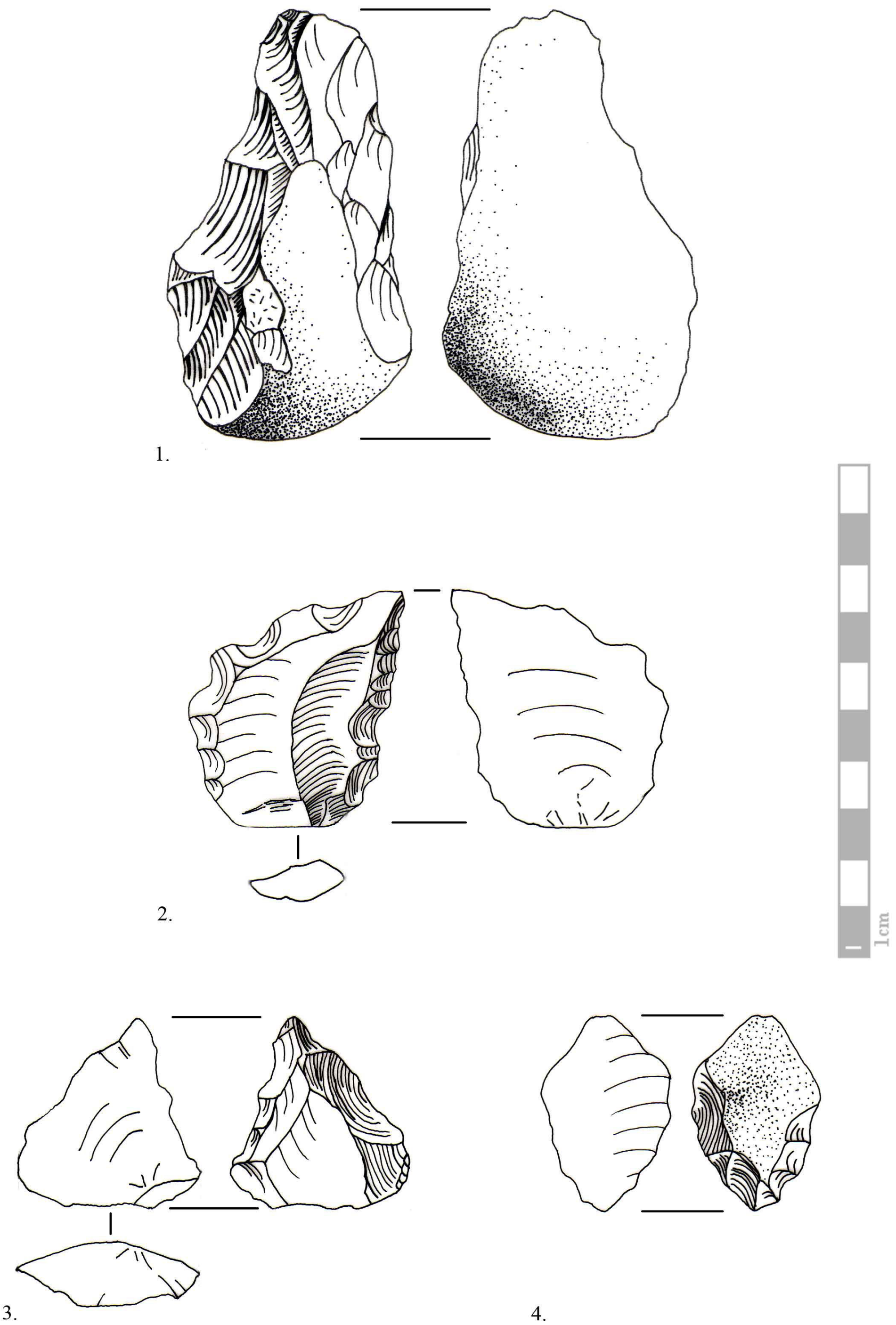


Fig. 4.7 Tools from Hackthorne. 1) Quartzite uniface (see photograph 2 in Fig. 4.4) 2) quartzite denticulate and denticulated/notched scraper 3) quartzite denticulate and denticulated/notched scraper 4) quartzite denticulate and denticulated/notched scraper on a flake fragment. Drawn by S. Dymond.

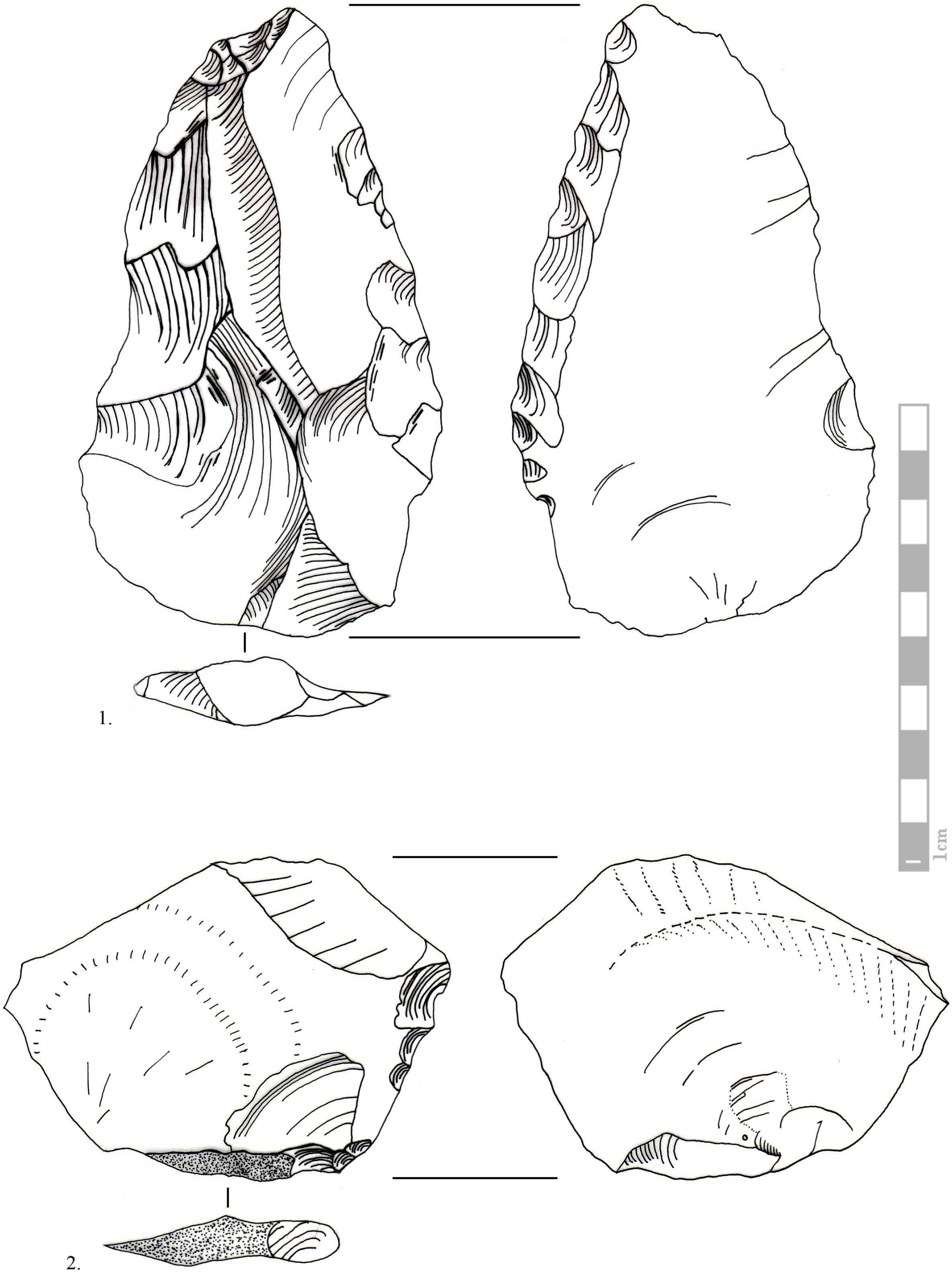


Fig. 4.8 Tools from Keratic Koppie. 1) Denticulate and 2) large denticulate on a Kombewa flake. Drawn by S. Dymond.

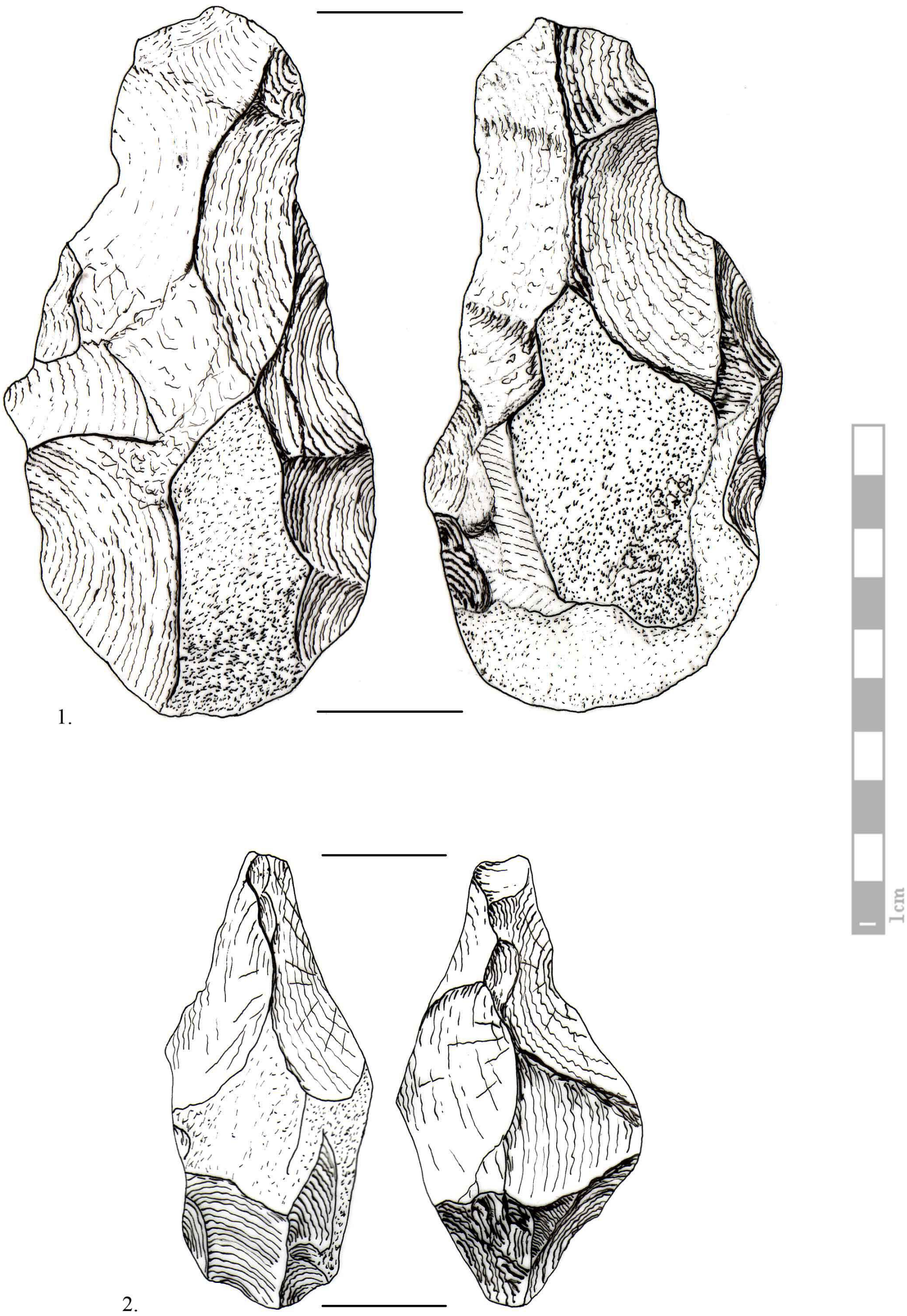


Fig. 4.9 Heavy-duty tools from Kudu Koppie ESA levels. 1) Square 3S3E, pick 2) square 3S2E, pygmy pick. Drawn by L. Pollarolo.

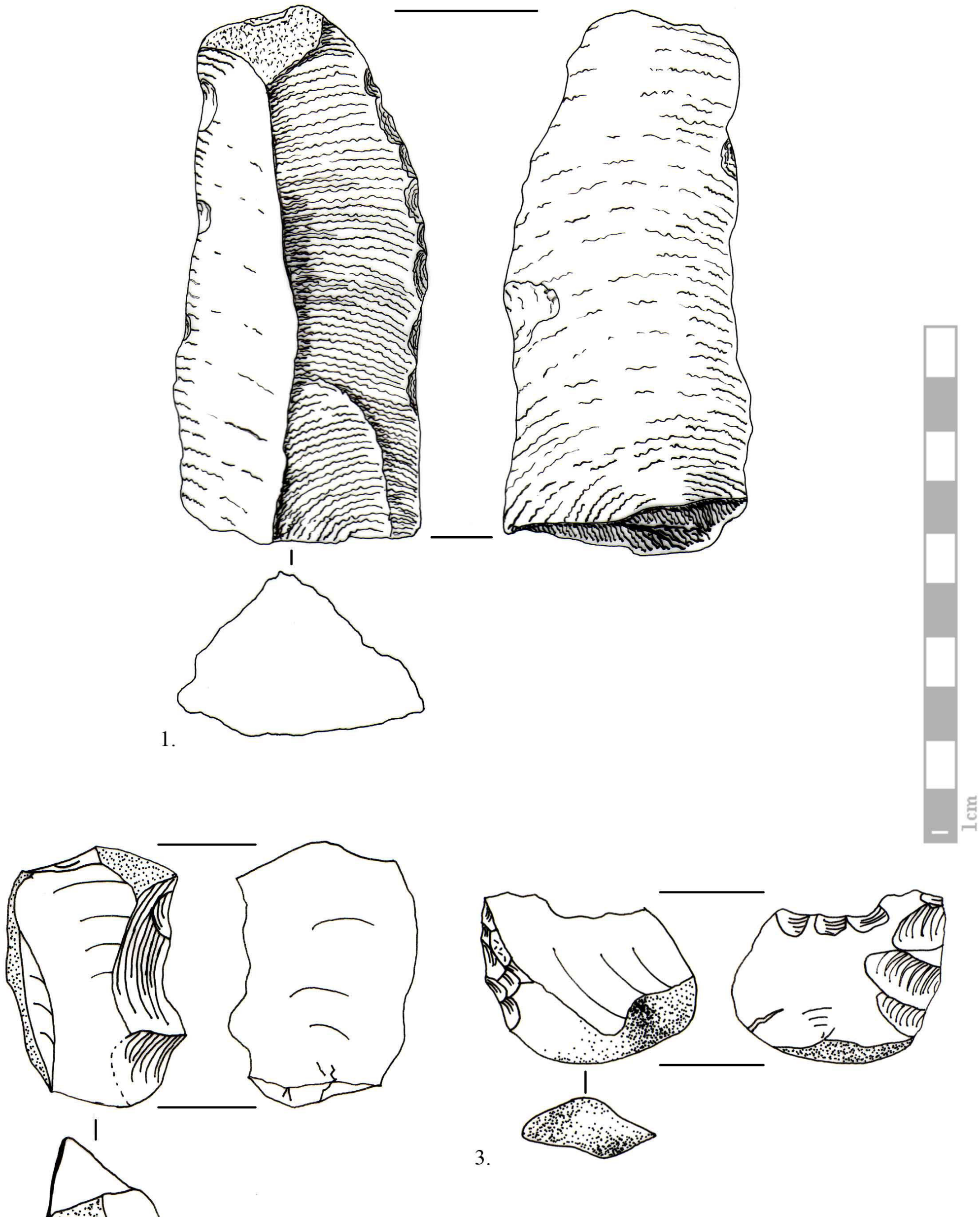


Fig. 4.10 Tools from the ESA levels of Kudu Koppie, square 3S2E. 1) Large denticulate 2) denticulated/notched scraper 3) denticulated/notched scraper. Number 1 drawn by L. Pollarolo, numbers 2 and 3 drawn by S. Dymond.

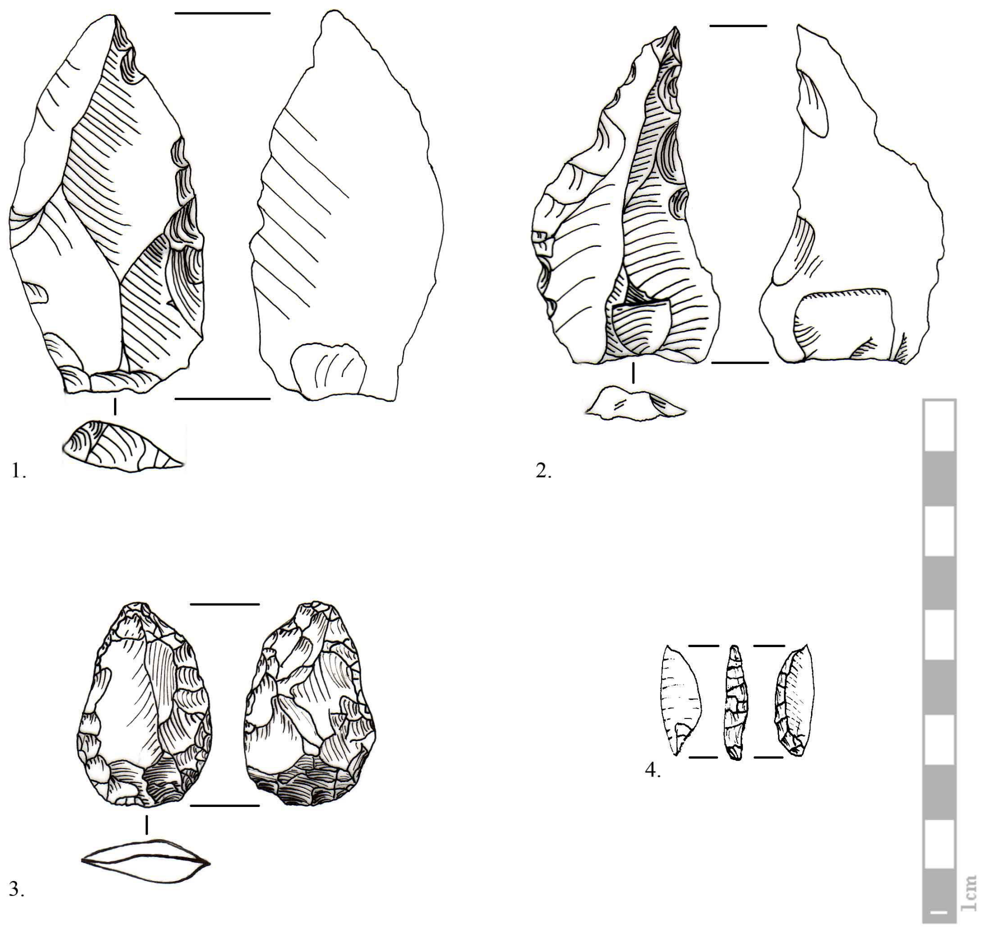


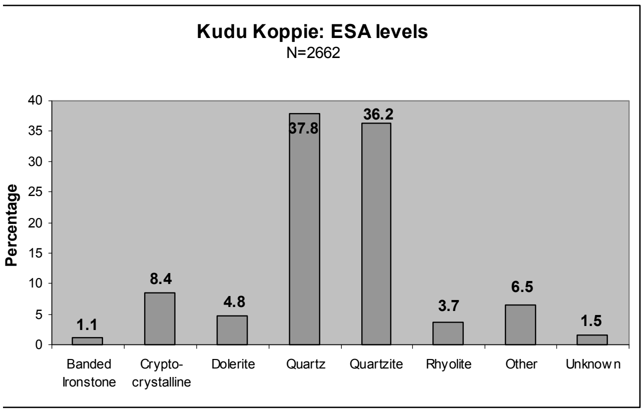
Fig. 4.11 Tools from the MSA levels of Kudu Koppie. 1) Denticulate – pointed form – from square 3S2E 2) Denticulate – pointed form – from square 3S2E 3) Bifacially retouched point from square 1S3E 4) LSA segment from the upper MSA levels of square 1S3E. Numbers 1 and 2 drawn by S. Dymond, numbers 3 and 4 drawn by L. Pollarolo.

TECHNOLOGICAL COMPARISONS

As Kudu Koppie is the one stratified site with distinct ESA and MSA assemblages, its technology will be discussed first for the sake of comparison with the single component sites.

KUDU KOPPIE: ESA ASSEMBLAGE

Although quartzite in the ESA (Fig. 4.12) accounts for the largest number of complete flakes (38.7%), quartz is almost equally important (31.4%). All other raw materials types are used in extremely small numbers. Apart from this, 13.9% of flakes are made of 'other' rock types, which here is a combination of sandstone and friable quartzite. Fine-grained rock types are therefore rare, with 13.9% of flakes made on poor quality rock types (sandstone and friable quartzite).



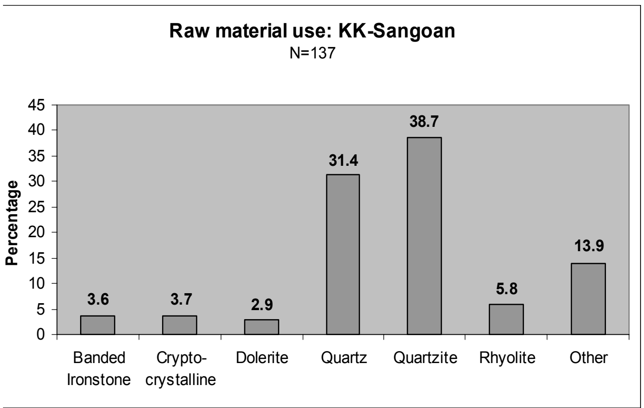
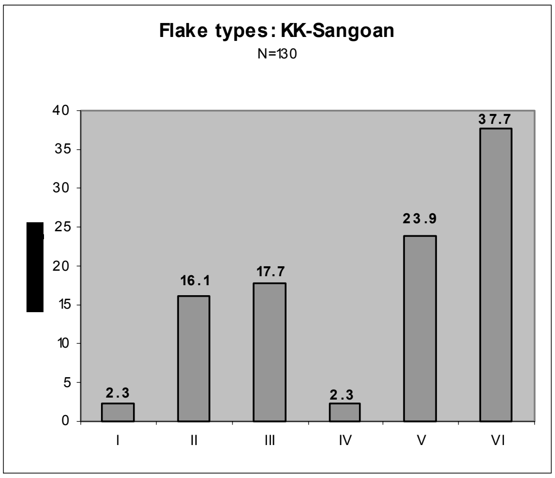
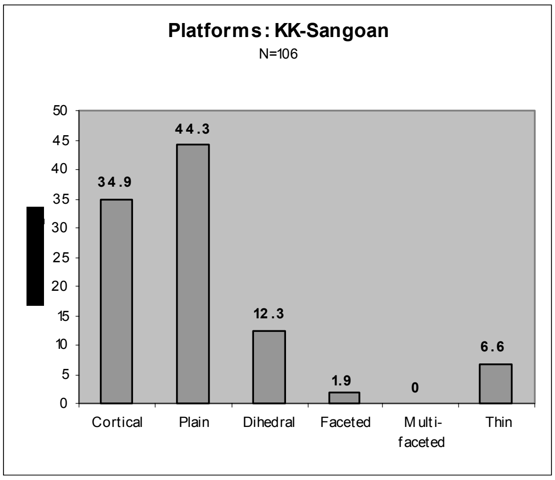
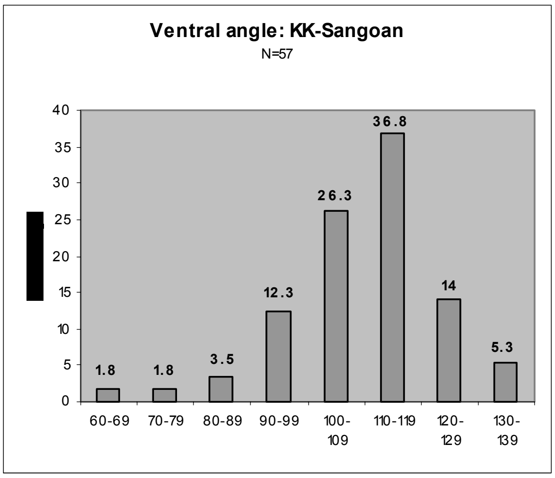


Fig. 4.12. Percentage of artefacts made using the various raw material types in the entire Kudu Koppie ESA assemblage (top), and percentage of complete flakes in each of the raw material types (bottom).







1. Percentage of flake types (for complete flakes) at Kudu Koppie, Sangoan levels.

2. Percentage of flakes with ventral angles in 10˚ increments at Kudu Koppie, Sangoan levels.

3. Percentage of platform types seen in the Kudu Koppie Sangoan assemblage.

Fig. 4.13 Raw Flake types, ventral angles and platform types in the Kudu Koppie ESA assemblage.

The proportion of type 1 and type 4 flakes (Fig. 4.13) is nearly identical in the KK-MSA and KK-ESA assemblages showing similar levels of core reduction as well as core reduction methods. Only a slightly higher number of type 5 flakes occur in the ESA. The difference between these two assemblages is rather seen in the smaller number of type 6 flakes (37.7%) and larger number of type 2 and type 3 flakes in the ESA, probably reflecting the scarcity of prepared cores in the ESA and their prominence in the MSA levels.

Flakes with cortical and plain platforms (Fig. 4.13) dominate with a combined percentage of 79.2%. The percentage of dihedral platforms (12.3%) is lower than in the KK-MSA assemblage, only 1.9% of flakes have faceted platforms, and no flakes with multifaceted platforms occur. Plain platforms therefore dominate (44.3%), with very few pieces showing two or more platforms. This is consistent with an assemblage with only a small prepared core component.

For the ventral angles (Fig. 4.13) of complete flakes, the number of pieces peak (36.8%) in the range of 110˚-119˚. There is however a wide spread in the range of ventral angles for complete flakes, with the majority falling between 90˚-99˚ through to 130˚-139˚. A total of 5.3% of flakes fall within the 130˚-139˚ range, which is significantly higher than in any other assemblage.

KUDU KOPPIE: MSA ASSEMBLAGE

Quartzite comprises the majority of flakes in the MSA assemblage (Fig. 4.14) and is important here. However, quartz is used in smaller numbers while fine-grained rock types such as banded ironstone, crypto-crystalline, rhyolite and dolerite are used more frequently. Crypto-crystalline flakes increase most significantly, from 3.7% in the Sangoan assemblage to 17.1% in this assemblage. This increase in fine-grained rocks comes at the expense of quartz, which declines from 31.4% in the KK-Sangoan assemblage to only 14.1%.

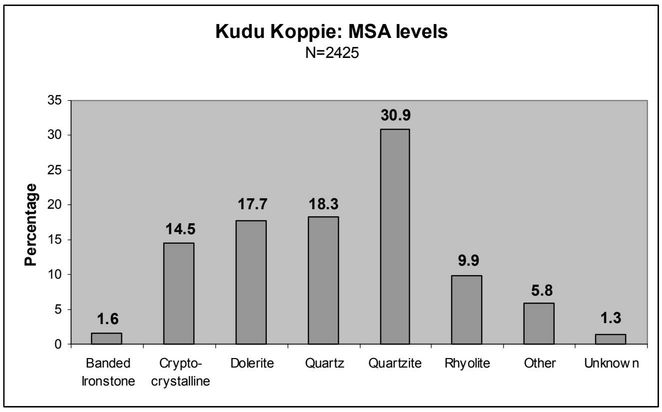
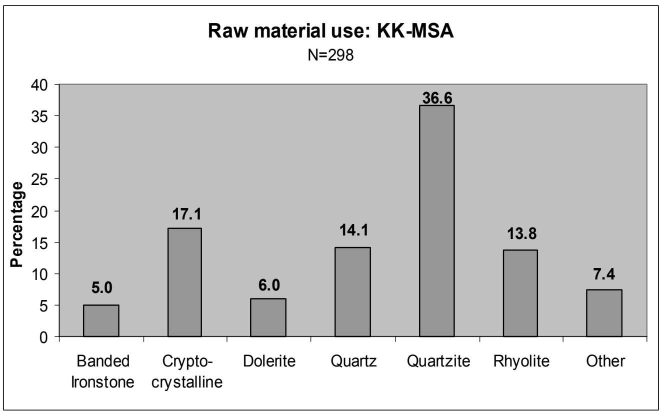
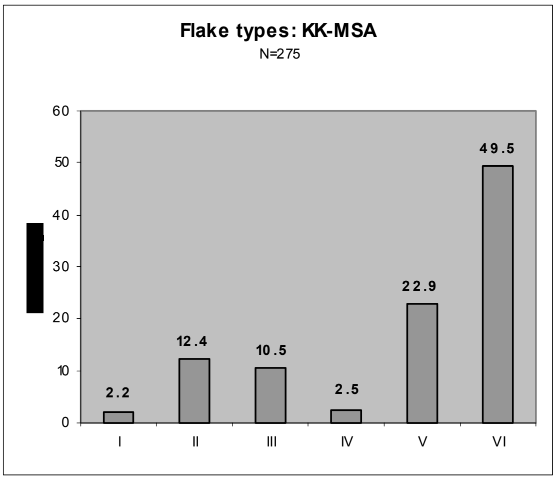


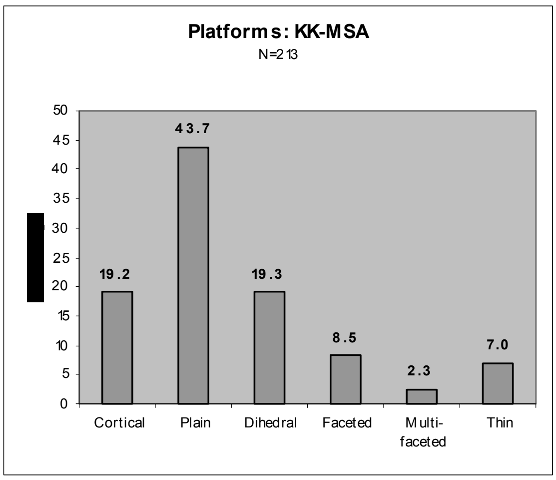
Fig. 4.14. Percentage of artefacts made using the various raw material types in the entire Kudu Koppie MSA assemblage (top), and percentage of complete flakes in each of the raw material types (bottom).

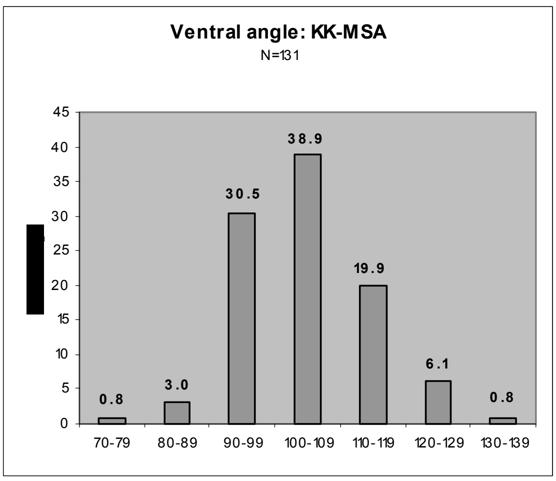


Nearly half (49.5%) of the MSA assemblage is comprised of type 6 flakes (no cortex on flake), with very low percentages of type 1 and type four flakes (Fig. 4.15). Type 2 and type 3 flakes form a smaller proportion than in the other three assemblages, while type 5 flakes occur in only slightly lower numbers than elsewhere.

Flakes with cortical platforms (Fig. 4.15) are relatively scarce at 19.2% when compared with the other assemblages, which range between 34.9% and 44.4%. Although the number of flakes with faceted and multi-faceted platforms is small, there is a definite increase in these platform types, as well as an increase in flakes with dihedral platform. Flakes with plain platforms occur within the range of the other assemblages. The trend is therefore more one of moving away from cortical platforms, which creates a slight increase in dihedral, faceted and multifaceted platforms. It is probably that the change in platform types represents the dominance of prepared core flaking at the site, though it may also reflect less primary flaking occurring at the site.







1. Percentage of flake types (for complete flakes) at Kudu Koppie, MSA levels.

2. Percentage of flakes with ventral angles in 10˚ increments at Kudu Koppie, Sangoan levels.

3. Percentage of platform types seen in the Kudu Koppie MSA assemblage.

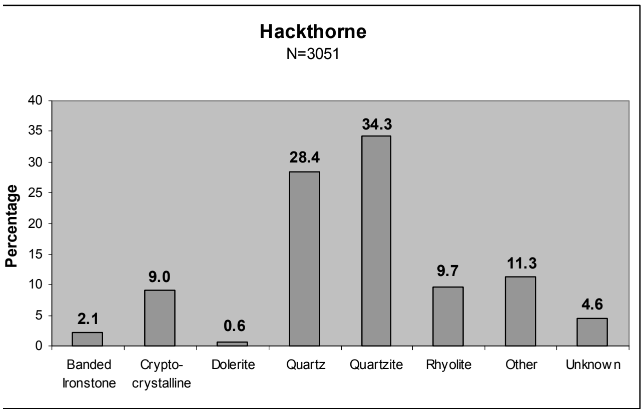
Fig. 4.15 Flake types, ventral angles and platform types in the Kudu Koppie MSA assemblage.

For the ventral angles of complete flakes (Fig. 4.15), the number of pieces peak (38.9%) in the range of 100˚-109˚, with an almost equivalent number (30.5%) in the range of 90˚-99˚. Only 6.1% of pieces occur in the range of 110˚-119˚, with only 10.7% collectively falling outside of these three ranges. This significant pattern here is that there are more angles in the 90 to 109 range, which relates to core preparation.

HACKTHORNE ASSEMBLAGE

The proportion of quartz (25.4%) to quartzite (37.1%) flakes (Fig. 4.16) is most similar to that of the KK-Sangoan assemblage. With the exception of dolerite, which does not occur close to the site, fine-grained rock types are quite well represented. Apart from this, 8.6% of flakes are made of 'other' rock types, which here is a combination of sandstone, friable quartzite and gneiss.

The assemblage shows a variable use of materials, with fine-grained raw materials and coarse, poor quality materials being used in addition to the quartz and quartzite. The gneiss in particular is a very unsuitable material for flaking but was used in very small quantities.



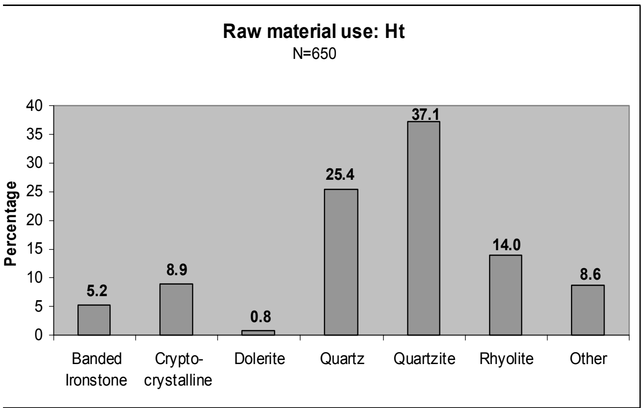
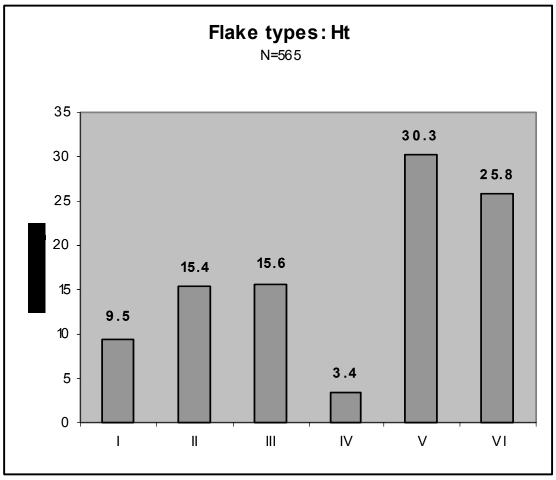
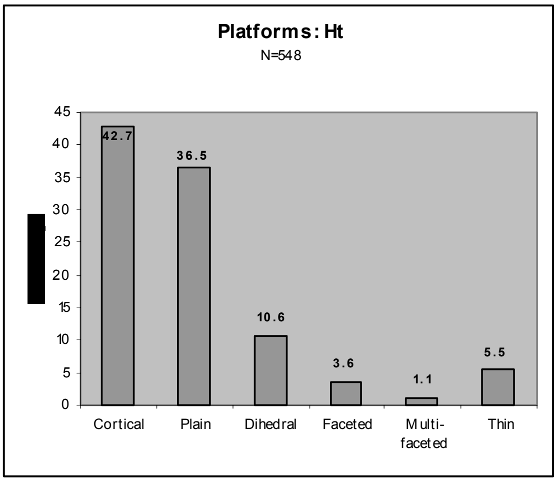


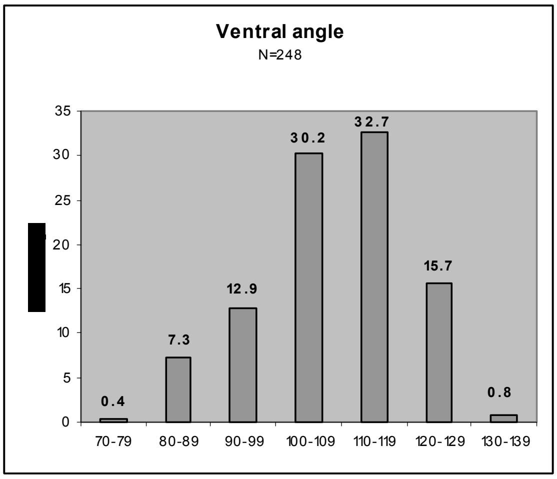
Fig. 4.16. Percentage of artefacts made using the various raw material types in the entire Hackthorne assemblage (top), and percentage of complete flakes in each of the raw material types (bottom).

At Hackthorne (Fig. 4.17), the proportion of type 1 and type 4 flakes is higher than in any of the other assemblages. In all the assemblages type 6 flakes outnumber all other flake types, but here, type 5 flakes (30.3%) outnumber type six (25.8%). The proportion of type 2 and type 3 flakes is most similar to the KRK and KK-Sangoan assemblages. This suggests that the initial stages or core reduction are well represented at the site, while the relative scarcity of type six flakes may reflect that cores were less intensively worked, and that fewer prepared cores were worked at the site.

Flakes with cortical and plain platforms dominate (Fig. 4.17) with a combined percentage of 79.2%, as is the case for the KK-Sangoan collection. Flakes with dihedral platforms (10.6%) form a smaller part of the assemblage than any of the other three collections. Faceted and multifaceted platforms account for very few of the complete flakes, but with a combined percentage of 4.7%, this is higher than at KRK and KK-ESA. Cortical and plain platforms therefore dominate but platform faceting was not uncommon when compared with other assemblages.







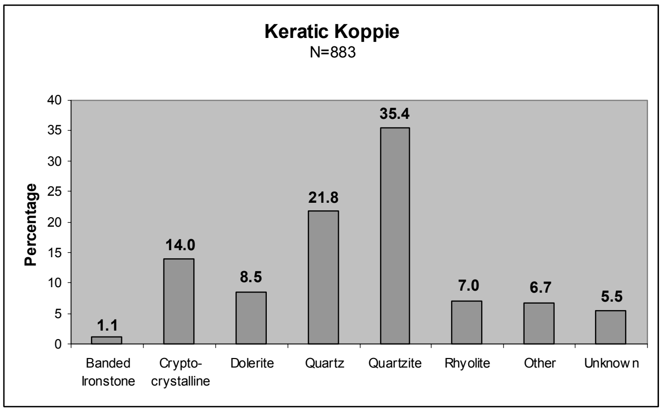
1. Percentage of flake types (for complete flakes) at Hackthorne.
2. Percentage of flakes with ventral angles in 10° increments at Hackthorne
3. Percentage of platform types seen in the Hackthorne assemblage.

Fig. 4.17 Flake types, ventral angles and platform types in the Hackthorne assemblage.

For the ventral angles of complete flakes (Fig. 4.17), the number of pieces peak (32.7%) in the range of 110˚-119˚. Despite this, ventral angles of 80˚-89˚ through to 120˚-129˚ are quite well represented. In this regard the collection most resembles that of the KK-ESA collection.

KERATIC KOPPIE ASSEMBLAGE

For complete flakes, quartzite (40.2%) forms a larger part of this collection (Fig. 4.18) than any other type, while quartz (17.4%) is less important and is only the third most commonly used rock type. Crypto-crystalline rock (18.2%) is instead the second most important rock type, while rhyolite (12.9%) in particular is also important. Other rock types such as banded ironstone (1.5%) and dolerite (3.0%) are used in small amounts. In addition, 6.8% of flakes are made of 'other' rock types, which here is a combination of sandstone, friable quartzite and gneiss. Flaking at the site shows less emphasis on the use of quartz and more emphasis on the exploitation of finer grained rocks. However, the rock types listed under 'other' are all poor quality types.



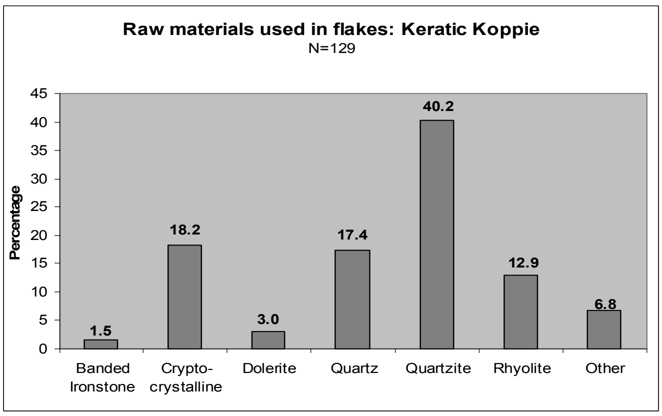
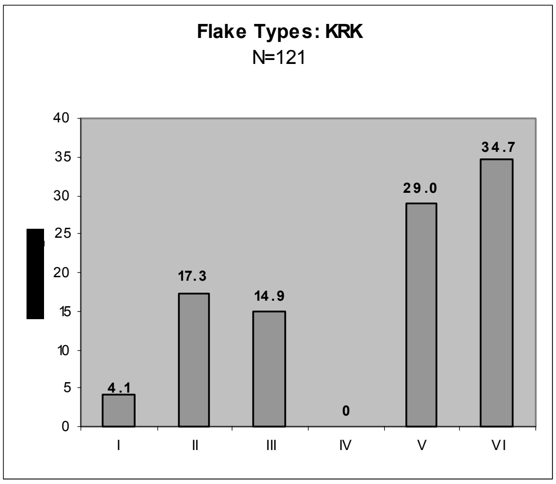
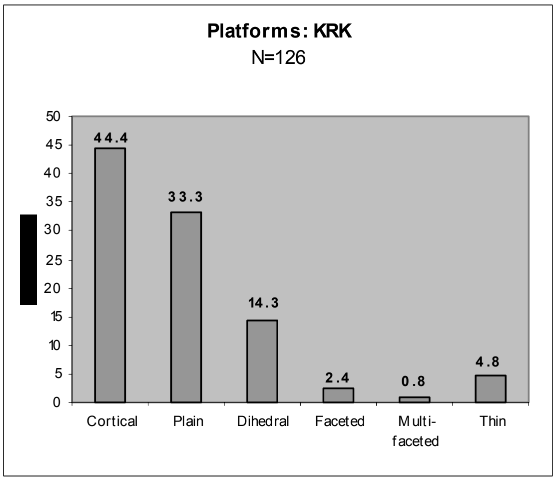
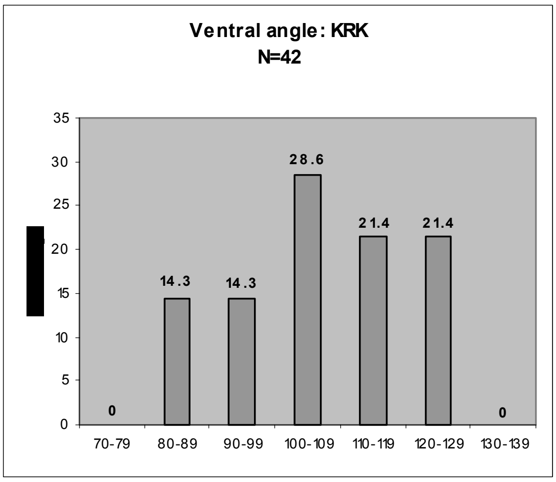


Fig. 4.18. Percentage of artefacts made using the various raw material types in the entire Keratic Koppie assemblage (top), and percentage of complete flakes in each of the raw material types (bottom).

No type 4 flakes are found in this assemblage (Fig. 4.19), although the percentage at other sites only varies from 2.3% to 3.4%. At 4.1%, the proportion of type 1 flakes is similar to Hackthorne but less than that of the two Kudu Koppie assemblages. Type 2 and type 3 flakes occur in similar numbers to all assemblages except in the KK-MSA assemblage. Type 5 and type 6 flakes together (63.7%) fall short of the percentage seen in the KK-MSA (72.4%) assemblage, but they are slightly higher than what is seen in the Ht (56.1%) and KK-ESA (61.6%) assemblages. While this suggests that more than primary flaking was occurring at the site and that prepared core flaking probably occurred here, no strong trends appear.







1. Percentage of flake types (for complete flakes) at Keratic Koppie.
2. Percentage of flakes with ventral angles in 10˚ increments at Keratic Koppie.
3. Percentage of platform types seen in the Keratic Koppie assemblage.

Fig. 4.19 Flake types, ventral angles and platform types in the Keratic Koppie assemblage.

The percentage of cortical flakes (Fig. 4.19) (44.4%) is higher than at all other sites, while the percentage of plain platforms (33.3%) is the lowest. The percentage of flakes with dihedral platforms (14.3%) is less that in the KK-MSA assemblage, but higher than that of the Ht and KK-Sangoan assemblages. Flakes with faceted and multifaceted platforms occur but in very small numbers, with a combined percentage of 3.2%. Therefore while almost 77% of flakes have cortical or plain platforms, the remainder of flakes has more than one facet. This indicates a dominance of primary flaking but also some presence of radial and prepared cores, as is indicated by the core types in this small assemblage.

For the ventral angles of complete flakes (Fig. 4.19), the number of pieces peak in the range of 100˚-109˚ (28.6%). The remainder of the pieces has ventral angles that are more generally spread across the range of 80˚-89˚ to 120˚-129˚. No flakes fall outside of this range, and no 10˚ interval in this range comprises less than 14.3%.

DISCUSSION: THE INFLUENCE OF RAW MATERIALS

All artefacts were assigned to a raw material type, and the percentage of complete flakes from each type is recorded in Fig. 4.20 below. Some attributes of complete flakes of varying raw material types are also set out below to establish the chosen methods of reduction and flaking properties of raw material types (Tables 4.13 to 4.15). Quartzite is the most abundant rock type available in the landscape and the most commonly used raw material in each of the four assemblages, ranging from 37% to 41% of all complete flakes. Other rock types were used in varying degrees. Dolerite, banded ironstone and to some extent crypto-crystallines and rhyolite occur in relatively small quantities and the flaking qualities of these rocks are suggested as best as possible based on my experience with experimental flaking of the same materials. Also, as banded ironstone consists of layers of ironstone and chert, the flaking properties vary according to the differing properties of the two rock types.

Figure 4.21 shows a comparison of the proportion of core types occurring in the various raw material types, while Table 4.16 provides more detail.

THE FOUR ASSEMBLAGES

When comparing the use of raw material types for flake production, Hackthorne (Ht) is most similar to the ESA levels of Kudu Koppie (KK-1), where quartzite and quartz respectively account for the majority of complete flakes, and where other rock types occur in similar proportions. Hackthorne sits atop the Miocene terrace and material was most likely available from exposure in gullies, as it is today, while Miocene terrace gravels were also available within a short distance of Kudu Koppie Keratic Koppie was slightly more distant from gravel exposures (maximum 1.5km).

Extremely little dolerite was used at Hackthorne, and this is probably because the site was more distant from a major source, while Kudu Koppie is very close to dolerite outcrops. While the best exposure of cobbles is currently in gullies near the Hackthorne site, the Kudu Koppie and Keratic Koppie sites are also located within a short distance of cobbles (maximum 1.5km), with Kudu Koppie probably having been situated a little closer to this resource. The Keratic Koppie assemblage is quite similar to the MSA levels at Kudu Koppie (KK-2), showing a decreased use of quartz, and an increase in the use of fine-grained rocks such as crypto-crystalline and rhyolite.

The pattern at Kudu Koppie therefore shows a pattern of decreased quartz usage over time, with the MSA showing a reduction in the use of quartz in particular, and some increase in the use of finer grained rocks such as rhyolite and crypto-crystalline. It is possible then that this pattern reflects changes in raw material use across the research area from ESA to MSA. Banded ironstone is used in small quantities across all four assemblages, but it was probably not used more extensively as it is a very tough material and hard to flake. With more or less equal accessibility across sites to the various raw materials, except for dolerite at Hackthorne, this pattern seems to reflect choice over availability and a pattern of increasing use of quartzite relative to quartz from ESA to MSA.

Dolerite is currently located within about 100m of the Kudu Koppie site and was not used as extensively as might be expected, considering its good consistency, when compared with most of the other available rocks. It is fine-grained and seems to have flaked well. However, dolerite decays rapidly and degrades to a clay-like texture. No data other than dimensions was therefore recorded for these pieces.

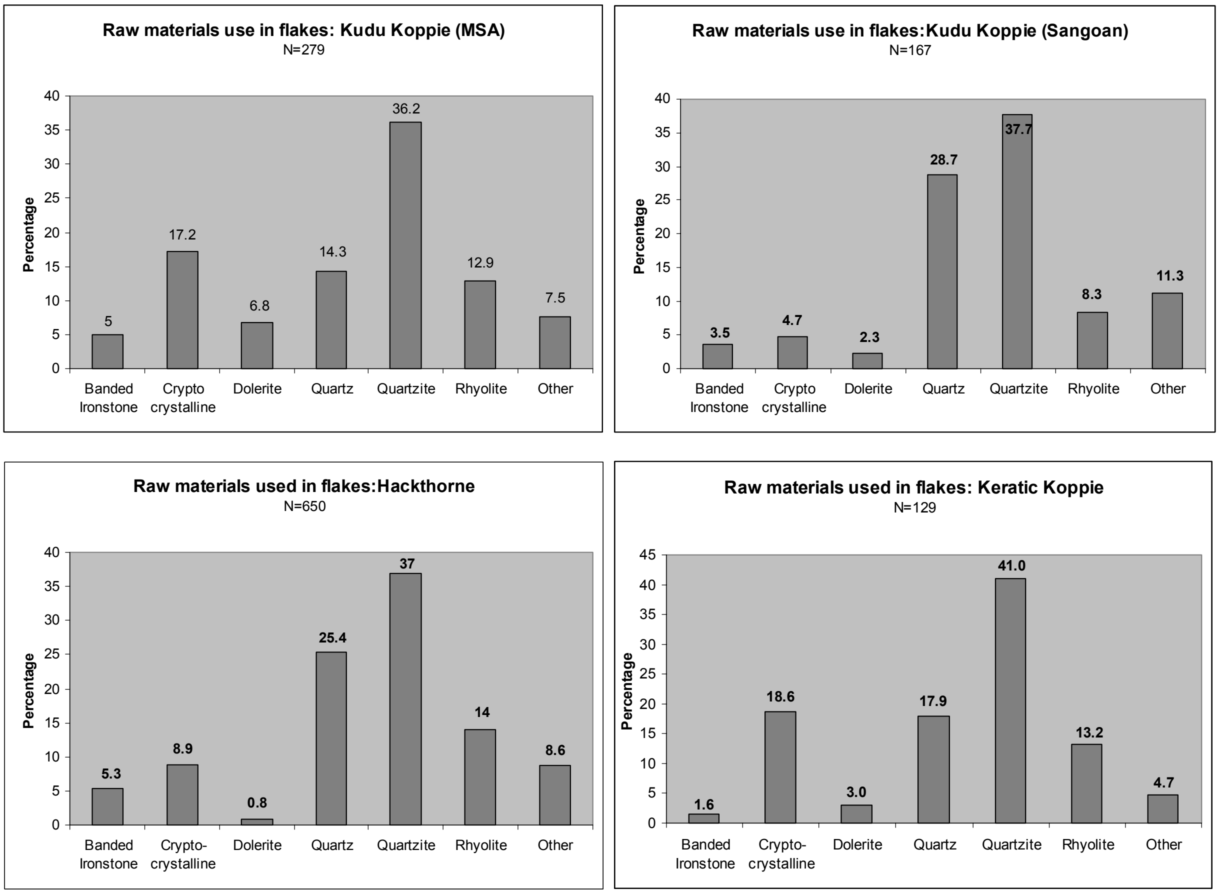


Fig. 4.20 Percentage of flakes made with various raw materials for all four assemblages.

CHARACTERISTICS OF RAW MATERIAL TYPES

As quartz and quartzite are the most abundant rock types available, it is not surprising that they constitute the majority of flakes and cores. Other rock types are used in smaller quantities probably due largely to their relative scarcity, and in the case of dolerite, due to its more limited distribution in outcrops near Kudu Koppie. The choice of reduction method is in part determined by raw material selection, which is also influenced by the shape of the core blank. For instance, crypto-crystalline rocks usually occur as smaller nodules, often of very irregular shape. It is not unusual then that many irregular cores occur in this material. Simpler core types, such as casual cores, irregular cores and chopper cores do not tend to show selection of rock types. Instead it is in the more complex core types, and specifically within the younger assemblages, that increased selection of rock types is seen. Figure 4.21 and Tables 4.13-4.16 provide details for the following discussion.

BANDED IRONSTONE

This rock type forms a very small part of the assemblages and cannot provide a dependable view of flaking properties. However, the data suggests that flakes will have an average maximum length of 32.1mm to 54.95mm. Flakes are generally corner or side struck rather than end struck, and 18.2% of flakes resulted in hinged or step terminations.

The banded nature of the rock also means that these cores are seldom homogenous, often leading to flaking difficulties as the force traveled through the ironstone and chert layers. The result is that some cores were well flaked and used in radial and prepared cores, while other nodules were difficult to work and produced step flakes making further flaking of the cores difficult, and a number of prepared cores appear to have been abandoned for this reason.

CRYPTO-CRYSTALLINES

In most assemblages this rock type has the shortest average maximum length. Flakes tend to be end struck, and in comparison to other rock types used, they have a greater tendency to produce hinged or overshot flakes. In the KK-MSA assemblage, 75% (N=6) of blade cores are made of this material, and it is often used in the more refined prepared cores of the KRK and KK-MSA assemblages. The often irregular shape of these nodules seems to result in a relatively large number of irregular, casual, polyhedral and chopper cores, with more regularly shaped pieces being used for the more complex core types such as prepared cores.

QUARTZ

The Limpopo basin quartz produces whole flakes that have a relatively small average maximum length of between 31.22mm to 34.53mm across the four assemblages. The average lengths and widths of pieces show a tendency for quartz flakes to be only slightly longer than they are wide, except in the KK-MSA assemblage, where flakes tend to retain an average technical length of about 30mm, but average width drops down to 23.6mm. This is consistent with the relatively high percentage (48.7%) of end struck flakes in this assemblage. Quartz quite readily produces hinge (2.3%-22.2%) and step terminations (2.3-17.2%), especially in the Hackthorne and Keratic Koppie assemblages (Fig. 4.15). Surprisingly, the two Kudu Koppie assemblages average approximately 90% of flakes with feathered terminations. Quartz was used for all core types with the exception of blade cores. The percentage of quartz cores is lowest in the KK-MSA and KRK assemblages. Although the core types produced in quartz do not change, there is a significant decrease in its use between the ESA and MSA, especially for more complex core types.

QUARTZITE

The average dimensions of quartzite flakes show that, along with rhyolite, it was generally used to produce the larger flakes in the assemblages. The proportions of corner, end and side struck flakes across assemblages suggest a degree of variability in methods of reduction. Quartzite has some tendency to form hinge and step terminations, with a relatively small number of overshot terminations (0% - 5.3%) (Fig. 4.15).

As this is the most commonly used material in all four assemblages, with a wide range of materials available in the Limpopo gravels, it seems to have been a useful and versatile resource. Quartzite was used for all core types (except blade cores) but in the KK-MSA assemblage quartz and quartzite together account for only 41% of prepared cores, while the remaining majority was produced on finer grained rocks such as banded ironstone, crypto-crystallines, dolerite and rhyolite.

RHYOLITE

This is a fine-grained homogenous rock that flakes in a relatively predictable manner though it tends to form hinge terminations (Fig. 4.15). Rhyolite tends to produce large flakes that are mostly end-struck, especially in the Hackthorne and the Kudu Koppie ESA assemblages, and these flakes are generally significantly longer than they are wide. Rhyolite was one of only two raw material types selected for blade production in the Kudu Koppie MSA assemblage, and it was also used relatively extensively in prepared and radial cores.

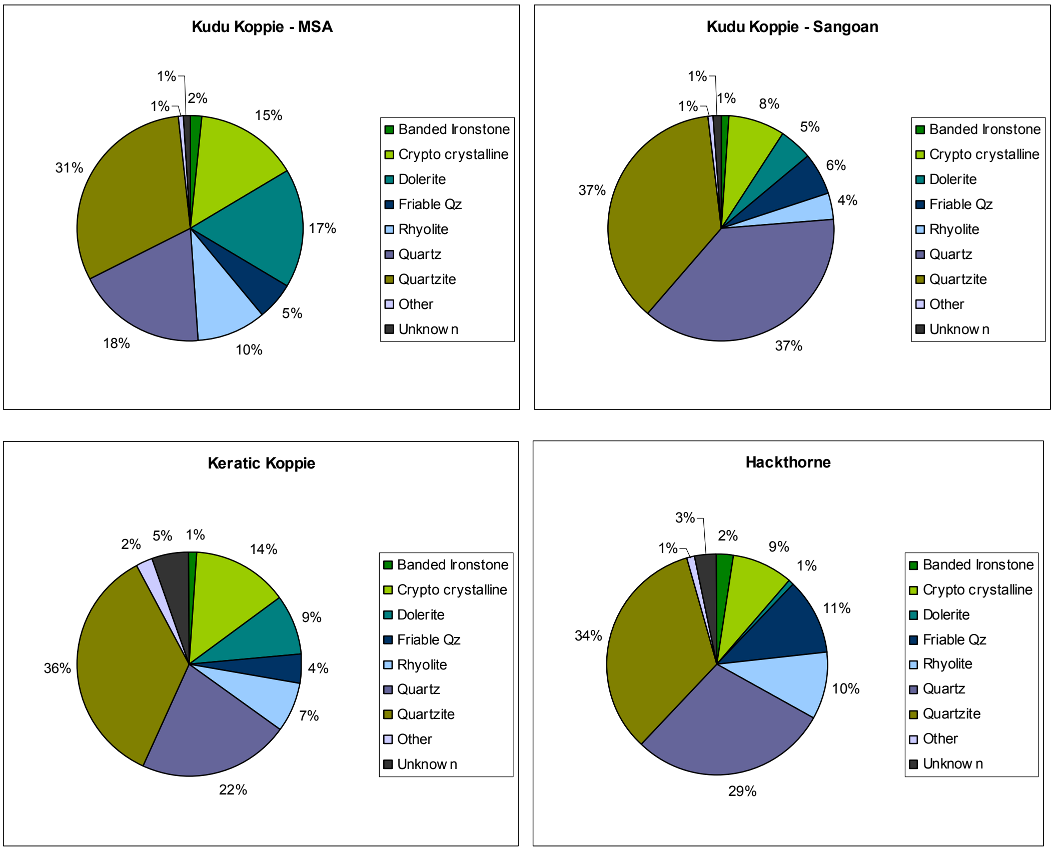


Fig.4.21 Comparison of raw material types used in core reduction in all four assemblages.

DISCUSSION

Both the raw material itself and the form or shape in which it occurs influence the flaking process. Most cores were made on rolled cobble and pebbles, and these offered few if any suitable angles to begin core reduction. Cobbles were therefore often broken or split to initiate the flaking process. The most desirable rock types are relatively fine-grained and homogenous, allowing the energy of the blow to pass more predictably through the core. Therefore for more complex core reduction, raw material selection provided an element of control and predictability.

	HACKTHORNE			**KERATIC KOPPIE**			**KUDU KOPPIE – MSA**			**KUDU KOPPIE - SANGOAN**		
	Average Max	Average Length	Average Width	Average Max	Ave Length	Average Width	Average Max	Average Length	Average Width	Average Max	Average Length	Average Width
Banded Ironstone	32.10	28.09	26.57	54.95	40.00	42.00	33.07	29.00	27.07	45.50	44.16	34.50
Crypto-crystalline	31.40	29.20	30.48	40.50	32.56	26.39.	29.91	27.27	21.78	33.00	28.3	24.85
Quartz	34.53	30.48	27.26	33.74	30.22	28.00	31.22	30.10	23.60	32.71	29.45	27.54
Quartzite	42.07	36.13	34.63	42.71	35.07	31.56	37.04	34.29	28.67	40.57	36.38	31.81
Rhyolite	39.48	36.87	29.53	43.98	43.18	31.64	39.46	36.62	29.62	48.78	43.69	38.69

Table 4.13. Average dimensions in mm of complete flakes, by raw material type. Shaded areas are figures based on extremely small flakes or samples? (<15).

	HACKTHORNE			**KERATIC KOPPIE**			**KUDU KOPPIE – MSA**			**KUDU KOPPIE - SANGOAN**		
	Corner struck	End struck	Side struck	Corner struck	End struck	Side struck	Corner struck	End struck	Side struck	Corner struck	End struck	Side struck
Banded Ironstone	47.0%	29.4%	23.6%	0%	50.0%	50.0%	21.4%	35.7%	42.8%	33.3%	50.0%	16.6%
Crypto-crystalline	21.6%	66.7%	11.7%	43.4%	47.8%	8.6%	46.8%	46.8%	6.3%	57.1%	14.2%	28.5%
Quartz	41.5%	37.4%	21.1%	21.7%	39.1%	34.7%	38.4%	48.7%	12.8%	45.4%	27.2%	27.2%
Quartzite	55.8%	20.7%	23.5%	32.0%	44.0%	22.6%	38.5%	47.9%	13.5%	29.3%	50.0%	24.1%
Rhyolite	38.6%	50.0%	11.4%	41.1%	41.1%	17.6%	33.3%	47.2%	19.4%	28.5%	57.1%	14.2%

Table 4.14. Percentage of complete flakes with corner, side and end flaking axis, by raw material type. Shaded areas are figures based on extremely small samples (<15).

	HACKTHORNE				**KERATIC KOPPIE**				**KUDU KOPPIE – MSA**				**KUDU KOPPIE - SANGOAN**			
	Feather	Hinge	Over-shoot	Step	Feather	Hinge	Over-shoot	Step	Feather	Hinge	Over-shoot	Step	Feather	Hinge	Over-shoot	Step
Banded Ironstone	63.6%	18.2%	0%	18.2%	100%	0%	0%	0%	78.5%	7.1%	0%	14.2%	75.0%	0%	0%	25.0%
Crypto-crystalline	54.9%	29.4%	13.7%	2.0%	78.2%	0%	4.3%	13.0%	68.7%	16.6%	4.1%	4.1%	71.2%	0%	28.5%	0%
Quartz	61.4%	19.3%	2.1%	17.2%	72.2%	22.2%	0%	5.5%	92.3%	2.5%	0%	5.1%	95.2%	2.3%	0%	2.3%
Quartzite	63.5%	13.3%	1.5%	21.7%	60.3%	13.2%	0%	11.3%	72.3%	1.0%	5.3%	11.7%	81.4%	14.8%	0%	1.8%
Rhyolite	57.3%	28.1%	1.2%	13.4%	82.3%	17.6%	0%	0%	71.4%	20.0%	0%	8.5%	84.6%	7.6%	7.6%	0%

Table 4.15. Percentage of complete flakes with feather, hinge, overshoot and step terminations, by raw material type. Shaded areas are figures based on extremely small sample sizes (<15).

		Banded Ironstone		Crypto-crystalline		Dolerite		Quartz		Quartzite		Rhyolite		Other	
Core type	**Assemblage**	**N=**	**%=**	**N=**	**%=**	**N=**	**%=**	**N=**	**%=**	**N=**	**%=**	**N=**	**%=**	**N=**	**%=**
Irregular	Ht	1	8.3	4	33.3	0	0	4	33.3	2	16.6	0	0	1	8.3
	KRK	0	0	3	30.0	0	0	0	0	0	0	2	20.0	5	50.0
	KK MSA	0	0	1	14.2	0	0	4	57.1	1	14.2	1	14.2	0	0
	KK Sangoan	0	0	3	23.0	0	0	1	7.6	6	46.1	2	15.3	1	7.6
Blade	Ht	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	KRK	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	KK MSA	0	0	6	75.0	0	0	0	0	0	0	2	25.0	0	0
	KK Sangoan	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Casual	Ht	2	12.5	0	0	0	0	6	37.5	5	31.2	2	12.5	1	6.2
	KRK	0	0	2	40.0	0	0	2	40.0	1	20.0	0	0	0	0
	KK MSA	0	0	1	100.0	0	0	0	0	0	0	0	0	0	0
	KK Sangoan	0	0	0	0	1	25.0	2	50.0	0	25.0	0	0	0	0
Chopper	Ht	2	9.0	5	22.7	0	0	7	31.8	4	18.1	2	9.0	2	9.0
	KRK	0	0	0	0	0	0	1	16.6	5	83.3	0	0	0	0
	KK MSA	3	27.2	2	18.1	0	0	1	9.0	3	27.2	1	9.0	1	9.0
	KK Sangoan	1	3.8	1	3.8	0	0	7	26.9	12	46.1	2	7.6	3	11.5
Polyhedral	Ht	0	0	2	16.6	0	0	6	50.0	4	33.3	0	0	0	0
	KRK	0	0	2	25.0	1	12.5	0	0	5	62.5	0	0	0	0
	KK MSA	0	0	0	0	0	0	1	25.0	2	50.0	1	25.0	0	0
	KK Sangoan	0	0	0	0	1	6.6	4	26.6	9	60.0	0	0	1	6.6
Prepared	Ht	1	10.0	0	0	0	0	2	20.0	3	30.0	3	30.0	1	10.0
	KRK	0	0	3	75.0	0	0	1	25.0	0	0	0	0	0	0
	KK MSA	2	5.8	6	17.6	4	11.7	2	5.8	12	35.2	8	23.5	0	0
	KK Sangoan	1	7.6	1	7.6	3	23.0	2	15.3	4	30.6	1	7.6	1	7.6
Radial	Ht	3	10.7	0	0	0	0	11	39.2	9	32.1	2	7.1	3	10.7
	KRK	0	0	0	0	0	0	2	12.5	9	56.2	0	0	5	31.2
	KK MSA	0	0	1	10.0	1	10.0	2	20.0	4	40.0	2	20.0	0	0
	KK Sangoan	1	3.8	2	7.6	0	0	6	23.0	14	53.8	2	7.6	1	3.8
Single platform	Ht	1	11.1	2	22.2	0	0	3	33.3	3	33.3	0	0	0	0
	KRK	0	0	0	0	0	0	1	33.3	0	0	2	66.6	0	0
	KK MSA	0	0	0	0	0	0	1	50.0	1	50.0	0	0	0	0
	KK Sangoan	0	0	1	90.0	0	0	5	45.4	4	36.3	0	0	1	9.0

Table 4.16 Number and percentage of core types per raw material, for the four assemblages.

CHAPTER 5

DISCUSSION: RESULTS OF ANALYSIS

KK- SANGOAN AND KK-MSA ASSEMBLAGES

All four of the assemblages have been affected by deflation, but importantly the stratigraphy at Kudu Koppie has made it possible to distinguish two assemblages that are separated well enough in time to characterize two industries. These are the KK-1 (ESA) and KK-2 (MSA) collections. The significance of this is that the site offers a view of change through time that can serve as a template for evaluation of the single-component sites. It is reasonable to suppose that the same types and shapes of raw materials would have been available for the makers of both assemblages, providing some valuable insight into changes in raw material selection and core reduction.

If this is to provide a key to characterizing ESA and MSA assemblages in the area and a means of interpreting where Keratic Koppie and Hackthorne fall within the chronology of the Limpopo, then a pattern of change must first be shown to exist. With technological and typological analysis it has been possible to establish such a pattern of change which will make it possible to contribute to answering the question of whether or not Hackthorne and Keratic Koppie are mixed ESA/MSA sites.

The distribution of the artefacts through the sediment at Kudu Koppie is consistent with increasing antiquity with depth. This can be seen in the formal tools, core types and various flake attributes. Some degree of mixing in the layers immediately above and below the division should be expected but does not seem to be significant.

In the basal layer (KK-ESA), formal tools are larger and cruder. The heavy-duty component numbers 21 pieces and includes a range of tool types different to the overlying MSA: 2 choppers, 3 picks, one core-axe, and an 8 to 1 ratio of heavy-duty scrapers over the MSA. Many of the eight heavy duty scrapers are made on large cores or angular pieces. By contrast, only two heavy-duty tools are associated with the MSA levels: both are large scrapers, one with a pick-like end. An adjacent square has produced a further three handaxes, three picks and a cleaver in the ESA levels. Heavy-duty tools form 23% of tools in the ESA levels, and only 4.4% in the MSA levels.

Light-duty tools comprise 95.6% of the MSA collection. Only one formal type is specifically diagnostic of the MSA, the tip of a retouched point. Of the ESA collection only 77% is light-duty tools, and there is relatively little difference in tool types between the ESA and MSA, though tools are more frequently made on finer grained rocks in the MSA. Denticulated/notched scrapers form roughly half of both the MSA (55.8%) and ESA (49.2%) collections. Light-duty denticulates however account for only 5.7% of the earlier assemblage, while they form 11.6% of the MSA tools.

The KK-1(ESA) assemblage is characterized by a generalized pattern of core reduction. Eight core types were made with a slight emphasis on chopper (22%) and radial (21%) types. Both these core types are generally bifacial. Prepared cores (12%) are larger and often quite crude, with the majority being preferential cores for the removal of a single large flake. They are made using a wide range of material types

The KK-2 (MSA) assemblage differs appreciably. This is best seen in the increasing selection of fine-grained raw material types, and in the emphasis on core types that would produce more standardized flakes. Blade cores (10%) only occur in the MSA levels, and together with prepared cores (42%) account for 52% of core types. Blade cores are made exclusively of crypto-crystalline and rhyolite rocks, while prepared cores were more extensively made on finer grained rocks and recurrent flaking is now more common. Chopper and radial cores decrease appreciably in number, and where these occur they are increasingly bifacially flaked.

While there is little change through time in the types of cores, there is a significant change in their proportion in the two assemblages. In the ESA assemblage, the pattern of core reduction and raw material selection is more expedient. The emphasis in the MSA assemblage changes to an increased standardization of flake production and selection of materials that would have facilitated this change.

This change can also be seen in flake attributes. As a result of the increasing sophistication of cores, there are relatively few flakes with cortical platforms, and there is an increase in the number of flakes with three or more platform facets in MSA levels. No multifaceted platforms occur in the older assemblage. There is also a change in the ventral angles of complete flakes. In the older levels only 12.3% of flakes have a ventral angle between 90˚-99˚, but in the MSA levels this increases to 30.5%. This is consistent with prepared core flake production, where it is expected that as prepared flakes are removed more or less parallel to the flaking surface, the ventral angles tend towards 90˚.

The division of flakes into types I-VI (after Toth 1982) is also very useful in showing the increased use of prepared cores in the KK-2 (MSA) assemblage. Type VI flakes have no cortex on the dorsal surface or platform and are typical of prepared flakes. Toth found that in an experimental ESA assemblage 12% of flakes will be type VI, but at Kudu Koppie they constitute 49.5% of the MSA assemblage. These figures are probably due to the use of prepared core technology in both assemblages but more extensively in the MSA levels. In the ESA levels 57% of flakes with dihedral platforms (N=8) and all faceted platforms (N=3) occur on type six flakes. In the MSA levels, 64% (N=11) of faceted and all multifaceted platforms (N=4) occur on type six flakes.

There is a clear trend for the increased use of fine-grained rocks in the MSA, as seen in both the complete flakes and the cores. In the older levels, only 16% of complete flakes are made of these rock types. In the younger levels, this rises to 41.9%. Although banded ironstone and dolerite are fine-grained, these are extremely tough rocks and were not exploited as extensively.

In general then the MSA is characterized by core types suited to the increased production of standardized flakes, facilitated by the selection of more fine-grained raw materials suited to more sophisticated flake production. Sangoan levels show limited use of fine-grained rocks and a generalized, more expedient manner of flake reduction. There is however no dramatic change in cores, tools and flake attributes, with many aspects of the ESA carrying through to the MSA. Change is therefore slow and rooted in the methods of the past (Byrne 2004; McBrearty 1988).

HACKTHORNE

No stratigraphic levels are found here and there can be no division into older or younger assemblages, but comparisons with Kudu Koppie allow for an assessment of the assemblage. Artefacts concentrate on the calcrete substrate, and even those pieces recovered from deep solution pockets within the calcrete occur in sand dated to 15.8 ± 1.1 ka. (Jacobs & Collett 2005).

Heavy-duty tools (44% of tools) are numerous and show that a significant ESA component exists in this assemblage. One handaxe and one cleaver have been recovered, but picks in particular are quite common. Of the six picks recovered, three are small 'pygmy' picks. One uniface and one large denticulate have been recovered, as well as ten large scrapers, often made on cores or large angular blocks. The light-duty component (55.8%) is dominated by denticulated/notched scrapers and denticulates.

Radial (23%) and chopper (19%) cores are the two most common types at Hackthorne. Chopper cores are bifacial, while about two thirds of radial cores are bifacial. All other core types occur in roughly equal proportions. This creates a very general pattern of core reduction, with only 9% being prepared cores. Of the ten prepared cores, three are on rhyolite. This may suggest some selection for raw materials, but it is not significant selection. Only 30% of prepared cores are preferential, with a range of recurrent types also represented.

There is a strong emphasis on complete flakes with cortical and plain platforms, suggesting that primary flaking is dominant. Dihedral platforms are not as common as in any other assemblage, although a small number of faceted and multifaceted flakes occur. While ventral angles of flakes occur more commonly in the range 100˚-119˚, angles from 80˚-130˚ occur. Ventral angles do not reflect a heavy an emphasis on prepared core technology, although there is perhaps the indication of raw material selection for prepared cores.

The Kudu Koppie and Keratic Koppie sites are both located approximately 1km away from existing exposures of the Miocene age terrace, yet the majority of cores at these sites occurs on cobbles or pebbles from the gravels. The high number of casual cores at Hackthorne and low overall percentage of cores in the assemblage may represent raw material testing for export to other sites. Hominids may have been testing the Hackthorne gravels and transporting selected cobbles, or reduced cores in some circumstances, to other sites. This is supported by the high proportion of Type I (entirely cortical) and Type IV (entirely cortical dorsal surface) flakes, as well as by the proportion of flakes with cortical and plain platforms.

Another explanation is that the high number of casual cores may be a result of the abundance of material availability, with knappers only further reducing pieces of suitable quality. However, even poor quality rocks are used at Hackthorne, and as the site is interpreted as mostly a factory site, the low number of cores is unusual. Only the KK-2 assemblage preserves a smaller percentage of cores, and this is probably due to the high number of flakes that could be produced using prepared cores, and recurrent types in particular.

KERATIC KOPPIE

Although this is a small assemblage some trends can be seen in the data. Again, artefacts concentrate on bedrock and cannot be subdivided stratigraphically.

Only nine formal tools were recovered, five (55.5%) are heavy-duty types and include a pick, a cleaver, a core -axe, a uniface, and a large scraper. Of the four (44.4%) light-duty tools, two are utilized flakes, with one denticulated/notched scraper and one denticulate. The larger tools indicate an ESA presence at the site, while the smaller tools provide too small a sample to be indicative of a time period.

This assemblage shows a generalized pattern of core use, with an emphasis on radial cores (29%), most of which are bifacial. Irregular cores form 18% of the assemblage and generally occur on finer grained rocks. To some extent this can be explained by the irregular shape of crypto-crystalline nodules. Chopper cores (11%) are mostly generally unifacial and are not as numerous as in the other three assemblages.

Only four prepared cores have been recovered, but three are made on crypto-crystalline rocks. Of these, three are recurrent centripetal, with one unclear type in quartz. They have been extensively flaked and the blank type is unclear as the cores have been exhausted.

Although it occurs in very small numbers, rhyolite is used for two of three single platform cores. It would have been well suited to this purpose because of its tendency to produce longer flakes, but with such a small sample no arguments can be made for raw material selection.

Significantly, crypto-crystalline is the second most important raw material for complete flakes, fine-grained rocks collectively accounting for 35.6% of flakes. Quartz is also used but in far smaller quantities at the site.

Data from the complete flakes appear to combine elements of both the older KK-1 and the younger KK-2 assemblages. Cortical platforms are extremely well represented, although plain platforms are less common than at other sites. A small number of faceted and multifaceted platforms occur, and dihedral platforms are more numerous than in any other assemblage with the exception of KK-1.

Type 5 and type 6 flakes combined also fall somewhere between the older and younger assemblages of KK1 and KK2. The graph portraying the ventral angles of flakes (Fig. 4.19) also shows a pattern not seen in the other assemblages. All angles between 80˚-129˚ are almost equally important, with only a slight peak in the range of 100˚-109˚.

COMPARISON OF SITES

There are a number of typological and technological characteristics which change through time at Kudu Koppie and aid in evaluation of the two single-component sites. These are discussed below for all four assemblages and summarized in Table 5.1.

Only 4.4% of tools in the MSA assemblage at Kudu Koppie are heavy-duty, and these may or may not be best attributed to the upper ESA levels as they occur in the contact levels between the two assemblages In either case, these consist of only two large scrapers, which are not particularly diagnostic of the ESA. Heavy-duty tools form a far larger part of the ESA assemblage at Kudu Koppie, as well as the Hackthorne and Keratic Koppie assemblages. In addition, these assemblages include tools such as picks, handaxes, cleavers and core-axes. Similarly, these assemblages do not comprise anywhere near as high a light-duty tool component, and none contains any typical MSA tool types such as retouched points (with the exception of one retouched point tip from Kudu Koppie). Therefore it seems reasonable to conclude that the Hackthorne, Keratic

Koppie and Kudu Koppie Sangoan assemblages contain an ESA component, while any MSA component at Hackthorne and Keratic Koppie remains to be assessed.

Blade cores only occur in the KK-MSA assemblage, adding to the MSA nature of this collection. Furthermore, 42% of cores are prepared types, providing a strong element of standardization for flake production. In the ESA levels, these are more generally prepared for a preferential flake removal, but in the MSA levels, recurrent types become increasingly important. No other assemblage has such an emphasis on prepared cores, however, and at Hackthorne and Keratic Koppie, the small number that does occur is generally recurrent types and may represent either reduction of cores through continued occupation of the site or a small MSA component at these sites.

The KK-MSA shows a strong tendency towards flakes of increasingly predetermined form, which is not so clearly seen in any other assemblage. In the KK ESA assemblage blade cores are absent and prepared cores are not a preferred method of flake production. Simple core types tend to dominate and no one type stands out significantly. This generalized pattern of flake production is also seen in the Hackthorne and Keratic Koppie assemblages and does not support a considerable MSA component for any but the KK MSA assemblage.

Chopper cores and radial cores in the MSA assemblage have a strong tendency towards bifacial flaking. This is not generally sustained in the other assemblages, with the exception of extensive bifacial flaking of chopper-cores at Hackthorne. Chopper cores at KRK occur in the same proportions as in the MSA collection, although chopper cores here are not significantly bifacial. However the tendency towards bifacial flaking in some assemblages may be a function of more intensive core reduction.

In general, ventral angles might be expected to be lower in assemblages with a large prepared core component. This can be seen in the MSA assemblage, where these angles peak in the range of 100˚-109˚ at 39%, but 31% are also within the 90-99˚ interval. This is only matched in the KRK collection, although prepared cores do not feature extensively in this assemblage. However, the prepared cores from this site are so extensively flaked as to be exhausted, and with such a small assemblage this observation may not accurately reflect the importance of this technique.

Type six flakes are high in proportion at the KRK and KK probably as a result of more intensive core reduction at these sites, which are situated away from the gravels exposed near Hackthorne, and also as a result of the production of flakes from the upper surface of prepared cores, where platform preparation has removed cortex from flake platforms. They occur as almost 50% of all complete flakes in the KK MSA, where 42% of cores are prepared types and where raw materials were not as readily accessible.

Platform types are also useful in establishing the role of prepared cores in an assemblage. The number of flakes with cortical platforms is substantially lower in the MSA assemblage than any other, indicating the differing pattern of core reduction at these sites. Faceted platforms occur in 8.5% of flake types for the MSA levels of KK, a percentage not matched elsewhere. Multifaceted platforms only form 2.3% of flakes in the KK-MSA levels, but no multifaceted platforms occur in the KK-ESA levels. These platform types do however occur in extremely low numbers at Ht and KRK, and may reflect the presence of more refined MSA-like prepared cores at these sites.

The MSA levels at Kudu Koppie are also important for showing increased selection of fine-grained rocks in the younger industry, associated with the increased use of these rock types for the production of cores that produced flakes of predetermined shapes or dimensions. The only other assemblage that shows such a trend is KRK. Although some of the crypto-crystalline rock used here is a locally occurring poor quality brecciated chert, prepared cores are made using better quality crypto-crystallines and show definite selection of good flaking materials for this one core type.

The combination of ESA and MSA traits at Keratic Koppie makes it likely that the collection contains components of both industries. This can be seen in the diagnostic formal ESA tool types, such as the core axe and the cleaver, while the one large denticulate appears MSA in nature. While denticulates are not industry-diagnostic types, this piece made on a large flake with a well-faceted platform and consistent retouch, traits that are more typical of the MSA at Kudu Koppie. MSA traits are also seen in the core types at KRK. The generalized nature and simpler core types of the ESA are mixed with four refined prepared cores, which are almost exclusively recurrent in nature. While the KK-MSA collection stresses standardization of flake production and careful raw material selection, the KRK collection contains only a small component that reflects these traits, suggesting that significant mixing of ESA and MSA material is present.

In contrast, there is little to suggest any more than nominal mixing of time periods at Hackthorne. Prepared cores are not extensively used. Although 70% of these are recurrent types, this discrepancy with the KK pattern may be due to small sample sizes. Chopper cores are almost exclusively bifacial, even more so than in the MSA collection. However, as chopper cores form a small component at KK-MSA it is unlikely that this is an indicator of MSA core reduction, and it could be a reflection of activity differences between Ht and KK. The 3.6% of flakes with faceted platforms and 1.1% of flakes with multifaceted platforms may possibly suggest that more refined prepared cores were in use at the site, in which case a quite small MSA component may be represented at Hackthorne. However, insufficient data is available to suggest more than very nominal mixing of cultural phases at Hackthorne.

	KK-MSA	**KK-Sangoan**	**Ht**	**KRK**
Heavy-duty tools	4.4%	23%	55.8%	55.5%
Light-duty tools	95.6%	69%	44.1%	44.4%
Blade cores	Present	Absent	Absent	Absent
Prepared cores	42%	12%	9%	7%
Subtypes	41% recurrent 41% preferential 18% unclear	54% preferential 31% recurrent 15% unclear	70% recurrent 30% preferential	75% recurrent 25% unclear
Core use pattern	Towards standardized flakes	Generalized	Generalized	Generalized
Chopper cores	91% bifacial	76% bifacial	95% bifacial	66% bifacial
Radial cores	80% bifacial	54% bifacial	36% bifacial	69% bifacial
Ventral angles peak in the range:	100˚-109˚	110˚-119˚	110˚-119˚	100˚-109˚
Type 6 flakes	49.5%	37.7%	25.8%	35%
Cortical platforms	19%	35%	42.7%	44.4%
Multifaceted platforms	2.3%	0%	1.1%	0.8%
Faceted platforms	8.5%	1.9%	3.6%	2.4%
Raw material selection for prepared cores	Yes	No	No	Yes

Table 5.1 Characteristics of the four assemblages.

ROLE OF RAW MATERIALS

Although changes to the landscape occur over time, it is likely that the makers of the two assemblages at Kudu Koppie had access to the same range of raw materials from the Limpopo gravels. No gravels are currently exposed in the immediate vicinity of this site, and cobbles would have to be collected from the Miocene terrace remnant which is approximately 1.5km away. Sandstone would have been available from the Koppie itself and dolerite is currently available within about 100m of the koppie. Most crypto-crystalline nodules are relatively small. It may be that these were considered too small by the makers of the ESA assemblage but became increasingly attractive to the knappers of the MSA.

A change in raw material exploitation is therefore a direct marker of choice and reveals a pattern of increasing selectivity for rocks that have better flaking properties and suit the chosen method of core reduction. Selection of particular raw materials for the production of specific artifact types appears relatively early in the ESA archaeological record (Schick & Toth 1994, Delagnes *et al*. 2006, Clark 2001c). It is therefore odd that such selection processes are not in place for the ESA levels. However, the explanation seems to lie in the increased production of prepared cores and blade cores in the MSA, which reflects an increased demand for flakes of standardized shape, and which requires the exploitation of finer raw materials with more predictable flaking properties.

The gravels themselves contain a wide range of raw material types, although quartz and quartzite constitute the vast majority of cobbles and pebbles. In terms of flaking properties, a range of poor quality and good quality rocks occurs in relatively small quantities, yet all of these seem to have been flaked at some point, even gneiss, which has an extremely large crystal structure.

Some material types, such as dolerite or quartzite, can have good or bad flaking properties relating to the texture of the specific rock. Where dolerite occurs as dykes, the outer margins cool relatively quickly, and produce a fine-grained rock, but the inner portions of dykes cool more slowly, and produce a coarse-grained rock. While chunks of coarse-grained dolerite occur in both assemblages at Kudu Koppie, flakes that have been recovered only seem to occur in finer grained rocks. However, as dolerite weathers extremely quickly and flake attributes are obscured, it is largely excluded from analysis. Quartzite artefacts occur on both finer and coarser grained rock types.

Rhyolite is an exceptional resource. It is very tough, but it is fine-grained and homogeneous. This makes the knapping process more predictable and makes it easier for the knapper to create artefacts of a preconceived design. Crypto-crystalline rocks are similarly fine-grained and not as tough, but they are not always homogeneous and often occur as small and irregular pieces.

Banded ironstone is incredibly tough and is fine-grained, but the banded nature often results in unpredictable flaking properties. Two prepared cores from Kudu Koppie were abandoned due to step flaking because of this. However, where the majority of the core is formed from a single thick chert layer, flaking properties are very favourable.

Quartzite forms the largest component of all four assemblages. While this must in part reflect its abundance in the landscape, its use in the MSA is more or less the same as in the ESA. Quartzite accounts for 35% of prepared cores in the MSA, slightly higher than the 31% of ESA cores. It therefore seems that it was suitable for producing prepared cores and was increasingly used for recurrent centripetal types, which provide smaller, triangular shaped flakes. It is significant though that quartzite is not used in any of the blade cores. Crypto-crystalline and rhyolite produce the longest, narrowest flakes, and only these types were selected for blade production.

Quartz is extremely brittle and can fracture unpredictably. Although quartz flakes conchoidally, textures and qualities vary significantly. This is the only raw material that decreases significantly in importance in the MSA levels. As an unpredictable raw material it was not much used in the MSA for prepared cores (2 of 34) and mostly produced irregular cores. Bipolar cores form a smallish component of all assemblages and these are almost exclusively quartz. However, as some core types occur on blanks that are bipolar pieces, it seems that they were initially begun using the bipolar method and once broken, these pieces seem to have been used as blanks for some freehand core types.

Ethnographic material (Andrefsky 1994) suggests that where high quality raw materials occur in low abundance they tend to be used to produce formal tool designs, but where they occur in high abundance, both formal and informal tools will be made. As raw material availability most likely remained the same, with low percentages of high quality materials, the trend towards fully recognizing the potential of these types is only seen in the MSA.

CORE REDUCTION

The most significant change in core reduction strategies between the ESA and MSA is seen in radial and prepared cores. Prepared cores defined here conform to the requirements generally agreed for this technique, but they do not appear similar to the classic tortoise shell cores, and therefore the term Levallois has not been used, although it would not be inappropriate.

The volumetric definition of Levallois technology accepts the fact that pieces which naturally have much of the shape necessary for Levallois flake production may need little further shaping. As long as the core volumes and organization are in place the requirements of Levallois core technology are met (Brantingham & Olsen 1994, Brantingham & Kuhn 2001). This is seen in all the assemblages where split cobbles naturally fulfill the requirement for two striking platforms that are hierarchically related, and the split face of the cobble is almost immediately suited to the near parallel removal of the prepared flake. The undersurface of cores is therefore usually mostly cortical and platforms are not extensively prepared.

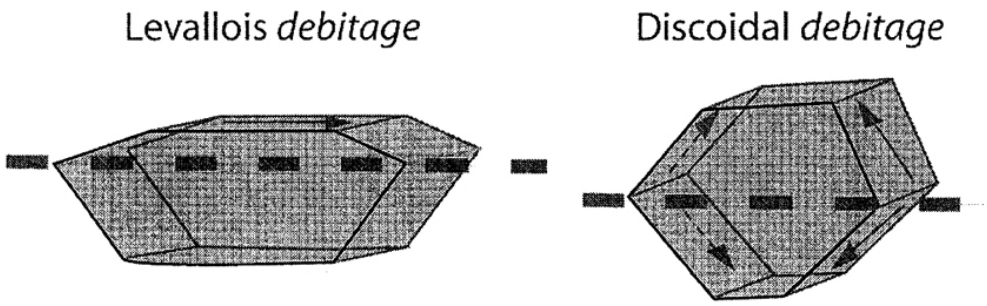


Fig. 5.1 Comparison of Levallois and discoidal cores, showing the plane of intersection and differing symmetries of the two core types. From Delagnes & Meignen 2006.

Especially in the early stages of prepared core technology at Kudu Koppie, some bifacial radial and prepared cores may appear similar because of this asymmetrical structure of cores made on split cobbles (see Fig. 5.1). Classic discoidal cores (Delagnes & Meignen 2006) have two highly convex and symmetrical surfaces which serve as the striking platforms, and unlike the Levallois cores, these surfaces intersect at a sharper angle, and flakes can be removed from either surface.

Within the Levallois technique, two methods are typically defined (Fig. 5.2) the preferential method, which produces a single, large blank from the flaking surface, and the recurrent methods, which produce several blanks from a single flaking surface (Boëda 1995, Delagnes 1995, Delagnes & Meignen 2006). Both are represented in the four assemblages.

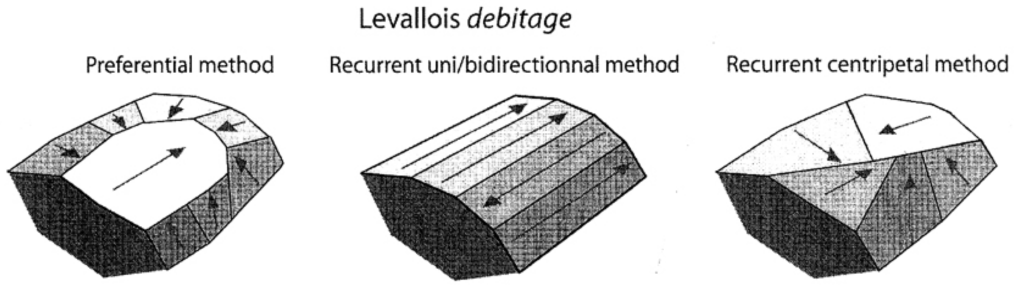


Fig. 5.2. Preferential and recurrent Levallois cores (from Delagnes & Meignen 2006).

Three recurrent Levallois reduction sequences are typically identified (Fig. 5.2), the unidirectional, bi-directional and centripetal (radial) patterns of removal (Delagnes & Meignen 2006). Of these, recurrent centripetal is by far the most common at the sites, with unidirectional and bidirectional recurrent types barely represented.

Changes between the ESA and MSA levels at Kudu Koppie show that prepared cores are increasingly used through time, although later cores are made on selected raw materials and are more refined in nature. Jane Wilkins of University of Calgary is currently studying the prepared cores of Kudu Koppie, in part to quantify the increasing refinement of these pieces.

It is often difficult to determine the blank type used in core production. Chopper cores typically occur on unsplit cobbles and pebbles, but these often seem to have been split for the production of radial and prepared cores. This can be seen in a few instances, but core reduction removes the evidence for this in the majority of cases. Some occur on thick flakes, on cortical pieces of cobbles, or on bipolar core remains. In a replication experiment, Barham (1987) found that it was not possible to flake quartz pebbles smaller than 50mm by direct percussion. It therefore seems likely that some quartz cores would have begun as bipolar pieces, and the same may be applicable to some of the cores produced on more spherical cobbles and pebbles as a means of producing suitable platform angles.

CHRONOLOGY

A pattern of change through time can be established at Kudu Koppie. The characteristics apparent in the KK-MSA assemblage are in accord with some of the characteristics described by Volman (1984) for his definition of earliest MSA assemblages (MSA1, >130,000 years) in South Africa. Flakes tend to be small and produce a relatively low number of flakes with faceted platforms, and the trend of very little scraper retouch and an emphasis on denticulated retouch are also in accord with the earliest MSA assemblages. Further, heavy-duty tools diagnostic of the ESA are absent from this assemblage. However, while retouched points are absent in Volman's MSA1, a single tip of a retouched point has been recovered from the MSA levels, and subsequent excavations have produced 2 further retouched points. Points occur in the Charaman and are seen by Cooke as the first tools to augment and finally replace the pick and handaxe. It seems then that points had been a small but important part of the end of the ESA in Zimbabwe, and may have carried through into the MSA levels at Kudu Koppie. It is not surprising that the Limpopo MSA cultural sequence might be significantly different to the South African sequence, given the great regional variability that exists in the African MSA in general. At present there are no good regional sequences which provide a clear chronological comparison for the Kudu Koppie MSA, apart from the limited information available from Cooke's cave sites in Zimbabwe.

The Acheulean does not seem to be represented in this landscape, and if it does occur it is not readily visible as a later Acheulean (v. a final ESA) industry. Large cutting tools are relatively rare in the Limpopo ESA assemblages, which place much greater emphasis on flake tools and core preparation than is typically seen in the Acheulean. The paucity of handaxes and cleavers does not appear to be an activity bias (Delagnes *et al*. 2006), as the accumulation of artefacts at the sites is too rich and must represent repeated visits.

The ESA assemblage at Kudu Koppie (Table 5.2) contains heavy-duty tools that have their best parallel in the Sangoan and Sangoan-Lupemban Complex. It does not contain any formal tools that might suggest an MSA component to this assemblage. The prominence of picks and heavy-duty scrapers, as well as the presence of a core-axe, suggest this is a Sangoan-like industry, particularly as a number of these types have also been excavated now from additional squares in the bottom layer. The relative importance of core preparation is also a feature of some Sangoan assemblages in Africa (e.g. Muguruk in Kenya, Sai Island in Sudan, and various Charaman (late Sangoan) sites in Zimbabwe). The low percentage of handaxes and cleavers at the site add further support to assigning this assemblage to the Sangoan Complex. When compared with a suggested definition for the Sangoan in southern Africa discussed earlier in this thesis, the Kudu Koppie ESA assemblage matches quite closely the criteria set out for a Sangoan Complex industry in this region, based largely on descriptions of the Charaman or late Sangoan in Zimbabwe. The flaking pattern at the site is generalized, and raw material selection for core types is also absent from this collection. This results in a relatively rough and inelegant collection that may compare to the 'degree of crudity' noted by Clark (1950) for Sangoan artefacts.

The same pattern is seen at Hackthorne and supports the suggestion that the earlier assemblages in the Mapungubwe National Park are best described as a regional variant of the Sangoan Complex. At Keratic Koppie, the Sangoan component appears to be mixed with MSA material. While Hackthorne seems to include a small MSA component, it is possible that the assemblage generally appears rather rough and crude as it seems Hackthorne is a factory site. This concern may be addressed in future studies.

There is some argument that these collections represent the Charaman industry, or terminal Sangoan as it is expressed in Zimbabwe. There is however no consensus that the Charaman ought to be differentiated from the Sangoan. While picks, handaxes and choppers are rare in the Charaman relative to the Sangoan, points and scrapers occur in larger numbers (Sampson 1974). Cooke recognizes the prevalence of 'pygmy' picks in the Charaman, as well as rare, diminutive forms of handaxes that seem to become replaced by large points. This replacement of larger tools by diminutive forms is to some extent represented in the assemblages and may reflect the last stages of the Sangoan, though there is no firm evidence at the site to support this view.

Suggested criteria for defining the Sangoan Complex in Southern Africa.	**Data from square 3S2E at Kudu Koppie (ESA assemblage)**
1) A small percentage of Acheulean-like heavy-duty tools should be present.	No handaxes or cleavers were recovered from this square, but a small number of handaxes and a cleaver were recovered from adjacent squares. Additional heavy duty tools recovered include two choppers and two knives.
2) Picks ought to be well represented.	Three picks and one possible broken pick with a scraper edge were recovered from the square.
3) Prepared cores should be present.	Prepared cores are present (12%) and increase significantly in the MSA levels (42%). Most of these are prepared for preferential removals.
4) Core scrapers and heavy duty scrapers should be present.	Eight large scrapers, often made on cores, are represented, as well as two additional large tools that also have a scraper edge.
5) A range of handaxes might be expected, including diminutive forms in the Charaman in particular.	No handaxes have been recovered from the square but a range of handaxes has been recovered from adjacent squares. A diminutive handaxe grading to a point in size has been recovered from Hackthorne.
6) Tools tend to be crude, large and made using coarse-grained rocks.	Many of the heavy duty scrapers and core scrapers, as well as some of the picks, are large and often crude. There is also no selection of finer-grained rocks, a trend seen in the MSA levels. A number of pieces are made in very coarse rocks, such as gneiss.
7) A large number of small scrapers should be represented in the assemblage. In the Charaman there is an increase in scrapers and points.	A large number (77%) of light duty tools occurs, and most of these are scraper types. A number of these occur on pointed forms though no true points are represented.
8) Core axes should be present.	One core axe is recorded for the square, but this tool type has often been interpreted by other researchers as either a pick, handaxe or core scraper.

Table 5.2 Comparison of square 3S2E with the suggested criteria for the Sangoan in Southern Africa.

It seems therefore that the Charaman, whether a separate entity from the Sangoan or not, best describes the early archaeology of the Mapungubwe National Park. On a continuum between the ESA and MSA, the Charaman, and the three ESA assemblages in this study, seem to fall at a point that is arguably the end of the ESA, the beginning of the MSA, or simply a transitional industry between the two. McBrearty has shown that the archaeology of this time period is complex, and with the influence of a more evolved hominid, the response of knappers to changing needs and conditions produced assemblages that are not easily pigeonholed within industries. Further research in this field will hopefully lead to a consensus of the definition of the Sangoan Industry, which is at present lacking, and address issues of regional variation within the Sangoan. For the present though it may be simpler to assign the three ESA assemblages to a local expression of the Sangoan.

CHAPTER 6

CONCLUSIONS

The MSA has traditionally been defined as a complex of industries that emphasizes flake tools and lacks handaxes and cleavers, as well as other core-tool types characteristic of the ESA. If this typological definition is followed, the heavy-duty tool component seen in the KK-1 (ESA), Ht and KRK assemblages can only be attributed to an ESA component in these three assemblages. Given the significant presence of picks, core-axes, heavy- and light-duty denticulated and notched scrapers, and possibly choppers (v. chopper-cores) believed by many researchers to be linked to wood-working, the best industrial attribution for such an industry is as a local variant of the Sangoan Industry. The low percentages of large cutting tools at the sites do not seem to be a function of expedient flaking for a once-off need (Delagnes *et al.* 2006), because all three sites are too extensive and must have been repeatedly revisited. It therefore seems that the Acheulean is either not represented at the sites or has only left ephemeral traces in the landscape of the area. The latter possibility is unlikely because such an ephemeral pattern is uncharacteristic of landscapes used by Acheulean toolmakers in southern Africa.

Not only do the heavy-duty tools in these earlier assemblages contain very few large cutting tools, but the handaxes also include diminutive forms that are typical of the Charaman or late Sangoan of Zimbabwe. Similarly, picks are quite common and also tend to occur as 'pygmy' picks. Core -axes, choppers, and to some extent picks (not pygmy types) are relatively rare, a trend recognized by Sampson (1974) as representing the Charaman, or terminal Sangoan industry. The relatively high number of large scrapers, particularly those occurring on cores or large angular pieces, is high, and supports the attribution of these assemblages to the Sangoan Complex, while the large number of light-duty pieces (77% of tools) consisting mostly of scraper types (56.5% of light-duty pieces), is higher than that recovered by McBrearty (1988) for the Sangoan-Lupemban at Muguruk (58.9% light-duty tools).

While prepared cores do not occur in the Sangoan levels at Kalambo Falls, they form a small but significant part of the Sangoan record in the research area. They similarly occur in other Sangoan assemblages, such as at Muguruk, Kenya (McBrearty 1988), and at Bambata and Pomongwe Caves, Zimbabwe (Cooke 1966). Prepared cores organized for preferential flake removals seem to be more common in the Sangoan levels, and decrease in importance so that recurrent types dominate in the MSA.

The KK2 (MSA) assemblage is characterized by various trends. Few heavy-duty tools occur and these are all large scrapers. The MSA character of this industry can be seen in an emphasis on the production of flakes of predetermined shape. The change in flaking strategies is manifest in various flake attributes, such as ventral angles, platform types and a prevalence of Type VI flakes. This change occurs with a simultaneous change in the pattern of raw material exploitation. This was possible because the hominids selected for fine-grained rocks with predictable flaking properties that facilitated the production of flakes of increasingly standardized shape.

The composition of the Hackthorne assemblage places it most comfortably at present within the Sangoan period, but there may be a small MSA component in this site if comparisons with Kudu Koppie MSA are informative. Although no typical formal MSA flake tools occur, some of the prepared cores could fit comfortably in the MSA. However, the low occurrence of prepared cores combined with the lack of raw material selection for artifact types at Hackthorne support the view that little mixing has occurred. The Keratic Koppie site however seems to represent a more clearly mixed MSA/Sangoan assemblage. The older component of this assemblage dominates, although one large denticulate and four refined prepared cores in particular seem more likely to represent an MSA component here. It is also notable that the denticulate and prepared cores are more refined in appearance than any tools or cores from the Ht or KK assemblages, and may represent a slightly later stage of the MSA here.

The high number of casual cores at Hackthorne suggests that hominids may have tested cobbles for suitability before transporting these to other sites for further working. This is supported by the high proportion of type I and type IV flakes at Hackthorne, as well as the high number of flakes with cortical and plain platforms. Further, the majority of cores recovered from sites situated away from the gravels show that these most often occur on cobbles or pebbles.

Being a marginal habitat sensitive to aridity, the local landscape may have been too inhospitable at times for habitation. A considerable gap in occupation may be represented at the Kudu Koppie site, although there is subtle change in the proportion of types represented rather than an abrupt change between the ESA and MSA assemblages. With the exception of blade cores, the reduction methods remain virtually the same, with mainly a shift toward more emphasis on core preparation for recurrent flakes. While it is argued that hominids of the Acheulean had some ability to produce artefacts of preconceived design (Semaw 1997, McNabb *et al.* 2004), the Sangoan is associated with a more evolved hominid (McBrearty 1988, White *et al*. 2003), and it has been argued that this period shows the first appearance of broad regional adaptations (Clark 1970). However, the hominids of the Sangoan period in the research area did not select raw materials that were more suitable for specific artefact types, either because they were not aware of the advantages, or because it was not important to them at the time. The first evidence for the selection of rock types for certain artefacts only occurs in the MSA levels.

The Sangoan has arguably been seen as an adaptation to a more wooded environment, with most formal tools adapted to woodworking, but this interpretation does not have to imply that environments in the Limpopo basin were identical to those habitats occupied by more classic Sangoan inhabitants. As the four assemblages cannot be dated, it is difficult to link these sites to any stage of climate change that has occurred in the area. However, although the region is currently semi-arid and prone to drought, the margins of the Limpopo River are currently wooded. Although the river has become considerably reduced since Miocene times, modern irrigation has in part led to the drying of the river. Therefore at times in the past the river margins may have been substantially more wooded with areas of open grassland, as is the case at Simbi in Kenya where McBrearty (1988) has excavated a Sangoan assemblage.

It seems clear that the three ESA assemblages are very similar to what Cooke described as Charaman in Zimbabwe. The proximity of the research area to Zimbabwe makes this likely, as the palaeo-Limpopo would not have provided a significant barrier at the time. However, as the original Sangoan assemblage from Sango Bay is an unexcavated surface collection, there is no clear sample to define this industry. Researchers have noted that problems with excavations, difficulties in dating sites, and stratigraphic problems mean that, while some researchers accept that the Sangoan Industry exists, defining it and placing it in a context of time and place are problematic.

At Kudu Koppie a record of change through time has been preserved in a stratified site. In the earliest levels handaxes and cleavers occur in low numbers, although heavy-duty tools form a significant part of the assemblage. Artefact types are consistent with those described by Cooke for the Charaman, or terminal Sangoan as it occurs in Zimbabwe. Therefore if the Sangoan does show the first regional adaptations, then the sites in the research area fit well into the Charaman or late Sangoan of southern Zimbabwe, and the Charaman in particular. However, the integrity of the assemblages upon which Cooke defined the Charaman has been questioned (Volman 1984). Kudu Koppie therefore reflects the transition from the ESA to the MSA, although whether it is correct to assign the earlier assemblage to the Sangoan Industry can be debated. This issue can only be determined more accurately once there is a greater understanding of what defines the Sangoan Industry and its place in time and space.

REFERENCES

Andrefsky, W. 1994. Raw-material availability and the organization of technology. *American Antiquity*. **59(1)**:21.34.

Andrefsky, W. 2000. *Cambridge Manuals in Archaeology: Lithics, Macroscopic approaches to analysis.* Cambridge: Cambridge University Press.

Armstrong, A.L. 1931. Excavations at Bambata Cave and researches on prehistoric sites in southern Rhodesia. *Journal of the Royal Anthropological Institute*. **61**:239-276.

Barham, L.S. 1987. The bipolar technique in southern Africa: a replication experiment. *South African Archaeological Bulletin* **42**: 45-50.

Barham, L.S. & Smart , P.L. 1996. An early date for the Middle Stone Age of Central Zambia. *Journal of Human Evolution* **30**:287-290.

Barham, L.S. 2000a. A speculative summary. In: Barham, L (*ed.*) *The Middle Stone Age of Zambia, South Central Africa*: 237-293. Bristol: Western Academic and Specialist Press Limited.

Barham, L.S. 2000b. The palaeobiogeography of central Africa. In: Barham, L (*ed.*) *The Middle Stone Age of Zambia, South Central Africa*: 223-236. Bristol: Western Academic and Specialist Press Limited.

Barham, L. 2001. Central Africa and the emergence of regional identity in the Middle Pleistocene. In: Barham, L. & Robson Brown, K. (eds) *Human Roots*: 65-80. Bristol: Western Academic and Specialist Press Limited.

Beaumont, P. 1990a. Nooitgedacht 2 and Rosebery plain 1. In: Beaumont, P. & Morris, D. (eds) *Guide to archaeological sites in the northern Cape: Post conference excursion 9th-13th September 1990*: 4-6. Southern African association of archaeologists.

Beaumont, P. 1990b. Rooidam 1&2 and Biesiesput. In: Beaumont, P. & Morris, D. (eds) *Guide to archaeological sites in the northern Cape: Post conference excursion 9th-13th September 1990*: 4-6. Southern African association of archaeologists.

Beaumont, P. & Vogel, J.C. 2006. On a timescale for the past million years of human history in central South Africa. *South African Journal of Science* **102**:217-228.

Boëda, E. 1995. Levallois: a volumetric construction, methods, a technique. In: Dibble, H.L. & Bar-Yosef, O. (eds) *The definition and interpretation of Levallois technology*: 41-68. Wisconsin: Prehistory Press.

Bordy, E.M. & Cantuneanu, O. 2002. Sedimentology and palaeontology of upper Karoo aeolian strata (Early Jurassic) in the Tuli Basin, South Africa. *Journal of African Earth Sciences* **35**:301-314.

Brantingham, J.P. & Kuhn, S.L. 2001. Constraints on Levallois core technology: a mathematical model. *Journal of Archaeological Science* **28**:747-761.

Brantingham, J.P. & Olsen, J.W. 2000. Raw material quality and prepared core technologies in Northeast Asia. *Journal of Archaeological Science* **27**: 255-271.

Byrne, L. 2004. Lithic tools from Arage Cave, Tautavel (Pyrénées Orientales, France): behavioural continuity of raw material determinism during the Middle Pleistocene? *Journal of Archaeological Science* **31**:351-364.

Cahen, D. & Moeyersons, J. 1977. Subsurface movements of stone artifacts and their implications for the prehistory of Central Africa. *Nature* **266** April: 812-815.

Cahen, D. 1978. Vers la revision de la nomenclature des industries préhistoriques de l'Afrique centrale. *L'Anthropologie* **82**:5-36

Clark, J.D. 1950. *The Stone Age cultures of Northern Rhodesia*. Claremont: The South African Archaeological Society.

Clark, J.D. 1959. The *Prehistory of Sothern Africa*. Harmondsworth: Penguin Books.

Clark, J.D. 1965. The distribution of prehistoric cultures in Angola. *Actas del V Congreso Panafricano de Prehistoria y de studio del Cuaternario. Tenerife.* 1963 **1**: 225-309.

Clark, J.D. 1970. *The Prehistory of Southern Africa*. Southampton: The Camelot Press Ltd.

Clark, J.D. 2001a. Geology, chronology and the history of the excavations In: Clark, J.D. (*ed.*), *Kalambo Falls Prehistoric Site III, the earlier cultures: Middle and Earlier Stone Age*: 1-33. Cambridge: University Press.

Clark, J.D. 2001b. The Chipeta Industry of the Sangoan Industrial Complex: the archaeology of the Mkamba Member, Ochreous Sands Bed In: Clark, J.D. (*ed.*), *Kalambo Falls Prehistoric Site III, the earlier cultures: Middle and Earlier Stone Age*: 234-285. Cambridge: University Press.

J.D. Clark. 2001c. Variability in primary and secondary technologies of the Later Acheulian in Africa. In: S. Milliken & Cook, J. (eds) *A very remote period indeed*: 1-18. Oxford: Oxbow books.

Clark, J.D. & Brown, K.S. 2001. The Twin Rivers Kopje, Zambia: Stratigraphy, fauna, and artefact assemblages from the 1954 and 1956 excavations. *Journal of Archaeological Science* **28**:305-330.

Clark, J.D. & Kleindienst, M.R. 2001. The Stone Age cultural sequence: terminology, typology and raw material. In: Clark, J.D. (*ed.*), *Kalambo Falls Prehistoric Site III, the earlier cultures: Middle and Earlier Stone Age*: 34-65. Cambridge: University Press.

Cooke, C.K. 1966. Re-appraisal of the industry hitherto named the Proto-Stillbay. *Arnoldia (Rhodesia)* **2(22)**: 1-11

Cooke, C.K. 1968. The Early Stone Age in Rhodesia: a review of the written evidence and a discussion on its validity following on the findings of the Wenner Gren Symposium No. 29 at Burg Wartenstein 1965. *Arnoldia (Rhodesia)* **3(39)**: 1-12.

Cormack, J.L. 1995. Core-based heavy duty implements: are they important? In: Schofield, A.J. (ed.) *Lithics in context: suggestions for the future direction of lithic studies (Lithic Studies Society Occasional Paper No. 5)* 89-93. London: Lithic Studies Society.

Davies, O. 1952. The Natal Sangoan Culture. *South African Journal of Science* **Feb:**212-214

Davies, O. 1976. The 'Sangoan' Industries. *Annals of the Natal Museum* **22(3):885-911.**

Delagnes, A. 1995. Variability within uniformity: three levels of variability within the Levallois system. In: Dibble, H.L. & Bar-Yosef, O. (eds) *The definition and interpretation of Levallois technology*: 201-211. Wisconsin: Prehistory Press.

Delagnes A. & Meignen L. 2006. Diversity of lithic production systems during the Middle Paleolithic in France: are there any chronological trends? In: E. Hovers and S. Kuhn (eds) *Transitions before the transition: evolution and stability in the Middle Paleolithic and Middle Stone Age*: 85-107. USA: Springer science & business media, inc. (Interdisciplinary Contributions to Archaeology).

Delagnes, A., Lenoble, A., Harmand, S., Brugal, J-P., Prat, S., Tiercelin, J-J. & Roche, H. 2006. Interpreting pachyderm single carcass sites in the African Lower and Early

Middle Pleistocene record: a multidisciplinary approach to the site of Nadung'a 4 (Kenya). *Journal of Anthropological Archaeology* **25**:448-465.

de Wit, M.C.J. 1996. The distribution and stratigraphy of inland alluvial diamond deposits in South Africa. *Africa Geoscience Review Special Edition* 3: 19-33.

de Wit, M.C.J., R.R. Marshall and T.C. Partridge 2000. Fluvial deposits and drainage evolution. In T.C. Partridge and R.R. Maud (eds): *The Cenozoic of Southern Africa.* New York: Oxford University Press. Pages

Fock, G.J. 1968. Rooidam, a sealed site of the 1St Intermediate. *South African Journal of Science* **64**:153-159.

Gibbon, R. 2002. Preliminary investigation into the context and integrity of an Earlier Stone Age site in the Shashe-Limpopo basin. Honours thesis, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand.

Good-win, A.J.H. 1926. South African stone implement industries. *South African Journal of Science* **23**:

Goodwin, A.J.H. 1948. Earlier, Middle and Later. *South African Archaeological Bulletin* **1(3)**: 74-76.

Goren-Inbar, N. 1992. The Acheulean site of Gesher Benot Ya'aqov – an Asian or an African entity? In: Akazawa, T., Aoki, K. & Kimura, T. (eds), *The evolution and dispersal of modern humans in Asia*: 67-82. Tokyo: Hokusen-sha.

Goren-Inbar, N., Lister, A., Werker, E. & Check, M. 1994. A butchered elephant skull and associated artifacts from the Acheulian site of Gesher Benot Ya'aquov, Israel. *Palēorient* **20/1**:99-112.

Goren-Inbar, N., Feibel, C.S., Verosub, K.L., Melamed, Y., Kislev, M.E., Tchernov, E. & Saragusti, I. 2000. Pleistocene milestones on the out-of-Africa corridor at Gesher Benot Ya'aqov, Israel. *Science* **289**:944-947.

Grün, R., Brink, J.S., Spooner, N.A., Taylor, L., Stringer, C., Franciscus, R.G. & Murray, A.S. 1996. Direct dating of the Florisbad hominid. *Nature* **382**: 500-501.

Humphreys, A.J.B. 1970. The role of raw material and the concept of the Fauresmith. *South African Archaeological Bulletin* **25**:139-144.

Isaac, G. 1982. The earliest archaeological traces. In: Clark, J.D. (*ed.*), *The Cambridge History of Africa, volume 1: From the Earliest Times to 500 B.C.*: 157-247. Cambridge: Cambridge University Press.

Jacobs, Z & Collett G. 2005. OSL dating of sedimentary samples from the archaeological sites at Keratic Koppie, Kudu Koppie and Hackthorne in the Limpopo Province. Unpublished report.

Jones, N. 1940. Bambata Cave: a re-orientation. Occasional paper of the National Museum of southern Rhodesia **1(9)**:11-28.

Klein, R.G. 2000. The Earlier Stone Age of Southern Africa. *South African Archaeological Bulletin* **55**: 107-122.

Kuman, K., Inbar, M., & Clarke, R.J. 1999. Palaeoenvironments and cultural sequence of the Florisbad Middle Stone Age hominid site, South Africa. *Journal of Archaeological Science* **26**: 1409-1425.

Kuman, K. 2001. An Acheulean factory site with prepared core technology near Taung, South Africa. *South African Archaeological Bulletin* **56**: 8-22.

Kuman, K. 2003. Site formation in the early South African Stone Age sties and its influence on the archaeological record. *South African Journal of Science* **99**:251-254.

Kuman, K., Le Baron, J.C. & Gibbon, R. 2005a. Earlier Stone Age archaeology of the Vhembe-Dongola National Park (South Africa) and vicinity. *Quaternary International* **129**:23-32.

Kuman, K., R.J. Gibbon, H. Kempson, G. Langejans, J.C. Le Baron, L. Pollarolo and M. Sutton. 2005b. Stone Age signatures in northernmost South Africa: archaeology of the Vhembe-Dongola National Park and vicinity. In F. D'Errico and L. Backwell (eds): *From Tools to Symbols, From Early Hominids to Modern Humans* (Roundtable sponsored by the French Embassy and the Palaeoanthropology Scientific Trust). April 2003, University of the Witwatersrand: 163-182. Johannesburg: Wits University Press.

Kuman, K. 2006. The Red Sands: Eastern Cape coastal archaeological sites, Podoland, Transkei, Wild Coast. Unpublished Report.

Kuman, K. 2007. The Earlier Stone Age in South Africa: site context and the influence of cave studies. In: Pickering, T.D., Schick, K. & Toth, N. (eds), *Breathing Life into Fossils: Taphonomic Studies in Honor of C.K. (Bob) Brain.* Bloomington (Indiana): Stone Age Institute Press, pp 181-198.

McBrearty, S. 1988. The Sangoan-Lupemban and Middle Stone Age Sequence at the Muguruk Site, Western Kenya. *World Archaeology* **19(3)**: 388-420.

McBrearty, M. 1991. Recent research in western Kenya and its implications for the status of the Sangoan Industry. In: Clark, J.D. (*ed.*), *Cultural beginnings: Approaches to understanding early hominid lifeways in the African Savanna*: 159-176. Bonn: Römischen Germanissches Zentralmuseum, Forschunginstitut für Vor-Und Frühgeschichte, Monographien 19.

McBrearty, S. & Brooks, A.S. 2000. The revolution that wasn't: a new interpretation of the origin of modern human behaviour. *Journal of Human Evolution* **39**:453-563.

Mitchell, P. 2002. *The Archaeology of southern Africa*. Cambridge: Cambridge University Press.

NcNabb, J., Binyon, F. Hazelwood, L. 2004. The large cutting tools from the South African Acheulean and the question of social traditions. *Current Anthropology* **45**:653-677.

Nockolds, S.R., Knox, R.W. O'B. & Chinner, G.A. 1978. *Petrology for students*. Cambridge: Cambridge University Press.

Potts, R. 1989. Olorgesailie: new excavations and findings in Early and Middle Pleistocene contexts, southern Kenya rift valley. *Journal of Human Evolution* **18**: 477-484.

Rapp, G. & Hill, C.L. 1998. *Geoarchaeology : The Earth-Science approach to archaeological interpretation*. New Haven : Yale University Press.

Roche, H. 1995. Les industries de la limite Plio-Pléistocène et du Pléistocène ancient en Afrique. In: Gibert, J. (*ed.*) *Congreso Internacional de Paleontologia Humana (Orce, September 1995), 3a Circular: 93*. Orce: Fundacion Caja de Grenada.

Roe, D.A. 2001. The Kalambo Falls large cutting tools : a comparative metrical and statistical analysis. In: Clark, J.D. (*ed.*), *Kalambo Falls Prehistoric Site III, the earlier cultures: Middle and Earlier Stone Age*: 234-285. Cambridge: University Press.

Rots, V. & Van Peer, P. 2006. Early evidence of complexity in lithic economy: core-axe production, hafting and use at Late Middle Pleistocene site 8-B-11, Sai Island (Sudan). *Journal of Archaeological Science* **33**: 360-371.

Sampson, G.C. 1974. *The Stone Age archaeology of Southern Africa*. New York: Academic Press Inc.

Schick, K. & Toth, N. 1994. Early Stone Age technology in Africa: a review and case study into the nature and function of spheroids and subspheroids. In: (Corruccini, R.S. & Ciochon, R.L. (eds) *Integrative paths to the past: paleoanthrologogical advances in honour of F. Clark Howell*: 429-450. Englewood Cliffs, New Jersey: Prentice Hall, Inc.

Semaw, S. 1997. 2.5 -Million-year-old stone tools from Gona, Ethiopia. *Nature* **385**: 333-336.

Singer, R. & Wymer, J. 1982. The *Middle Stone Age at Klasies River Mouth in South Africa*. Chicago: University of Chicago Press.

Taylor, D.M., Marchant, R., & Hamilton, A.C. 2001. A reanalysis and interpretation of the palynological data from the Kalambo Falls prehistoric site In: Clark, J.D. (*ed.*), *Kalambo Falls Prehistoric Site III, the earlier cultures: Middle and Earlier Stone Age*: 66-81. Cambridge: University Press.

Tryon, C.A. 2006. "Early" Middle Stone Age lithic technology of the Kapthurin Formation (Kenya). *Current Anthropology* **47**:367-375.

Toth, N. 1982. The stone technologies of early hominids at Koobi Fora, Kenya: an experimental approach. PhD Dissertation, University of California, Berkeley.

Tryon, C.A. & McBrearty, S. 2002. Tephrostratigraphy and the Acheulian to Middle Stone Age transition in the Kapthurin Formation, Kenya. *Journal of Human Evolution* **42**:211-235.

Tyson, P.D. & Partridge, T.C. 2000. Evolution of Cenozoic climates. In: Partridge, T.C. & Maud, R.R. (eds), *The Cenozoic of Southern Africa*: 371-387. New York: Oxford University Press.

Van Peer, P., Fullagar, R., Stokes, S., Bailey, R.M., Moeyersons, J., Steenhoudt, F., Geerts, A., Vanderbeken, T., De Dapper, M. & Geus, F. 2003. The Early to Middle Stone Age Transition and the Emergence of Modern Human Behaviour at site 8-B-11, Sai Island, Sudan. *Journal of Human Evolution* **45**:187-193.

Van Riet Lowe, C. 1947. A brief account of an archaeological reconnaissance of Natal. *South African Archaeological Bulletin* **2(7)**:69-78.

Volman, T.P. 1981. The Middle Stone Age in the Southern Cape. PhD thesis, University of Chicago.

Volman, T.P. 1984. Early prehistory of South Africa. In: Klein, R.G. (*ed.*). *Southern African Preshistory and Palaeoenvironments*: 169-220. Rotterdam: Balkema.

Wadley, L., Williamson, B. & Lombard, M. 2004. Ocher in hafting in Middle Stone Age southern Africa: a practical role. *Antiquity* **78**: 661-675.

Wayland, E.G. & Smith, R. 1923. *Some primitive stone tools from Uganda.* Entabbe: Geological Survey of Uganda Occasional Paper 1.

Whittaker, J.C. 1997. *Flintknapping: Making and understanding stone tools.* Austin, Texas: University of Texas Press.

White, T.D., Asfaw, B, DeGusta, D, Gilbert, H, Richards, G.D, Suwa, G and Howell, C.F. 2003. Pleistocene *Homo sapiens* from Middle Awash, Ethiopia. *Nature* **423** June: 742-747.

Wurz, S. 2002. Variability in the Middle Stone Age lithic sequence, 115,000-60,000 years ago at Klasies River, South Africa. *Journal of Archaeological Science* **29**: 1001-1015.

Wynn, T. & Shennan, S. 1995. Handaxe enigmas. *World Archaeology* **27**:10-24.
World Archaeology **27**:10-24.