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The Acheulean in South Africa, with announcement of a new site (Penhill Farm) in the lower Sundays River Valley, Eastern Cape Province, South Africa

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Abstract:

Our understanding of the South African Acheulean is heavily biased towards sites located in the interior of the country, namely in the Cradle of Humankind and those located along the Vaal and Orange Rivers. Although these sites have contributed significantly to our understanding of this complex tradition, our interpretations are often limited due to issues with site and assemblage preservation, and dating. It is therefore necessary to locate, excavate, and describe new sites and assemblages from a wider range of environments so that we can understand crucial aspects of hominid behaviour within a variety of ecological, climatological, and environmental contexts. Only two Acheulean sites have been recorded in the Eastern Cape Province (e.g., Amanzi Springs and Geelhoutboom) and of these only one has ever been excavated (Amanzi Springs). As a result there have been no well-described and dated Acheulean assemblages in this province, even though several authors have noted the presence of this material. This paper provides an introduction to a new study region in South Africa: the lower Sundays River Valley. By providing a detailed review of the South African Acheulean, we discuss the significance of this new study region in relation to our wider understanding of the South African Acheulean.

Key words: Acheulean; South Africa; Sundays River Valley; Eastern Cape

1. Introduction

The lower Sundays River Valley is situated within the Eastern Cape Province of South Africa (Fig. 1). Alluvial (river) terrace deposits found within this lower valley have been the subject of a range of studies that have explored: terrace origin, composition, age, preserved paleontological remains, river ecology, and their significance with reference to the topographical evolution of southern Africa (Ruddock 1948, 1957, 1968; Forbes & Allanson 1970; Partridge & Maud 1987; Hattingh 1994, 1996, 2008; Hattingh & Goedhart 1997; Dollar 1998; Hattingh & Rust 1999; Ross *et al.* 1999; Erlanger 2010; Erlanger *et al.* 2012). However, no study addresses the cultural stratigraphy of these terraces in terms of associated Earlier Stone Age (ESA) – more specifically Acheulean – artefact occurrences, within a dated framework.

Recent research conducted within the lower Sundays River Valley by D. Granger, R. Gibbon and E. Erlanger has provided cosmogenic nuclide burial dates of between 4.26-0.26 Ma (million years) for the preserved alluvial terrace deposits (Erlanger *et al.* 2012). This research has highlighted that within three of these dated deposits ESA artefacts are preserved: Penhill Farm dated to $<1.37 \pm 0.16$ Ma; Bernol Farm dated to 1.14 ± 0.20 Ma; and Atmar Farm dated to 0.65 ± 0.12 Ma (Granger *et al.* 2013). In this paper we present this new study area as a valuable resource for expanding our knowledge of South Africa's Acheulean record. Emphasis in this paper is placed upon the most informative site to date, Penhill Farm. We further provide a review of the Acheulean in South Africa and discuss the Sundays River sites within the larger context of the Acheulean tradition in this country.

Insert Figure 1 here

2. A review of the Acheulean in Africa

The Acheulean tradition is regarded as the most significant technological development that occurred during the evolution of the ESA, which encompasses the Lomekwian (see criticism by Domínguez-Rodrigo & Alcalá 2016), Oldowan and Acheulean traditions, dating from 3.3 to 0.3/0.25 Ma in Africa (Harris *et al.* 2007;

Diez-Martín & Eren 2012; Harmand *et al.* 2015). Although the Lomekwian is the earliest industry at 3.3 Ma, it is currently known from only one small assemblage (Harmand *et al.* 2015). In contrast, the Oldowan has long been recognised as a persistent but variable, primarily core- and flake-based (Mode 1) technology that occurs from 2.6 to 1.7 Ma (Barsky 2009; Carbonell *et al.* 2009; Semaw *et al.* 2009). This persistence, however, is a testament to its applicability to perform whatever tasks were required during these early developmental stages. At 1.7 Ma, a new stone tool technology (Mode 2) presents itself (Semaw *et al.* 2009; Diez-Martín *et al.* 2015), and it is also present in South Africa at this early time (Gibbon *et al.* 2009a). This change in technology marks the start of the Acheulean and this tradition is widely recognised as the longest persisting and most widespread Stone Age technology in the world (Mitchell 2002), one that is inherently variable across both space and time (Sharon *et al.* 2011). As a result of this longevity, it is frequently divided into three different phases (Kuman 2014): an Early Acheulean (which starts at 1.7 Ma and continues until ca. 1 Ma), a Middle Acheulean (from ca. 1 Ma to 0.6 Ma), and a Later Acheulean (from ca. 0.6 Ma to 0.3 Ma).

2.1 Classification

2.1.1 Advent of Large Cutting Tools (LCTs)

The first detailed descriptions of the Acheulean were presented by Mary Leakey (1971) based on assemblages retrieved from Olduvai Gorge (type site EF-HR). From this it was clear that the most diagnostic Acheulean artefacts included Large Cutting Tools (or LCTs), which distinguish it from the Oldowan (Semaw *et al.* 2009; Sharon 2010; Sharon *et al.* 2011). These types, including handaxes, cleavers and picks, are found in Acheulean assemblages in association with various other core and flake forms, similar to those found in the Oldowan (McNabb & Beaumont 2011b). At certain sites (e.g., Peninj and Olduvai Gorge type site EF-HR), these LCTs are frequently retouched and take on the form of large scrapers with pointed distal ends (de la Torre & Mora 2005; de la Torre *et al.* 2008).

Handaxes, cleavers and picks occur in a variety of shapes, sizes and forms through time (see early descriptions and definitions by Kleindienst 1961, 1962; Roe 1964, 1968; Leakey 1971; Newcomer 1971; Isaac 1977; Jones 1979). Generally speaking handaxes are tools shaped through primary flaking to a convergent distal end (Kuman *et al.* 2014), either through unifacial and/or bifacial working (Li *et al.* 2014). Primary flaking involves the removal of large flakes that shape the blank (either a cobble or a flake); secondary shaping consists of small removals around the peripheries of a tool to make the edges regular (Kuman *et al.* 2014). Early examples place emphasis upon creating a sharp distal end or tip (Kuman *et al.* 2014), whereas later in time more emphasis is placed upon creating sharp cutting edges around the lateral margins of the tool (Kuman 2014). The functional uses of handaxes (and LCTs in general) are debated (see discussions by Machin *et al.* 2007; Semaw *et al.* 2009; Beyene *et al.* 2013; Diez-Martín *et al.* 2015); however, it appears that primary uses would have included some form of heavy-duty butchery, wood working, and digging (Kuman 2014; Beyene *et al.* 2013; Diez-Martín *et al.* 2015). Cleavers require a different strategy of production and frequently have less shaping, often confined to one or both lateral edges of the piece. Emphasis rather is placed upon creating a single broad sharp cutting edge, or 'bit', at the distal or lateral portion of the piece; this edge is rarely retouched (Kuman *et al.* 2014; Li *et al.* 2014). Blank types also vary (large flakes, but also cobbles and split cobbles) and shaping often occurs to thin the bulbar area (Kuman *et al.* 2014). This tool could then have been used for heavy-duty chopping, cutting, hacking, and perhaps scraping wood (Kuman 2014; Diez-Martín *et al.* 2015). Pick and pick-like tools have shaping focused on the distal end of the piece with much less emphasis on the body (Li *et al.* 2014). It would appear that these tools were most suitable for digging tasks (Beyene *et al.* 2013; Diez-Martín *et al.* 2015). Although Leakey's (1971) use of the term 'biface' implies a less 'functional subjectivity' to handaxes and cleavers, often handaxes are not bifacial, and some pieces, especially in the earliest Acheulean, are frequently trihedral and pick-like (Kuman 2014; Kuman *et al.* 2014). Accordingly, the term LCT is regarded as the best generic term today for these pieces.

Through time, these characteristic LCTs vary in appearance and form. Generally speaking, LCTs in most early assemblages are unrefined and robust (thicker), are frequently referred to as being large and pick-like (e.g., pick-like handaxes), and the amount of preparation and shaping (trimming) can be minimal (Lepre *et al.* 2011; Beyene *et al.* 2013). Flake scars are frequently large and deep suggesting the exclusive use of hard (stone) hammer percussion (Klein 2000a), as seen at Olduvai Gorge in the early Bed II assemblages (de la Torre & Mora 2014). Later in time, during the following Middle and Later Acheulean phases, LCTs tend to take on a much more refined appearance. Roe (1994) was able to characterise changes in technology at Olduvai Gorge following the Early Acheulean, in which later LCTs are thinner in profile and more regular in shape. In addition to this, overall artefact symmetry is improved and the increase in thinner forms is due to a greater use of large flakes as blank types, followed by more refined trimming and shaping techniques (e.g., soft-hammer percussion, as documented by de la Torre & Mora 2014 on later Bed II, III and IV assemblages). The well-known 'classic' and 'refined' looking handaxes and cleavers show the 'upper limit' of the technology, particularly in the Later Acheulean after 0.6 Ma (Kuman 2014), although differences in raw materials and environments create considerable variability across these later assemblages (Clark 2001). There can be more refined or crude forms that occur throughout any of these phases, and it is not uncommon to see extremely crude 'early' looking LCTs in the Sangoan Industry (a terminal industry of the late ESA; Kuman *et al.* 2005) and some more refined LCTs during the Early Acheulean as well. Furthermore, tool standardisation was not the desired outcome of hominids during the Acheulean as artefact production was more focused on creating functional tools (Kuman 2014). Although this may be the case, during later phases in the Acheulean, however, the increase in LCT symmetry and standardisation may indeed be the result of some kind of aesthetic consideration evident in those well made pieces (Klein 2000b; McNabb *et al.* 2004), or the improved technological competence of the producers and a focus on the use of better raw materials (Kuman 2014).

The presence of these LCTs, even if just a single specimen within a site, is argued by some (e.g., Kuman 2007) to represent an Acheulean assemblage, whereas others in the past have argued that a much higher percentage (at least 40%; Leakey 1971) is required to make such classifications. More recently Goren-Inbar and Sharon (2006) discuss Acheulean site classification if handaxes in an assemblage are largely absent. In this regard site classification based purely upon handaxe frequencies is of little use now. Handaxes will seldom be produced 'evenly' across space, and the functional uses of these tools, as well as their role in mobility patterns, must be considered (Goren-Inbar & Sharon 2006). It is likely that individual site variation is based on the requirements of a given group, the raw materials available in a given area, or even transporting of artefacts off-site, hence giving rise to variable LCT frequencies.

2.1.2 Large flake Acheulean

Another important component of the Acheulean is the production of large flakes >100 mm in length (Sharon 2006, 2008, 2010; Mishra *et al*. 2010). Although many of the core forms present in most Acheulean assemblages are largely similar to those in the Oldowan, the production of large flakes in the Oldowan is extremely rare (Harmand *et al.* 2015). Mishra *et al*. (2010) describe this difference according to strategies in core reduction: the Oldowan is characterised by small cores giving rise to small flakes, and the Acheulean, which also retains small cores and flakes, is also characterised by the addition of larger cores that are used to produce larger flakes (along with new flaking strategies to reduce these larger cores; McNabb & Beaumont 2011b). Accordingly, it appears that with the advent of LCTs, a major technological barrier had been broken and the emphasis then shifted to producing these large flake blanks upon which handaxes, cleavers and picks could be produced (Mishra *et al*. 2010; Sharon 2010).

2.1.3 Improved core reduction

For the Early Acheulean there is only limited documentation of flaking strategies that may resemble prepared core technology, but improved knapping strategies have been identified in some earlier assemblages (see Texier 1995; Semaw 2000; Delagnes & Roche 2005; and see Leader *et al.*, this volume). Most notable though is the hierarchical bifacial centripetal method described in the Early Acheulean from Peninj (de la Torre 2009). This is a fairly complex flaking process that maintains bifacial working through asymmetry created between the upper and lower planes of the core (one surface will form a subordinate plane from which the principal upper surface can be exploited). This process is geared towards core surface preparation, which prepares a core in such a way that flake detachment is more carefully controlled. Thus the presence of more 'organised' strategies during the Acheulean attests to the evolutionary development of prepared core technology within and from the Early Acheulean (White *et al.* 2011).

Prepared core technology first appears during the later stages of the Early Acheulean and is now recognised as forming a component in several early assemblages (Kuman 2001; McNabb 2001; Fluck 2002; Sharon 2006; Sharon & Beaumont 2006; Lycett 2009; Lycett *et al*. 2010; McNabb & Beaumont 2011b; Leader 2013). One example of this more advanced core reduction is the Victoria West Industry, a regional development in the interior of South Africa. At Canteen Kopje in the Northern Cape, it is dated to >1 Ma (Gibbon *et al*. 2013; Leader 2013; Li *et al.* 2017). Victoria West cores document an advanced system of preferential detachment of large side-struck flakes from assymetrical cores (Sharon 2006; Sharon & Beaumont 2006; Leader 2013). Other techniques of core preparation during the Acheulean occur elsewhere in Africa in the Sahara (the Tabalbala-Tachengit technique, with no absolute dates; Tixier 1957; Biberson 1961; Clark 1992, 2001; Sharon 2006; Sharon & Beaumont 2006), and in Kenya and elsewhere with the Kombewa Core Method (>1 Ma; Clark 1998; Chavaillon & Berthelet 2004; Sharon 2006). However, the Victoria West method is the oldest form of core preparation (Li *et al.* 2017).

Although it is both extremely difficult and frequently problematic to create a list of diagnostic 'Acheulean tool/artefact types,' McNabb and Beaumont (2011b) in this regard state that the basic Acheulean 'package' therefore includes the advent of LCTs, the production of large flakes from cores (through improved core preparation strategies) and core and flake forms synonymous to those found during the Oldowan.

2.2 Hominid behaviour during the Acheulean

In considering hominid ranging abilities in the Acheulean, tethering to important resource areas is evident throughout, but there appears to be a notable increase in the size of territories over time (Clark 1994; Rogers *et al.* 1994; Harris *et al.* 2007). One way of establishing these ranging abilities is by looking at the raw materials used for artefact production, and from where these have been sourced. For the interior of South Africa (specifically Vaal River Basin sites), most sites occur on what would have been the banks of the Vaal River; raw materials in the form of river cobbles and boulders were readily available close by. In this regard Klein (2000a) states that for most known southern African localities, raw materials were available within only a few kilometers. However, at the Later Acheulean site of Elandsfontein in the Western Cape of South Africa, Deacon & Deacon (1999) highlight that raw material sourcing may have occurred over distances of between 10-30 km, perhaps upwards of 40 km (Braun *et al.* 2013). In relation to modern hunter-gatherers, Klein (2000a) suggests that Acheulean hominid territories were most likely not comparable or as extensive.

However, this increased ranging attests to the use of more varied landscapes during the Acheulean (Kuman 2014).

One of the most significant technological developments of the Acheulean is the controlled use of fire, which brought with it behavioural changes connected to social interactions and the ability to control aspects of diet, bodily warmth, and protection from predators (Alperson-Afil *et al.* 2007). Evidence suggesting this controlled use of fire, however, is highly contested and frequently difficult to interpret as many sites are only poorly preserved and occur in open-air localities (see reviews by James 1989 and Alperson-Afil *et al.* 2007). However, in South Africa two sites retain early evidence for burning: Swartkrans, at 0.96 Ma, contains bone which appears to have been burnt in a campfire and was then subsequently washed into an underground cave deposit (Brain & Watson 1992; Brain 1993b); Wonderwerk Cave contains burnt bone and vegetation from a single horizon dated to 1.1 Ma and is regarded as indicating *in situ* burning (Beaumont & Vogel 2006; Beaumont 2011; Berna *et al.* 2012). However, it is beyond Africa where the clearest early evidence for the use of hearths exists. This is present in Israel, at the site of Gesher Benot Ya'aqov, with evidence dating to 0.8-0.7 Ma (Alperson-Afil *et al.* 2007; Alperson-Afil & Goren-Inbar 2010).

Additional social, technological, conceptual and organisational developments took place during the Acheulean. Lithic technology during the entire Acheulean changes very little, suggesting the development of a standard 'conceptual and purposeful' design for LCTs (McNabb *et al*. 2004; Sharon *et al.* 2011). Although there is variation in LCTs between sites, due to raw material differences, preferences by individual hominid groups, and even (immeasurable) factors concerning hominid age and skill level (Clark 2001), most pertinent is the consistency in their overall form through time. Irrespective of whether this standardisation in tool manufacture was intentional or not, the proliferation and abundance of LCTs throughout Acheulean sites suggests that a level of social interaction and cohesion had developed that was not as advanced during the preceding Oldowan (McNabb *et al*. 2004). It would be difficult to assume that a 'standardised' design could proliferate and be replicated across continents without a 'social dissemination' of these ideas (McNabb *et al*. 2004; and see discussions by Lycett & von Cramon-Taubadel 2008), whereas others have suggested that this was at least partly under genetic control (see Corbey *et al.* 2016). McNabb *et* *al*. (2004) discuss the possibility of 'social traditions' within the Acheulean, whereas others have questioned whether the term 'tradition' can even be used to describe such a technology (Lycett & Gowlett 2008).

Irrespective, the increase in overall social organisation may also be related to improved subsistence strategies, and faunal assemblages in South Africa that could address this are currently limited to the Later Acheulean sites of Elandsfontein and Cave of Hearths. Klein (2000a,b) questions whether Acheulean hominids had either primary or secondary access to animal resources. Were Acheulean hominids hunters or scavengers? At Cave of Hearths, Ogola (2009b) has shown that fauna had a complex accumulation history and hominids appear to have been the accumulators whilst carnivores the modifiers of assemblage components. At the open-air site of Elandsfontein, Klein *et al.* (2007) conclude that there is little taphonomic evidence to suggest that hominids had played a significant role in the accumulation of the faunal assemblages.

However, new lithic research by Wilkins and Chazan (2012) at the site of Kathu Pan, Northern Cape Province, South Africa provides compelling evidence for blade production, as well as the development of hafted points (Wilkins *et al*. 2012) during the Later Acheulean. These technological adaptations are most frequently associated with the Middle Stone Age (MSA) and they brought with it an improved ability for hominids to hunt and injure game. At ca. 500 ka (thousand years) at Kathu Pan, this pushes back the earliest forms of hafting by 200 ka; this directly implies that the proliferation of hafting during the MSA was not a unique 'MSA invention', but rather, one which developed towards the terminal point of the world's longest lasting stone tool tradition, the Acheulean (Wilkins *et al*. 2012). However, more recently Rots and Plisson (2014) provide a critique of this study and call this finding into question based upon methodological and interpretive differences. A response by Wilkins *et al.* (2015) asserts that their findings are robust, based upon a combination of evidence. Irrespective of these recent debates this research hints at the possibility of improved hunting proficiency during the Acheulean and that hominids were actively seeking out game for capture.

2.3 Acheulean hominids

The term 'hominid' is used in this paper to refer only to humans and their ancestral kin going as far back as their divergence from the great apes or 'pongids (see discussions by Underdown 2006; Wood & Harrison 2011; Clarke 2014). The significant changes that occur within the archaeological record at the start of the Acheulean were most likely brought on by the arrival of a new African hominid species called *Homo ergaster* (also known as African *Homo erectus*; Rightmire 1990; Klein 2000a,b; Coolidge & Wynn 2009; Grine *et al.* 2009; de la Torre & Mora 2014). The earliest appearance of this hominid occurs in East Africa, Kenya, at 1.7 Ma at the site of Koobi Fora (Lepre & Kent 2010). In South Africa, *ergaster* specimens are found in direct association with Acheulean artefacts at Sterkfontein, in the Member 5 levels, estimated to 1.7-1.4 Ma (Kuman & Clarke 2000); at Swartkrans, *ergaster* fossils are dated to >1.7 Ma (Pickering *et al*. 2012). *Homo ergaster* is characterised by more sapient (human-like) traits, and these include: an increase in cranial capacity, modern body proportions (long legs and arms), reduced sexual dimorphism (size differences between male and females), an improved ability to walk long distances (increased ranging), better adaption to heat, higher quality diet, more complex social structures (sharing, cooperating, colonising, organising), and the skillful use of stone technologies (Bar-Yosef & Belfer-Cohen 2001).

Stone artefact production during later phases of the Acheulean is frequently associated with several other hominid species. Although there is much debate as to the classification of these specimens (see discussions by McBrearty & Tryon 2006; Coolidge & Wynn 2009; Herries 2011; Dusseldorp *et al.* 2013; Wadley 2015), it is clear that a more evolved form of *Homo* is responsible for these advanced developments during the Middle and Later Acheulean. For the Middle Acheulean, at around 1 Ma, hominid remains are preserved within the Bouri Formation (Daka Member, Middle Awash, Ethiopia; Asfaw *et al.* 2002) and Danakil Formation (Buia, Eritrea; Abbate *et al.* 1998). The former represents *Homo ergaster*, interestingly showing intermediacy between both earlier and later African fossils; its temporal and geographic position indicates that *Homo ergaster* was the ancestor of *Homo sapiens* (Asfaw *et al.* 2002). The well-preserved *Homo* cranium from Buia provides an interesting mixture of characters typical of both *Homo ergaster* and *Homo sapiens* (Abbate *et al.* 1998). This mix of traits provides crucial data on the morphological variation of early-middle Pleistocene *Homo* crania, suggesting morphology similar to that of *Homo sapiens* had begun to differentiate in Africa at 1 Ma (Abbate *et al.* 1998).

Hominids responsible for the Later Acheulean include archaic forms of *Homo sapiens* (the term 'archaic' is used to refer to all sub-species under and including *Homo heidelbergensis* and *rhodesiensis*). Fossil specimens for these hominids include: the Bodo cranium, Ethiopia, at 0.65-0.55 Ma (Clark *et al.* 1994); a skullcap from the site of Elandsfontein, South Africa, at ca. 0.5 Ma (Drennan 1953; Singer 1954; Klein *et al.* 2007); the Ndutu cranium, Tanzania, at 0.4 Ma (Rightmire 1983; Clarke 1990); and the Kabwe cranium, Zambia, at >0.4 Ma (Rightmire 1998).

Artefact refinement during the Later Acheulean can be linked to the slower maturation rate of more advanced *Homo* (Kuman 2014). Hominids learned to make stone tools by watching and learning their group's tradition. Early *Homo ergaster* is well recognised as having a faster maturation rate compared to that of modern humans, based primarily on differences in dental development (see discussions by Smith 1993; Dean *et al.* 2001; Dean & Smith 2009; Graves *et al.* 2010; Antón & Snodgrass 2012; Schwartz 2012). With the advent of archaic *Homo sapiens,* maturation rates are likely to have slowed, allowing more time to be spent on not only observing and interacting with other group members, but also innovations that improved artefact technology.

3. The South African sites

In this section we provide a background to the Acheulean sites of South Africa that are >0.5 Ma (Fig. 1; Table 1), since these are most relevant to the Sundays River Valley sites for comparative purposes. A detailed discussion is provided for five specific sites, namely Canteen Kopje, Wonderwerk Cave, Amanzi Springs, Cave of Hearths and Montagu Cave, and here we provide basic information that relates specifically to site context, chronology (age) and assemblages, with a focus on stone tools only. In addition to these discussions basic descriptive comparative data are provided for each site that concerns cores, retouched pieces and LCTs, looking specifically at variations in artefact frequency and production strategies.

Insert Table 1 here

3.1 Canteen Kopje

Canteen Kopje is a Vaal River Basin site found within the Northern Cape Province, close to the town of Barkly West. Recent studies (see Table 1 for references) provide an improved understanding of the formation of the site and the preserved Early Acheulean assemblages. Excavations in Areas 1 and 2 (Beaumont & McNabb 2000; McNabb 2001; McNabb & Beaumont 2011a,b), and Pit 6 (Leader 2013), provide details on the stratified gravels and sands found across this site, however, the depositional units between these areas are not entirely comparable (De Wit 2008).

Although this may be the case, deposits in Pit 6 preserve two Early Acheulean assemblages, overlain by Victoria West Acheulean material (Leader 2013). Through the application of the cosmogenic nuclide burial dating method, the two lower units have been dated to 1.51 Ma (Organised Core Acheulean assemblage) and >1.5 Ma (Basal Early Acheulean assemblage); the Victoria West Prepared Core assemblage is >1 Ma (Table 1; Gibbon *et al.* 2013; Leader 2013; Kuman in press; Li *et al.* 2017). These gravels at Canteen Kopje form part of the Rietputs Formation (McNabb & Beaumont 2011a,b).

A detailed analysis of the Pit 6 assemblages is provided by Leader (2013; see summary in Table 2). As the assemblage names suggest, the difference between the two basal units is primarily related to core reduction, of which the Basal Early Acheulean lacks both prepared and organised cores, whereas the overlying Acheulean levels contain organised cores (those with more organised knapping techniques in the form of asymmetrical control; Leader 2013). The Basal Early Acheulean assemblage is comprised mainly of flakes and flaking debris, with simple cores (casual and irregular, 55%); bifaces (n=33) are dominated by cleavers and other tools include flaked-flakes and scrapers (Leader 2013). Andesite is the most favoured raw material, with a small amount of hornfels. The overlying Organised Core assemblage is similar in composition, with the addition of bifacial chopping tools. Improved core reduction strategies here are seen as an important advancement over the older underlying Basal Acheulean levels (Leader 2013). The uppermost Victoria West Prepared Core assemblage provides the most advanced core reduction strategy at the site as a small component among the cores (Fig. 2d; Table 2). It is suggested, by Li *et al.* (2017), that this assemblage represents the earliest representation of Prepared Core Technology (PCT) in the world.

Canteen Kopje provides a unique Acheulean sequence. The catchment area of the Vaal River sampled at this site was clearly utilised over a very long period of time, most likely due to its favourable location and proximity to good quality raw materials, especially in the form of large andesite boulders (McNabb & Beaumont 2011b). These boulders were then reduced as cores, from which large flakes could be obtained that could then serve as blanks for LCT production (especially relevant for the Victoria West cores; Table 2; McNabb & Beaumont 2011b).

Insert Table 2 here

3.2 Wonderwerk Cave

Wonderwerk Cave is situated on the eastern flank of the Kuruman Hills, in the Northern Cape Province. The site is comprised of deposits filling a phreatic tube, approximately 10-20 m in height, that extends inwards 140 m at the base of a hillside (Chazan *et al.* 2008). The cave formed in the dolomites of the Late Archean-Early Proterozoic Ghaap Group, found underlying the Banded Ironstone Formation of the Griqualand West Sequence (Beaumont & Vogel 2006; Matmon *et al.* 2012).

At present, the longest ESA sequence at the site occurs in the (approx.) 2 m deep sequence of Excavation 1 (Berna *et al.* 2012). This sequence has been divided into different archaeological and lithostratigraphic strata; the correspondence between these strata is limited. Most relevant here are the assemblages pertaining to archaeological Strata 5-11 (see Table 1 for ages and references). Sedimentological details summarised by Beaumont and Vogel (2006) for the Wonderwerk excavations highlight three main constituents for all the ESA levels, which include: a well-sorted reddish fine silt and sand comprised of sub-rounded quartz grains (with extraneous origin; Chazan *et al.* 2012), roof debris (of varying quantities between the strata), and organic residues (e.g., wood ash) introduced through humans, porcupines and birds. Water transport from the cave entrance and aeolian action are possible sources for the introduction of the extraneous sands (Beaumont & Vogel 2006; Chazan *et al.* 2008). Overall, Wonderwerk Cave provides a unique sequence of extremely dry deposits, which most likely accounts for the high preservation of organics (Beaumont & Vogel 2006). This sequence also provides one of the longest records of *in situ* ESA and ESA/MSA transitional material (Chazan *et al.* 2008).

The earliest assemblages from Strata 10 and 11 are small (Beaumont & Vogel 2006; Chazan *et al.* 2012). However, in general the upper Strata (5-11) from Excavation 1 all represent a Mode 2 Acheulean technology, dominated by bifaces and a limited number of cores and flakes (Fig. 2b; Chazan *et al.* 2008). Other characteristic features of the local Acheulean, such as Victoria West technology and cleavers, are poorly represented (Chazan *et al.* 2008). Basal Stratum 11 marks the advent of bifacial technology with two crude asymmetrical bifaces, shifting in Stratum 10 to bifaces with noninvasive retouch (Fig. 2b; Table 3; Chazan *et al.* 2008; Berna *et al.* 2012; Chazan 2015).

Previous research has classified the upper Strata (5-7) assemblages as Fauresmith (Late, Middle and Early; Beaumont & Vogel 2006), although there is a lack of both large flake-blade (or Levallois) production and prepared core technology for these levels. More recently though, Chazan (2015) suggests there is the possibility that these artefacts are typologically 'Fauresmith.'

Basic trends in biface shape and size are summarised in Table 3, from Chazan (2015). These notes discuss technological progression in the LCT sample from Strata 5-10, and these new data show a refinement in LCTs through time. Specifically, there is a progression in the systematic production of LCTs using noninvasive removals in Strata 8-10, with a shift towards more invasive removals in Strata 5-8.

Insert Table 3 here

3.3 Amanzi Springs

Amanzi Springs is the only ESA site in the Eastern Cape to be sufficiently documented through excavation. Located within the Uitenhage District, on a hillside overlooking the Coega River Valley, the site is associated with a series of spring deposits (Amanzi Springs Formation) corresponding to two separate phases of artefact accumulation (the two lower members preserve the Acheulean material – the Enqhura and Rietheuvel Members; Deacon 1970). Although there are other ESA sites within the Eastern Cape (e.g., Geelhoutboom; Laidler 1947), the majority is surface scatters and contextually are of minimal value. It appears that Amanzi Springs was most likely a favoured point on the local landscape, due to its availability of fresh water and its vantage point over the Coega Valley (Deacon 1970). The preserved deposits also appear to represent multiple occupations, through time.

Studies at Amanzi Springs by Inskeep (1965) and Deacon (1970) investigate the stratigraphy of the site, artefact typology, the presence of organic remains, the extent of the deposits, and the duration of site occupation. Our understanding of this site, however, is still limited (Deacon 1970). Overall the site is of secondary context and contains a rich sample of diagnostic Acheulean material including handaxes, cleavers, large bifacial tools, flakes and retouched pieces, all of which were described as heavy and unstandardised in form (Table 4; Fig. 2e; Inskeep 1965; Deacon 1970). The site has not been dated, but based on the LCT study by McNabb *et al.* (2004), a roughly Middle Pleistocene age would be appropriate (Table 1).

Amanzi Springs serves as the only proxy with which new ESA material can be compared for the rest of the Eastern Cape (Table 4).

Insert Table 4 here

3.4 Cave of Hearths

Situated within the Limpopo Province the Cave of Hearths site is found within the Makapan Valley, an area preserving ancient sediments within caves found along its margin (Maguire 2009). The surrounding landscape is characterised by high lying quartzites and dolomites, of which the dissolution of the latter has given rise to a complex cave system preserving three Beds (1-3) with ESA artefacts (Latham & Herries 2004, 2009 provide detail on the development of these beds). Although no absolute dates have been obtained for these beds, Herries and Latham (2009) provide a maximum age of 0.78 Ma, with a best age estimate at 0.5 Ma (Table 1). Mason (1988) originally envisioned occupation within the cave, along with the preservation of primary *in-situ* knapping activities, but McNabb (2009) has shown that the assemblages have been disturbed and are of secondary context. McNabb (2009) also concludes that the assemblages do not appear to represent an intensive long-term accumulation or one by a large group of hominids.

Originally excavated in the 1950s by Mason (1962; 1988), updated details of the assemblages are presented by McNabb (2009; see Table 5), with LCT refinement studies more recently provided by Couzens (2012) and Li *et al.* (submitted). A sample of 2212 artefacts occurs within a sloping talus cone, comprising a range of LCTs (cleavers dominate), cores (non-prepared), flakes (some retouched) and various unknapped elements (hammerstones, manuports and spheroids; McNabb 2009). Raw materials vary, yet quartzite is the most favoured and well-preserved material; its influence on tool production and behaviour though is negligible (McNabb 2009). Blank type selection followed strict rules for specific artefact types (e.g., size for LCTs), and these blanks were sourced from suitable outcrops in the surrounding landscape (McNabb 2009). For LCTs, large side-struck flakes are most common and these were then reduced (mostly off-site) according to a highly standardised knapping strategy (McNabb 2009). Although this strategic reduction was employed, individual variation in the morphology of LCTs suggests an unstandardised final form (Fig. 2a; Table 5; McNabb 2009). Cores and flakes are also dominated by quartzite, yet the lack of small debitage (chunks, chips and flakes) in the cave suggests off-site knapping (McNabb 2009). As with LCTs, blanks for core reduction were chosen primarily on size, and an abundance of discoids in the assemblages suggests an emphasis on the reduction of flat blanks that are thin in cross-section; McNabb (2009) proposes that discoids may have served both as cores and as tools.

Insert Table 5 here

3.5 Montagu Cave

The Montagu Cave site is located near to the town of Montagu, in the Western Cape Province. Found within the valley of the Little Karoo, flanked by the Cape Fold Mountains of the Swartberg (to the North) and the Langeberg (to the South), this cave is located along the southern boundary of the valley within Table Mountain Sandstones (Keller 1973). Comprised of two chambers, an inner and an outer, excavations have only been conducted in the outer chamber where archaeological material is preserved in a series of cave strata (Keller 1973). Based on the morphology and dimensions of this chamber and its opening, occupations of the cave appear to have been most intense towards the rear (Keller 1973). The cave was formed by the dissolution of weaker strata in the exposed Table Mountain Sandstones, causing roof collapse and an overall expansion of the cave system (Keller 1973). Keller (1973) provides a detailed account of the stratigraphy and associated assemblages preserved at the site, of which later Acheulean material is described from Layers 3 and 5 (Tables 1 & 6). A comparison of these assemblages shows that both are dominated by a high percentage of waste debris (Keller 1973). Overall, the distribution of LCTs (Fig. 2c), minimally trimmed pieces, cores and scrapers is similar; however, differences in the types of scrapers, the range of core types, and types of waste do occur between the layers. Scrapers are smaller in Layer 3 whereas large scrapers appear in Layer 5; discoidal cores dominate both layers, with a higher prevalence of plano-convex cores in Layer 5 (Keller 1973). These are described as being similar to unstruck Victoria West cores (Keller 1973); however McNabb *et al.* (2004) state that illustrations of the cores do not indicate this.

Keller (1973) interprets the site as a workshop where hominids were sourcing locally available quartzite cobbles, from the nearby valley, upon which artefacts were then produced. Occupation of the cave took place over multiple periods, evidenced by the preservation of what appear to be horizons of flaking debris and tools, suggesting knapping floors (McNabb *et al.* 2004). The site remains undated (Table 1).

Insert Table 6 here

Insert Figure 2 here

4. Discussion

Almost all of the South African Acheulean assemblages occur within disturbed, secondary context, open-air locations (Klein 2000a; Herries 2011; Lombard *et al.* 2012). Although an extensive distribution of surface sites covers most of southern Africa (Fig. 1; Table 1; see also Sampson 1974; Klein 2000a; Harris *et al.* 2007; Kuman 2007, 2016; Herries 2011), the majority of these lacks stratigraphic context and conditions for early site preservation are rarely met (Kuman 1998). For millions of years the southern African landscape has been dominated by erosion and planation, thus occasional sediment traps within which ESA artefacts could be buried are extremely limited; where sites do occur (Fig. 1; Table 1) these are restricted to occasional caves (e.g., most of the Cradle of Humankind sites, and Cave of Hearths, Montagu and Wonderwerk Caves), fluvial deposits (sites along the Vaal and Orange Rivers and elsewhere, e.g., Canteen Kopje, Rietputs 15, and Three Rivers), valley fill deposits (Cornelia), seasonal lake basins (pans or playas, e.g., Kathu Pan 1 and Doornlaagte), sporadic spring mounds (Amanzi Springs), coastal sites within aeolian environments (Elandsfontein), and open-air sites of mixed origin (e.g., Goldsmiths, Maropeng and Geelhoutboom). In reality though there are no sites in South Africa with rich sedimentary sequences, with artefacts and fossils, like those found in East Africa. As a result the total number of sites from which we can base our understandings of the Acheulean tradition in South Africa is low, particularly for earlier phases of the Acheulean. The discussion below highlights some of the general issues we have with these types sites; these relate primarily to site context, dating, and the assemblages.

Until recently, the artefact-bearing sites located in the Cradle of Humankind in Gauteng (e.g., Swartkrans, Kromdraai A, Coopers Cave, and Sterkfontein; Table 1) have provided most of the only early deposits with stone tools for the whole country (Kuman 2016), thus highlighting the limited distribution and preservation of early sites elsewhere (Kuman 1998). Although these sites occur preserved within cave infills none is a living site, but rather, areas where surface occupation material was sporadically channeled (through surface wash/flow) into cave entrances (Kuman 2003). In addition to this these pieces frequently lay exposed on the surface at cave entrances for long periods of time (seen in artefact weathering), before being differentially deposited into the caves themselves (Kuman 2007). As a result all of these assemblages have been modified, due mainly to incomplete site capture and/or a winnowing of the smallest assemblage components (Field 1999). None is a primary-context accumulation that could provide detailed spatial information. In general these cave deposits are also difficult to interpret due to re-working, dissolution, solution cavities, collapses and mixing (Kuman 2003). All possibilities of understanding landscape-use patterns are therefore restricted as our interpretations are limited to only a few keyhole sites. It is clear that cave entrances would have been favoured points on the local landscape at the time, sought after for shade, water and protection, but this is generally the limit of our interpretations.

High energy alluvial gravel sites (e.g., Canteen Kopje, Rietputs 15, Three Rivers; Table 1) have contributed significantly in moving our focus away from the Cradle of Humankind sites as they document the widespread distribution and proliferation of the Acheulean tradition across the sub-continent (Kuman 2007). However, they contain heavily abraded time-averaged assemblages (Mason 1962; Leader 2009, 2013) and assessing the behavioural and technological complexity of these assemblages is limited due to a lack of vital site spatial information, as well as fauna. Our interpretations are based purely upon the artefacts themselves. With that said, new research by Leader (2009, 2013) on the assemblages from Rietputs 15 and Canteen Kopje provides vital information of artefact production and core preparation strategies during the Early Acheulean. Locating more of these alluvial sites within finer silts and sands (low energy environments with better artefact preservation) is needed.

Slightly more favourable lower energy deposits include those found at Amanzi Springs, Doornlaagte, Kathu Pan 1, Elandsfontein and Cornelia, as well as the cave sites Wonderwerk Cave, Cave of Hearths and Montagu Cave (Table 1). The cave assemblages at sites Cave of Hearths, Montagu and Wonderwerk Caves have contributed significantly to our understandings of hominid behaviour and technological advancements during the Pleistocene (e.g., use of fire at Wonderwerk Cave ca. 1 Ma; Berna *et al.* 2012); these sites also have greater potential for dating (e.g., Cave of Hearths and Wonderwerk Cave; Herries & Latham 2009; Matmon *et al.* 2012; Goldberg *et al.* 2015). Some of the best and most informative sequences are preserved at pan sites, which document repeated visits to the area by hominids sourcing both game and water (e.g., Kathu Pan 1; Porat *et al.* 2010; Wilkins & Chazan 2012; Wilkins *et al.* 2012). The coastal dune and cave sites provide some of the best conditions for faunal preservation (e.g., Elandsfontein and Cave of Hearths; Luyt *et al.* 2000; Klein *et al.* 2007; Curnoe 2009; Ogola 2009b), as does the bone bed at Cornelia (Brink *et al.* 2012). Elandsfontein (Table 1) is a major fossil and archaeological locality in the Western Cape where the assemblages document hominid production and use of stone artefacts at different places on the landscape (Braun *et al.* 2013). New archaeological and geological data obtained by Braun *et al.* (2013) are thus showing some landscape archaeology potential, where it is possible to investigate the relationship between hominid behaviour and the surrounding environments across various spatial scales.

The majority of all southern African sites though contains little datable material (volcanics and fauna), and developing a reliable chronology is therefore difficult (Klein 2000a; Mitchell 2002; Phillipson 2005; Kuman 2007; Herries 2011). This is in stark contrast to the sites of East Africa where the preservation of volcanic sediments and ash, interspersed between depositional units, allows for direct dating and regional inter-site correlations (Klein 2000a). Stratigraphy and dating in South Africa is therefore heavily reliant on the documented East African sequence, and no site can be correlated to any well-dated external stratigraphy (Klein 2000a).

Well-dated Acheulean sites in southern Africa are therefore few in number (especially between 1.3-0.78 Ma; Table 1; Kuman 2014), due primarily to the poor conditions of site preservation (discussed above) and the limit of reliable means of dating within such contexts (Herries 2011). Cave sites provide the best potential for dating in this region (see especially recent work by Matmon *et al.* 2012 and Goldberg *et al.* 2015), as do the alluvial gravel sites. Although the context of these alluvial sites is not ideal they are still contributing significantly to our understanding of southern African site chronology. New dating approaches, such as the cosmogenic burial dating method, are now providing a range of ages for these sites and the applicability of this method is now well documented (Granger 2006, 2014; Gibbon *et al.* 2009a; Gibbon *et al.* 2013; Granger *et al.* 2013; Gibbon *et al.* 2014; Leader 2013; Granger *et al.* 2015).

Several important southern African sites remain to be placed securely in time and their age can currently only be estimated through either faunal (e.g., Coopers Cave D, Sterkfontein Member 5, Kromdraai A, Swartkrans Member 2, and Goldsmiths) or artefact comparisons (e.g., Maropeng, Three Rivers, Doornlaagte, Amanzi Springs and Montagu Cave). At present the only ESA sites in southern Africa with reliable age ranges include: Rietputs 15 (Gibbon *et al.* 2009a), Canteen Kopje (Gibbon *et al.* 2013; Leader 2013), Wonderwerk Cave (Matmon *et al.* 2012; Goldberg *et al.* 2015), Swartkrans Member 3 (Gibbon *et al.* 2014), Cornelia (Brink *et al.* 2012), Elandsfontein (Braun *et al.* 2013), Cave of Hearths (Herries & Latham 2009) and Kathu Pan 1 (Porat *et al.* 2010).

Many of the South African assemblages also lack adequate description, due either to the limited quantity of material recovered (e.g., Coopers Cave, Kromdraai A, Goldsmiths), or, dating (e.g., Doornlaagte and Amanzi Springs), and site formation issues (e.g., Maropeng, Geelhoutboom, and Goldsmiths). There is a need to locate and describe (both typologically and technologically) new assemblages for southern Africa.

4.1 An introduction to the Sundays River Valley

In this regard, assemblages from the lower Sundays River Valley can contribute to our understanding of the South African Acheulean. The present-day Sundays River originates along the edge of the Great Escarpment. From here it flows south towards the Indian Ocean, intersecting the Klein Winterhoek Mountains about 80 km from the coast (Hattingh & Rust 1999). These mountains, extremely rich in quartzites and sandstones, account for more than 95% of the clasts downstream (Ruddock 1948; Hattingh 1994; Hattingh & Rust 1999). Flowing south from these mountains the lower Sundays River enters the Algoa Basin, comprised of highly erodible shale and mudstones (Ruddock 1948; Hattingh & Rust 1999; Fig. 3a).

The unique underlying geology of this region has enabled the lower Sundays River Valley to record changes in drainage evolution in the form of preserved fluvial terrace deposits (Hattingh & Rust 1999). Haughton (1928, 1935) was the first to identify these fluvial gravel deposits, and later research by Ruddock (1948) sought to provide a more detailed understanding of the terraces and their major physiographic features.

Based on pre-existing palaeontological and archaeological data at the time, Ruddock (1957) then concluded that the terraces preserved a record spanning the middle to the end of the Pleistocene. Ruddock (1968) then later suggested that three phases of seaward tilting and warping in the Algoa Basin were responsible for terrace formation.

More recent work on the lower Sundays River Valley has been provided by Hattingh (1994, 1996, 2008), Hattingh and Goedhart (1997) and Hattingh and Rust (1999). These studies provide a more accurate separation of the terraces based on their heights and on morphological, compositional and topographical differences (Dollar 1998). These authors demonstrate that a total of 13 terraces occurs, of which the upper nine (seen to be from the Late Miocene through Pliocene, 180-40 m above the present river level and primarily comprised of gravel deposits) can be distinguished from the lower four (Pleistocene through Holocene, 25-3 m above the present river level, primarily comprised of fine silt and sand; Hattingh 1994, 1996, 2008; Fig. 3b). The highest and oldest of these (Terrace 1) occurs 180 m above the present river level and the lowest (Terrace 13) occurs only a few meters above this present level (Hattingh 2008). Overall, these terrace deposits range in thickness from 3-12 meters (Hattingh 1996).

Numerous models have been put forward to account for the formation and evolution of these terraces (please see Ruddock 1957; Hattingh 1994, 1996, 2008; Hattingh & Goedhart 1997; Dollar 1998; Hattingh & Rust 1999 for discussions), but most relevant is a recent cosmogenic ^{26}Al and ^{10}Be dating study of the preserved terraces by Erlanger *et al.* (2012). This work sought to provide a chronology for the terraces such that uplift mechanisms and erosion rates could be questioned, and during their work Stone Age artefacts were seen eroding out from terrace deposits at three of their dating sites, namely Atmar Farm, Bernol Farm and Penhill Farm (Erlanger 2010; Granger *et al.* 2013; Fig. 3c). Most importantly these authors now provide new age ranges for the upper and lower terraces, where the former are now seen to span the Early Miocene to Early Middle Pleistocene, with the latter now spanning the Middle Pleistocene to Holocene.

Insert Figure 3 here

4.2 History of archaeological studies

Surface Stone Age artefacts in these terraces were first documented by Ruddock (1957), assisted by the Abbé Breuil and Clarence van Riet Lowe. These authors sampled artefacts primarily from the higher terraces, with artefacts being found in the bottom of gravel pits, the sides of road cuttings or atop terrace outcroppings (Ruddock 1957). No record was kept for those artefacts obtained from *in situ* positions within the gravel deposits.

The artefacts retained a varied condition (weathering/abrasion state) and a range of 'Stone Age cultures' occurred (Acheulean, Fauresmith, MSA and LSA; Ruddock 1957). These artefacts were subsequently divided, based on their condition, into six different weathering categories in an effort to differentiate between assemblages that might have been of different ages. A five-stage typological classification system was also utilised in this regard, but the details are not provided. Based on the analysis of 271 artefacts a clear trend in artefact typology and condition emerged, with the typologically youngest pieces being the most unworn. Overall, based on this classification, an Early, Middle and Late Acheulean (the Stellenbosch, an earlier term for the Acheulean at the time) was proposed, tying in with the condition of the artefacts as worn to fresh, respectively (Ruddock 1957).

These authors also attempted to determine an age for the artefacts, based on this typological and weathering state classification. Worn pieces were regarded as having been influenced by fluvial processes (many of which showed clear clast imbrication), or by some form of downslope movement along terrace outcrops, friction from nearby cobbles, bioturbation, movements within the gravels, or animal trampling (Ruddock 1957). However, due to the lack of stratigraphic control on all the samples obtained the age these authors provided, at the time, were purely speculative; van Riet Lowe suggested that the artefacts could be synonymous with those Early and Middle Acheulean occurrences in the Vaal River (Ruddock 1957).

Ever since this original survey work no one has revisited the terraces looking specifically for Stone Age implements; this remained the case until studies by Erlanger (2010) and Erlanger *et al.* (2012). Specifically, these authors noted the presence of flakes, cores and Acheulean handaxes at Penhill Farm (dated to 1.37 ±

0.16 Ma), Bernol Farm (dated to 1.14 ± 0.20 Ma) and Atmar Farm (dated to 0.65 ± 0.12 Ma; Granger *et al.* 2013; Fig. 3c). Understandably, based on these dating results and their reconfirmation that this Stone Age material occurs *in situ* within these terrace deposits (as opposed to just on the surface as recorded by Ruddock 1957), this provided justification to return to the area and locate sites through survey that would be worthy of detailed excavation.

Research by Lotter (2016) has focused on the survey and excavation of these three properties (Fig. 3c) with terrace deposits bearing Stone Age artefacts that span the Early to the Later Acheulean. The Atmar Farm site has been fully excavated but only poorly preserved, very abraded artefacts were recovered, including Acheulean LCTs. More favourable conditions occur at Bernol Farm, and although this site so far has only been tested, its fine alluvial deposits and gravel stringers preserve both Acheulean artefacts and some fauna. The fine alluvium at this site indicates floodplain deposition with minor re-working and sorting by river flow (Granger *et al.* 2013). The combination of good artefact preservation (minimal abrasion) with fauna is why this site is being targeted for future excavations. These will explore the range of preservation within the deposits. However, emphasis in this paper is placed on providing an introduction to Penhill Farm, the most valuable and informative site of all three.

4.3 Penhill Farm site context

Penhill Farm preserves a circular (amphitheater-like) exposure of Terrace 9 deposits that occur as a continuous vertical exposure of fine sediments and gravels. From the top of this exposure occur several meters of fine lightly coloured sterile overbank sands and silt (alluvium), which are massive and structureless. In the southern part of this exposure, underlying the exposed wall of fine sediments, is an imbricated pebble and cobble horizon of unknown thickness. It is this horizon that was dated by Erlanger *et al.* (2012), using the cosmogenic nuclide burial method, providing an age of 1.37 ± 0.16 Ma for overbank fine deposition (Granger *et al.* 2013). Stone Age artefacts have not been found in these gravels.

Towards the east an erosion channel has been cut into this fine alluvium and this has subsequently been filled with poorly sorted colluvium. At the base of this channel occurs a debris flow deposit, originally and incorrectly defined as a gravel stringer by Erlanger (2010) and Erlanger *et al.* (2012). This debris flow deposit is discontinuous, occurring only within the base of the cut channel, and it rises towards the surface at its southern boundary (Fig. 3d). This deposit preserves an extremely abundant collection of well-preserved ESA artefacts, and overall deposit thickness ranges from approximately 20 to 50 cm. It appears that this debris flow swept a lag of nodules, gravels and artefacts into a cone, likely from a nearby source upslope only several meters away (Granger *et al.* 2013). This flow was then deposited into the base of the erosion channel. Underlying the debris flow at approximately 2.5 m are the sterile overbank silts and sands, presumably continuing down to the dated gravels, which may be at a similar depth to those dated gravels in the southern portion of the exposure.

It must be emphasised here that the date provided by Granger *et al.* (2013) now has a questionable association with the debris flow deposit as it would have taken some time for the erosion channel to form after the deposition of the overbank fines. The infilling of this channel, with the poorly sorted colluvium, would also have taken some time to occur as the upslope lag of calcrete, silcrete and gravels needed to form prior to the debris flow event. For this reason we are currently in the process of submitting new dating samples to provide greater chronological resolution for Penhill Farm.

4.4 Introduction to the assemblage

A typological assessment of the Penhill Farm assemblage provides important information on both the character and composition of the excavated artefacts (Table 7). The total assemblage consists of 9904 artefacts and although it is dominated by flaking debris (88%) it provides good samples of cores (n=206), complete flakes (n=469) and formal tools (n=510). Overall, quartzite is favoured in artefact production (>85%), followed by siltstone and hornfels; all other materials are rare (Table 8).

Insert Tables 7 & 8 here

Flake fragments, incomplete flakes and small flaking debris (SFD<20mm) account for the most frequent debris types; the latter type accounts for 50.9% of the total assemblage (Table 7). A bipolar debris component does occur at Penhill, although this accounts for a very small percentage of the total assemblage. Raw material use for this flaking debris shows large variability and all raw material types are represented.

The classification of complete flakes illustrate that side- and end-struck flakes are the most frequent types, followed thereafter by corner-struck pieces (Table 7). All of the other remaining flake types are rare, but bipolar flakes do occur as do core maintenance flakes (i.e., rejuvenation and trimming types), albeit infrequently. As above, raw material use here follows that for the flaking debris in that there is large variability and all raw material types are represented.

Core classification illustrates that discoidal, casual and chopper-cores are most frequent at Penhill Farm (Table 7). Only a single bipolar core was recovered, and this likely accounts for the very small sample of bipolar flaking debris and complete flakes. The remaining core types are uncommon, although notable samples of irregular and single platform cores do occur, and no boulder-cores were found (Fig. 4). Raw material use is dominated by quartzites, but interestingly no cores occur on quartz, lava and silcrete, even though both flaking debris and complete flakes occur on these materials.

Insert Figure 4 here

Formal tool classification shows an abundance of scrapers, accounting for 34.3% (n=175) of the total formal tools sample, followed thereafter by MRPs and denticulates (22.9% and 16.1%, respectively; Table 7; Figs. 5 & 6). LCTs account for only a small percentage of the total formal tools sample (9.6%, n=49), and retouched flakes are nearly as frequent (9.4%, n=48). All remaining tool types are rare. Raw material use for both assemblages shows that LCTs are only made on quartzite and siltstone, the former being the most favoured material. For the remaining formal tools, siltstone and hornfels use follows thereafter. No formal tools are made on quartz and silcrete.

Insert Figures 5 & 6 here

A closer look at the Penhill Farm scrapers and LCTs shows a high frequency of denticulated and notched types for the former. Collectively, these two types account for 65.7% of the total scraper sample (n=115). Notable samples of side, composite, convex, concave and end types occur, followed by rare heavy-duty/core scrapers and individual double side and end and convergent scrapers (Fig. 6). LCT classification shows that handaxes (n=16) are marginally more frequent than cleavers (n=15). Picks (n=7) and bifaces (n=5) account for the remaining LCT sample, followed by a sample of broken handaxes/LCTs (n=6; Table 7; Figs. 7 & 8).

Insert Figures 7 & 8 here

Although a more detailed description of the Penhill Farm assemblage will be presented in future papers, some basic trends from Lotter (2016) can be highlighted here. The core sample shows that there is an abundance of simple, unstructured, knapping strategies on predominantly cobble and split cobble blanks. The level to which these cores are reduced is low. The large sample of formal tools shows a preference for flake blank use and the production of small retouched items, most notably scrapers. Retouch though is generally simple and expedient, with little emphasis on careful edge modification. Within this formal tools sample the LCT assemblage is large, contains much variability in size and shape across individual pieces, and is characterised by the use of flake blanks. The primary strategy in shaping is bifacial reduction extending across large portions of the LCTs, although the majority retains some cortex and thus reduction/shaping is still limited.

4.5 Inter-site assemblage comparisons

The purpose of this section is to provide some basic comparisons between Penhill Farm and other local Acheulean sites that are within the general time range of the

Sundays River sites, namely Canteen Kopje, Wonderwerk Cave, Amanzi Springs, Cave of Hearths and Montagu Cave. Emphasis here is placed upon drawing basic typological and technological comparisons between these assemblages relating to three of the most informative assemblage components at each site, namely cores, retouched pieces and LCTs. Providing such comparisons, from a purely descriptive and qualitative standpoint, is difficult, due mainly to variability at the assemblage level and differences in artefact analysis and classification, through time. However, every effort has been made to synthesise basic trends that are most prevalent, along with other notable variations (Tables 2-6). As such these comparisons are broad and although this section is largely speculative, it is informative nonetheless as it provides a rough indication for site-level similarities between the assemblages.

4.5.1 Core reduction

Interestingly there is a great deal of similarity in the way cores are reduced at each of the highlighted sites. Discoidal cores, with radial/centripetal reduction strategies, account for the majority of all cores at Amanzi Springs, Montagu Cave (all layers) and Cave of Hearths (all beds). However, some sites do illustrate greater variability in core reduction and retain notable samples with differing strategies, namely: the Victoria West levels at Canteen Kopje, showing simple casual cores are the most frequent core type and Amanzi Springs, with a high prevalence of casual cores.

From this it would appear then that the high frequency of radial core reduction at Penhill Farm is largely comparable with the majority of the highlighted sites, and the fact that radial core reduction has played an important role in the majority of these sites is significant. One interesting point though is a lack of bipolar cores at all of the highlighted sites, yet at Penhill Farm these elements do occur. This indicates some variety in the reduction of cores at Penhill, but the fact that these pieces are so infrequent suggests such activity was rather the exception than the norm.

Perhaps more interesting is the high frequency of casual cores at both Canteen Kopje and Amanzi Springs, which should relate to the high abundance of raw materials in the local landscape at both sites (Deacon 1970; Leader 2013). A similar trend is evident at Penhill Farm, where raw materials are readily available in the local landscape, coupled with a high frequency of these simple casual cores. It would appear at all these sites then that there was no need to economise raw materials and extensively reduce cores. This would be further supported by the low scar counts on the remaining cores types at Penhill Farm.

4.5.2 Retouched piece frequency and reduction

There are remarkable similarities in the types of retouched artefacts that are common in most of the highlighted sites. Scrapers, although variable between all of the sites, are common and account for notable percentages of retouched formal tools in most of the sites, including: Amanzi Springs, Montagu Cave (all layers), Cave of Hearths (all beds) and Canteen Kopje (Victoria West levels); side scrapers are generally more common, especially at Amanzi Springs. Conversely, there are some important differences that occur in the frequency of retouched pieces at certain sites. For example, Cave of Hearths (all beds) retouched artefacts show a greater range of types, including denticulated and composite pieces, and Montagu Cave (all layers) has a high frequency of minimally trimmed flakes, chips and chunks.

Overall, scrapers are the most frequent retouched formal tools at Penhill Farm. Although denticulated and notched scrapers are most common, side scrapers account for a notable sample. This suggests that Penhill Farm compares well with the majority of the highlighted sites, yet proportions of simpler denticulated and notched types at Penhill Farm are higher. Perhaps there is also good comparability to sites like Cave of Hearths and Montagu Cave. These sites show a wider range of retouched items, and most significantly they also include composite pieces (Cave of Hearths; McNabb 2009) and minimally trimmed pieces (Montagu Cave; Keller 1973). As composite pieces are absent from the rest of the highlighted sites, this type may therefore form an important component in certain Later Acheulean assemblages. Composite pieces, although infrequent at Penhill Farm, have clearly played an important role in subsistence activities. In addition to this the high percentage of MRPs may be largely comparable to those ‘minimally trimmed items’ from Montagu Cave. Both of these sites are cave sites, and although the Cave of Hearth assemblages do not appear to represent a long-term occupation or one by a large group of hominids (McNabb 2009), Montagu Cave illustrates repeated site visits and occupations over multiple periods (Keller 1973). Clearly Penhill Farm was never a cave site, but perhaps then the presence of these tools here, and in the two cave sites, may purely then relate to similarities in site-based subsistence activities.

Available data that highlight the way in which these retouched artefacts are produced show several similarities between the sites. Retouch, although highly variable, is generally irregular, noninvasive (short removals), marginal to blank edges, and the edge shapes created show little standardisation (exceptions do occur). Where data are available, flake blanks are favoured for retouching (e.g., at Amanzi Springs and all beds at Cave of Hearths). By site, however, there are some notable differences that characterise these retouched pieces, most notably at Canteen Kopje where notched and denticulated retouch occurs infrequently, and at Amanzi Springs where denticulated retouch is common but notching is uncommon.

Penhill Farm retouched artefacts clearly share some of the traits listed above. However, there is a clear preference for simpler notched and denticulated edges at this site and these types may compare well with those at Canteen Kopje and Amanzi Springs. It is interesting that Amanzi Springs also retains a high prevalence of denticulated edges, as does Penhill Farm, and with this site occurring in the same region, perhaps these edges were best suited to subsistence activities in the local landscape. However, these types also occur in the majority of sites, which only illustrates their importance in providing a solution to specific subsistence activities.

4.5.3 LCT frequency and reduction

The most difficult artefacts to compare between the sites are most definitely the LCTs. This is mainly due to the high level of variability that occurs in their production, between sites and even within single assemblages. Furthermore, we need to consider that our understanding of LCT production has changed through time, as have the methods we use to quantify and describe this technology. Perhaps this high variability should be expected when discussing the artefacts. Nonetheless, a basic assessment of which LCTs are most frequent at the highlighted sites and a discussion of the general strategies employed in their reduction will help shed light on how exactly the Sundays River LCTs compare.

Accordingly, the frequency of LCT types show some notable similarities and differences between the sites. Handaxes are the most common LCTs at Amanzi Springs (with other large bifaces), Montagu Cave (all layers; marginally more than cleavers) and Wonderwerk Cave (all strata). Cleavers are most frequent at Canteen Kopje (Victoria West levels) and Cave of Hearths (all beds). Overall, handaxes and cleavers are most common in the majority of sites, and where picks and bifaces do occur they are generally less frequent; this is a typical feature for the Acheulean in general, with the exception of some very early Acheulean sites that are dominated by pick-like handaxes. Conversely, there are some notable differences in LCTs between these sites, most notably at Amanzi Springs, which has a high prevalence of handaxes with other large (variable) bifaces and Montagu Cave (all layers), showing a large sample of variable bifaces (which appears to be related to its context as a factory site).

Penhill Farm shows that handaxes are the most frequent LCTs, followed closely by cleavers; picks are infrequent and bifaces are rare. The Penhill Farm LCT sample would compare well then with the majority of sites above, where handaxes and cleavers are the most frequent types. However, there is a clear difference between Penhill Farm versus Canteen Kopje and Cave of Hearths, where these latter two sites show an abundance of cleavers. Furthermore, the large samples of variable bifaces that occur at Amanzi Springs and Montagu Cave are clearly a component that is missing at Penhill Farm, but perhaps this is more related to the methods used in LCT classification though. One must remember that LCTs are functional items (Kuman 2014b), and that these pieces would have been created to perform specific tasks in the local environment. Perhaps then the Penhill Farm LCTs indicate what could arguably be similar functional responses to a given environment, and therefore basic subsistence activities, in relation to the majority of the highlighted sites.

Data that highlight the way in which LCTs are produced are broken down here into five sections, and the following similarities and differences occur between the assemblages:

Blanks: Flake blanks are favoured for LCT production in the large majority of the highlighted sites, regardless of raw material, evident at Montagu Cave (all layers), Cave of Hearths (all beds) and Canteen Kopje (Victoria West levels). In contrast, cobble blanks are favoured for LCT production at Amanzi Springs whereas flat slabs are favoured at Wonderwerk Cave.

Thinning, shaping and edge refinement/retouching: Collectively this tends to be more extensive at sites Montagu Cave (all layers) and Wonderwerk Cave (Strata 5-8); Cave of Hearths LCTs show high variability with sporadic elegantly shaped pieces (all beds). This tends to be less extensive (minimal) at sites Amanzi Springs and Wonderwerk Cave (Strata 8-10).

Symmetry: Where data are available, LCT symmetry tends to be absent or very low at the majority of sites, including Canteen Kopje (Victoria West levels), Amanzi Springs, Montagu Cave (all layers) and Cave of Hearths (all beds).

Standardisation: Where data are available, LCT standardisation is low at sites Canteen Kopje (McNabb & Beaumont 2011b) and Cave of Hearths (all beds).

Tip shapes (McNabb et al. 2004): Where data are available, tip shapes are predominantly generalised convergent at Amanzi Springs, Montagu Cave (all layers) and Cave of Hearths (all beds). Wide or divergent tips are also frequent at Cave of Hearths (all beds) and Montagu Cave (all layers).

The manner in which the Penhill Farm LCTs are produced show some important similarities to, and some differences from, several of the trends noted above. First, flake blanks are favoured for LCT production; blank use is comparable with the majority of the highlighted sites. However, Amanzi Springs shows that cobble blanks are more favoured (Deacon 1970).

This is interesting considering that cobble blanks are also readily available in the lower Sundays River Valley, yet hominids here preferred to work cores first to obtain large LCT flake blanks. Even more interesting is that raw material use between these sites is largely consistent (quartzites are favoured). Overall, this clearly shows that the strategies employed in LCT reduction between Amanzi Springs and Penhill Farm differ. The flaking strategies required by cobble blank reduction, versus flake blank reduction, will vary. Although the vast majority of the Penhill LCTs shows bifacial working, the quantity of flake scars and the coverage of these scars is generally low; variability does occur though. More refined and elegant LCTs occur at Penhill, but these are in the minority. This suggests that the Penhill LCTs tend to compare better with those from older sites and/or assemblages, i.e., those above that show less extensive LCT thinning, shaping and edge refinement.

In addition to this, the level of standardisation (e.g., in shape, size and finishing) in the Penhill LCTs, along with symmetry, is low. Once again, although there are exceptions to this, the vast majority of LCTs shows very little to suggest either of the above. Low levels of LCT symmetry have been noted at Canteen Kopje (Victoria West levels), Amanzi Springs and Montagu Cave (all layers). Furthermore, also low at Canteen Kopje is LCT standardisation, a pattern also evident at Cave of Hearths (all beds). It would appear then that there are similarities in the overall appearance of LCTs between these highlighted sites and those at Penhill. All these observations though illustrate the large degree of variability in the Acheulean LCTs through time.

The final comparison to be made concerns LCT tip shapes. Although these data are not available at all of the highlighted sites, where it is present the majority of the sites have generalised convergent tipped LCTs. Although this occurs at Montagu Cave (all layers) and Cave of Hearths (all beds), most relevant is that these types also occur at Amanzi Springs. Occupying the same region, both Amanzi Springs and Penhill Farm may illustrate a uniform and consistent approach in LCT tip shaping, which best suited the local environment at the time. LCT tips play a crucial role in tool function, and the fact that these generalised types are common at both sites is an important feature that may speak to the similarities in tool use between these sites.

In summary a speculative minimum age for Penhill Farm, based on the characteristics of the LCTs in relation to the comparative sites discussed here, would place the site somewhere between >1-0.78 Ma, due to similarities in thinning, shaping, edge refinement/retouching and the clear lack of tool standardisation.

5. Conclusions

If more sites in favourable, datable, contexts are not found, South Africa will always trail East Africa as a source of information regarding early tool-makers. For the Eastern Cape specifically there is a need to provide more ESA sites along the coastal periphery so that we can understand crucial aspects of hominid behaviour within these sorts of ecological, climatological, and environmental contexts. It is widely recognised that there is a significant dearth of information pertaining to the Eastern Cape's ESA archaeology (Sampson 1974; Klein 2000a; Mitchell 2002; Phillipson 2005; Herries 2011; Lombard *et al.* 2012). At present our understanding of the South African Acheulean is still heavily biased though towards those sites located in the interior (the Cradle of Humankind sites and those located along the Vaal and Orange Rivers), with sites such as Elandsfontein more the exception. Only two sites in the Eastern Cape Province (e.g., Amanzi Springs and Geelhoutboom; Laidler 1947; Inskeep 1965; Deacon 1970) have been recorded in some detail, and of these only one has ever been excavated (Amanzi Springs). As a result there have been no well-described and dated Acheulean assemblages in this province.

For the first time in half a century, and for the first time in the entire Eastern Cape Province, with the dating results provided by Erlanger *et al.* (2012) and Granger *et al.* (2013), we have now been able to investigate ESA artefact occurrences within a general chronological framework. The study by Lotter (2016) thus provides the first comprehensively described ESA sites for this region, from which we can now begin to construct our understanding of the local Acheulean tradition. In addition to this the following three points are pertinent.

First, a fundamental problem with many sites is our inability to compare them chronologically. The fact that all of the Sundays River sites have been constrained to specific periods means that their suitability for such comparison is high. Furthermore, the detailed analysis performed on these artefacts by Lotter (2016) provides comparable ESA artefact data not only for the region but also for the continent.

Second, the lower Sundays River Valley has an extremely complex distribution of alluvial terrace deposits, and based on what has been recovered from only two of these terraces (and three sites), the research potential in this valley is high. With more surveys it is entirely possible that more sites will be located, and although the contextual nature of these will likely vary, there is great potential to expand research efforts. The Vaal River Basin has in the past provided a large number of sites, which contextually have not been ideal. Irrespective of this though, these alluvial sites have contributed significantly to our understanding of the Acheulean tradition. From this research, it is now possible for the lower Sundays River Valley to contribute equally to these understandings, and to provide important comparative data from largely different ecological and environmental contexts.

Third and last, although the conditions for terrace formation have been unique for the Sundays River, it would be hard to think that the neighboring valleys do not provide informative assemblages (e.g., Coega, already reported by Ruddock 1957), possibly within datable contexts. The potential for exploration in this region is thus great.

Perhaps most significant is that for the first time since Amanzi Springs was excavated, analysed, and published, there are now another three ESA sites against which the Amanzi Springs material can be compared.

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8. Figure and Table captions

Figure 1. Location of the South African sites discussed in text. Grey indicates the Eastern Cape Province. Modified after Kuman (2016).

Figure 2. A sample of artefacts from the five comparative sites. Bifaces and cleavers from Cave of Hearths Beds 1-3 (a: modified after McNabb 2009); bifaces from Wonderwerk Cave Strata 8-10 (b: modified after Chazan *et al.* 2008); cleaver and handaxes from Montagu Cave Layer 3 (c: modified after Keller 1973); Victoria West cores from Canteen Kopje (d: modified after Leader 2013); cores and handaxes from Amanzi Springs (e: modified after Deacon 1970).

Figure 3. Contextual information for the lower Sundays River Valley and the associated sites. Important geological features (a: redrawn and modified after Hattingh and Rust 1999); alluvial terraces with associated heights (b: redrawn and modified after Erlanger 2010 and Hattingh 2008); study area showing site location and terrace exposures (c: redrawn and modified after Erlanger 2010);

Penhill Farm site showing exposed profile with artefact-bearing debris flow deposit.

Figure 4. Cores on cobbles. Discoidal (a: quartzite), single platform (b: quartzite), chopper-core (c: siltstone) and irregular (d: siltstone) types are shown (drawings by Wendy Voorvelt).

Figure 5. Formal tools. Denticulate on quartzite flake (a), awl on quartzite cobble (b), quartzite composite piece (c: scraper and knife), and siltstone knife (d) (drawings by Wendy Voorvelt).

Figure 6. A sample of quartzite scrapers. Double side and end on a flake (a), composite (b: notched and denticulated) on flake fragment, denticulated on unifacial discoidal core (c), and heavy-duty on split cobble (d) (drawings by Wendy Voorvelt).

Figure 7. A sample of cleavers with those made on quartzite flakes (a, b) and siltstone flakes (c), and on a quartzite cobble (d) (drawings by Wendy Voorvelt).

Figure 8. A sample of LCTs. Pick on siltstone flake (a), siltstone biface on cobble (c) and quartzite handaxe on flake (e); biface on quartzite flake (b) and handaxes on siltstone (d) and quartzite (f) flakes (drawings by Wendy Voorvelt).

Table 1. South African Acheulean sites >0.5 Ma. Geelhoutboom is excluded.

Table 2. Basic comparative data from Canteen Kopje. All information is from Leader (2013) unless otherwise indicated. LCT information from McNabb and Beaumont (2011b) relates to Stratum 2a and 2b in Areas 1 and 2; Stratum 2a is comparable to the Pit 6 Victoria West levels.

Table 3. Basic comparative data for Wonderwerk Cave, from Chazan (2015).

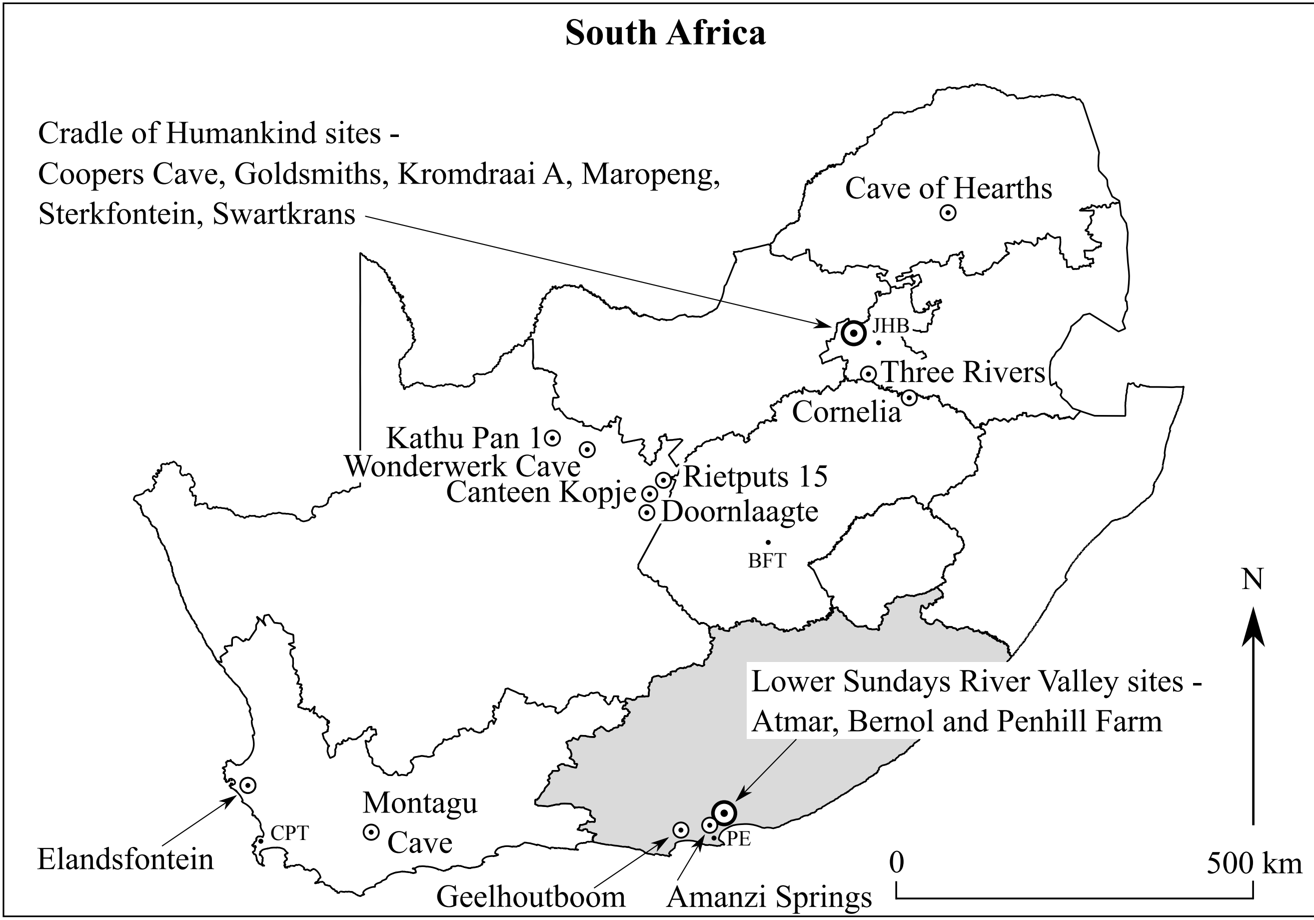
Table 4. Basic comparative data for Amanzi Springs from Deacon (1970). Additional LCT information is from McNabb *et al.* (2004).

Table 5. Basic comparative data for Cave of Hearths, from McNabb (2009).

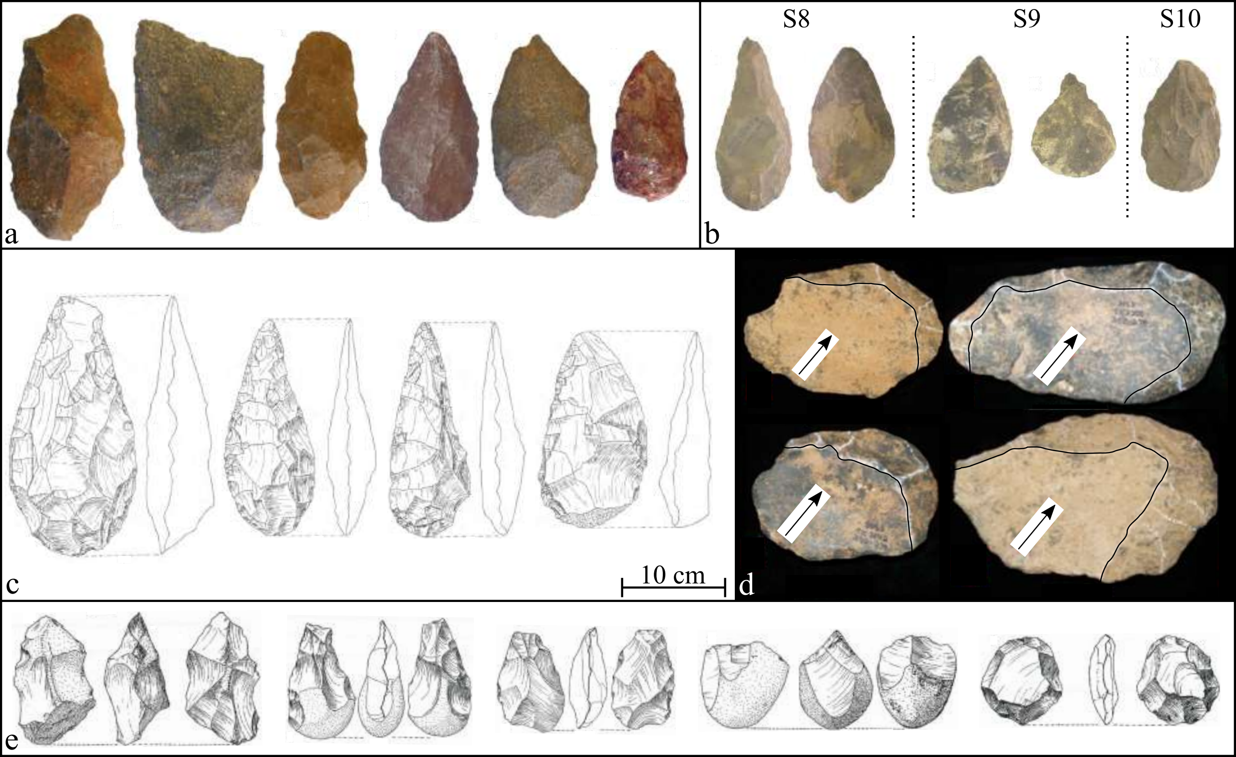
Table 6. Basic comparative data for Montagu Cave, from Keller (1973). Additional LCT information is from McNabb *et al.* 2004.

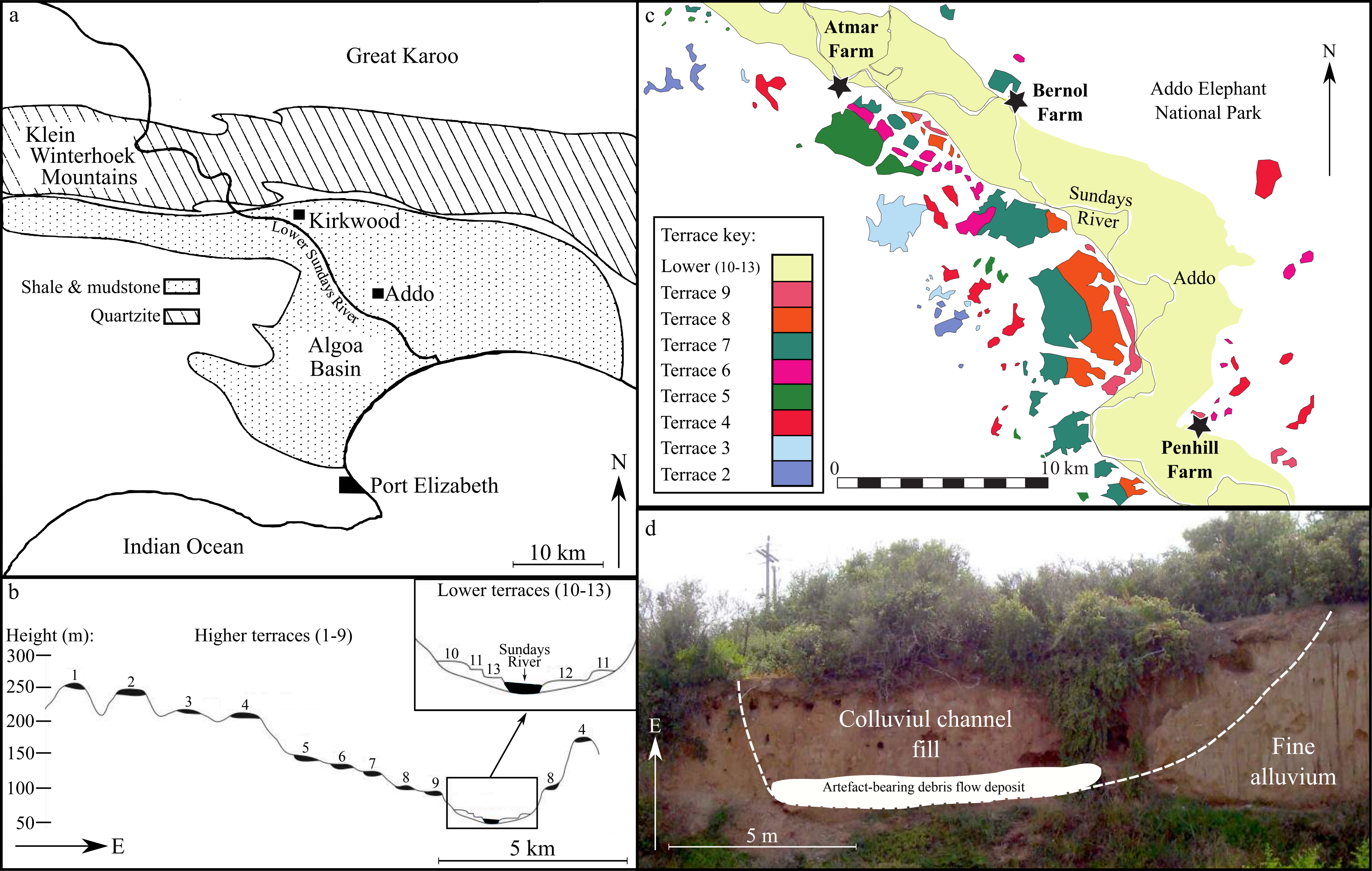
Table 7. Penhill Farm artefact classification (n=9904).

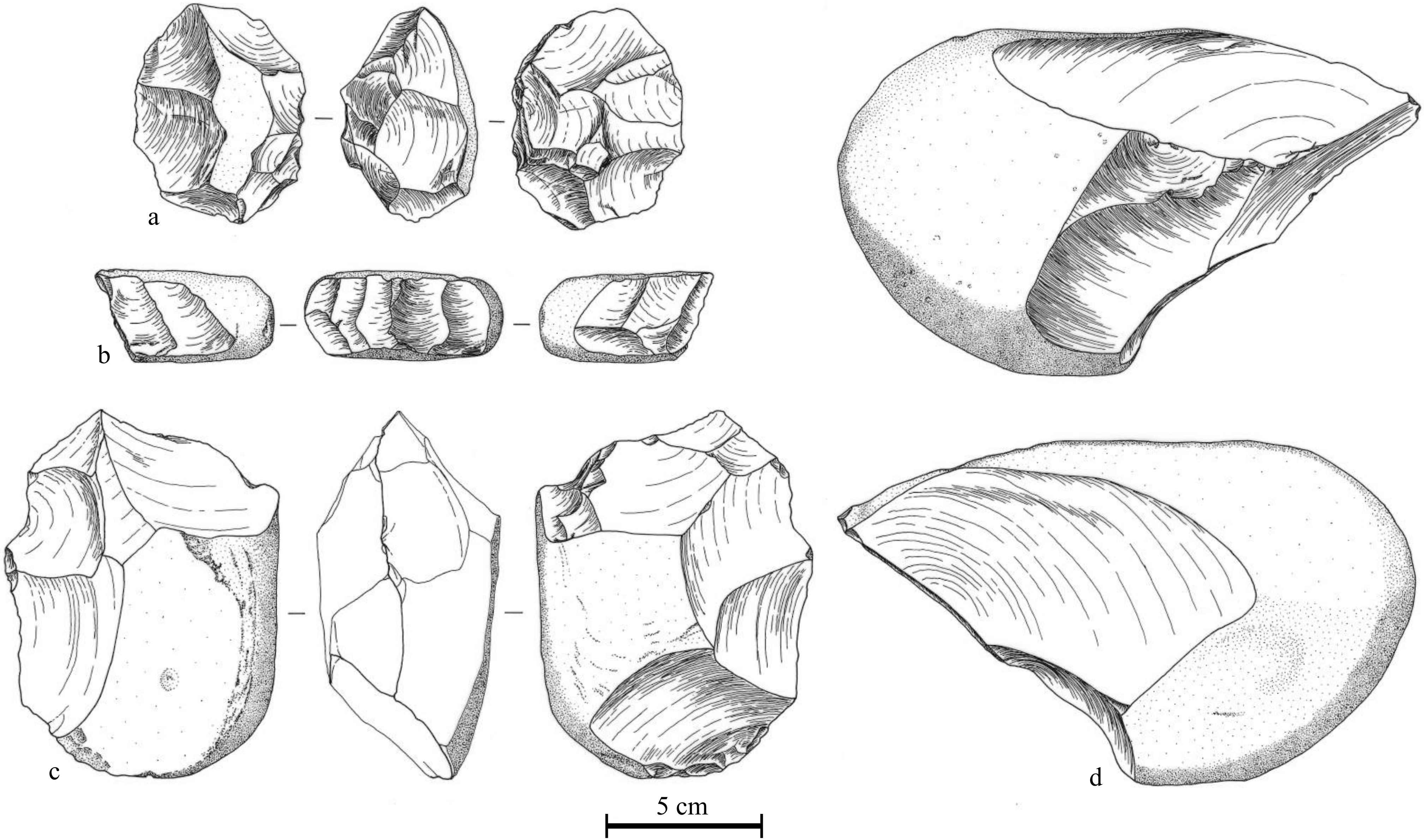
Table 8. Raw material and artefact condition data (on all pieces ≥20 mm). Bracketed values indicate percentages. Quartzite (qzte) is divided into coarse (C) and fine (F) types.



South Africa
Cradle of Humankind sites -
Coopers Cave, Goldsmiths, Kromdraai A, Maropeng,
Sterkfontein, Swartkrans
Cave of Hearths
JHB
Three Rivers
Cornelia
Kathu Pan 1
Wonderwerk Cave
Rietputs 15
Canteen Kopje
Doornlaagte
BFT
N
Lower Sundays River Valley sites -
Atmar, Bernol and Penhill Farm
Montagu
Cave
CPT
Elandsfontein
PE
0
500 km
Geelhoutboom
Amanzi Springs


a
S8
S9
S10
b
c
10 cm
d
e


a
Great Karoo
Klein Winterhoek Mountains
Kirkwood
Lower Sundays River
Shale & mudstone
Quartzite
Addo
Algoa Basin
Port Elizabeth
N
Indian Ocean
10 km
b
Height (m):
Higher terraces (1-9)
300
250
200
150
100
50
E
5 km
Lower terraces (10-13)
Sundays River
c
Atmar Farm
Bernol Farm
Addo Elephant National Park
N
Sundays River
Addo
Penhill Farm
Terrace key:
Lower (10-13)
Terrace 9
Terrace 8
Terrace 7
Terrace 6
Terrace 5
Terrace 4
Terrace 3
Terrace 2
0
10 km
d
E
Colluviul channel fill
Fine alluvium
Artefact-bearing debris flow deposit
5 m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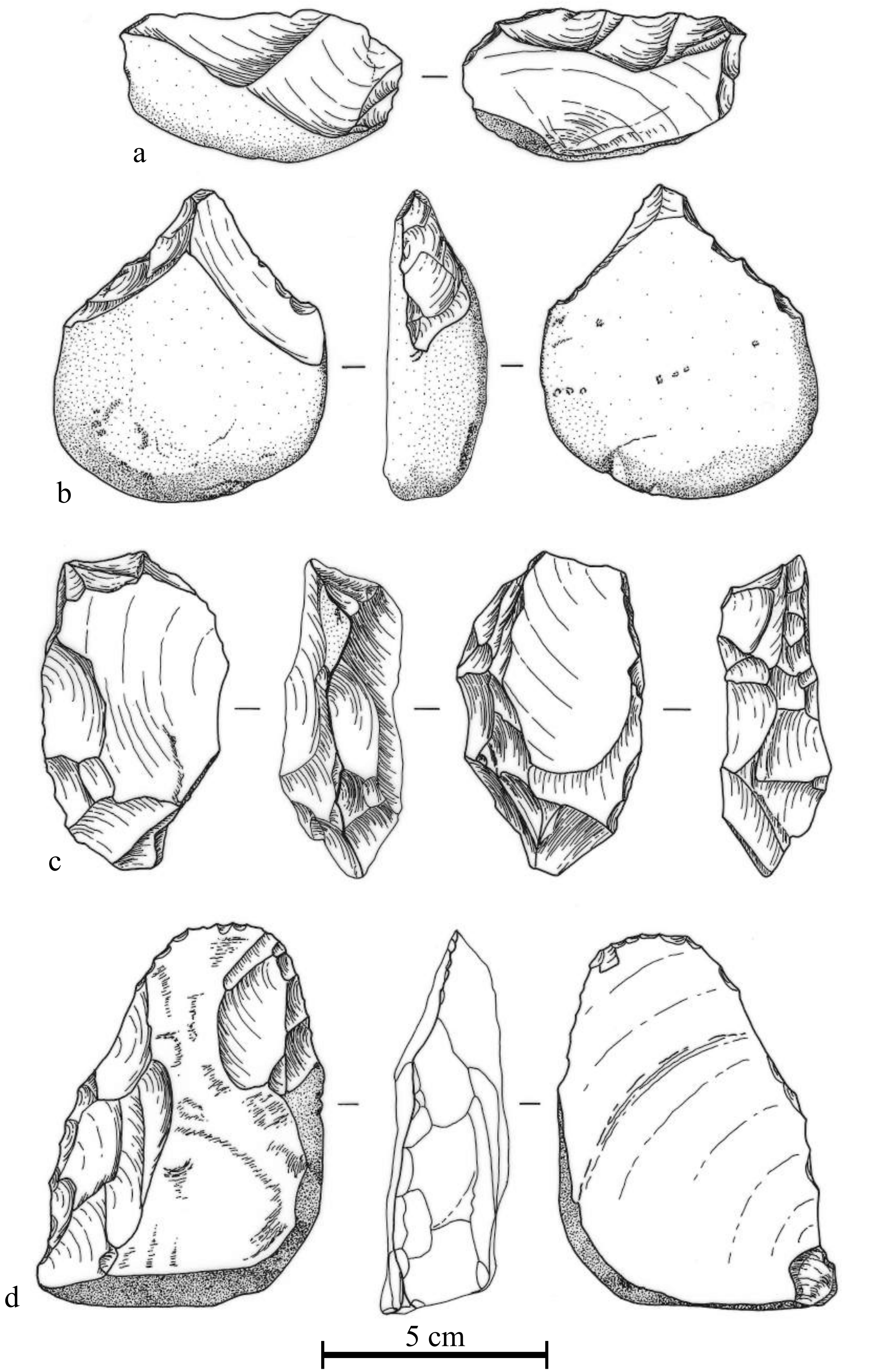
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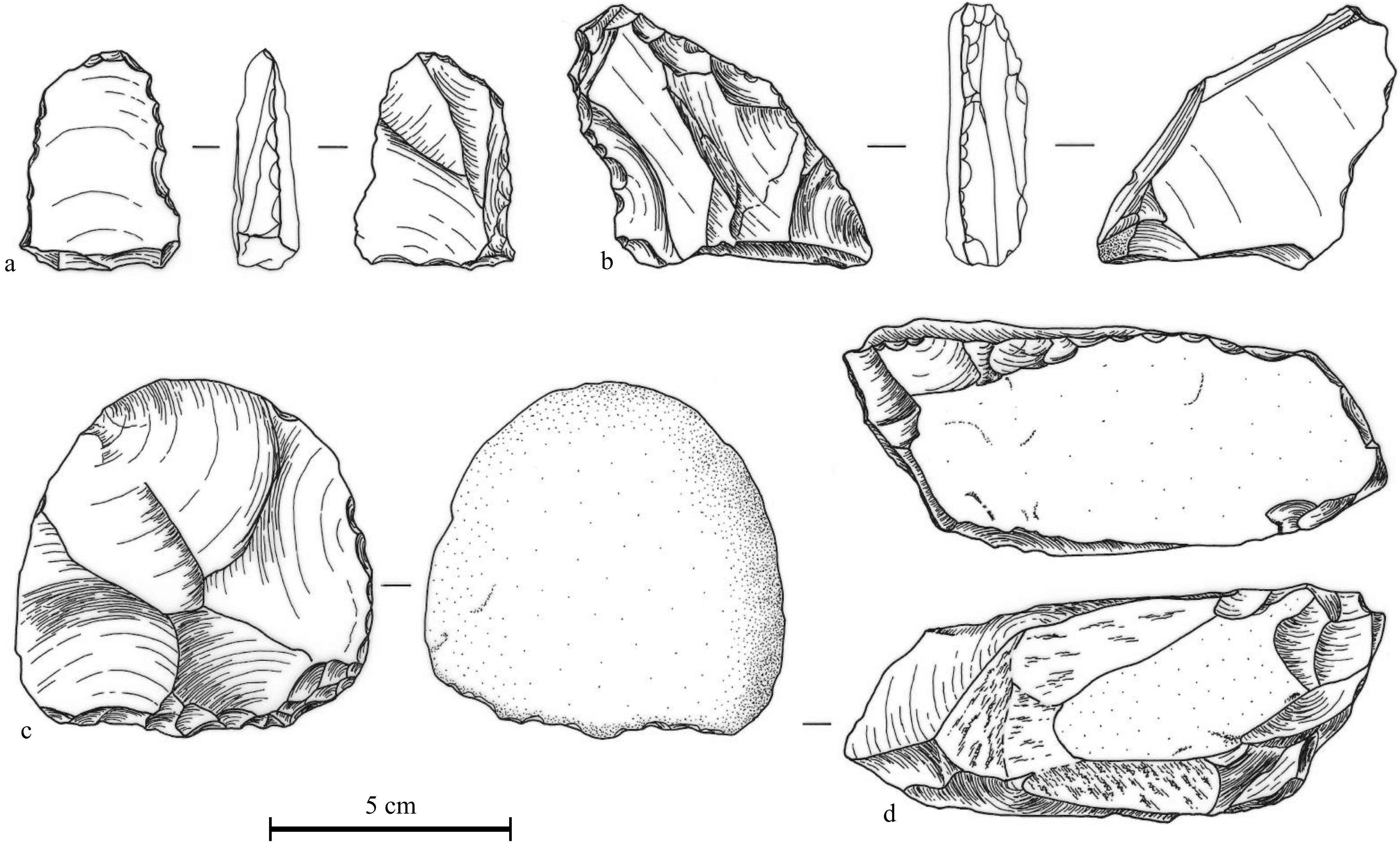
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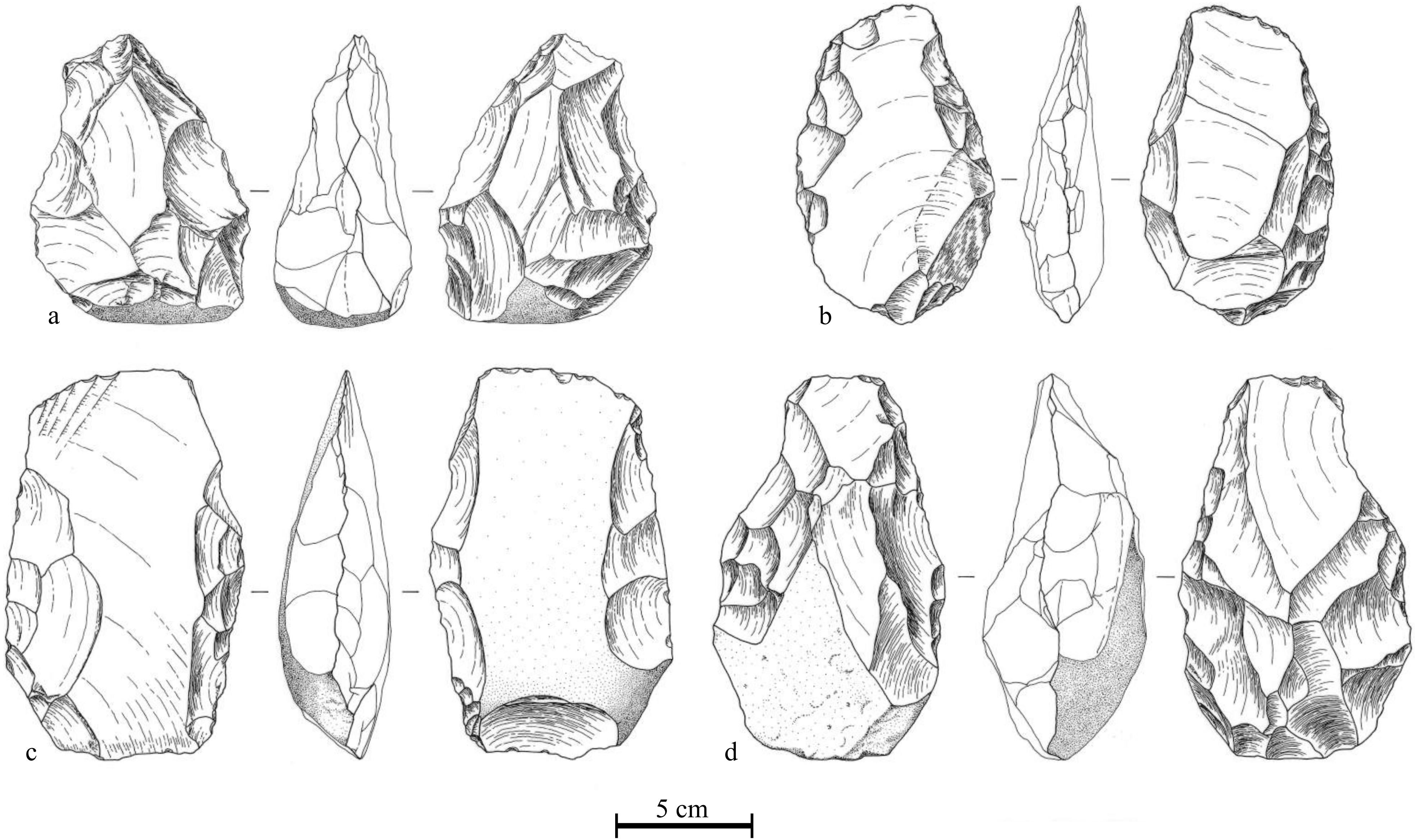
a
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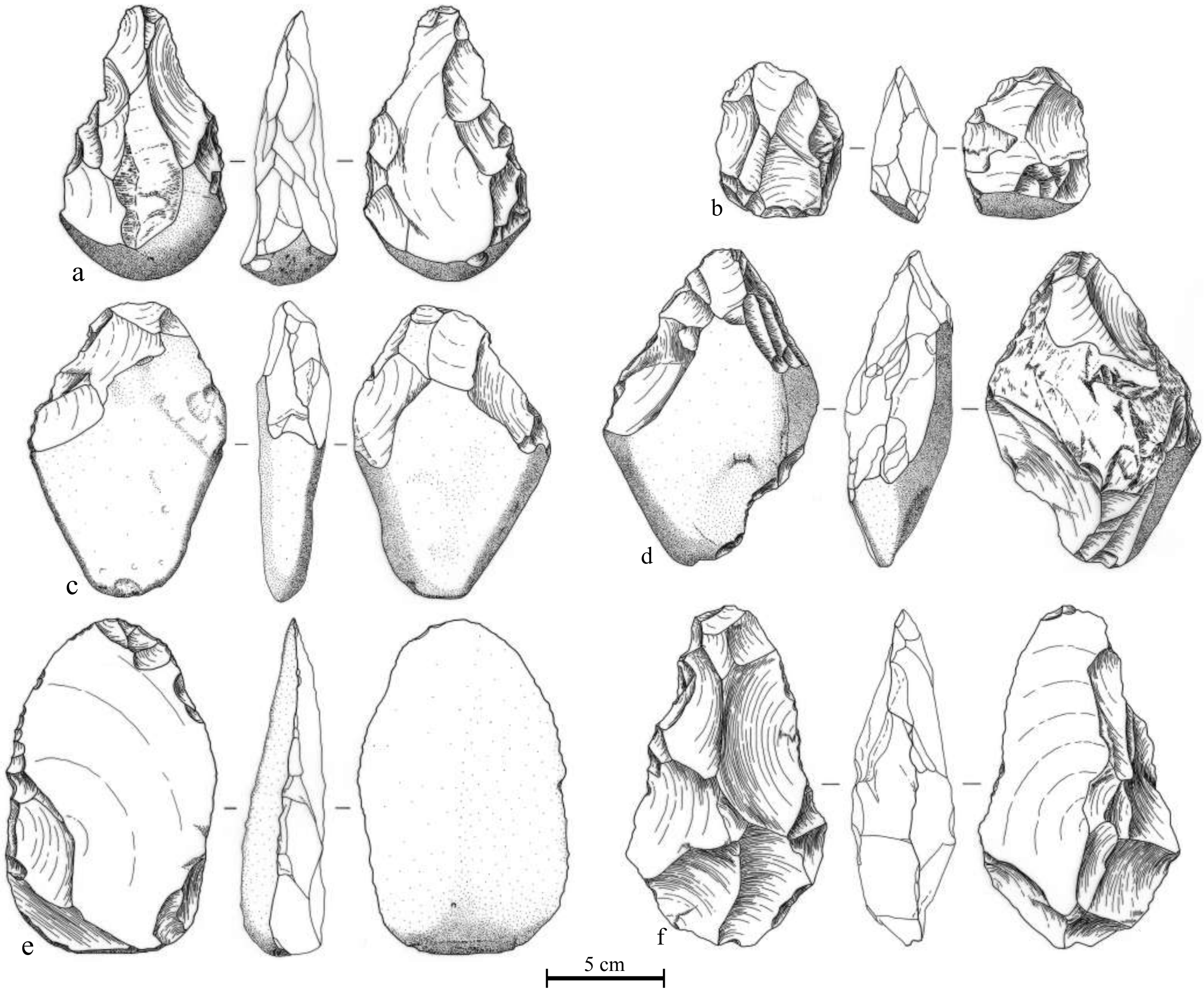
5 cm


a
b
c
d
e
f
5 cm

Site name:	Age (Ma):	Age estimate:	Stratigraphic context:	Cultural industry:	Key references:
Coopers Cave	1.9-1.6	Fauna	Coopers D; cave infill	Early Acheulean?	Steininger & Berger 2001; Berger *et al*. 2003; Kuman 2003, 2007; Hall 2004; de Ruiter *et al.* 2009
Sterkfontein	1.7-1.4	Fauna; artefacts	Members 5 East and West; cave infills	Early Acheulean	Vrba 1975; Stiles 1979; Clarke 1994a; Kuman 1994, 1998, 2003, 2007, 2014, 2016; Reed 1997; Field 1999; Kuman & Clarke 2000; Avery 2001; Luyt & Lee-Thorp 2003; Smith & Grine 2008; Ogola 2009a; Pickering & Kramers 2010; Stratford 2011; Clarke 2012
Rietputs 15	1.7-1.3	Cosmogenics	Alluvial gravels; Rietputs 15 Formation	Early Acheulean	Kuman 2007, 2014, 2016; Gibbon *et al.* 2009a; Leader 2009; Couzens 2012
Canteen Kopje	>1.5	Cosmogenics	Alluvial gravels; Pit 6	Early Acheulean	De Wit 1996, 2008; Beaumont & McNabb 2000; Beaumont 2004; Gibbon *et al.* 2008, 2009b; McNabb & Beaumont 2011a,b; Gibbon *et al.* 2013; Leader 2013; Kuman 2016
Canteen Kopje	1.51	Cosmogenics	Alluvial gravels; Pit 6	Early Acheulean	De Wit 1996, 2008; Beaumont & McNabb 2000; Beaumont 2004; Gibbon *et al.* 2008, 2009b; McNabb & Beaumont 2011a,b; Gibbon *et al.* 2013; Leader 2013; Kuman 2016
Wonderwerk Cave	1.5-1.1	Cosmogenics; palaeomagnetism	Stratum 11	Early Acheulean	Chazan *et al*. 2008; Beaumont 2011; Matmon *et al.* 2012; Chazan 2015; Goldberg *et al.* 2015
Kromdraai A	1.5-1.0	Fauna	Cave deposits; miners dump	Early Acheulean	Kuman *et al.* 1997; Field 1999; Kuman 2003, 2007, 2016

Site name:	Age (Ma):	Age estimate:	Stratigraphic context:	Cultural industry:	Key references:
Swartkrans	1.5 0.96	Fauna; cosmogenics	Members 2 and 3; cave infills	Early Acheulean Middle Acheulean	Leakey 1970; Vrba 1975; Brain & Sillen 1988; Clark 1991, 1993; Brain & Watson 1992; Brain 1993a,b; Watson 1993; Clarke 1994b; Field 1999; Susman *et al.* 2001; Backwell & d'Errico 2003; Kuman 2003, 2007, 2014, 2016; Egeland *et al.* 2004; Pickering *et al.* 2004, 2007; Pickering *et al.* 2008; Sutton 2012; Gibbon *et al.* 2014
Canteen Kopje	>1	Cosmogenics	Alluvial gravels; Pit 6	Early Acheulean; Victoria West	McNabb 2001; Sharon & Beaumont 2006; McNabb & Beaumont 2011a,b; Gibbon *et al.* 2013; Leader 2013; Kuman 2016; Li *et al.* 2017
Goldsmiths	>1	Fauna; artefacts	Miners dump of disturbed cave infills	Early Acheulean	Mokokwe 2005; Kuman 2007, 2016; Jacoby *et al.* 2013
Maropeng	>1	Artefacts	Open-air site of colluvial pavement	Early Acheulean	Pollarolo *et al.* 2010; Morrissey 2015; Kuman 2016
Three Rivers	>1	Artefacts	Alluvial gravels	Early Acheulean	Mason 1962
Cornelia	1.07-0.99	Palaeomagnetism; biostratigraphy	Valley fill; alluvial and colluvial gravels and clays	Acheulean	Brink *et al.* 2012; Kuman 2016
Wonderwerk Cave	1.07-0.99	Cosmogenics; palaeomagnetism	Strata 8-10	Acheulean	Beaumont & Vogel 2006; Chazan *et al.* 2008; Berna *et al.* 2012; Matmon *et al.* 2012; Chazan *et al.* 2015; Goldberg *et al.* 2015
Wonderwerk Cave	<1	Cosmogenics; Palaeomagnetism	Strata 5-8	Later Acheulean Fauresmith	Binneman & Beaumont 1992; Beaumont & Vogel 2006; Chazan *et al.* 2008; Beaumont 2011; Matmon *et al.* 2012; Chazan *et al.* 2015; Goldberg *et al.* 2015

Site name:	**Age (Ma):**	**Age estimate:**	**Stratigraphic context:**	**Cultural industry:**	**Key references:**
Elandsfontein	1.0-0.6	Palaeomagnetism; fauna; artefacts	Preserved palaeosurface in dune sands	Later Acheulean	Singer & Crawford 1958; Singer & Wymer 1968; Netterberg 1974; Klein 1978; Avery 1988; Klein & Cruz-Uribe 1991; Deacon 1998; Luyt *et al.* 2000; McNabb *et al.* 2004; Klein *et al.* 2007; Archer & Braun 2010; Braun *et al.* 2013
Doornlaagte	1.0-0.5 (Middle Pleistocene)	Artefacts	Living floor near pan periphery	Later Acheulean	Butzer 1974; Netterberg 1974; Deacon 1988; Mason 1988; Beaumont 1990; McNabb *et al.* 2004
Amanzi Springs	Middle Pleistocene	Artefacts	Disturbed spring mound	Later? Acheulean	Inskeep 1965; Deacon 1970; McNabb *et al.* 2004
Cave of Hearths	<0.78	Palaeomagnetism; ESR	Cave Breccias; Beds 1, 2 and 3	Later Acheulean	van Riet Lowe 1954; Mason 1962, 1988; Latham & Herries 2004, 2009; McNabb *et al.* 2004; Underhill 2007; Curnoe 2009; Herries & Latham 2009; Maguire 2009; McNabb 2009; McNabb & Sinclair 2009a,b; McNabb *et al.* 2009; Ogola 2009b; Couzens 2012; Li *et al.* this volume
Montagu Cave	<0.6	Artefacts	Cave strata; Layers 3 and 5	Later Acheulean	Keller 1973; McNabb *et al.* 2004
Kathu Pan 1	0.682-0.435	OSL; ESR	Stratum 4a	Late/final Acheulean; Fauresmith	Porat *et al.* 2010; Herries 2011; Wilkins & Chazan 2012; Wilkins *et al.* 2012

Table 2

Site name: Canteen Kopje Pit 6 Victoria West levels		
Artefact:	**Data:**	**Key points:**
Cores	Flaking strategy/ reduction	Simple core reduction strategies are most common. Casual cores with only one or two removals are the most frequent type. Thereafter, notable samples of irregular, chopper-core, polyhedral and discoidal/radial types occur. Most notable is the sample of organised cores, all of which show some form of asymmetry and/or shaping to exploit a preferential or elongated core surface. In addition to these types occur the asymmetrical Victoria West 'hoenderbek' prepared cores; these types account for 9% of all reduction strategies. Scar counts are greatest on these Victoria West cores and the largest scars occur on boulder cores, where the largest surface has been exploited. Scar size on the Victoria West cores is also large relative to total core size.
Retouched pieces	Number of retouched pieces	Scrapers are the most common retouched tools. These are broken down into a general 'scraper' category (those with consistent retouch on one or more edges), and denticulated/notched, heavy-duty, and convergent types. General types are the most common; however, denticulated/notched types account for approximately 17% of the total scraper sample.
	Flaking strategy/ reduction	There is little mention of how retouch has been performed and what characterises it, most likely due to the extremely abraded state of the artefacts. Where mention has been made, this retouch appears restricted to specific edges on tools and is fairly consistent along these edges. Notched and denticulated retouch is uncommon.
LCTs	Number of LCTs	The Victoria West levels show a large sample of LCTs (n=118, here excluding LCT flakes). Cleavers are the most frequent type, followed thereafter by handaxes. More robust LCTs (picks and pick-like handaxes) are less common.

Table 2 continued…

Site name: Canteen Kopje Pit 6 Victoria West levels		
Artefact:	**Data:**	**Key points:**
LCTs	Flaking strategy/ reduction	Only very basic information is provided concerning the reduction of LCTs and this relates mainly to blank type. Again, this is likely due to the poor state of artefact preservation that limited any detailed analysis. Overall, large flake blanks are favoured for LCT production; only a single handaxe and cleaver were made on cobble blanks. By size, cleavers are notably smaller than handaxes (especially those on andesite). McNabb & Beaumont 2011b: Handaxes and cleavers are predominantly asymmetrical in plan view (with a few exceptions). There is no standardised/formalised outline for LCT shapes. Cleavers show less thinning and shaping than handaxes, and for the former most of this is restricted to the lateral edges of the tool and the butt (for removal). In addition, cleaver shaping frequently involves any strategy that requires the least amount of working. Handaxe thinning and shaping is more invasive and covers more of the LCT, due mainly to an emphasis on shaping the converging tip. Handaxes therefore show greater symmetry overall.

Table 3

Site name: Wonderwerk Cave Strata 8-10 and 5-8		
Artefact:	Data:	Key points:
Cores	Flaking strategy/ reduction	The core sample is limited for all strata. Those that are present show no elaborate production, and only a small sample (5) has greater than five removals. Although several pieces appear to show slightly more organised knapping (e.g., a radial arrangement), Chazan (2015) concludes that there are no discernible trends in core reduction at the current stage of analysis.
Retouched pieces	Number of retouched pieces	Little data is provided that addresses the frequency of retouched tools, and what characterises this retouch. However, this form of tool modification is most frequent on LCTs and it is addressed below.
	Flaking strategy/ reduction	
LCTs	Number of LCTs	Handaxes are the most frequent LCT, followed thereafter by infrequent cleavers.
LCTs	Flaking strategy/ reduction	Strata 8-10: Systematic production of handaxes with shaping that is noninvasive. These pieces are highly variable in morphology, the amount of cortex retained, and the positioning of the distal edge/tip. Retouch to regularise these working edges is absent. Tip shapes are commonly pointed or rounded. Butts are mostly cortical and unworked. The production of cleavers on large flakes develops during this period. Strata 5-8: Handaxe reduction shows a shift towards invasive removals. Retouch is more prevalent and is frequently used to create working edges and to enhance the distal tips (and regularise working edges). Some pieces show retouch around the entire circumference of the tool, albeit infrequently. Shaping occurs throughout all portions of the tools.

Table 4

Site name: Amanzi Springs		
Artefact:	Data:	Key points:
Cores	Flaking strategy/ reduction	The majority of all cores are classified as discoidal/radial. This suggests that radial core reduction strategies are most frequent; however, a notable sample of cores has only a single or maximum of two removals, suggesting that casual core reduction is also common. In addition to these, a number of irregular cores shows a multi-directional reduction strategy.
Retouched pieces	Number of retouched pieces	Scrapers are the most common type of retouched tool, most notably informal side scrapers, thereafter followed by end types.
	Flaking strategy/ reduction	Only limited information is provided which speaks to both the type and character of retouch on modified pieces. Overall, flakes are favoured for reduction and retouch is minimal. Retouch is more extensive and prevalent on larger flakes. Based on artefact images supplied by Deacon (1970), retouch appears to range from discontinuous, to partial, continuous and total, for artefacts in the illustrated sample. Although notching appears infrequent, edge denticulation is common. Retouch appears short and uninvasive and is restricted to blank margins.
LCTs	Number of LCTs	Handaxes and other large bifaces are the most common LCTs; cleavers are poorly represented and picks are rare.
	Flaking strategy/ reduction	Overall LCT shapes and finishes are highly variable. Cobble blanks are most favoured for LCT production, which are frequently split longitudinally. Flakes are also utilised but infrequently. Handaxes are generally pear-shaped and show minimal flaking. There is little trimming and shaping of both the edges and pointed distals, although more refined examples do occur. Where edge trimming is present this is variable, as is edge thinness. Butts are normally cortical. Cleavers are poorly represented but where they do occur their plan forms are highly variable. Bifaces are common and are divided into several sub-types. Most common are elongated types that lack any tip emphasis but have edge trimming. Some retouch can be found on the points. McNabb *et al.* 2004: A sample of analysed LCTs shows an abundance of convergent generalised tip shapes. A visual assessment indicates a lack of symmetry in all three portions (tip, medial and distal) of the LCTs.

Table 5

Site name: Cave of Hearths Beds 1-3		
Artefact:	Data:	Key points:
Cores	Flaking strategy/ reduction	Discoidal cores are the most frequent core type, reduced by alternate flaking applied in a centripetal manner. However, a range of other core types (and hence reduction strategies) occurs.
Retouched pieces	Number of retouched pieces	Flaked flakes, a range of scrapers, denticulates and composite tools (those with two different types of retouch on different artefact edges) are the most common retouched tools. For scrapers, transverse types are the most frequent.
Retouched pieces	Flaking strategy/ reduction	Flake blanks are favoured for retouching. Overall standardisation in tool retouching is minimal. Scrapers are highly variable in form and retouch appears to occur only on flake edges that were suitable; retouch therefore follows the natural shape of the flake edge. Retouch is frequently continuous.
LCTs	Number of LCTs	Bifaces and cleavers are the most frequent LCT types (where bifaces here refer to LCTs with a variety of converging tip shapes). Cleavers are notably more abundant.
	Flaking strategy/ reduction	Flake blanks are most favoured for LCT production. Overall LCT symmetry is low and there is little standardisation in final forms. Exceptions do occur but these appear to be sporadic. There is no consistent strategy in biface thinning and shaping; however, partial marginal flaking is most common, yet opposite faces are frequently knapped differently. As for cleavers the pattern is slightly different, where partial marginal flaking on both faces is most favoured (least effort strategy). Overall, cleavers show less reduction than bifaces, and refinement in the LCTs is low. Even though several pieces occur that are more elegantly shaped and thinned the emphasis on this is minimal.

Table 6

Site name: Montagu Cave Layers 3 and 5		
Artefact:	Data:	Key points:
Cores	Flaking strategy/ reduction	Discoidal cores are the most common core type, the majority of which are trimmed bifacially. This gives rise to cores with mostly round and ovoid plan shapes. Additional core types do occur that show a range of reduction strategies, but these are infrequent.
Retouched pieces	Number of retouched pieces	The most common retouched tools include an abundance of small scrapers, with multiple forms. These also include small samples of heavier-duty core scrapers. A range of minimally trimmed flakes, chips and chunks also occur, but are less common.
	Flaking strategy/ reduction	Only basic information is provided that characterises retouched items. Overall, chunks are the most favoured blank for retouching. Thereafter, retouch is mostly unifacial along a single edge (one side), giving rise to a steep edge. The retouched edges are generally irregular in shape.
LCTs	Number of LCTs	Handaxes and cleavers are the most common LCTs. Handaxes are only marginally more abundant than cleavers in both layers. A notable sample of variable bifaces is also present.
	Flaking strategy/ reduction	The majority of blanks utilised for LCT production is indeterminate, but where these can be determined there is a preference for large side-struck flakes (especially for cleavers). Handaxes are predominantly bifacial and this trimming continues to the base of the tools where the butts are shaped/trimmed. The majority of handaxes are only coarsely finished, yet finer types do occur infrequently. Handaxe shapes that are most common include ovate, long ovate and lanceolate shapes. Cleaver edges are generally parallel sides with distal bits that are straight or slightly angled (termed guillotene). For those on flakes the platforms show either some reduction or complete removal, which would account for the high percentage of bifacial butt trimming. Butts are mostly U-shaped. The majority of cleavers shows coarse finishing, yet more refined examples do occur. McNabb *et al.* 2004: Convergent with a generalised tip and wide/divergent tips are the most common tip shapes for a random sample of LCTs. In addition to this a visual symmetry assessment shows that LCTs are predominantly asymmetrical throughout all portions (tip, medial and base).

Table 7

Flaking debris:	**N**	**%**
SFD	5046	50.9
Chunk	298	3.0
Incomplete flake	1773	17.9
Flake fragment	1553	15.7
Split flake	10	0.1
Bipolar	35	0.4
Total	8715	88.0
Formal tools:		
Handaxe	16	0.2
Broken handaxe/LCT	6	0.1
Cleaver	15	0.2
Pick	7	0.1
Biface	5	0.1
Knife	4	0.04
Chopper	2	0.02
Side chopper	1	0.01
End chopper	0	0
Flaked flake	15	0.2
Retouched flake	48	0.5
Scraper~		
Composite	15	0.2
Concave	8	0.1
Convex	10	0.1
End	5	0.1
Side	18	0.2
Double side and end	1	0.01
Notched	49	0.5
Convergent	1	0.01
Denticulated	66	0.7
Heavy-duty/core	2	0.02
MRP	117	1.2
Burin	2	0.02
Awl	1	0.01
Denticulate	82	0.8
Composite tool	14	0.1
Total	510	5.1

Complete flakes:	**N**	**%**
End-struck	165	1.7
Side-struck	166	1.7
Corner-struck	101	1.0
Kombewa	1	0.01
Core trimming	4	0.04
Bipolar	13	0.1
Handaxe trimming	10	0.1
Bi-bulb	2	0.02
Core rejuvenation	7	0.1
Total	469	4.7
Cores:		
Core fragment	13	0.1
Casual	54	0.5
Bipolar	1	0.01
Chopper-core	48	0.5
Discoidal	55	0.6
Discoidal w/removal	1	0.01
Irregular	18	0.2
Polyhedral	4	0.04
Single platform	12	0.1
Boulder-core	0	0
Total	206	2.1
Other:		
Modified cobble	1	0.01
Split cobble	3	0.03
Total:	4	0.04
Assemblage total	**9904**	**100**

Table 8

Raw material	Artefact condition				Total
	Fresh/ unabraded	Slightly abraded	Heavily abraded/ rolled	Weathered	
Quartz	0	0	0	0	0
C Quartzite	165 (3.4)	65 (1.3)	6 (0.1)	2 (0.04)	238 (4.9)
F Quartzite	3085 (63.5)	776 (16)	52 (1.1)	16 (0.3)	3929 (80.9)
Siltstone	245 (5)	87 (1.8)	14 (0.3)	17 (0.3)	363 (7.5)
Silt-quartzite	7 (0.1)	1 (0.02)	0	0	8 (0.2)
Hornfels	153 (3.1)	48 (1)	5 (0.1)	49 (1)	255 (5.2)
CCS	0	0	0	0	0
Lava	8 (0.2)	2 (0.04)	0	0	10 (0.2)
Silcrete	6 (0.1)	2 (0.04)	1 (0.02)	2 (0.04)	11 (0.2)
Claystone	30 (0.6)	9 (0.2)	2 (0.04)	3 (0.1)	44 (0.9)
Indet.	0	0	0	0	0
Total	3699 (76.1)	990 (20.4)	80 (1.6)	89 (1.8)	4858 (100%)