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RESEARCH ARTICLE

Understanding Early Later Stone Age technology at a landscape-scale: evidence from the open-air locality Uitspankraal 7 (UPK7) in the Western Cape, South Africa

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Abstract

Understandings of past human behaviour in southern Africa are hampered by a site-based approach to prehistoric technological systems which relies on spatially isolated samples from one or a few key ‘type-sites’. Lithic technological behaviour, however, was a landscape-scale process with raw material acquisition, reduction, transportation, use, maintenance and discard taking place at varied locations. This study takes a landscape approach to the investigation of early Later Stone Age (ELSA) technology on the Doring River by exploring two points in what we believe to be one system. We compare data from an open-air lithic scatter from Uitspankraal 7 (UPK7) located on the Doring, the major river and lithic source in the area, with a published rockshelter sample from Putslaagte 8 (PL8) located 2 km from the Doring and 15 km to the north-west of UPK7. Differences between the two assemblages support a scenario in which hornfels blades and flakes were produced at the river and transported into the surrounding landscape, with limited transportation of cores. Intriguingly little evidence of quartz-bipolar reduction was found in the open-air sample at UPK7, raising the possibility that different ELSA technological components were organised in distinct patterns across the landscape. Results suggest that the composition of ELSA assemblages is highly situational, with proportions of quartz and/or bipolar technology, for instance, appearing responsive to local context. Overall, this study highlights the importance of taking a landscape orientated approach to investigating the nature and cause of continuity and variability in the archaeological record. Such an approach will inevitably lead to a more comprehensive understanding of early LSA technology, behaviour and landuse patterns.

Key words: Early Later Stone Age, open-air, landscape archaeology, lithic technology, Uitspankraal 7, South Africa

Introduction

Archaeological research documents and explains change through time and across space in an attempt to understand prehistoric lifeways and the dynamic interplay between the social, technological and environmental milieus in which people lived in the past. The complex nature of human behaviour, however, makes identifying behaviourally meaningful patterns and interpreting variability in the archaeological record among the biggest challenges faced by archaeologists. In the context of southern African stone age research, a hierarchical approach is traditionally used to 'order' broad-scale variability, with the archaeological record arranged into temporally discrete technocomplexes (also referred to as Industrial complexes), comprising groups of geographically dispersed Industries that possess a range of technological features in common that are indicative of shared manufacturing traditions (cf. Bishop and Clark 1967; Lombard et al. 2012). A site-based approach has dominated this research, with Industries defined based on data pertaining to one or a few key 'type sites/assemblages', typically derived from rockshelter deposits. Such an approach hinges on the identification of diagnostic artefact 'types' and/or technological characteristics that are then used to group superficially similar assemblages into Industries. Small scale temporal differences within Industries are generally expressed as 'phases' while spatial variation between assemblages dating within the same temporal boundary are typically understood to represent regional variants of a particular Industry and/or distinct Industries in themselves (Lombard et al. 2012).

Although the technocomplex approach remains a valuable tool for linking assemblages in dated contexts (such as rockshelter sequences), with those from settings where dates are difficult to obtain (such as is the case in many open-air settings), it does not adequately accommodate the range of finer-scaled variability expected to occur as a result of the diverse geological, environmental and social contexts characterising the different regions in which these Industries have been identified. Contributing to the problem, and perhaps of greater concern when attempting to understand

prehistoric lifeways, is that the current paradigm ignores the fact that lithic technological behaviour occurs at a landscape-scale with activities such as the acquisition of lithic materials, the reduction of stone, the transportation of artefacts and/or tool stone, the use, maintenance and eventual discard of artefacts taking place at multiple landscape locations. In this way, sites represent aggregates of technological behaviour at a single spatial point within a broader system (Barton and Riel-Salvatore 2014). An approach that views technological systems at a landscape scale is required if we are to expand upon traditional site-type based understandings of past human behaviour and gain a more holistic understanding of the interaction between past humans, their technological systems and the landscape in which they lived. Acknowledging these facts, this paper explores the early Later Stone Age (ELSA) on the Doring River from a landscape-scale perspective, comparing data from a newly analysed open-air artefact scatter from Uitspankraal 7 (UPK7), located on the major river itself and at the lithic source, with a rockshelter sample from Putslaagte 8 (PL8) located 2 km from the Doring and 15 km to the north-west of UPK7. By exploring two points in what we believe to be one system this study explores how different aspects of this technological system are articulated at a landscape level.

This paper begins with a brief overview of the LSA lithic sequence as it is currently understood in southern Africa, outlining associated ages and providing defining lithic technological features for each technocomplex. Focus is placed on summarising the earliest late Pleistocene portion of the LSA as the assemblage from UPK7 was preliminarily assessed as relating to this period based on technological similarities with the PL8 rockshelter sample. The validity of this initial assessment is explored as part of the research presented later in this paper. The aim of this overview is not to provide comprehensive coverage but rather to establish the general framework within which the new data presented in this paper can be considered and to highlight the dominance of rockshelter sites as the primary contributors of data with which each technocomplex has been defined. For more detailed coverage of the LSA sequence of southern Africa, the reader is directed to the

foundational works of J. Deacon (1984) and Mitchell (1988, 2002) as well as the more recent revised sequence presented in Lombard et al. (2012) on which the summary presented here is largely based. Following this broad overview, results from the recently published rockshelter sample at PL8 are summarised focussing on the defining features of the local ELSA and Robberg as identified at the site. The background to the UPK7 sample is then provided and the methods used in this study described. After a descriptive presentation of results, the major findings of this study are considered. All dates are cited as calibrated ages and are expressed as 'ka' (thousand years ago) with all radiocarbon ages calibrated using OxCal 4.2 (Bronk-Ramsey 2009) and the Southern Hemisphere terrestrial calibration curve SHCal13 following Hogg et al. (2013).

Southern African Later Stone Age (LSA) sequence

The LSA sequence in southern Africa extends back to at least 40 ka when the technological systems of the LSA are recognised to have replaced those of the Middle Stone Age (MSA) in at least some parts of the subcontinent (e.g. Beaumont 1978; Lombard et al. 2012). A number of distinct technocomplexes are currently recognised for the LSA period including: ceramic final LSA (<2 ka); final LSA (~0.1-4 ka); Wilton (~4-8 ka); Oakhurst (~7-12 ka); Robberg (~12-18 ka); and ELSA (~18-40 ka) (Lombard et al. 2012). The nature and timing of changes between these technocomplexes are variable across southern Africa and most sites contain discontinuous sequences indicative of episodes of occupation separated by periods of non-occupation (Mackay et al. 2014). Common to all LSA sequences, however, is the general absence of evidence for MSA prepared core technology, such as prepared cores types (including Levallois and radial cores), flakes with faceted platforms, and MSA retouched artefact types such as bifacial points and unifacial points. Each technocomplex within the LSA is associated with a defined temporal range and is characterised by a number of distinct technological features and/or artefact types, typically described based on characteristics identified at one or a few key type-sites (summarised in Table 1). The earliest pre-12 ka part of the LSA sequence is often referred to as the late Pleistocene

microlithic (e.g. J. Deacon 1984; Mitchell 1988; Orton 2014) and is represented by the Robberg and ELSA technocomplexes, and we discuss the characteristics of these in some detail below. Note that the term ‘blade’ is used in this study to refer to parallel sided flakes whose axial lengths are at least twice as long as the axial width. No *a priori* distinction was made between blades and bladelets (cf. Pargeter and Redondo 2016).

The Robberg technocomplex (~12-18 ka)

Identification of the Robberg’s technological systems dates back to the 1940s (see Wadley 1996: 64), but it was not until over 30 years later that it was formally recognised and defined based on excavations at Nelson Bay Cave on the Robberg Peninsula. Assemblages attributed to the Robberg generally date to ~18-12 ka, though they may begin earlier and end later in the southeast than elsewhere in southern Africa (Loftus et al. 2016). The earliest dates reported so far for the Robberg, for instance, are associated with the late Pleistocene sequence at Sehonghong in Lesotho (Pargeter et al. 2017). Robberg assemblages are broadly characterised by evidence for the systematic production of small blades/bladelets (generally inferred from the presence of high frequencies of blades/bladelets and/or the cores from which they were produced); the preferential use of fine-grained materials such as silcrete, fine grain silicious (FGS)/crypto-crystalline silicates (CCS; sometimes referred to as opalines) and quartz; the common use of bipolar techniques for reducing stone (as evidenced by bipolar flakes and cores and/or the presence of pièces esquillées); and relatively low frequencies of formal retouched artefact types (H. J. Deacon 1979; J. Deacon 1984; H. J. Deacon and J. Deacon 1999; Klein 1974; Mitchell 1988, 1995, 2002; Wadley 1993, 1996: 23-30). Small non-elongate flakes measuring <20 mm in maximum dimension (sometimes referred to as ‘micro-flakes’), represent an additional key component of the Robberg at some sites (e.g. Porraz et al. 2016b). The Robberg has been identified at sites throughout southern Africa, typically in rockshelter deposits (e.g. H. J. Deacon 1976; J. Deacon 1984; Humphreys and Thackeray 1983; Kaplan 1990; Mitchell 1995; Schweitzer and Wilson 1982; Pienaar et al. 2008; Wadley 1996). Only

a handful of possible open-air Robberg-like assemblages has, however, been identified (Beaumont and Morris 1990; Churchill et al. 2000; Palmison 2014; Price-Williams and Barham 1982; Wilkins and Chazan 2012). The identification of these assemblages is based primarily on the presence of distinctive bladelet core types and are rarely associated with small flakes and/or blades/bladelets.

The ELSA technocomplex (~18-40 ka)

Early manifestations of LSA technology dating ~40-18 ka in southern Africa are often referred to as the early LSA or ELSA (e.g. Ambrose 2002; Orton 2006; Lombard et al. 2012), a term originally introduced into the archaeological lexicon by Beaumont and Vogel (1972) to accommodate a geographically dispersed and technologically diverse range of stone tool Industries from sub-equatorial Africa. Although understudied, the ELSA is generally characterised by assemblages dominated by small relatively unstandardised flakes and a strong emphasis on the use of locally available lithic material types such as quartz (e.g. Beaumont 1978; Porraz et al. 2016a) and CCS (e.g. Clark 1999; Mitchell 1994). In contrast to the assemblages of the Robberg, the presence and frequency of blades/bladelets is highly variable, though most assemblages are largely bladelet-poor. Bipolar techniques represent the dominant method used to reduce lithic material with *pièces esquillées* (sometimes referred to as scaled pieces or *outils écaillés*) being particularly common. A number of ELSA assemblages have significant, sometimes dominant, large flake components (e.g. Wendt 1976) leading to a degree of uncertainty regarding the ELSA's standing as a distinct technological stone working tradition and status as a discrete technocomplex (Ambrose 2002; Beaumont and Vogel 1972; Clark 1997; Kaplan 1990; Lombard et al. 2012; Mitchell 2002; Villa et al. 2012; Wadley 1991) and the term 'ELSA' has been criticised as being a "catch-all category" for poorly defined late Pleistocene assemblages "united only by their informality" (Clark 1997; Mitchell 2002: 115; Wadley 1993). At present it is perhaps the pre-22/18 ka date of these assemblages and the significant contribution of local material types that best defines them as ELSA. While the term remains in use as an archaeological technocomplex, it is acknowledged that the

assemblages it encompasses are characterised by much variation and that this variability remains to be documented and described in a range of settings (Wadley 1993; Clark 1997; Ambrose 2002; Mitchell 2002; Orton 2006; Lombard et al. 2012). A recent analysis of late Pleistocene lithic material from Putslaagte 8 rockshelter (PL8) in the Western Cape (Low and Mackay 2016) represents one such attempt to better understand and define the late Pleistocene ELSA and Robberg within a specific region.

Evidence from PL8

The late Pleistocene lithic sequence at PL8 rockshelter in the eastern Cederberg of the Western Cape contains two successive, yet distinct, assemblages characterised by high proportions of small blades (Low and Mackay 2016). The youngest of these is characteristically Robberg and associated with an age of c. 18-21 ka. Underlying this assemblage is material dating c. 22-25 ka with this assemblage interpreted as representing a new component/local expression of the ELSA that differs technologically from that recognised at sites on the opposite side of the Cape Fold Mountain Range and in the north of the subcontinent where the ELSA is largely quartz-bipolar dominant (Low and Mackay 2016). The following overview of the PL8 late Pleistocene sequence focusses on data for artefacts >20 mm only (summarised in Table 11) as to ensure comparability with the results presented later in this paper from UPK7. While the imposition of the >20 mm size cut-off obviously results in slight shifts in published numerical frequency values for PL8, overall no major change in the general frequency trends observed between the Robberg and ELSA units occurs.

The younger of the late Pleistocene assemblages at PL8 was found to be associated with dates and technological characteristics typical of the Robberg technocomplex. The Robberg at PL8 is hornfels dominant (62.1% of total assemblage), blade-rich (15.3% of complete flakes), associated with the preferential use of silcrete for the production of blades, has a low frequency of retouched artefacts (2.4% of flaked assemblage), a relatively high frequency of cores (12.5% of flaked assemblage) and

is associated with a significant contribution of bipolar working for reducing stone (7.9% of flaked assemblage), particularly in the core component (26.9% of complete cores). A degree of continuity between this assemblage and the underlying ELSA was observed in the similar yet slightly higher frequency of hornfels in the latter (76.7% of total assemblage), the equally low frequency of retouched artefacts (2.4% of flaked assemblage) and the high frequency of blades (17.8% of complete flakes). Several technological features, however, distinguish the ELSA from the overlying Robberg at PL8. While both assemblages are associated with the production of blades, notable differences occur in lithic material preference, methods of production and the size of the blades produced. While the Robberg is associated with the preferential use of silcrete to produce small blades, the ELSA is characterised by a preference for the use of hornfels and the manufacture of blades of a comparatively larger size. Blade production in the Robberg was relatively formalised, involving phases of core maintenance and high proportions of optimal phase blades, while in the ELSA blades were more irregular, with no evidence for core maintenance. Production of these blades involved the exploitation of natural ridges on hornfels cobbles. The ELSA assemblage at PL8 is also associated with a considerably lower frequency of cores (5.4% of flaked assemblage) and a lower contribution of bipolar techniques for reducing stone (bipolar technology forms 3.0% of flaked assemblage). Blade to blade core ratios differed strikingly between these assemblages. The ratio for all material types during the Robberg is 1.1:1 and when restricted to hornfels is 2.3:1. In contrast, the blade to blade core ratio for the ELSA is 8.0:1 for all lithic materials and 35.0:1 when restricted to hornfels with this difference primarily driven by the relative paucity of hornfels cores. Results for blade to blade core ratios during the ELSA hinted at an organisational system where hornfels blades were produced elsewhere in the landscape and introduced to the site and/or the cores from which they were produced were systematically removed from the sample (Low and Mackay 2016). While the results from PL8 are important, particularly in highlighting the technological variability associated with the ELSA, there is a need to further explore this variability within a regional context at a landscape-scale to determine whether similar patterns hold true at

other sites and in a range of landscape settings (i.e. rockshelter and open-air localities). Specifically, based on the PL8 results it was concluded that an assessment of surface archaeology along the Doring River was necessary to further investigate the possibility that blade production occurred closer to the Doring as the primary source of hornfels.

Uitspankraal 7: site background and description

UPK7 is a semi-arid, open-air locality situated on a remnant sediment stack of fluvial and/or aeolian origin near the confluence of the Biedouw and Doring Rivers and in the rain shadow of the Western Cape's Cederberg Mountains (Figure 1). The site is situated within the modern winter rainfall zone (WRZ) experiencing >66% of its mean annual precipitation (~200 mm) during the winter months between April and September (cf. Chase and Meadows 2007). Erosion at UPK7 has resulted in the exposure of a dense concentration of stone artefacts on the terrace surface which lies roughly seven meters above the Doring River on its north-eastern side. The scatter includes numerous technologically- and spatially distinct components (Figure 2), including a previously-published post-Howiesons Poort accumulation in 'area of analysis' (AoA) 1 and 2 (Will et al. 2015). Some 12 m east of the post-Howiesons Poort cluster is an area of ~76 m² (AoA 3) recently exposed by migration of the aeolian sands which cap the deposit (Figure 3). The hornfels-dominated assemblage in this deflation feature rests on a substrate situated upslope of the post-Howiesons Poort assemblage and downslope of an assemblage containing pottery (Will et al. 2015; Figure 2). AoA 3 was initially assigned to the ELSA based on visual comparison with the excavated sample from PL8 located approximately 15 km to the north-west (Figure 1). The cluster contains very few potentially Levallois or discoidal elements (n=7, including one preferential Levallois core and six convergent flakes) in the assemblage of over 3000 recorded pieces, strongly suggesting post-MSA accumulation. Minimal evidence was observed suggesting the reworking of stone material in the assemblage (i.e. post-depositional movement of artefacts via natural agents of water and/or wind resulting in the smoothing over of edges on an artefacts surface) in the study sample with only 5.2%

(n=158) of all lithic artefacts exhibiting any degree of rounding. In terms of the dominant hornfels lithic component, only 5.6% display surface patination (n=117) and 6.8% (n=143) show signs of chemical weathering resulting in the deterioration of surface features. The lack of evidence for significant reworking and/or weathering of the stone assemblage, in addition to the presence of several conjoin and refit artefacts found at UPK7 (including a core and flake refit identified in the north-west corner of the AoA 3) suggest that artefacts have not moved far despite post-depositional processes likely operating the site. Based on these observations, we thus assume that AoA 3 is associated with a reasonable degree of spatial integrity; ongoing geomorphological analyses are aimed at testing this assumption. Formational issues aside, the questions arising from our identification of this sample were:

- A. To what, if any, known part of the LSA does it most likely relate?
- B. If ELSA or Robberg, how does it articulate with the assemblage at PL8?

Methods

Data collection in AoA 3 at UPK7 reported in this paper was undertaken over the course of two month-long field seasons, the first in October 2014 and the second in March 2015. The locations of all stone artefacts measuring >20 mm in addition to any diagnostic artefacts <20 mm (e.g. backed artefacts, bipolar artefacts etc.) were marked out and the artefacts allocated unique identification numbers. Spatial positions were recorded using a Nikon C-Series Total Station rectified to WGS84 using local control points previously established with a Trimble RTK base and rover DPGS.

Technological attributes and measurements were recorded for each artefact in the field. No artefacts were collected and each was replaced in its original location after analysis. Lithic material type, cortex type, cortex percentage, maximum dimension (recorded as the maximum length of the artefact irrespective of artefact percussion orientation) and weight were recorded for all artefacts regardless of the degree of fragmentation. Whether an artefact was associated with bipolar reduction was also recorded. Bipolar artefacts were identified in this study based on the presence of

certain technological attributes commonly found to be associated with this reduction technique, specifically the occurrence of crushing on opposed edges and/or compression waves extending towards one another from opposing directions suggestive of impact from two points of applied force (Barham 1987; De la Peña 2015). Bipolar flakes typically exhibit crushed platforms, sheared bulbs of percussion and crushed distal ends while the reduced cores characteristically display crushed chisel-like edges (Barham 1987; De la Peña 2015). Additional technological attributes and measurements were recorded for complete specimens (Tables 2 and 3). The length, width and thickness of complete flakes were measured as axial dimensions oriented to the flaking/percussion axis. During the first field season, core dimensions (length, width and thickness) were measured in relation to the main flaking axis and the primary core face with the additional recording of maximum block dimensions taken during the second field season. For the purpose of this paper, core size data will only be considered using the larger core sample (n=138) recorded during the March 2015 field season (i.e. based on maximum core dimensions) as these results are comparable to the data collected from PL8. The length of the longest complete flake scar on each core was also recorded to approximate the maximum size of flakes detached prior to abandonment. Additionally, when considered in relation to other technological features, such as the size of complete flakes, an assessment can be made regarding the likely degree of reduction represented in the assemblage and/or the possibility of the importation/exportation of certain artefacts from/to the site. If the size of the largest flake scar on a core, for instance, is smaller than the average size of flakes of the same material in the assemblage, it can be argued that the core was heavily reduced and/or that larger flakes were introduced to the site (Holdaway and Stern 2004: 186-187). To assess whether the >20 mm size cut off would mask potentially important technological detail, a sample of artefacts <20 mm in maximum dimension was recorded from six 50 cm by 50 cm samples squares placed in transects across the site. The results presented in the paper pertain to the >20 mm data only as the exclusion of the <20 mm sample has little effect on the overall patterns observed (see below).

Results: characterising the probable ELSA lithic scatter (AoA 3) at UPK7

General assemblage composition

A total of 3078 stone artefacts >20 mm was analysed from AoA 3 at UPK7. Table 4 provides a general overview of this sample based on counts for artefact class, artefact completeness and lithic material type. Complete and broken flakes are dominant, forming almost 83% of the assemblage. Notable is the relatively high frequency of cores (7.8% of material analysed) and the relatively low frequency of retouched artefacts (1.1% of artefacts analysed). Most retouched artefacts in the assemblage are miscellaneous retouched pieces (n = 24) though some distinctive ‘types’ are present including: one hornfels naturally backed knife (NBK), two pièces esquillées (one hornfels and one FGS/CCS specimen), two hornfels burins and five scrapers of various material types (hornfels = 2, FGS/CCS = 1 and silcrete = 2) (Figure 7). Non-flaked stone artefacts form 1.5% of the assemblage with this component including a range of sandstone and quartzite hammerstones (n=20), a quartzite anvil, several ground pieces of stone (n=6), including a single specimen of ground ochre, and an assortment of manuports such as unworked quartz crystals (n=2) and heat-fractured hornfels river cobbles.

Lithic materials and cortex

The AoA 3 assemblage is hornfels-dominant with this lithic type forming roughly 68% of the material analysed (Table 4). Quartzite is the next most common material (28%) followed by quartz (1.6%) and FGS/CCS (1.2%) with all other lithic types contributing less than 0.5% each to the total assemblage (Table 4). Figure 3 illustrates the hornfels dominant nature of the scatter particularly in comparison to the probable post-Howiesons Poort MSA zone (AoA 1 & 2) located to the west which is dominated by silcrete and quartzite. Overall, the AoA 3 assemblage is characterised by a high degree of cortex retention with almost 65% of flaked artefacts (including both complete and broken specimens) preserving cortical surfaces (Table 5). Cortex retention is highest on hornfels artefacts and the very small dolerite sample with the lowest cortex rates associated with the small

number of silcrete specimens (Table 5). Of the cortex observed on hornfels artefacts, 97.8% is consistent with that found on cobbles in the adjacent riverine source. Quartzite, on the other hand, appears largely to have been acquired from nearby outcrops, including the surrounding cliff lines and adjacent scree slopes (92.4%) with little use made of fluvial cobbles (7.2%). Unless otherwise stated, the following discussion concentrates on results for complete flaked stone artefacts only.

Blade technology

The AoA 3 assemblage is associated with a strong elongate hornfels element (Table 6). Blade forms make up 18.3% of complete flakes. Almost one-quarter of complete hornfels flakes are blades (24.1%). In contrast, under 10% of complete quartz, FGS/CCS and quartzite flakes are associated with this flake form, with blades making up 9.7%, 9.5% and 4.1% of the flakes in these material types respectively. The sample sizes of complete flakes for the remaining material types (i.e. silcrete and dolerite) are too small to make meaningful comment. Looking at the dominant flaking products associated with complete cores in the assemblage reveals that just over 40% preserve evidence for the production of at least some blades. In terms of material types, over half of all complete hornfels cores are associated with production of blades (52.7%) in contrast to quartzite cores where only 11.1% are associated with blade production. The number of complete cores in the remaining material types is very small (Table 6). The blade to blade core ratio in AoA 3 is 4.2 (i.e. 4.2 blades per blade core) when all lithic materials are considered and 4.4 when looking exclusively at the dominant hornfels component.

All complete blades were additionally classified according to the Soriano et al. (2007) scheme to identify the likely stages of production represented in the assemblage and the degree of preparation, if any, involved in the production process. Results for this breakdown are presented in Table 7. The blade sample is characterised by a relatively high proportion of specimens associated with the initial stages of blade production (20.7% of blades) and a high frequency of blades preserving dorsal

cortex (65.5%). The lack of crested blades and blades associated with core maintenance, however, suggests that there was little or no investment in the initial preparation of cores and highlights the inelaborate nature of blade manufacture at the site. A small number of hornfels blades are morphologically similar to crested blades but are entirely cortical on their dorsal surface with the ‘pseudo-crest’ representing a natural angular ridge that was exploited during production (Figure 7d). This natural cortical ridge likely acted to help guide flake removal resulting in the consistent production of large blades.

Bipolar technology

The AoA 3 assemblage is associated with very limited evidence for the use of bipolar reduction (Table 6). Bipolar artefacts, for example, form 0.7% of the total flaked stone assemblage with bipolar cores making up 1.5% of the core sample and bipolar flakes representing only 0.8% of all complete flakes (Table 6). To test the possibility that this lack of bipolar artefacts was a result of the sample size cut-off implemented, all artefacts <20 mm were recorded from a series of six 50 by 50 cm sample squares laid out across the site; only one additional bipolar artefact (a bipolar core) was identified in the sample of 147 (0.7%). The possibility that bipolar artefacts may preserve differently to the relatively larger free-hand produced artefacts in open-air contexts also requires consideration. This is currently being tested by a recovery bias experiment at the site looking at the differential preservation and movement of bipolar versus free-hand artefacts in open-air semi-arid contexts prone to fluvially driven erosional processes.

Flaking patterns – complete flakes

Results for flaking patterns based on data for complete flakes are summarised in Table 8. The AoA 3 assemblage is associated with a high frequency of complete flakes exhibiting between 1-50% dorsal cortex, between 1-3 dorsal flake scars, usually indicative of a unidirectional flaking pattern, have single flake platforms (i.e. flake platforms that are relatively smooth planar non-cortical

surfaces with no ridges associated with previous flaking), feather terminations and are associated with minimal evidence for the use of overhang removal. A degree of variability can be seen in the flaking patterns associated with different material types. While hornfels appears to be primarily associated with unidirectional flaking, complete flakes of FGS/CCS and silcrete are associated with higher frequencies of high dorsal flake scar counts, a higher proportion of non-unidirectional dorsal flake scar patterns, a higher frequency of multi-flake platforms (i.e. flake platforms preserving evidence of three or more flaked surfaces in the form of multiple ridges on the platform surface) and the occurrence of overhang removal. FGS/CCS flakes, for example, record the highest frequency of complete flakes with 4-6 dorsal flake scars (55%) while silcrete flakes are associated with the highest frequency of flakes preserving >7 dorsal flake scars (12.5%). Similarly, the incidence of overhang removal appears to be strongly associated with silcrete (25% of complete flakes) and FGS/CCS (14.3% of complete flakes) lithologies. Although the sample sizes for FGS/CCS (n=21) and silcrete (n=8) are relatively small, the contrasting flaking patterns observed in association with these materials may be indicative of differences in reduction intensity and the desire to maximise output from materials that were not as readily available in the immediate environs as the locally derived hornfels.

Flaking patterns – complete cores

Results for flaking pattern based on core data are summarised in Table 9. Overall, the AoA 3 assemblage is associated with a high frequency of cores with cortex, particularly in the >50% cortex range (almost half of the complete cores fall in this high-range category), a high proportion of cores with blades as the dominant flaking product (18.5%) and a high frequency of cores with unidirectional flaking on either one or two core faces (72.3%). Just over 53% of complete cores preserve a minimum of seven flake scars and almost 30% associated with flake scar counts of >10. Cores are additionally associated with high rates of aberrant terminations with just over 30% of complete cores having a minimum of five step and/or hinge terminations.

Artefact size

The mean and standard deviations for the weight and metrics of complete flakes and cores in terms of lithic material types are presented in Table 10. Based on mean results, flakes manufactured from quartzite represent the heaviest, widest and thickest of all complete flakes in the assemblage. In contrast, quartz flakes are on average the smallest in all dimensions followed by the small sample of flakes manufactured from FGS/CCS and silcrete. Mean results for hornfels flakes generally fall somewhere between the two. Based on mean results for complete cores, quartzite specimens are the largest and heaviest in the assemblage with an average weight of over 560 g and a mean maximum dimension of 100.3 ± 30.7 mm (Table 10). In contrast, hornfels cores, which form just over 80% of the core sample, are smaller with an average weight of 77.5 ± 52.0 g and a mean maximum dimension of roughly 60 mm. A frequency histogram of core weights, regardless of lithic material type, demonstrates that most cores weigh less than 100 g with the highest frequency of these cores falling between 30-60 g (Figure 4). Similarly, a frequency histogram of core maximum dimensions and a boxplot of the maximum length, width and thicknesses of complete cores support the idea that core sizes overall are relatively constrained (Figure 5). Most cores, for instance, have a maximum dimension within the range of 50-70 mm (Figure 5). The occurrence of a few outliers is likely due to the large quartzite specimens in the sample.

Metrical data can also be used to examine more specific technological questions relating to the production of hornfels blades. On average, hornfels blades are longer (mean length: 45.0 ± 14.5 mm), narrower (mean width: 16.5 ± 5.7 mm) and thinner (mean thickness: 7.8 ± 4.7 mm) compared to the complete flake category as a whole. The frequency histogram of blade lengths shows that a range of blade sizes are present in the assemblage with the highest frequencies concentrated on blades with lengths ranging between 25-55 mm (Figure 6). The box-plot of blade lengths, widths and thicknesses shows that roughly half of the blades have a length falling between 30-55 mm with

results for width and thickness appearing more constrained. Roughly 60% of blades, for instance, possess widths of around 10-20 mm and thicknesses of around 5-10 mm (Figure 6).

Hornfels blade cores are on average lighter (mean weight: 72.2 ± 42.8 g) and smaller (mean length: 59.8 ± 11.9 mm; mean width: 39.6 ± 10.1 mm; mean thickness: 24.2 ± 6.6 mm) compared to the core category as a whole (Table 10). The average length of the longest complete flake scar on hornfels blade cores is 45.2 ± 13.0 mm. This is almost identical to the mean length of complete hornfels blades in the assemblage of 45.0 ± 14.5 mm. That is, almost all of the blades in the sample could have come from these cores in their state at discard, and it is thus unlikely that the cores were subject to significant on-going reduction after initial blade production. Combined with the relative frequency of cortex on these cores, our impression is that these blade production systems were characterised by relatively short reduction chains.

Discussion

Is the AoA 3 lithic scatter at UPK7 a local expression of the ELSA?

Spatial and technological evidence supports the notion that the AoA 3 lithic scatter at UPK7 is in fact representative of a local expression of the ELSA in the eastern Cederberg. Spatially, the scatter is positioned on a substrate situated vertically above of a clearly MSA post-Howiesons Poort scatter and below a later Holocene LSA one containing pottery (Figure 2). That no major evidence for Levallois and/or discoidal reduction systems were observed in the sample (only one preferential Levallois core and seven convergent flakes were recorded, representing 0.2% of the total assemblage) supports the notion that the assemblage is not of MSA origin but rather that we are dealing with an assemblage of LSA derivation (ESA remains in the form of handaxes are present in the colluvium at UPK7 [Figure 2] and at nearby UPK1 that rests on a well-developed calcrete [Bleed et al. In Press]). The question then is: to which part of the LSA does the AoA 3 assemblage likely belong? Pending dating results from OSL samples taken at the site, to explore this question

we must rely upon comparisons between the technological characteristics of the AoA 3 assemblage and current understandings of the ‘defining’ technological features associated with each technocomplex within southern Africa’s LSA sequence (Table 1), as well as those from the nearby PL8 sequence (Low and Mackay 2016).

From a purely technological standpoint, the AoA 3 assemblage can be defined based on a number of key features relating to its lithic technology. The assemblage is hornfels-dominant, blade-rich, associated with a very low frequency of retouched artefacts and lacks evidence for a significant contribution of bipolar techniques for reducing stone. Based on these characteristics alone it is reasonable to exclude several technocomplexes in the LSA sequence. The absence of pottery – and its common presence elsewhere at UPK7 – seems to discount the ceramic final LSA as a probable candidate. Technological features such as the blade-rich nature of the AoA 3 assemblage suggests assignment to the final LSA or Oakhurst is unlikely, given that both of these are generally flake-based technocomplexes that lack clear evidence for the preferential production of blades. Despite the presence of a single hornfels NBK in the AoA 3 sample (an artefact type generally associated with the Oakhurst Industry) the fact that this artefact type has also been found in association with the Robberg at sites such as Elands Bay Cave (Mitchell 1988: 105; Orton 2006: 13), Sehonghong (Mitchell 1994, 1995) and Umhlatuzana (Kaplan 1990), warns against placing too much emphasis on the presence of such a small sample; – a cluster of at least 35 NBKs in another part of the site east of the limits of Figure 2 likely provides a better example of the Oakhurst. Similarly, although the Wilton technocomplex contains a significant blade/bladelet element, the unretouched nature of the blades in the AoA 3 sample as well as the lack of backed artefacts or a significant retouched component in general, renders the Wilton unfavourable as a likely designation; mid Holocene occupation of the site may be better reflected in the concentration of small convex scrapers made predominantly on CCS and silcrete 30 m north of the scatter analysed here (Figure 3). Eliminating known late, middle and early Holocene LSA technological variants, it seems likely that the AoA 3

scatter at UPK7 is most closely aligned to the late Pleistocene LSA, and thus either the ELSA or Robberg. As the ELSA is currently understudied and poorly defined in many regions, however, we must look to the local late Pleistocene archaeological record for more clues.

As discussed previously, analysis of the late Pleistocene LSA sequence at PL8 rockshelter revealed the existence of two hornfels-dominant assemblages, both characterised by a high frequency of blades, a low frequency of retouched artefacts, and a significant contribution of bipolar techniques for reducing stone, particularly evident in the core component (Low and Mackay 2016). The primary distinguishing features between the two assemblages relates to the dominant lithic material and methods associated with the blade production systems in each unit. In the ELSA at PL8 hornfels is the dominant rock for blade production (Figure 9) while silcrete dominates in the Robberg blade corpus. Hornfels cores are far more common than silcrete cores in the ELSA, while the opposite is true in the Robberg. The main method of blade production in the ELSA involved the opportunistic removal of elongate flakes down natural ridges on hornfels cobbles with limited core maintenance; in the Robberg, crested blades occur and optimal phase blades dominate, reflecting a more regimented production system.

Technologically, the AoA 3 lithic assemblage at UPK7 conforms quite strongly with the stratified ELSA assemblage from PL8 (Tables 11 and 12; Figure 9). Hornfels dominates the blade component of the assemblage, and silcrete blades are most striking by their near total absence ($n=1$). The same is true of cores; the sample of cores from AoA 3 is quite large ($n=241$) but includes only a single broken silcrete example, and none among the blade cores; analysis of the PL8 Robberg sample suggested that silcrete cores were a major focus of lithic transport. While the blades in the ELSA at PL8 were much longer than those in the Robberg ($\text{mean}_{\text{ELSA}}=34.0$, $\text{s.d.}=14.6$; $\text{mean}_{\text{Robberg}}=26.9$, $\text{s.d.}=8.8$), the blades at UPK7 AoA 3 are larger again ($\text{mean}=44.9$, $\text{s.d.}=14.6$). As with the PL8 ELSA, the blade sample from UPK7 AoA 3 lacks evidence of core maintenance in the form of

crested blades, but includes numerous blades struck down natural ridges on hornfels cobbles.

Production of blades by this means was in many ways the defining feature of the ELSA at PL8, and is well expressed in the AoA 3 assemblage at UPK7.

Assuming that the UPK7 sample relates to some known variant of the LSA, it seems most likely to be a local expression of the ELSA previously documented at PL8. This suggestion is based both on the strong resemblance to the defining blade production system documented for the local ELSA, and the poor fit with any other industry. The amount of variation from known examples required to accommodate the UPK7 AoA 3 sample into the Robberg, Oakhurst, Wilton, late LSA etc. is far greater than that required to class it as ELSA. The fact that more compelling examples of several of these industries have been observed elsewhere at UPK7 obviates recourse to local factors (e.g. the immediate availability of hornfels) in accounting for these differences. If we thus accept that the AoA 3 assemblage is a Doring River expression of the ELSA, we can use the similarities and differences with the PL8 sample to begin to explore the manner in which ELSA technology was organised at a landscape scale in the eastern Cederberg.

The organisation of ELSA technology at a landscape-scale in the eastern Cederberg

Results demonstrate that the ELSA assemblage at UPK7, like that at PL8, is predominantly associated with the production of blades from locally acquired hornfels river cobbles. The inelaborate nature of the technology is reflected in the high degree of cortex retention in the assemblage, the constrained size of cores, the high proportion of blades relating to the initial stages of production, such as those with cortical platforms and/or cortical dorsal surfaces, and the absence of evidence for core maintenance. Knappers at the site took advantage of the natural ridges on subangular river cobbles to detach flakes and blades generally in a single direction (i.e. unidirectionally) using free-hand techniques, with minimal initial core preparation required.

In contrast to the dominant hornfels reduction system identified, different reduction goals appear to be associated with the non-hornfels artefacts at AoA 3. The reduction of quartzite at the site, for example, is associated with the production of large, chunky, irregular (i.e. non-elongate) flake forms from very large cores. These quartzite cores were discarded relatively quickly after the removal of only a small number of flake products (typically 3-6) with quartzite artefacts (flakes and cores) representing by far the largest specimens in the assemblage. Quartz-bipolar systems at UPK7, though almost absent, are associated with the local acquisition, reduction and discard of non-riverine rocks.

In contrast to the onsite reduction of hornfels, quartzite and quartz, it is likely that FGS/CCS and silcrete artefacts were imported to UPK7 and discarded. The presence of a small number of FGS/CCS blades combined with the absence of cores of this material suggests that such specimens may have been produced elsewhere in the landscape with technological attributes indicating the use of a different system of reduction. Partial cresting on some FGS/CCS blades (Figure 7f), for instance, is indicative of a more complex reduction system (at least compared to that involved in the manufacture of hornfels blades) involving a degree of initial core preparation. Alternatively, if the small sample of FGS/CCS and silcrete artefacts was produced onsite, the cores from which they were manufactured must have been removed. This scenario, however, is unlikely due to the absence of other flaking debris associated with these lithic material types.

At a technological level, the ELSA artefact scatter at UPK7 resembles the stratified ELSA material from PL8, but there are notable compositional differences. The UPK7 ELSA assemblage is characterised by a much higher proportion of cores, a higher number of non-flaked stone artefacts relating to the manufacturing process, such as hammer stones and anvil, and a much higher rate of cortex retention, particularly in the core technological class. The stark contrast in results for hornfels blade to blade core ratios between the two sites – close to an order of magnitude in

difference – supports the proposition that the manufacture and discard of hornfels artefacts were staged in different landscape settings. The production of hornfels blades appears to have taken place closer to the source of hornfels cobbles on the Doring river with subsequent transportation of the products into the surrounding landscape and apparently limited transportation of cores.

In contrast, non-hornfels artefacts manufactured on lithic materials not readily available in the immediate environs (i.e. FGS/CCS and silcrete) were likely transported to UPK7 and discarded on site having been produced elsewhere in the landscape. Similar to the organisation of hornfels technology – and in contrast to the Robberg – there is little evidence for the transportation of FGS/CCS and silcrete cores during the ELSA with strategies apparently emphasising the transportation of flaking products rather than the cores used to produce them. Another interesting result relates to the association between bipolar technology and specific landscape contexts. Results indicate that the bipolar-quartz signal is weak in the open-air ELSA setting at UPK7 with a comparatively stronger association (though still somewhat weak compared to sites on the opposite side of the Cape Fold mountain range and in the north of the subcontinent) being identified in the stratified rockshelter deposit at PL8. Bipolar technology is 20 times more common in the ELSA core component at PL8 than at UPK7. It is likely that the transportation of hornfels blades, but not hornfels cores, from the Doring is partly responsible for the relatively heavy use of locally-available quartz at PL8 (e.g. the quartz to hornfels ratio at PL8 is 10 times higher than at UPK7) as well as the higher frequency of evidence for bipolar technology at PL8 (e.g. bipolar cores are more common than blade cores in the PL8 sample; while bipolar cores represent less than one thirteenth of the blade core frequency at UPK7). Quartzite may have functioned in an equivalent role in the ELSA at UPK7, forming a discrete secondary production system focussing on local rocks. These results suggest that different ELSA technological components may have been organised in distinct patterns at the landscape-scale within the study area.

These results indicate that the dominant technological organisational system in place during the ELSA in the eastern Cederberg involved the transportation of flaking products around the landscape, with minimal movement of cores. Intriguingly this strategy may represent a key elemental difference in the way technology was organised during the ELSA compared to the Robberg Industry which temporally supersedes it. The increased frequency of cores in the Robberg context at PL8, for instance, may suggest that the small size of cores and the more fragile nature of the small flakes and blades/bladelets produced favoured a system in which cores were transported around the landscape. A greater understanding of Robberg technology from a range of site contexts in the study area, however, is required to test this hypothesis. Future research must therefore be directed at gaining a more comprehensive understanding of how and where artefacts were manufactured, and subsequently discarded, during the Robberg and whether these patterns differ to those observed for the ELSA. Important in any such discussion will be the recognition of potential variability in the patterns of artefact discard, particularly in relation to specific artefact classes, which may suggest differential patterns of manufacture, transportation and use between the two broad technological periods of the ELSA and Robberg. The challenge will be to provide adequate explanations for why such continuity and/or variability occurs.

Technological diversity in the ELSA of southern Africa

The results from UPK7 and PL8 combine to document a new, local expression of the ELSA associated with the Doring River in the eastern Cederberg. Considered within the broader context of the earliest LSA in southern Africa, these results contribute to the apparent diversity that marks the stone technology made and used by populations during this period and a number of key aspects of ELSA lithic assemblages can be identified. The first defining aspect relates to the prominent role played by locally acquired lithic materials in the material provisioning strategies employed by populations during the ELSA with variation between sites appearing to reflect differences in the local geological landscapes associated with each. While local hornfels is dominant in the ELSA at

the sites along the Doring in the eastern Cederberg (i.e. UPK7 and PL8), for instance, local quartz is the major lithic type during the ELSA at Elands Bay Cave (Porraz et al. 2016a), Border Cave (Beaumont 1978) and Heuningneskrans (Beaumont 1978) and local CCS dominates the ELSA at Rose Cottage Cave (Clark 1999) and Sehonghong (Mitchell 1994). Continuity between ELSA assemblages can therefore be seen in the strong emphasis on the use of local lithic materials with variability expressed in terms of differences in the specific types emphasised in each local context. Previous characterisations of the ELSA, which often recognise quartz as a defining feature (e.g. Wadley 1993; Mitchell 2002), must therefore be adjusted to emphasise the local nature of the material used rather than attempting to identify one or a few key lithic types that appear to have been targeted at several sites during the earliest LSA.

The second defining aspect of the ELSA in southern Africa relates to the high degree of technological diversity observed in the lithic assemblages between sites. This diversity is implied, for example, by variability in the methods used to reduce lithic materials and/or the dominant flake forms produced. In most discussions of ELSA technology reference is made to the extensive use of bipolar techniques for reducing stone, particularly in association with the use of quartz (cf. Ambrose 2002; Lombard et al. 2012; Mitchell 2002; Wadley 1993), though sometimes in association with other lithic types such as CCS (cf. Clark 1999; Mitchell 1994). This was indicated in Beaumont and Vogel's (1972) original definition by the criteria suggesting an abundance of *pièces esquillées* and by Mitchell (2002: 115) who identifies "an emphasis on quartz, typically reduced by bipolar flaking" as one of the only features that unites these late Pleistocene assemblages. While evidence for a strong emphasis on bipolar technology (whether in the form of bipolar flakes, bipolar cores and/or *pièces esquillées*) does appear to be particularly common in many ELSA assemblages (e.g. Beaumont 1978; Clark 1999; Deacon 1984; Mitchell 1994; Porraz et al. 2016a), the data from UPK7 is important in suggesting that its use is situational rather than time- or material- specific. Bipolar technology, for instance, is well represented in the ELSA at PL8

located on a tributary of the Doring and with no immediate access to hornfels, though is almost absent in the ELSA assemblage at UPK7 which is situated at the source hornfels.

Another technological feature contributing to the diversity associated with the earliest LSA relates to variability in the occurrence of evidence for blade/bladelet technology. This point was recognised even in the earliest descriptions of the ELSA though was agreed to be dependent upon access to “suitable” lithic materials (cf. Beaumont and Vogel 1972: 155). Blades/bladelets are infrequent and/or absent from the ELSA sequences at sites such as Border Cave (Beaumont 1978) and Boomplaas (Deacon 1984). In contrast, results from UPK7 and PL8 demonstrate that, at least in this part of the subcontinent, blade technology formed a significant component of the technology made and used during the earliest LSA. This also appears to be the case during the ELSA at Rose Cottage Cave (Clark 1999), Sehonghong (Mitchell 1994), Umhlatuzana (Kaplan 1990) and Elands Bay Cave (Porráz et al. 2016a). These results suggest that the blade/bladelet production systems were in place in some areas of southern Africa during the earliest stages of the LSA, though in a somewhat unsystematic form and with temporal differences in the lithic types, flaking strategies and the general size of the blades/bladelets produced usually observed (e.g. Kaplan 1990; Low and Mackay; Mitchell 1994; Porráz et al. 2016a). Variability in the presence of blade/bladelet technology in some ELSA assemblages, but not others, however, implies that the transition to the LSA was not uniform in character across southern Africa and hints at a scenario in which different technological trajectories may have been involved.

Conclusion

This paper has described a probable ELSA lithic scatter from the semi-arid, open-air locality UPK7 in the eastern Cederberg of the Western Cape. Comparisons with the stratified ELSA material from the nearby rockshelter PL8 not only provides support for the interpretation of the UPK7 sample as a local expression of the ELSA, but also highlights important continuity and variability in how ELSA

technology was articulated at a landscape level within a restricted geographical area (~20km east to west). The UPK7 data suggests that different ELSA technological components may have been organised in distinct patterns at the landscape-scale. Results provide evidence for an organisational system involving the manufacture, transportation and discard of different artefacts in different landscape contexts. Results support the hypothesis that hornfels blade production occurred close to the Doring River as the primary source of the hornfels with the subsequent transportation of blades around the landscape and minimal movement of cores. The transportation of hornfels blades, rather than the cores used to produce them, appears to have resulted in the comparatively higher reliance on locally-available quartz and bipolar technology in the PL8 rockshelter context. Overall, this study demonstrates the value of viewing technological systems at a landscape-scale and provides an example of how evidence from open-air contexts can be integrated with evidence from traditional, stratified rockshelter deposits within a regional setting to allow for a more comprehensive understanding of early LSA technology, behaviour and landuse patterns. An important point made clear when lithic technologies are viewed as landscape-scale systems is that the character of any given assemblage will be highly situational, responding to the local environmental, geological and social conditions of a region at a particular time. While ordering board-scale variability into technocomplexes has its use, it often masks these situational differences. A landscape-scale approach should thus form a key component in the methodological arsenal for archaeologists interested in exploring the interplay between past humans, their technological systems and the landscape in which they lived.

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Tables

Table 1. General summary of the southern Africa LSA lithic sequence including associated chronology and defining lithic assemblage characteristics based on Lombard et al. (2012)

Technocomplex	Other names / variants	MIS	Date (ka)	Lithic assemblage characteristics	Key reference/s
ceramic final LSA	ceramic post-classic Wilton, Late Holocene with pottery	1	<2	frequency of retouched artefacts variable, but include long end scrapers & small numbers of backed artefacts, associated with pottery (grit- or grass-tempered)	Deacon, J. 1984
final LSA	post-classic Wilton, Holocene microlithic	1	~0.1-4	highly variable, large unretouched flakes common, scrapers, backed artefacts & adzes	Deacon, J. 1984
Wilton	Smithfield C, Holocene microlithic	1	~4-8	blades/bladelets common, retouched artefacts numerous & highly standardised, small convex scrapers, small backed artefacts common	Deacon, J. 1972; Deacon, J. 1984
Oakhurst	Albany, Lockshoek, Smithfield A, terminal Pleistocene/early Holocene non-microlithic	1	~7-12	large side-struck flakes common, blades/bladelets rare, retouched artefacts uncommon but those present include scrapers, naturally backed knives	Deacon, J. 1984
Robberg	late Pleistocene microlithic	2	~12-18	evidence for the systematic production of small blades/bladelets (usually associated with a shift to fine-grained lithic materials such as silcrete and/or FGS/CCS), some bipolar technology, retouched artefacts rare, pièces esquillées (aka. outils écaillés or scaled pieces)	Deacon, J. 1984
ELSA	Early LSA, late Pleistocene microlithic, MSA/LSA transitional	3/2	~18-40	bipolar technology common, blade frequencies highly variable, retouched artefacts rare, pièces esquillées (aka. outils écaillés or scaled pieces)	Beaumont 1978; Wadley 1993

Table 2. Explanation of additional technological attributes recorded on complete flakes.

COMPLETE FLAKES: TECHNOLOGICAL ATTRIBUTES		
Attribute	Categories	Definition
dorsal cortex amount	0%, 1-50%, 51-100%	Refers to the amount of cortex (the 'rough' weathered exterior surface of the stone material) on the dorsal surface of the flake
dorsal flake scar count	0, 1-3, 4-6, >7	Recorded as the number of scars, including partial flakes scars, on the dorsal surface of a flake measuring over 5 mm in maximum dimension
dorsal flake scar pattern	unidirectional	Two or more scars that originate from the one direction
	bidirectional opposing	Two or more scars that originate from two opposed directions
	bidirectional orthogonal	Two or more scars that meet at right angles to one another from two platforms
	centripetal	Three or more scars that converge to a centripetal point from three or more differing directions e.g. typical on Levallois flakes
	polydirectional other/unknown	Three or more scars from three or more different directions Not possible to determine dorsal flake scar pattern possibly due to the absence of flake scar arises on small pieces
overhang removal	yes, no	Appears as slight crushing and/or stepping along the edge of the platform on the dorsal surface of the flake. Used to strengthen core platform, particularly useful when removing flakes from small cores with high platform angles (Clarkson 2008: 288)
flake platform type	cortical	'Natural' surface unmodified by previous flaking. Typically associated with flakes removed early during the reduction of a core
	single flake	Relatively smooth, planar, non-cortical single flaked surface
	double flake	Preserves evidence of two flaked surfaces, divided by an arris/ridge
	multi-flake	Preserves evidence of three or more flake removals on platform surface (i.e. multiple arises/ridges)
	linear crushed/shattered	Extremely thin platform with a width less than 1.5 mm Damaged platform. Typically occurs on small thin flakes produced using bipolar techniques
termination type	feather	Thin termination, tapering at the distal end
	step	Results from an abrupt traverse break or snap at right angles to the ventral surface during the flakes removal from the core
	hinge	Distal end terminated with a 'rounded' shape at right angles to the longitudinal flake axis (resembling a door hinge)
	plunge	Forms a 'J-shape' resulting from the distal end curving prominently away from where the core face was positioned (aka. outré passé)
	axial	Flake terminated by passing right through the bottom of the core

Table 3. Explanation of additional technological attributes recorded on complete cores.

COMPLETE CORES: TECHNOLOGICAL ATTRIBUTES		
Attribute	Categories	Definition
cortex percentage	0, 1-50, 51-100	Refers to the amount of cortex on the core surface
flake scar count	1-3, 4-6, 7-9, >10	Represents the minimum number of flakes removed from the core as earlier flake scars are removed during further reduction. Recorded as the number of flake scars, including partial flake scars, greater than 5 mm in maximum dimension
aberrant terminations	0, 1-2, 3-4, 5-6, >7	Records the total number of step and hinge terminations present on a core including those associated with partial flake scars over 5 mm in maximum dimension
dominant core flaking products	flakes	Dominated by flake scars relatively irregular in size and/or shape
	blades	Flake scars are predominantly elongate with lengths at least twice as long as wide and parallel sides
	mixed	Roughly equal mix of blade/bladelet and irregular flake scar morphologies
	point	Flake scars terminate in a point. Arises of the removed flakes lateral margins must begin to converge from above or at the midway mark along a flakes percussion length to converge at the distal end
flaking direction	unidirectional unifacial	Flakes removed in single direction on a single face/exploitation surface
	unidirectional bifacial	Flakes removed in single direction on two faces/exploitation surfaces
	bidirectional unifacial	Flakes removed in two opposed directions on a single face/exploitation surface
	bidirectional bifacial	Flakes removed in two opposed directions on two faces/exploitation surfaces
	centripetal unifacial	Flakes removed towards a central point on a single face/exploitation surface
	centripetal bifacial	Flakes removed towards a central point on two faces/exploitation surfaces
	polydirectional	Flakes removed in multiple directions on multiple faces/exploitation surfaces

Table 4. Technological class and artefact completeness counts for the UPK7 ELSA assemblage based on lithic material types

class	material	complete	broken	total
core	hornfels	131	37	168
	quartzite	54	7	61
	quartz	7		7
	FGS/CCS	1	1	2
	silcrete		1	1
	dolerite	2		2
	total	195	46	241
flake	hornfels	1272	478	1750
	quartzite	482	219	701
	quartz	31	9	40
	FGS/CCS	21	11	32
	silcrete	8	3	11
	dolerite	5	1	6
	total	1819	721	2540
retouched flake	hornfels	21	3	24
	quartzite	3	1	4
	quartz			
	FGS/CCS	1	3	4
	silcrete	3		3
	dolerite			
	total	28	7	35
flaked piece	hornfels		139	139
	quartzite		75	75
	quartz			
	FGS/CCS			
	silcrete			
	dolerite		1	1
	total		215	215
non-flaked	hornfels	1	9	10
	quartzite	16	7	23
	quartz	2	1	3
	sandstone	4	2	6
	ochre	1	4	5
	total	24	23	47
All	total	2066	1012	3078

Table 5. Count and frequency of cortex type and percentage for all flaked stone artefacts regardless of artefact completeness from UPK7

cortex	category	hornfels		quartzite		quartz		FGS/CCS		silcrete		dolerite		total	
		count	%	count	%	count	%	count	%	count	%	count	%	count	%
type	fluvial	1374	97.8	35	7.2	2	7.7	9	34.6	3	37.5	4	57.1	1427	72.9
	outcrop	29	2.1	449	92.4	6	23.1	9	34.6	4	50.0	2	28.6	499	25.5
	crystal					15	57.7							15	0.8
	indeterminate	2	0.1	2	0.4	3	11.5	8	30.8	1	12.5	1	14.3	17	0.9
percentage	0	676	32.5	355	42.2	21	44.7	12	31.6	7	46.7	2	22.2	1073	35.4
	1-25	535	25.7	183	21.8	10	21.3	14	36.8	3	20.0	3	33.3	748	24.7
	26-50	355	17.1	106	12.6	7	14.9	3	7.9	2	13.3	2	22.2	475	15.7
	51-75	237	11.4	91	10.8	7	14.9	7	18.4	1	6.7	1	11.1	344	11.3
	76-99	241	11.6	93	11.1	2	4.3	1	2.6	2	13.3	1	11.1	340	11.2
	100	37	1.8	13	1.5			1	2.6					51	1.7

Table 6. Counts and frequencies for: (a) blade flake forms (complete specimens only), (b) blade cores (complete specimens only), (c) all artefacts associated with bipolar flaking systems (regardless of artefact completeness), (d) bipolar flakes (complete specimens only), and (e) bipolar cores (complete specimens only) in terms of material types in the UPK7 ELSA assemblage

flaking system	category	material	count	%
BLADE TECHNOLOGY	blade flake forms	hornfels	306	91.9
		quartzite	20	6.0
		quartz	3	0.9
		FGS/CCS	2	0.6
		silcrete	1	0.3
		dolerite	1	0.3
		total	333	100.0
	blade cores	hornfels	69	87.3
		quartzite	6	7.6
		quartz	4	5.1
		FGS/CCS		
		silcrete		
		dolerite		
		total	79	100.0
BIPOLAR	bipolar technology	hornfels	2	10.0
		quartzite	1	5.0
		quartz	15	75.0
		FGS/CCS	2	10.0
		total	20	100.0
	bipolar flake	hornfels		
		quartzite	1	7.1
		quartz	12	85.7
		FGS/CCS	1	7.1
		total	14	100.0
	bipolar cores	hornfels	1	25.0
		quartzite		
		quartz	2	75.0
		FGS/CCS		
		total	3	100.0

Table 7. Count and frequency of blade types and marginal cortex location for complete blades in the UPK7 ELSA assemblage

production stage	categories	count	%
initial stage	A1	1	0.3
	A2	20	6.0
	A3	48	14.4
	total	69	20.7
main production phase	B1	98	29.4
	B2	7	2.1
	B4	7	2.1
	B5	1	0.3
	B6	80	24.0
	B8	3	0.9
	B11	28	8.4
	total	224	67.3
other	D2 or E1	40	12.0
total		333	100.0
dorsal cortex percentage	0	115	34.5
	1-25	74	22.2
	26-50	68	20.4
	51-75	33	9.9
	76-99	29	8.7
	100	14	4.2
total		333	100.0
marginal cortex location	left	46	63.0
	right	27	37.0

Table 8. Count and frequency of attributes relating to flake flaking patterns and flake platform attributes in the UPK7 ELSA assemblage

attribute	categories	count	%
dorsal cortex amount	0	627	34.5
	1-50	784	43.1
	51-100	408	22.4
	total	1819	100.0
dorsal flake scar count	0	47	2.7
	1-3	1219	68.8
	4-6	506	28.6
	>7	47	2.7
	total	1819	100.0
dorsal flake scar pattern	unidirectional	1506	85.0
	bidirectional opposing	110	6.2
	bidirectional orthogonal	42	2.4
	centripetal	3	0.2
	polydirectional	41	2.3
	other/unknown	70	4.0
	total	1772	100.0
overhang removal	yes	113	6.2
	no	1706	93.8
	total	1819	100.0
flake platform type	cortical	527	29.0
	single flake	1150	63.2
	double flake	19	1.0
	multi-flake	63	3.5
	linear	42	2.3
	crushed/shattered	18	1.0
	total	1819	100.0
termination type	feather	1064	58.5
	step	242	13.3
	hinge	184	10.1
	plunge	65	3.6
	axial	264	14.5
	total	1819	100.0

Table 9. Count and frequency of attributes relating to core flaking patterns in the UPK7 ELSA assemblage

attribute	categories	count	%
core cortex percentage	0	13	6.7
	1-50	87	44.6
	51-100	95	48.7
	total	195	100.0
core flake scar count	1-3	20	10.3
	4-6	71	36.4
	7-9	47	24.1
	>10	57	29.2
	total	195	100.0
core aberrant terminations	0	18	9.2
	1-2	56	28.7
	3-4	60	30.8
	5-6	53	27.2
	>7	8	4.1
	total	195	100.0
dominant core flaking products	flakes	115	59.0
	blades	36	18.5
	mixed	43	22.1
	point	1	0.5
	total	195	100.0
flaking direction	unidirectional unifacial	128	65.6
	unidirectional bifacial	13	6.7
	bidirectional unifacial	25	12.8
	bidirectional bifacial	2	1.0
	centripetal unifacial	4	2.1
	centripetal bifacial	3	1.5
	polydirectional	20	10.2
	total	195	100.0

Table 10. Mean, standard deviation and median of weight and size data for complete flakes and complete cores based on material types for the UPK7 ELSA assemblage. Core data is for complete cores from the second field season only

category	material	no.	weight			length			width			thickness		
			mean	S.D.	median	mean	S.D.	median	mean	S.D.	median	mean	S.D.	median
all complete flakes	hornfels	1272	9.6	13.1	5.0	33.1	14.2	30.0	23.2	10.1	21.0	8.0	4.4	7.0
	quartzite	482	27.0	48.4	10.0	37.0	16.1	33.0	32.4	16.5	28.0	12.2	6.7	11.0
	quartz	31	2.9	2.4	2.0	22.2	6.8	21.0	14.7	4.0	15.0	6.2	2.8	5.0
	FGS/CCS	21	4.4	3.2	3.0	25.1	7.5	24.0	20.8	8.0	18.0	7.1	3.2	7.0
	silcrete	8	9.8	7.5	9.5	41.4	15.8	36.5	26.8	10.5	22.5	6.8	2.6	7.0
	dolerite	5	13.6	22.7	4.0	31.2	9.4	25.0	24.2	16.1	16.0	7.6	6.7	4.0
	total	1819	14.1	28.3	6.0	33.9	14.8	30.0	25.5	12.8	22.0	9.0	5.4	8.0
all complete cores	hornfels	112	77.5	52.0	60.5	59.2	12.4	57.5	42.5	11.1	40.0	24.9	7.6	24.0
	quartzite	21	563.4	561.4	350.5	100.3	30.7	101.0	77.9	26.4	73.0	52.6	23.5	48.0
	quartz	4	109.0	195.3	12.5	53.0	43.5	34.0	33.5	19.0	24.5	22.5	13.1	17.0
	FGS/CCS	1	12.0		12.0	35.0		35.0	23.0		23.0	17.0		17.0
	total	138	148.8	277.0	68.0	65.2	23.1	60.0	47.5	19.6	41.0	29.0	15.3	25.0

Table 11. Summary of results for UPK7 compared to the PL8 ELSA and Robberg assemblages

technological feature	UPK7	PL8	
		ELSA	Robberg
hornfels as a % of assemblage	67.9	76.7	62.1
cortical artefacts as % of assemblage	65.0	44.8	52.1
retouched artefacts as a % of assemblage	1.1	2.4	2.4
cores as a % assemblage	7.8	5.4	12.5
blades as a % of flakes	18.3	17.8	15.3
blade cores as a % of cores	18.4	25.0	61.5
hornfels blades as a % of hornfels flakes	24.1	16.3	8.9
hornfels blades cores as a % of hornfels cores	52.7	12.5	54.5
blade to blade core ratio (all materials)	4.2	8.0	1.1
blade to blade core ratio (hornfels)	4.4	35.0	2.3
bipolar artefacts as a % of assemblage	0.7	3.0	7.9
bipolar cores as a % of cores	1.5	33.3	26.9
bipolar flakes as a % of flakes	0.8	0.4	6.8

Table 12. Summary of results identifying continuity and variability in the ELSA technology associated with UPK7 and PL8

	Continuity	Variability
General assemblage composition	<ul style="list-style-type: none"> • Hornfels dominant • Overall low frequency of retouched artefacts (particularly compared to other stone artefact industries/periods in southern Africa) • Similar frequencies of flaked pieces 	<ul style="list-style-type: none"> • Higher frequency of cores and hammerstones at UPK7 • Higher frequency of retouched artefacts at PL8 • Higher degree of cortex retention at UPK7, particularly within the core technological class
Blade technology	<ul style="list-style-type: none"> • Blade manufacture is inelaborate, involving little or no investment in initial core preparation and/or core maintenance 	<ul style="list-style-type: none"> • Higher proportion of blades associated with the initial stages of blade production at UPK7
Bipolar technology	<ul style="list-style-type: none"> • Overall low frequency of artefacts associated with bipolar technology (particularly compared to the ELSA in the north of the subcontinent and on the opposite side of the cape fold mountain range) 	<ul style="list-style-type: none"> • Bipolar technology slightly more frequent in the ELSA at PL8
Flaking patterns	<ul style="list-style-type: none"> • Dorsal flake scars suggestive of a unidirectional flaking pattern dominant on complete flakes at both sites • Minimal evidence for overhang removal • Single flake platforms dominant 	<ul style="list-style-type: none"> • UPK7 associated with higher frequency of flakes with dorsal cortex, cortical platforms and low dorsal flake scar counts • UPK7 cores associated with higher frequency of high flake scar counts, higher rates of aberrant terminations and a higher frequency of unidirectional flaking • PL8 cores associated with a greater range of flaking patterns with bidirectional flaking on one or two faces and polydirectional flaking particularly common
Artefact size		<ul style="list-style-type: none"> • Cores, flakes and blades are on average much larger in the UPK7 assemblage compared to PL8

Figure captions

Figure 1. Map showing the location of UPK7 (white circle with dot) in relation to PL8 (white triangle with dot). Other white triangles in the main image represent other excavated LSA sites nearby: Klipfonteinrand (KFR) and Mertenhof (MRS). Inset: Dark grey shading represents the distribution of the modern winter-rainfall zone; light grey shading represents the modern year-round rainfall zone; unshaded area represents the modern summer rainfall zone. Major excavated LSA sites shown are Border Cave (BC), Elands Bay Cave (EBC), Klipfonteinrand (KFR) and Nelson Bay Cave (NBC). Rectangle documents the location of the study area.

Figure 2. Map of UPK7 showing the spatial distribution of tempo-technological artefact types. A base layer of aerial footage from 2010 depicts vegetation coverage as darkened amorphous patches

Figure 3. Map of UPK7 showing the spatial distribution of lithic material types, illustrating the hornfels dominated ELSA zone which is discrete from the silcrete and quartzite dominated MSA areas. A base layer of aerial footage from 2010 depicts vegetation coverage as darkened amorphous patches

Figure 4. Frequency histogram of UPK7 core weights for: (1) all cores; and (2) cores <100 g

Figure 5. Frequency histogram of core maximum dimensions and boxplot of core sizes for UPK7

Figure 6. Frequency histogram of blades lengths and boxplot of blade sizes for UPK7

Figure 7. Selection of ELSA flakes and retouched artefacts from UPK7: (a) FGS/CCS bipolar flake; (b) silcrete core rejuvenation flake; (c) FGS/CCS core rejuvenation flake; (d) selection of

‘pseudo-crested’ cortical hornfels blades; (e) selection of plunging hornfels blades; (f) partial crested FGS/CCS blade; (g) selection of laminar hornfels blades; (h) selection of smaller hornfels blades; (i) silcrete end-scraper; (j) hornfels naturally backed knife; (k) hornfels burin blade; (l) hornfels retouched flake; (m) FGS/CCS pièces esquillées; (n) hornfels pièces esquillées; (o) large quartzite retouched flake. (White bar is 10 mm)

Figure 8. Selection of ELSA cores from UPK7: (a-f) unidirectional hornfels blade cores; (g-m) unidirectional hornfels cores; (n) bidirectional orthogonal hornfels core; (o) bidirectional opposing hornfels core; (p) large multidirectional quartzite core; (q) large unidirectional quartzite core; (r) multidirectional hornfels core. (White bar is 10 mm)

Figure 9. Selection of ELSA artefacts from PL8: (1a-b) hornfels blade cores; (2a-d) ventral, side profile and dorsal surfaces for a sample of hornfels blades; (3) selection of hornfels blades showing (a) ventral and (b) dorsal surfaces (White bar is 10 mm)

ARTEFACT TYPES

- ◆ Thumb nail scraper
- Pièces esquillées
- ◡ Naturally backed knife
- Pottery
- ▲ Unifacial point
- ◆ Handaxe

SURFACE TYPE

- ▨ Colluvium
- ▨ Aeolian sand
- ▨ Calcareous sediment
- Consolidated silty sand

AREA OF ANALYSIS (AOA)

- Probable MSA (AoA 1 & 2)
- Probable ELSA (AoA 3)