PHASE 2 SPECIALIST STUDY OF MIDDLE STONE AGE LOCALITIES ON THE FARM ZANDKOPSDRIFT 357, GARIES DISTRICT, NORTHERN CAPE PROVINCE

Swartkop Hill

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Executive summary

Purpose

This report details the results of a Phase 2 mitigation undertaken on portions of the farm Zandkopsdrift 357 in the Garies area, Northern Cape Province. The Phase 2 was requested by Sedex Minerals (Pty) Ltd, a 74% subsidiary of Frontier Rare Earths SA (Pty) Ltd, and AGES (Pty) Ltd following on recommendations emanating from a Phase 1 Archaeological Impact Assessment (AIA) and Heritage Impact Assessment (HIA) conducted by the Archaeology Contracts Office Department of Archaeology University of Cape Town and AGES (Pty) Ltd.

Background

During the Phase 1 survey significant archaeological occurrences were identified that will be impacted upon by a proposed rare earth minerals mine. The heritage assessments of Zandkopsdrift (ZKD) primarily focussed on an area covering about 300 ha proposed for prospecting and the development of mining infrastructure.

Relatively high densities of Middle Stone Age (MSA) artefact scatters were identified in the survey area along drainage lines and in particular around outcrops of rocks sourced for lithic material on Swartkop Hill. The initial study suggested that the larger ZKD area probably acted as a factory site for stone tool manufacture. Medium to high significance was assigned to these localities in view of the densities of Stone Age material. In addition, the identification of a highly weathered proto-handaxe signals an ephemeral Earlier Stone Age (ESA) presence. Later Stone Age (LSA) artefactual material was also noted as well as a single fragment of a clay vessel that can be attributed to a LSA hunter-gatherer/herder occupation.

Summary

The Phase 2 investigations confirmed the presence of substantial MSA assemblages, ephemeral utilization during the ESA and a transient LSA of low significance. Visits to the area by MSA populations over a long period of time created an overlay of episodic events that resulted in high-density scatters of artefacts centred on outcrops of flakeable stone material. The raw materials used in the production of the MSA sequence demonstrate a focus on chalcedonies exposed by weathering of the Swartkop Volcano. A very minor use of quartz was identified at lithic scatters located at some distance from the main quarrying areas. The LSA lithic scatters exhibit the use of a greater range of materials that include the local chalcedoneous rock with lesser frequencies of quartz and other cryptocrystalline silicas (CCS)

The methodology applied in the Phase 2 at sites ZKD1_3017DD and ZKD2_3017DD on Swartkop Hill was based on two probabilistic sampling methodologies, namely systematic and stratified random sampling (Richardson and Gajewski 2003). The aim was to establish a spatial distribution pattern and assess the density of lithics to ensure that the sampling process delivered a representative collection and reliable data. Within the extant grid at site 1, ZKD1_3017DD, an excavation was carried out in two 1-metre squares within square D of the grid. At other MSA localities the assessment comprised survey transects while ESA and LSA lithic clusters were subjected to random sampling.

The survey established the main archaeological occurrences to be centred on rock outcrops that served as good sources of raw material for the manufacture of stone tools. Outcroppings of fine-graded chalcedonies within the lithological zones that developed through alteration, supergene weathering and metasomatism are eminently suitable for the manufacture of stone tools.

The focus of stone procurement and knapping activities during the MSA correspond to areas of high concentrations of rare earth elements that will be targeted for extraction in the first phases of the mine development. The archaeological investigations accordingly focussed on areas with key outcrops. Two major sites, namely ZKD1_3017DD and ZKD2_3017DD, were extensively sampled with another seven localities subjected to less intensive sampling. Representative probabilistic sampling of surface material was undertaken at the two major localities comprising an area of 85 and 25 square metres respectively. In addition an area within the extant grid at ZKD1_3017DD was excavated up to a plinthic horizon. The excavation aimed to determine the depth of the deposit, to document changes in the stratigraphy and to assess the typomorphological and technological attributes of lithics from a likely subsurface deposit. It was established that the archaeological strata consist of a built-up of lithics and also sediments associated with natural erosion along the hillside. No other cultural materials were present in the deposit.

The characteristics of the ZKD assemblages point to a long period of procurement of flakeable stonetool material sourced from surface outcrops that contained high-grade chalcedoneous deposits. All major outcrops at ZKD were evidently investigated by prehistoric people as is apparent from the extensive knapping activities but only specific localities were targeted to take advantage of deposits and pockets of more homogeneous fine-grained stone. The full chain of operation (*chain opératoire*) was carried out including sourcing, knapping of suitable material and the manufacture of a range of formal tool types. Evidently extractive activities at sources of high-quality stone material would have influenced the settlement and mobility patterns of the groups involved in these activities (Bamforth 2006:522).Acquiring good flakeable material and to transport end products involve organizational and behavioural strategies. It is commonly accepted that stone tool assemblages reflect aspects of human behaviour. The characteristics of lithic resources, their spatial distribution across the landscape and other organizational processes should feature in any such reconstruction of behavioural particulars (Wilson 2011:163).

There is a clear spatial pattern in lithic distribution at ZKD. Artefact densities differ according to distance from raw material sourced. At the preferred source outcrops the largest concentrations of lithics are near the source with markedly lesser densities on the periphery. Whereas deposits undoubtedly also built up through hill wash, the highest densities always cluster around good sources of flakeable material. Lithic materials are not predictable regarding flaking properties and fracture toughness (Webb and Domanski 2008). The outcrops at ZKD comprise differential-grained lithologies and high levels of waste material are present at localities that were extensively exploited. Outcrops that could not deliver suitable material exhibit low levels of debitage concomitant with stone tool production.

The total (n = 10 617) of sampled lithics produced indices of 46% for debitage (discarded material from the reduction process and from the shaping of tools), 2% cores (or objective pieces), 46% flaked blanks (detached pieces) and 6% formal stone tools. The range of tool types and the relative frequencies between surface-collected samples and the excavated subsurface deposits from ZKD are comparable. The presence of formal tools such as awls and scrapers in the subsurface deposit suggests that quarried chunks of material were subjected to initial stages of flaking and immediate tool production close to the source of stone extraction. The main differences between the two collections are in the higher numbers of waste material recovered from the subsurface deposit and a higher relative mass for the excavated material in relation to the number of lithics. The lithics from the lower levels of the excavation also become exponentially larger and have a more robust appearance. It is likely that this trend may reflect earlier phases of utilization of the ZKD resources. From the analysis of the extensive ZKD sequence it is inferred that the surface material at this locality and at least the upper levels of the excavation can most probably be assigned to a MSA3 sequence dating to approximately 60 000 to 25 000 years ago (Mitchell 2008:52).

Debitage in the form of waste from stone tool production dominates the lithics. Whereas core types include typical MSA prepared Levallois and radial cores the multi-directional cores are more numerous. Cores were used to deliver flake and blade blanks and the characteristic MSA convergent flakes produced from prepared cores. The flake and blade blanks were frequently expediently utilized. Appreciable numbers of flaked blanks were shaped through retouch to produce formal stone tool types that mainly include a range of scrapers and a surprisingly high number of awls. MSA pressure-flaked points are rare. The characteristics of the ZKD MSA assemblage suggest a landscape-use pattern centred on the procurement of raw materials that were eminently suitable material for the manufacture of stone tools. Such visits were probably scheduled to also take advantage of seasonal locally-available food resources. In view of the probable low population densities during the MSA the scale of extractive and stone tool manufacturing processes at ZKD is remarkable.

This report also includes background information on the Stone Age archaeology of the region in order to contextualize the heritage resources of the area under investigation as well as relevant heritage legislation and conservation policies.

Recommendation

Within the context of the above the Swartkop Hill MSA assemblage and associated sites are deemed of high cultural significance (NHRA 1999: Act 25:2(vi)) at the local to regional scale. Unfortunately, as with most other open-air MSA localities, the ZKD MSA assemblages are not associated with organic cultural materials or with markedly well-developed stratified archaeological deposits. It is the considered opinion of the heritage team that the substantial sample of more than 10 000 pieces of lithics obtained through the Phase 2 assessment is representative and that further mitigation will not add more qualitative data. No additional archaeological mitigation is accordingly recommended as this will merely increase the volumetric sample that has to be curated and stored.

The major MSA localities identified at ZKD during the Phase 1 AIA were extensively investigated during the Phase 2 mitigation and Specialist Study. In the event that future construction or mining activities reveal any buried sites the processes should stop until a suitable qualified Stone Age archaeologist has investigated the archaeological occurrences.

Subject to the approval of this Phase 2 Specialist report by the South African Heritage Resources Agency (SAHRA) it is accordingly recommended that an application for a destruction permit should be approved in order for infrastructural developments of the Zandkopsdrift Rare Earth Element Project to proceed.

Stakeholder consultation

No formal stakeholder consultation was undertaken as part of this assessment due to the fact that an extensive procedure had been followed as part of the environmental process commissioned by Frontier Rare Earths SA (Pty) Ltd and conducted by AGES (Pty) Ltd.

A number of local people in the region were interviewed and questioned on their knowledge of the regional history.

Qualifications

It should be kept in mind that archaeological deposits usually occur below ground level. Should archaeological artefacts or skeletal material be revealed in the area during construction activities, such activities should be halted and a university or museum notified in order for an investigation and evaluation of the find(s) to take place (*cf*. National Heritage Resources Act (NHRA) Act No. 25 of 1999, Section 36 (6).

A copy of this report will be lodged with SAHRA as stipulated by the NHRA Act No. 25 of 1999, Section 38 (especially subsection 4).

The recommendations contained in this document will be reviewed by SAHRA in order to consider the significance of the sites located at ZKD prior to issuing a destruction permit.

Contents

FIGURES

Glossary, acronyms, abbreviations and basic stone tool terminology

AIA Archaeological Impact Assessment
EIA's Environmental Impact Assessments
HIA Heritage Impact Assessment

Archaeological remains can be defined as any features or objects resulting from human activities, which have been deposited on or in the ground, reflecting past ways of life and are older than 100 years.

Conservation as used in this report in relation to heritage resources 'includes protection, maintenance, preservation and sustainable use of places or objects so as to safeguard their cultural significance' (NHRA 1999: Act 25:2iii).

Cultural significance means 'aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance' (NHRA 1999: Act 25:2(vi).

Development means any 'physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of a heritage authority in any way result in a change to the nature, appearance or physical nature of a place, or influence its stability and future well-being' (NHRA 1999: Act 25:2(viii).

Heritage. Heritage resources have lasting value in their own right and provide evidence of the origins of South African society. They are limited and non-renewable. The NHRA section 32, p. 55 defines these as an 'object or collection of objects, or a type of object or list of objects, whether specific or generic, that is part of the national estate and the export of which SAHRA deems it necessary to control, may be declared a heritage object'.

These include historical places, objects of archaeological, cultural or historical significance; objects to which oral traditions are attached and which are associated with living heritage; objects of scientific value, fossils, etc.

NHRA. National Heritage Resources Act.

SAHRA. South African Heritage Resources Agency.

The Act means the National Heritage Resources Act, 1999 (Act No. 25 of 1999).

The Stone Age: ESA (Earlier Stone Age), **MSA** (Middle Stone Age), **LSA** (Later Stone Age).

List of abbreviations

Abbreviation	Description
ASAPA	Association for South African Professional Archaeologists
AIA	Archaeological Impact Assessment
BP	Before Present
EIA	Environmental Impact Assessment
ESA	Earlier Stone Age
HIA	Heritage Impact Assessment
LSA	Later Stone Age
MSA	Middle Stone Age
NHRA	National Heritage Resources Act No.25 of 1999, Section 35
SAHRA	South African Heritage Resources Association
ka	Thousand years before present, a date
ky	=Thousand years

Basic stone tool terminology

A core is a block of raw material from which flake-blades or bladelets have been removed. It is classified as a core only if there are at least three negative flake removal scars. Cores generally show much morphological variability and the size of raw materials influences the kind or reduction technology used (Andrefsky 2005)

A flake is a fragment of stone which has been removed from a core. Such a blank can be used to manufacture a variety of tools. The tiny flakes removed when shaping a flake blank are also called flakes (see retouch below). Flakes, but also bladelets and blades, are the main products of any reduction process.

Detached flakes are often classified as debitage or waste (Andrefsky 2005). However, flakes were undoubtedly used for a variety of tasks on wood, meat and bone as suggested by artefact function studies and supported by ethnographic accounts (Van der Ryst 2006).

Retouch is when small flakes or chips are removed from a blank flake in order to shape or transform a flake into a tool. Retouch shows in tiny regular negative scars on the tool.

Blank is a piece of stone (a flake) that has been removed from a core. It can potentially be modified through further shaping into a specific type of formal tool.

Other lithic terms used in this document:

Acheulean. A second phase of the ESA associated with Large Cutting Tools such as handaxes and usually with early *Homo* species.

Anatomically Modern Humans (AMH). We use the term to describe fossils that clearly belong to the species *Homo sapiens sapiens*. Some physical anthropologists include all populations whose physique lies within the range of variation of living people and fossil forms of pre-modern humans, such as the Neandertals, in the singe subspecies *Homo sapiens sapiens*, whereas others prefer species names such as *Homo neanderthalensis* for archaic types. The term AMH has fewer biological implications and it is therefore generally used for fossils that clearly belong to the same species as us (UNISA AGE2701:2009).

Artefacts. Traces of hominin behaviour in the form of tools.

Backing. A blade or flake that has been intentionally dulled on one margin (similar to a knife blade).

Biface. A tool with two surfaces (faces) that meet to form one cutting edge.

Bifacial trimming. Secondary shaping on both surfaces. A **uniface** exhibits trimming only on one surface, commonly the ventral surface.

Blade. A flake with parallel or sub-parallel sides that is at least twice as long as it is wide.

Cortex. A chemical or mechanical weathered surface on stone.

Debitage refers to waste from stone tool manufacture.

Distal. The tip of a flake or tool.

Dorsal. The side of a flake or detached piece with scars of previous flake removals or the side showing the original cortex/skin of the rock in the case of a primary (first in the sequence) flake.

Fauresmith. A transitional industry at the interface of the ESA and the MSA that dates to around 250 000/200 000 years ago. Prepared cores and small well-made handaxes are usually a feature of this phase.

Hominin. Members of the Homininiae, the subfamily to which humans belong.

Howiesons Poort. A MSA microlithic industry with tools made on fine-grained stone that date to around 60 000/65 000 years ago. At sites where a Howiesons Poort phase is present, it is often found interleaved between macrolithic MSA tools of earlier and later phases.

Knapper/knapping. A knapper is a skilled craftsperson who produces stone flakes and formal tools through a reduction process, known as knapping.

Lithic means stone and is derived from Greek.

Oldowan. The earliest phases of the ESA. It is characterized by the use of chopper tools made on pebbles by early hominins.

Proximal. The section of a flake or a tool that contains the striking platform and the bulb of percussion/bulbar scar of the fracture zone.

Stratigraphy. The ordered layering of units, e.g. the building up of a deposit over successive visits to a locality. The sequence of strata is used to relatively date the layers and the materials in layers to older and more recent occupations.

Systematic random sampling. It is a probabilistic sampling process that requires the ordering of units by randomly selecting a unit from among ordered units such as a grid square. Archaeologists often prefer systematic samples because they are quick to select and give good coverage or an even spread of a site. The archaeologist must cognisant of possible topographical, geological or other features in the sampling interval that may match some regularity in the data (Richardson and Gajewski 2003).

The possibility of stratification/strata should always be taken into account. In probabilistic **systematic random sampling** restricted random samples are collected to obtain a more accurate estimate than possible with completely random samples. Subgroup units are formed and a simple random sample of units is selected from within each subgroup. For example, the archaeologist may select a representative sample to be taken from the north and the south end of a site or from deeper levels to determine stratification. The definition of strata could be based on any property or on a combination of properties, such as geology or elevation or any aspect that is thought likely to affect the parameters under study, for example the density or particular spatial distribution of artefacts at a site (Richardson and Gajewski 2003).

Striking platform. The area where a flake or blade was struck to remove it from the core.

Typology. A systematic classification scheme used to order different types according to their characteristics in a relational system.

Ventral. The smooth surface of a detached piece with no evidence of previous flake removals. It usually contains a flake scar, the **bulb of percussion** that forms as a result of the force exerted to remove the flake from a core.

1 Introduction

Sedex Minerals (Pty) Ltd (Sedex), a 74% subsidiary of Frontier Rare Earths SA (Pty) Ltd (Frontier), intends the mining of Rare Earth Elements (REE) on portions of the farm Zandkopsdrift 357 in the Garies area, Northern Cape Province. Following on the initial Phase 1 Archaeological Impact Assessment (AIA) and Heritage Impact Assessments (HIA)[1,2] Habitat was commissioned to undertake a detailed Phase 2 AIA and to mitigate Middle Stone Age (MSA) archaeological sites that will be impacted upon by future developments of the Zandkopsdrift REE Project (ZRP) (*see* 2 for background information on the project). In this instance a Phase 2 was required in terms of the National Heritage Resources Act (Act No. 25 of 1999, section 35) because the proposed development cannot be realigned to save or protect the heritage resources (*see* South African Heritage Resources Agency (SAHRA) 2007:4 *APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports*). The archaeologists who conducted the Phase 1 AIA and HIA consequently recommended mitigation, and therefore a Phase 2 AIA, of MSA sites on Swartkop Hill that will be destroyed through mining for REE:

> *No mitigation is required with the standard drilling procedures used during prospecting. However, it is recommended that surface collections of artefacts are made prior to commencement of mining operations as it seems likely that the mining will result in the destruction of the archaeological material on the kopje (Webley and Halkett 2010:15-16).*

This report details the results of the final Phase 2 investigation and specialist study. It describes the methodology applied in the assessment of the archaeological occurrences at ZKD, provides an account of the sampling of representative lithic collections and the test excavation, contextualizes the archaeological history of the larger Namaqualand area and gives a brief overview of applicable heritage legislation and conservation policies.

A copy of the report will be submitted to the South African Heritage Resources Agency (SAHRA). Note that the Phase 2 report and the recommendations contained in the document will be reviewed before SAHRA can issue a destruction permit for the sites that will destroyed by future mining activities.

2 Background to the project

2.1 Prospecting and mining

Sedex is involved in the development of a rare earths mine, the Zandkopsdrift Rare Earth Element Project (ZRP) [3] in the Northern Cape on portion 2 of the farm Zandkopdrift 537, about 30 km south of Garies. The prospecting right is held by Sedex, a subsidiary of Frontier. The current phase comprises

[1] Webley, L and Halkett, D. 2010. *Archaeological (Incl Heritage) Impact Assessment: Proposed Prospecting on Portion 2 and Remainder Portion of the farm Zandkopsdrift 537, Garies, Northern Cape*. The Archaeology Contracts Office: Department of Archaeology University of Cape Town.

[2] Kruger, N. 2011. *Sedex Minerals: Zandkopsdrift 357, Garies, Northern Cape Province. Consolidated Phase 1 Archaeological Impact Assessment Report*. Compiled by N Kruger for AGES (Pty) Ltd.

[3] Venter, M et al. 2010. J1580 2010*. Amended NI 43-101 Resource Estimate and Technical Report on the Zandkopsdrift Rare Earth Element (REE) Project, located in the Republic of South Africa. Accessed 14 March 2012*

further exploration to assess and determine the economic potential with a view to long-term development that will comprise infrastructure such as a processing plant, stockpile facilities and tailings dams.

A series of drilling programmes to prospect for REEs are focused on a small hill, Swartkop, probably named for the surface outcrops and horizons of very dark rock. The REE-bearing carbonatite complex at ZKD is associated with the early Cretaceous alkaline Koegel Fontein intrusive complex located within the Mesoproterozoic Namaqua-Natal Orogenic Belt (Schmitz and Bowring 2004; Eglington 2006; Venter et al 2010). The carbonatite occurs as a circular intrusive that is elevated about 40 m above the surrounding plains and is represented in outcrops by highly weathered secondary Fe-Mn material. The subsurface REE-enriched zones broadly correspond to several of the prominent surface outcrops[4] . These outcrops of weathered carbonatite have been the *loci* of Stone Age activities and served as extraction sites for stone-tool quarrying and knapping.

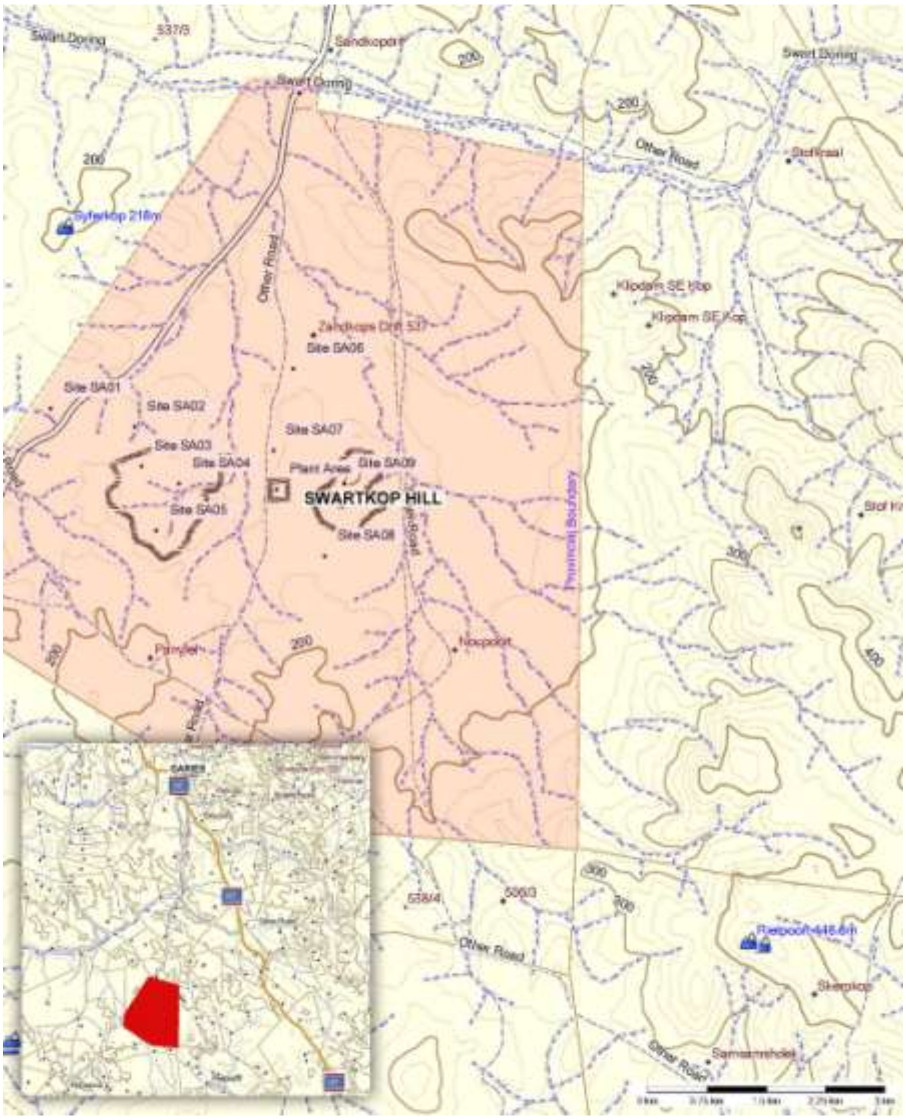


Figure 1 **The Zandkopsdrif study area at Swartkop Hill.**

[4]Venter, M et al. 2010:11.

2.2 The geology of the siliceous zones in the Zandkopsdrift Carbonatitic Complex[5]

The ZKD Carbonatite is made up of a number of primary phases. The phases have undergone deformation and metosomatic alteration as a result of subsequent intrusions and the associated gaseous and liquid pulses associated with younger intrusive phases.

During alteration and supergene weathering of the carbonatitic phases a base fluid environment is generated with increased silica solubility in this fluid of elevated pH. As it migrates outward from the central part it comes into contact with meteoric water from the host gneissic environment, resulting in a lowering in pH of the fluid. This results in an oversaturation of silica in solution, with subsequent precipitation of chalcedoneous material in the host rock. As some of the late carbonatite dyke phases have a high porosity they tend to be preferentially silicified by these solutions.

The chalcedoneous material is very fine-grained. The rock colour is defined by the oxidised iron content and ranges from brown grading into almost black typical of the rocks making up the weathered carbonatite. The texture of secondary monazite crystals in the fine-grained dyke phase is preserved as yellow mottles with pore spaces and ferrous clay minerals overprinted by the chalcedoneous material. In-hand specimens of the ferrugineous chalcedony break across grain boundaries in typical concave glassy fragments.

At ZKD highly altered zones with chalcedoneous rock present as resistant low ridges of 30 to 100 cm in a semi-circular arrangement around a central carbonatite pipe (Spathelf 2012). The host rocks for the carbonatite complex are the ca 1.4 to 1 Ga supracrustal gneisses of the Garies terrane (Eglington 2006; Spathelf 2012). The formation history of the mobile Namaqua-Natal Belt is complex and the numerous structural, metamorphic and intrusive complexities are subject to debate (Partridge 1998; Cornell et al 2006; Venter et al 2010). A few isolated outliers of younger sedimentary formation and late stage quartz veins are also present.

The chalcedoneous material in the host rock is highly suitable to the production of stone tools and served as a prime source of raw material in the manufacture of the MSA assemblages present at ZKD. Quartz veins were also used in the production of stone tools but in very low frequencies during the ZKD MSA. Late Holocene Later Stone Age (LSA) populations and, during the recent past, hunter-gatherers/herder groups who frequented ZKD likely utilized quartz pebbles and veins more extensively for the production of the microlithic stone tools that characterize their stone tool industries.

2.3 Heritage assessment

AGES (Pty) Ltd was commissioned for an AIA study of demarcated areas on the western portion of the farm. This study followed on an initial HIA conducted by the Archaeology Contracts Office at the

[5] Spathelf, P. E-communication 24 February 2012.

University of Cape Town[6] of eastern sections of the property which focused on Swartkop Hill and areas around the Swartdoring River. The scope of the AIA and HIA studies was to identify all heritage resources such as archaeological and historical localities and features, graves and places of religious and cultural significance; to consider the impact of the proposed project on such heritage resources, and to submit appropriate recommendations with regard to the cultural resources management measures that may be required at affected sites/features[7].

The following recommendations on the MSA occurrences at ZKD emanated from the AIA and HIA investigation by Webley and Halkett (2010):

> Despite the aridity of the area around Swartkop, and its distance from the Swartdoring River, it clearly formed a focus for pre-colonial populations. It appears that Middle Stone Age peoples were attracted to the kopje as a source of raw material for the manufacture of stone tools; in other words that it functioned as a factory site. This outcrop of fine-grained rocks is unique within the granite landscape of Namaqualand. It is possible that some of the rocks were carried or traded as far as the Namaqualand coast, some 40 km away. The artefacts on Swartkop are the only substantial Middle Stone Age surface scatters in the region.
>
> **Significance:** Section 35 of the NHRA prohibits any person, without a permit, from destroying, damaging, excavating, altering, defacing or disturbing any archaeological sites and material, palaeontological sites and meteorites. The two flakes are of low significance. *The MSA artefacts on Swartkop are highly significant for our understanding of the distribution and development of the Middle Stone Age in the arid North-West. Its function as a factory site may also allow us to examine pre-historic trading networks.*
>
> **Mitigation:** No mitigation is required with the standard drilling procedures used during prospecting. However, it is recommended that surface collections of artefacts are made prior to commencement of mining operations as it seems likely that the mining will result in the destruction of the archaeological material on the kopje.' (Webley and Halkett 2010:15-16).

2.4 Site description and environmental setting

The research area lies in the Sandveld below the foothills of the Kamiesberg Mountains in central Namaqualand. The region forms part of the Nama-Karoo Biome and is characterized by Succulent Karoo vegetation with winter rainfall (Mucina et al 2006:220–299). Namaqualand occupies 25 per cent of the four major subdivisions recognized within the Succulent Karoo but it is the richest of the four in representing 75 per cent of the region's floral component (Cowling and Pierce 1999:20-21). The seemingly uniform desert shrubland of the summer landscape supports rich and diverse floral taxa that include some 1700 species of dwarf succulent shrubs and 630 species of geophytes. The

[6] Webley, L. and Halkett, D. 2010. *Archaeological (Incl Heritage) Impact Assessment: Proposed Prospecting on Portion 2 and Remainder Portion of the farm Zandkopsdrift 537, Garies, Northern Cape*. The Archaeology Contracts Office: Department of Archaeology University of Cape Town.

[7] Kruger, N. 2011. *Sedex Minerals: Zandkopsdrift 357, Garies, Northern Cape Province. Consolidated Phase 1 Archaeological Impact Assessment Report*. Compiled by N Kruger for AGES (Pty) Ltd.

approximate 390 species of annuals that comprise 8% of the flora of the Succulent Karoo provide the spectacular spring flowering displays of Namaqualand (Cowling and Pierce 1999:21). The climate is semi-arid with often patchy rainfall pattern.

The current summer-dry, winter-wet climate pattern developed around 4 million years before the present (Cowling and Pierce 1999:26). Regional palaeoenvironmental proxies suggest a desert climate that was not as extreme as at present (Cowling and Pierce 1999:35). Over the last 1.5 million years of alternating wet and dry conditions the winter rainfall zone experienced somewhat moister climatic conditions during the long cold glacial periods but with more arid interglacials (Cowling and Pierce 1999; Chase and Meadows 2007; Dewar and Stewart 2011).

Zandkopsdrift lies about 25 km southeast of Garies within the undulating plains of the Sandveld. There are a number of small hills on the farm of which Swartkop, rising 40 m from the plains, is the focus of this report. This hill is located within the south-eastern part of the mine property. The Swartdoring and Groen rivers that flow west towards the Atlantic Ocean coast divide the northern parts of the farm. Both rivers flow only briefly after winter rains. Fog belts produced by the cold Benguela Current of the Atlantic Ocean move inland and provide relief during the very dry and hot summers (Cowling and Pierce 1999:22).

Figure 2 View from Swartkop Hill at ZKD2_3017DD. Note the yellow flags demarcating the extent of the ore body

3 Terms of reference

- Following the recommendations of the Phase 1 AIA and HIA assessments Habitat was commissioned to undertake a detailed Phase 2 mitigation for Frontier and AGES (Pty) Ltd Gauteng. The focus of the Phase 2 was to conduct a sampling programme of MSA lithics.

- A permit (No. 80/11/12/003/51) was issued by SAHRA to do a surface collection or excavations in order to obtain representative samples of artefactual material to allow characterization of the site and dating.

- The main aim was to recover and scientifically analyze a large enough sample of artefactual material to form a general idea of the age, significance and broader cultural meaning of the archaeological sites that will be impacted upon by the proposed development.

- Careful planning can minimize the impact of archaeological surveys on development projects by selecting options that cause the least amount of inconvenience and delay. Permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that measures are in place to ensure that the archaeological sites that will be impacted upon by the development have been adequately recorded and sampled.

- The Museum of Anthropology and Archaeology at the University of South Africa will store the archaeological sample under conditions where the collection will be curated and made available for future research, education and promotion of our cultural heritage according to SAHRA's (2007:4) *Minimum Standards: the Archaeological Component of Heritage Impact Assessment Reports*.

- Based on the outcome of the Phase 2 a comparative rating of significance will be assigned to heritage resources as prescribed in the National Heritage Resources Act (Act 25 of 1999).

- The heritage practioners that were commissioned to conduct the Phase 2 will recommend appropriate mitigation measures in accordance with the guidelines of the Act.

4 Research methods and limitations

4.1 Methodology

Prior to conducting the fieldwork a detailed desktop assessment, reappraisal of the previous AIA and HIA studies and a literature study of sources on the archaeology of the region were conducted. Based on our understanding of the archaeology and history of the broader region a Phase 2 methodology was developed, adjusted and refined. Whereas the primary impacts associated with the mining operations will be limited to the footprint area identified through assessment of various alternatives, we decided to reappraise all previously identified sites.

The **first stage** of the Phase 2 assessment comprised revisiting each of the previously identified archaeological sites. While the various reports[8,9] provided the necessary background, we became

[8] Webley, L and Halkett, D. 2010. *Archaeological (Incl Heritage) Impact Assessment: Proposed Prospecting on Portion 2 and Remainder Portion of the farm Zandkopsdrift 537, Garies, Northern Cape*. The Archaeology Contracts Office: Department of Archaeology University of Cape Town.

[9] Kruger, N. 2011. *Sedex Minerals: Zandkopsdrift 357, Garies, Northern Cape Province. Consolidated Phase 1 Archaeological Impact Assessment Report*. Compiled by N Kruger for AGES (Pty) Ltd.

aware that the scope of in particular the MSA deposits, the exact nature of the assemblages, the typological attributes, diversity and the potential subsurface deposits could only be accurately determined and evaluated by revisiting the sites. Once we gained an understanding of the archaeological footprint in the context of the landscape we also investigated and found a number of additional localities with artefactual material.

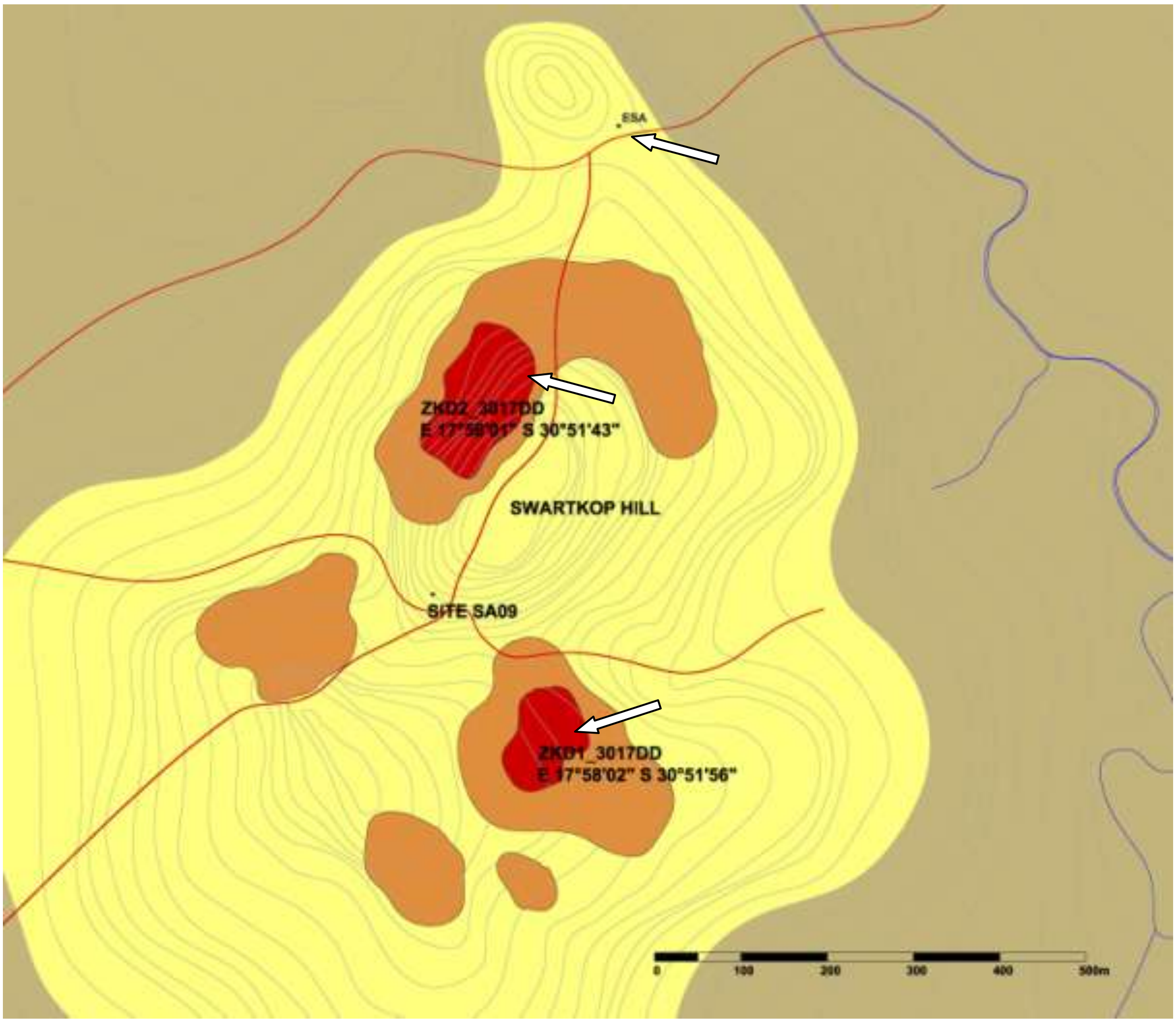


Figure 3 **Indicative contour map of Swartkop Hill. Arrows indicate the two main sampled localities and the area where the ESA handaxes were identified. Yellow represents low concentrations of lithics, orange medium and red high densities.**

The following methodology was applied during the reassessment phase:

- Each known archaeological site or lithic scatter was visited on foot and appraised to establish the nature and extent as well as the likelihood of subsurface deposits.
- The methodology used was to place a one-meter drawing frame on lithic scatters in the survey transects to determine and document the distribution of all stone tools and lithic debris.

The lithic concentrations investigated were in only two instances deemed to be significant enough to be subjected to a second-stage assessment (*see* Figure 3). The numbering of these localities, namely **ZKD1_3017DD**, and for the second site, **ZKD2_3017DD,** is based on the 1:50 000 topographical map for the area, namely KOTZESRUS 3017DD. The site is consequently designated by map number (3017), map quadrant (DD) and site number (ZKD1/ZKD2). Note that this numbering system, where each identified site is numbered consecutively, is generally used at most southern African universities. This enables at the most basic level a linking of sites to the 1:50 000 topographical maps.

For these two localities the following non-invasive methodology was applied:

- The lithic assemblage was thoroughly inspected to determine the extent and distribution of lithic concentrations at local site-scale.

- Each of these sites was remapped with the aid of a hand-held GPS system.

- We established that the areas abutting surface outcrops of high-quality chalcedoneous material were associated with intensive knapping activities. The sampling subsequently concentrated on areas of highest density.

- Two probabilistic sampling methodologies, specifically systematic random sampling and stratified random sampling, were deemed appropriate to establish the spatial distribution pattern and density of lithics to ensure that the sampling process delivers a representative collection and reliable data.

- A non-site distributional approach (Doelman 2005:54) was used to define a boundary based on natural (outcrop) and distributional criteria because the wide spread and likely displacement of surface material precluded an exact determination of site perimeters.

- To establish the parameters of spatial distribution patterning and density it was decided to first evaluate a 1 x 1-metre grid sample through systematic random sampling. A centre reference/datum line was set out along the contour with the base point centred on one of the low-lying ridges with chalcedoneous zones. A grid was set up with gridlines extending perpendicular from the datum (*see* Figure 4).

- Ten (10) alternating 1-metre blocks were sampled on both sides of this line. All surface lithics were systematically collected and bagged.

- The results of the first sampling were deemed insufficient and the sampling method was adjusted to incorporate a larger grid that included an additional outcrop.

- The squares were subdivided and all lithics were collected through stratified random sampling from twelve 2.5 x 2.5 meter squares at **ZKD1_3017DD** (*see* Figure 4). The squares were selected taking into account the positioning of outcrops and relative distance that would likely affect the parameters under study, namely the density and spatial distribution of debitage and artefacts (Richardson and Gajewski 2003).

Following the sampling at the first site **ZKD1_3017DD**, the second site, **ZKD2_3017DD**, was only sampled by using a 2.5 x 2.5 grid (*see* Figure 5).

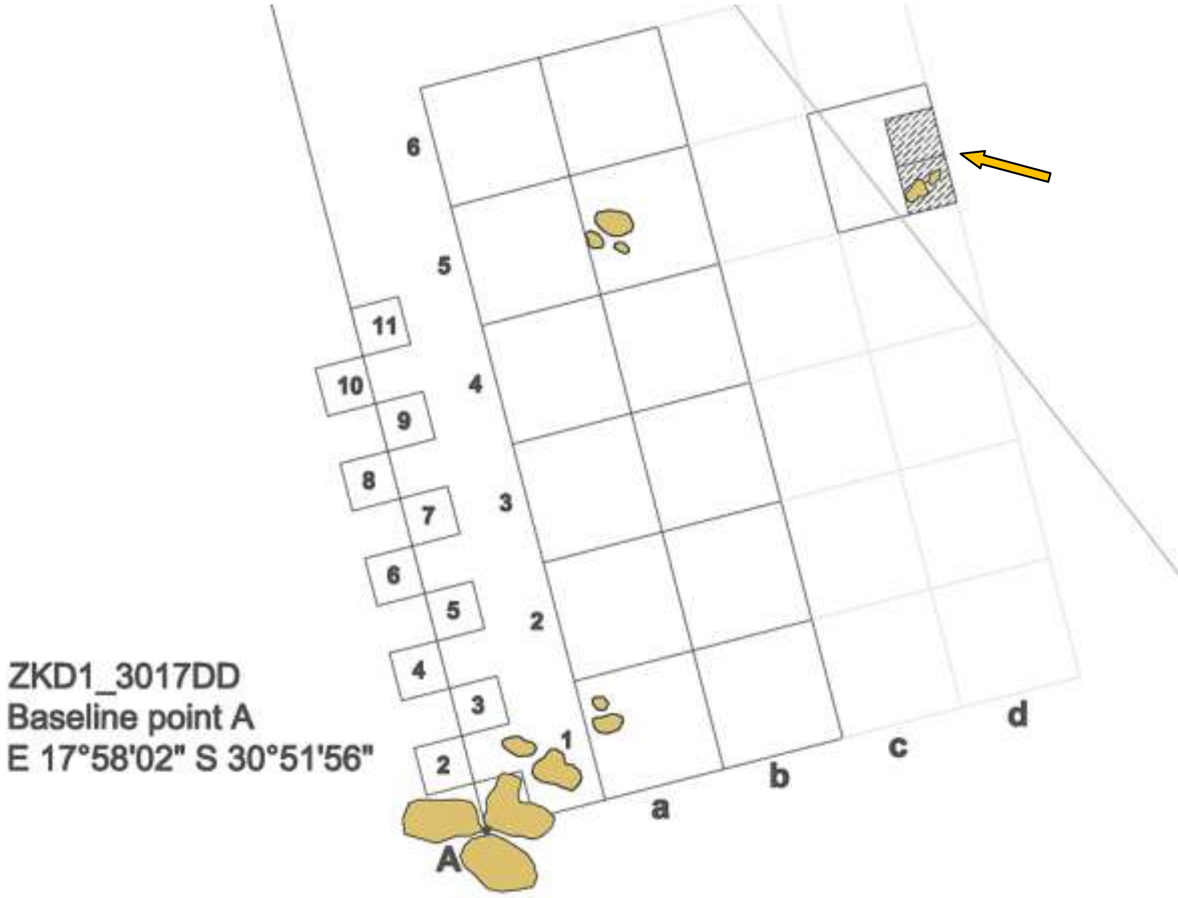


Figure 4 **Grid at ZKD1_3017DD. Line A was sampled in 10 alternating 1-metre squares. Twelve areas of 2.5 x 2.5 metres were sampled from a-b. Square d5 (indicated by an arrow) was surface-sampled and two quadrants were excavated up to the plinthic horizon. The sepia forms represent some of the outcrops.**

As a result of the relatively large sample obtained from locally dense scatters we considered it essential to investigate the nature and extent of a possible subsurface deposit. The following methodology was applied at **ZKD1_3017DD**.

- Within the extant grid an excavation was carried out in two 1-metre squares within square D of the grid. This was undertaken to determine the depth of the deposit, to document changes in the stratigraphy and to assess the technological and typomorphological attributes of lithics from the likely subsurface deposit. All excavated material was screened, sorted and bagged. A plinthic horizon was reached at a depth of 600 mm[10] (*see* Figures 4 and 8 to 11).

[10]We would like to acknowledge the kind assistance of Mr Jan Smits and Christo Stevens .

- At the second site, **ZKD2_3017DD**, lithics were sampled from six (6) 2.5 x 2.5 meter squares. This was undertaken to establish whether a similar pattern of densities could be determined and to compare the MSA typologies from different knapping localities at Swartkop Hill.

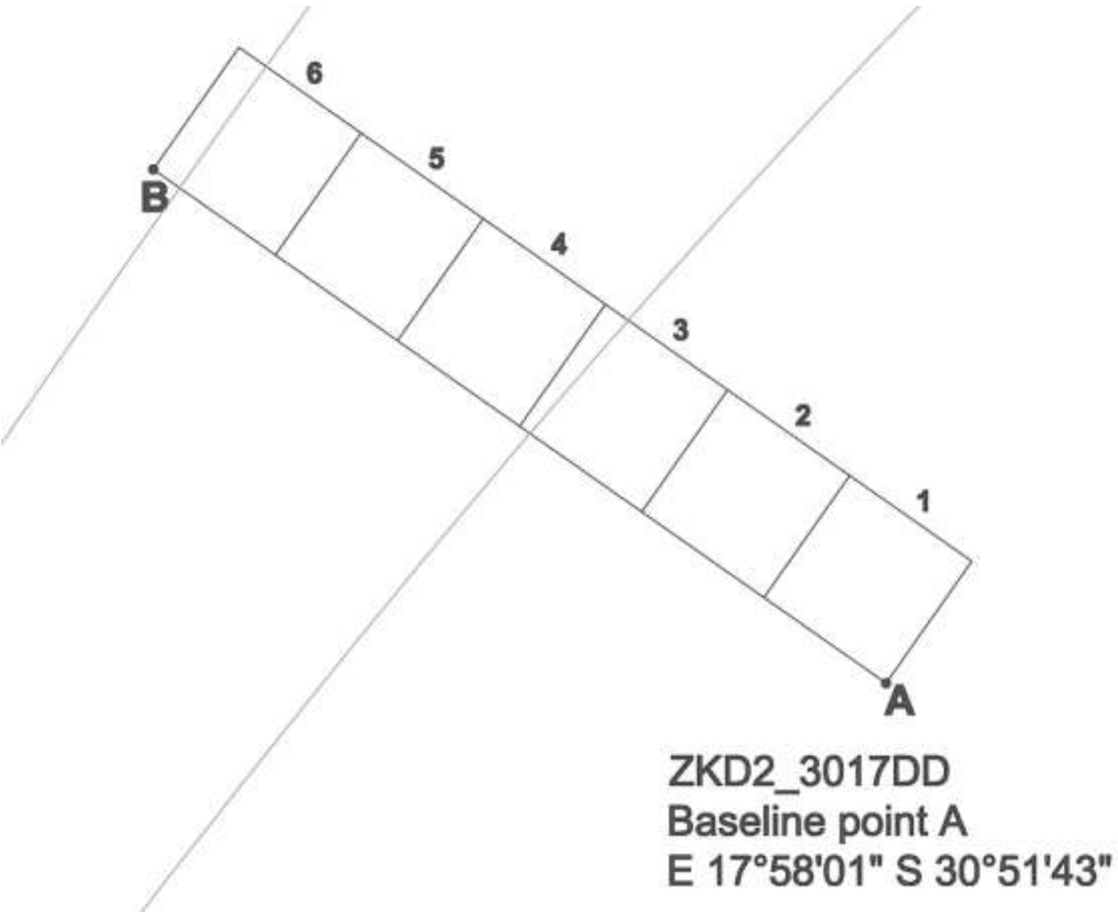


Figure 5 Grid at ZKD2_3017DD. Six areas of 2.5 x 2.5 metres were sampled.

At seven (7) other localities random surface sampling was undertaken of clusters where we identified some ESA (Earlier Stone Age), other MSA localities where quartz was additionally used as a raw material, and LSA collections.

Following the weeklong Phase 2 assessment at ZKD the lithics were subsequently analyzed during February/March 2012. Standard archaeological procedures and methodologies were used.

- All the collected lithics were brushed/washed to remove dust and other accretions and then rebagged according to squares within the grid and labelled.

- Each bagged sample was weighed and decanted on a laboratory table. The lithics were provisionally sorted into classes, further subdivided according to categories, counted and bagged. The lithics were classified according to the following system (based on Deacon 1984a, 1984b; Wadley 2005) and refined for site-specific attributes and technology:

DEBITAGE	CORES	FLAKES	CONVERGENT FLAKES	BLADES	SCRAPERS	AWLS	ADZE	HAMMERSTONE
Chunks Chips	Levallois Radial Multidirectional: Cortical Multidirectional: Non-cortical Pyramidal Blade	**Endstruck >30 mm** Cortical Non-cortical Utilized Retouched Broken Core rejuvenation **Endstruck <30 mm** Cortical Non-cortical Utilized Retouched Broken Cortical **Sidestruck >30 mm** Cortical Non-cortical Utilized Retouched Broken **Sidestruck <30 mm** Cortical Non-cortical Utilized Retouched Broken	**>30 mm** Convergent flakes Utilized Broken **POINTS** Unifacial Bifacial **HANDAXE**	**>30 mm** Cortical Non-cortical Utilized Retouched Broken **BLADELETS <25 mm** Cortical Non-cortical Utilized Retouched Broken	**LARGE** End Side End and side Circular Sidestruck **MEDIUM** End Side End and side Circular Sidestruck **SMALL** End Side End and side Flakes **SPOKESHAVE /NOTCHED SCRAPER**	**AWL/ SCRAPER COMBINATION**		

- The data were logged in Excel spreadsheets and subjected to statistical analyses.

4.2 Limitations

All possible surface archaeological features and occurrences were investigated. In line with the nature of archaeological resources it is probable that mining and the development of associated infrastructure are likely to reveal subsurface sites, human remains or areas of high-density stone tool distributions. In the event that any major archaeological feature is exposed all construction work should be stopped. A suitably qualified professional archaeologist should be contacted to undertake specialist investigations in line with the SAHRA Act (Act No. 25 of 1999).

5 The regional Stone Age context

Archaeological traces in the form of mostly stone tools suggest a widespread presence for tool-producing Plio-Pleistocene hominins[11] in southern Africa. This important part of the prehistory of southern Africa, known as the Stone Age, is chronologically divided into the ESA, MSA and LSA. The ESA is characterized by the use of large stone cutting tools, in particular handaxes and cleavers. Following on the ESA the MSA typologies represent greater specialization in the production of stone tools, and in particular flake, blade and scraper tools and also a more extended range of specialized, formal tools. During the LSA small (microlithic) tools and a range of decorative items as well as rock art were produced. Ceramics were used and/or produced by hunters and Khoekhoe herders towards the terminal phases of the LSA over a period of around 2000 years. The earliest dates for the use of ceramics in Namaqualand are around 2027 to 1736 BP (Dewar and Orton *In press*:14).

In addition to the conventional Stone Age division (Deacon 1984a, 1984b) used for southern Africa assemblages, a classificatory system of five successive Modes that describe **broad** patterns in stone tool manufacture is currently applied (Barham and Mitchell 2008:16). This system avoids the association of particular tools with bounded periods of time. Processes of cultural and technological change were probably more gradual and continuous given that certain tool types are not restricted to a specific period so that developments within the various periods represent continuous processes of change. Any one assemblage can accordingly contain artefacts of various Modes (please refer to Annexure 1: Modes of lithic technology).

The archaeology of Namaqualand is dominated by millions of stone tools that derived from the utilization of the resources of the region by hunter-gatherers and herders until the recent past. Some 1500 LSA, 90 MSA (that include both sealed and open living sites as well as quarries) and 50 ESA localities have been documented in Namaqualand (Dewar and Stewart 2011:1; Dewar and Orton *In press*:4). The ESA is usually represented by isolated examples of handaxes. During the LSA the resources of the region were more intensively utilized. Both terrestrial and marine resources were actively sourced and shell middens are conspicuous along the Namaqualand coast line.

The more recent occupations of the region are also better documented and understood as numerous shell middens, deflated open-air localities and some rock shelters sites have been recorded through research projects but in particular on account of the many archaeological impact assessments undertaken prior to mining activities by archaeologists such as Lita Webley, Genevieve Dewar, Tim Hart, Jason Orton and Dave Halkett (Halkett 1997; 2001a, 2001b, 2001c, 2002a, 2002b, 2003, 2006; Halkett and Hart 1997, 1998; Halkett and Orton 2004, 2005; Orton and Halkett 2004, 2006, 2007; Orton 2005a, 2005b, 2006, 2011, 2012; Halkett and Dewar 2007). It also resulted in the publication of several academic articles (Orton et al 2005; Dewar and Jerardino 2007; Dewar et al 2006). Dewar and Orton (*In press*:1) indeed point out that a ‘unique feature of archaeological research in Namaqualand is that it has been conducted almost exclusively through the commercial sector’.

[11] The term “hominin” instead of the customary term “hominid”, acknowledge that African apes, including human ancestors, are closer to each other phylogenetically than any of them are to orang-utans (Mitchell 2002). The term hominid includes all the higher primates (chimps, gorillas, orang-utans, ancestral human types and ourselves), while hominin refers to those genera which evolved **after** the split with the chimps.

The MSA in sealed shelter sites has received particular attention (Dewar 2011). Conversely, there is a lack of detail on open-air and surface MSA sites in Namaqualand. This is changing with the publication of current research projects aimed at the collection of MSA material in both the northern and southern regions of Namaqualand (Mackay et al 2010; Dewar and Stewart 2011).

In the study region under review no published data are available on the MSA in open contexts. Webley (1992b) recorded implements typical of the MSA microlithic Howiesons Poort industry at Keurbos Cave some 15 km north-east of Garies. Excavations at the small rock shelter of Wolfkraal close to Kharkams in the Kamiesberg also recovered typical MSA tool types (Webley 1984)[12] (Webley and Halkett 2010:8).

This period is of particular significance as the origins of modern culture and language are associated with the emergence of anatomically modern humans, *Homo sapiens*, during the MSA. The upland savannas of southern Africa are seen as a focal region of biological and cultural evolution during this time (Beaumont and Vogel 2006). A recent project that is focussed on human adaptations in low-productivity environments known as *Adaptations to Marginal Environments in the Middle Stone Age* (AMEMSA) aims to investigate the economics, technologies and social organization that populations in Namaqualand developed to cope with the stress of marginal environments (Dewar and Stewart 2011:1). The research project aims to test the hypothesis that pre-modern humans exhibit a pattern of mosaic settlement that is directly related to favourable climatic periods. According to these premises physical and cultural modernity were required to cope with the demands of marginal ecozones to enable *Homo sapiens* populations to maintain settlement in harsh environments on a more constant basis (Dewar and Stewart 2011:1). Subsistence resources are unpredictable and patchy in marginal environments so that flexible social and technological strategies with innovative behaviour were required to successfully cope with environmental constraints.

The southern African Stone Age sequence can be divided into the following periods:

Period	**Approximate dates**
Earlier Stone Age (ESA)	more than 2 million years ago - 250 000/200 000 years ago
Middle Stone Age (MSA)	200 000/250 000 years ago – 20 000 years ago to around the Last Glacial Maximum (LGM) in some regions
Later Stone Age (LSA) (Includes Rock Art) Hunter-gatherer and herder groups	>20 000 – 200 years ago and up to historic times in certain areas

From the site surveys conducted at ZKD it is evident that Stone Age artefacts from all three these periods are present on the mine property, although a somewhat ephemeral presence is suggested for the ESA. In the next section we will focus on the Stone Age archaeology of ZKD with particular reference to the MSA since sites from this period dominate the archaeology of this locality.

[12] Kruger, N. *Sedex Minerals: Zandkopsdrift 357, Garies, Northern Cape Province. Consolidated Phase 1 Archaeological Impact Assessment Report*. Compiled by N Kruger for AGES (Pty) Ltd, p. 8.

6 The Stone Age at Zandkopsdrift

6.1 The Phase 1 AIA

During the Phase 1 AIA high MSA artefact scatters were identified in the survey area along drainage lines while areas with higher-density MSA artefact distribution was evident around outcrops of source material for lithics on Swartkop Hill. The survey generally concentrated around areas directly associated with the proposed locations of the tailings and plant sites and it was concluded that the ZKD area probably served as a factory site. At some localities the presence of flakes with secondary retouch were attributed to the LSA. This corresponds with the occurrence of a single fragment of decorated pottery found that can possibly be attributed to a LSA hunter-gatherer or herder presence. A highly weathered ESA proto-handaxe was also recovered.

The Phase 2 focussed on the areas of high-density lithics as these occur directly within the footprint of the development and because the REE-enriched zones that will be targeted for mining broadly correspond to several of these prominent surface outcrops. The methodology has already been explained in 4.1 above. The discussion in this section will focus on the results of the sampling procedures.

6.2 The Phase 2: Findings and discussion on the Zandkopsdrift assemblages

6.2.1. Quarry extraction activities and the technological analyses of the lithics

Most of the data in the following discussion apply to the main sites **at ZKD1_3017DD** and **ZKD2_3017DD** that have a dominant MSA character. The general discussion on tool types (6.2.2) apply to all three Stone Age periods but differential technological and morphological attributes of each period will be pointed out.

MSA assemblages generally exhibit much variability in raw material usage and artefact morphology, with often low frequencies of formally-retouched artefact types (Henshilwood et al. 2001; Villa et al. 2005, 2010; McCall 2007:1738; Wilkins 2010; Herries 2011:1). The ZKD MSA is based on the chalcedoneous rocks sourced at outcrops and quartz materials were infrequently used. The ZKD sites around the source rock outcrops contain extensive scatters of stone tools and manufacturing waste (debitage). The large percentage of waste from stone tool manufacture, a range of core types, and the predominance of flakes and blades in the assemblage clearly demonstrate *in situ* stone-tool production. Whereas the main focus was evidently on the procurement of raw materials and the production of flake and blade blanks, the range and variety of flakes, blades and formal artefacts suggest that groups in addition scheduled visits to take advantage of locally available raw material and possibly food resources.

At the two main sites a clear spatial distributional pattern was observed where the densest lithic concentrations occurred in the immediate surroundings of rock outcrops with chalcedoneous material of good knapping quality suitable for the production of stone tools. This became evident during our initial sampling of Line 1 at ZKD1_3017DD. The lithic numbers in the 1-metre squares closest to the outcrop began to peak close from the source, probably in an area where there was space for knapping activities. Two squares had markedly higher relative frequencies; these then dropped off and again show incremental lithics closer to the next outcrop. This trend informed our decision to extend the grid to incorporate more outcrops and also to centre the excavation on one of the outcrops that was evidently targeted for extraction.

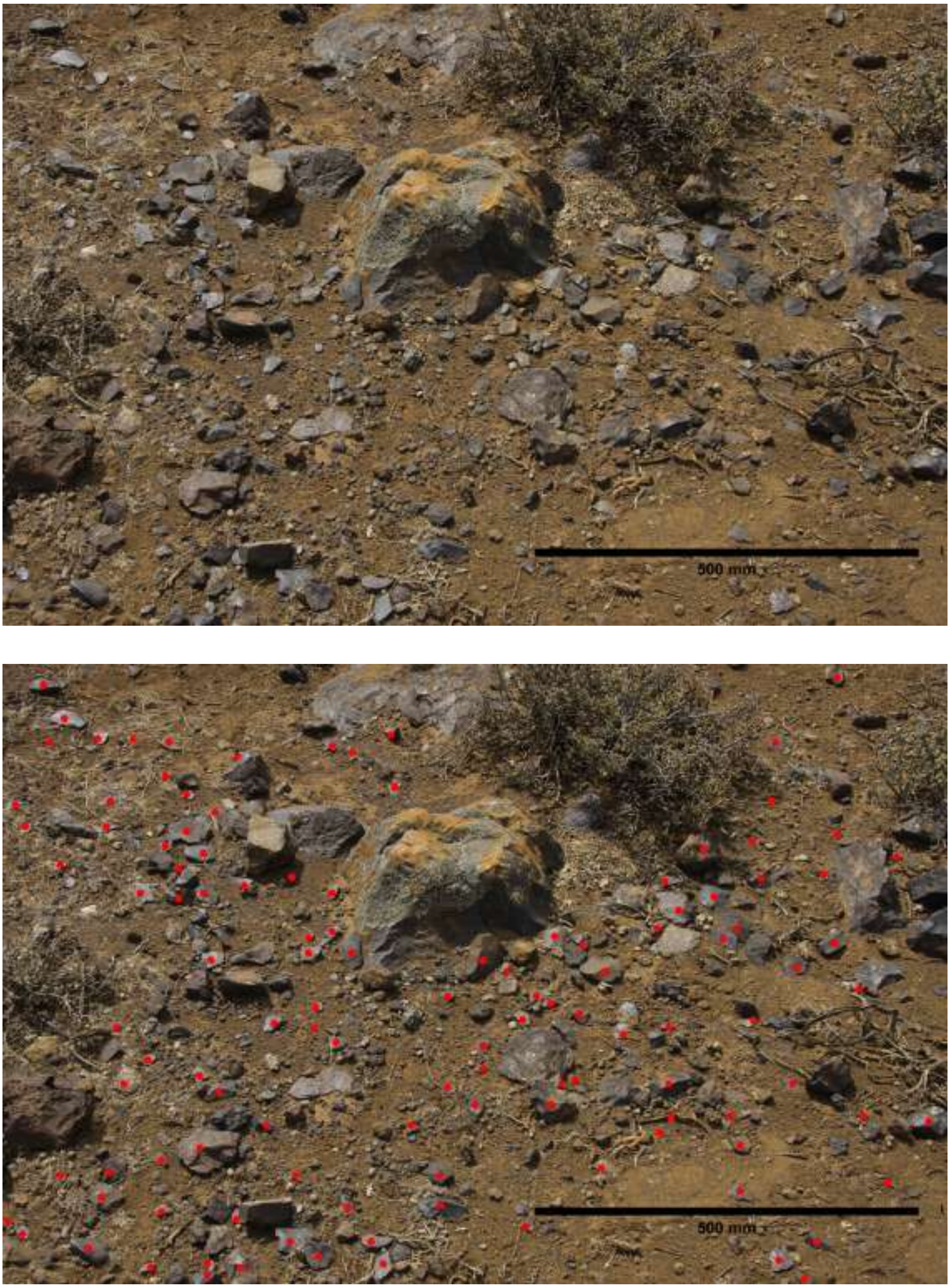


Figure 6 An example of a knapping area at ZKD2_3017DD at a small chalcedoneous outcrop. The distribution of stone tools is indicated by red dots in the above photograph.

Figure 7 Grid at ZKD1_3017DD with Line A being sampled in 10 alternating 1-metre squares.

Figure 8 ZKD1_3017DD Squares D5/A and D5/B before the excavation.

Figure 9 ZKD1_3017DD Squares D5/A and D5/B during the excavation.

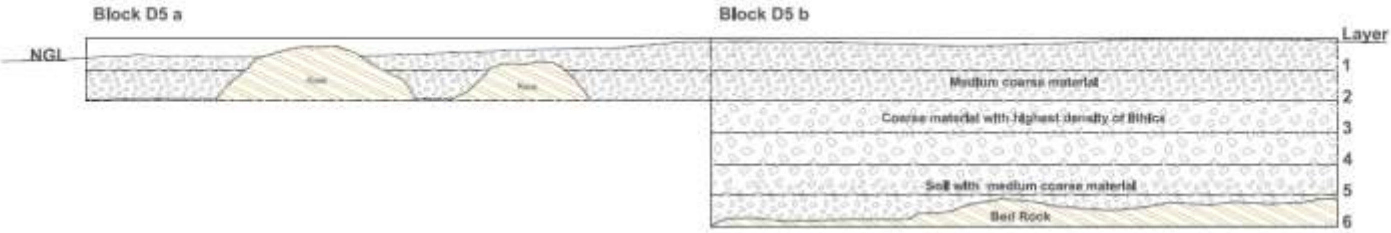


Figure 10 Stratigraphy of the excavation

Figure 11 ZKD1_3017DD Screening the excavated material from Squares D5/A and D5B.

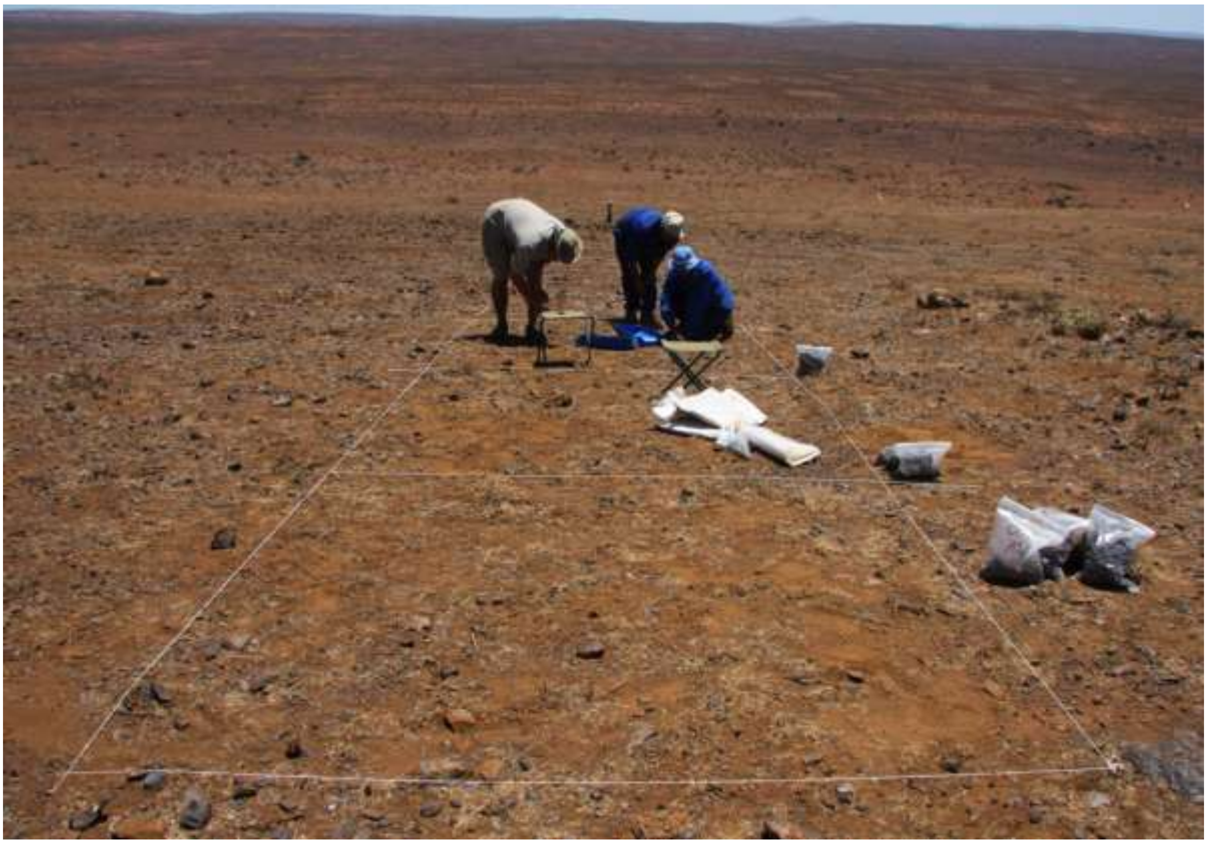


Figure 12 ZKD2_3017DD. Collecting lithics from six 2.5 x 2.5 metre squares.

The following table and pie chart illustrate the frequencies of tool types from each of the areas that were sampled.

TOTAL NUMBER OF LITHICS FROM ZANDKOPSDRIFT									
	ZKD1_3017DD						ZKD2_3017DD	Ad hoc sampling	TOTAL
	Surface	Line 1	Squares A	Squares B	Excavation D5	Remainder Surface D5			
Debitage	7	143	954	946	1491	96	1215	64	**4916**
Cores	27	8	25	40	45	1	65	25	**236**
Flakes	88	170	606	714	603	65	656	76	**2978**
Convergent flakes	24	16	76	61	37	1	64	4	**283**
Points			9	25	11		1	1	**47**
Blades	100	65	310	290	256	42	188	8	**1259**
Bladelets	0	24	55	56	38	6	98	11	**288**
Scrapers	42	31	103	63	45	16	119	8	**427**
Awls	8	14	12	28	18	3	36	3	**122**
Awl /scraper combination			1	2			1	0	**4**
Spokeshaves		3		1		1	5	1	**11**
Adzes		3	32	1	2	1	1	0	**40**
Handaxe								2	**2**
Hammerstone				2				2	**4**
TOTAL	**296**	**477**	**2183**	**2229**	**2546**	**232**	**2449**	**205**	**10 617**
MASS IN KG	**11**	**5.75**	**34.5**	**43**	**94**	**3**	**46**	**7**	**244.25**

Figure 13 Total number of lithics from Zandkopsdrift recovered through sampling and excavation.

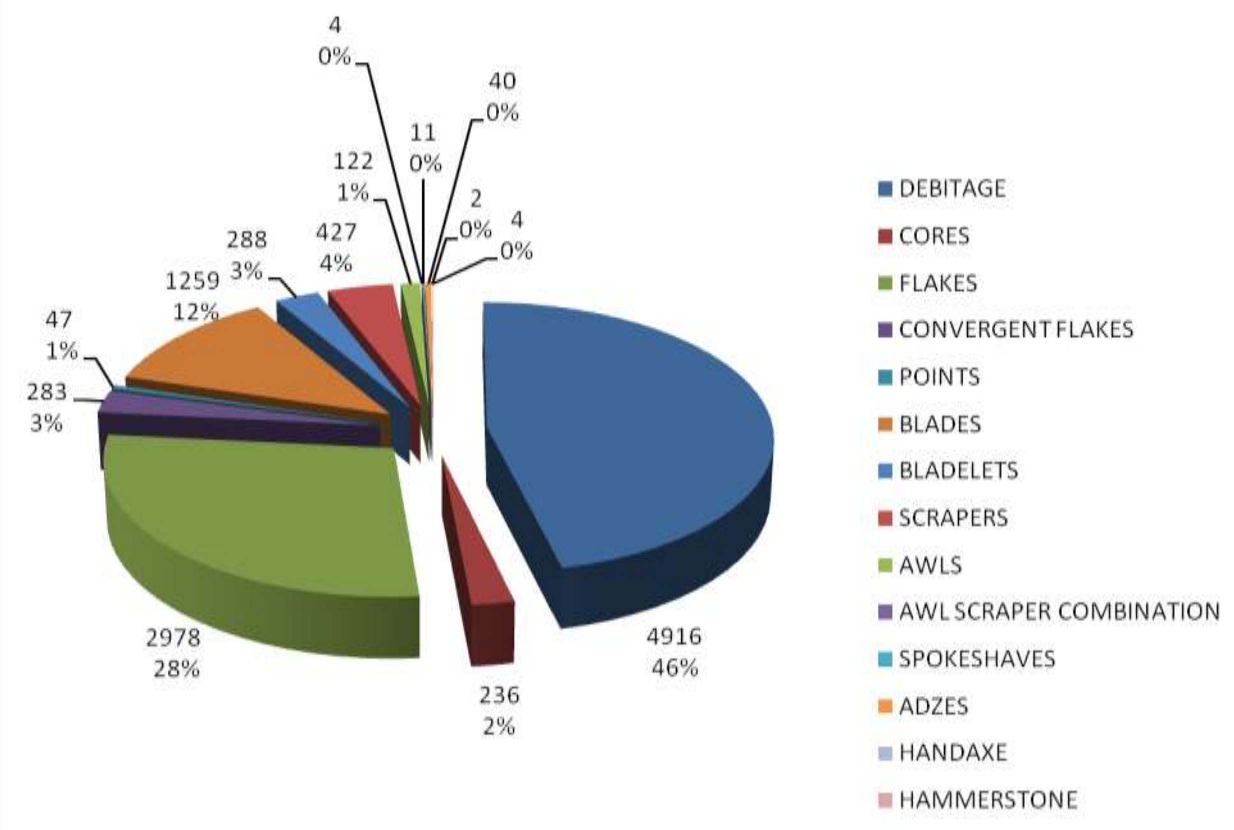


Figure 14 Relative percentages of all debitage, cores, flaked blanks and formal tool types for *all* lithics at ZKD.

Note *that the total numbers for some classes of tool types are so low in relation to the very high numbers for other classes, that they are statistically not significant.*

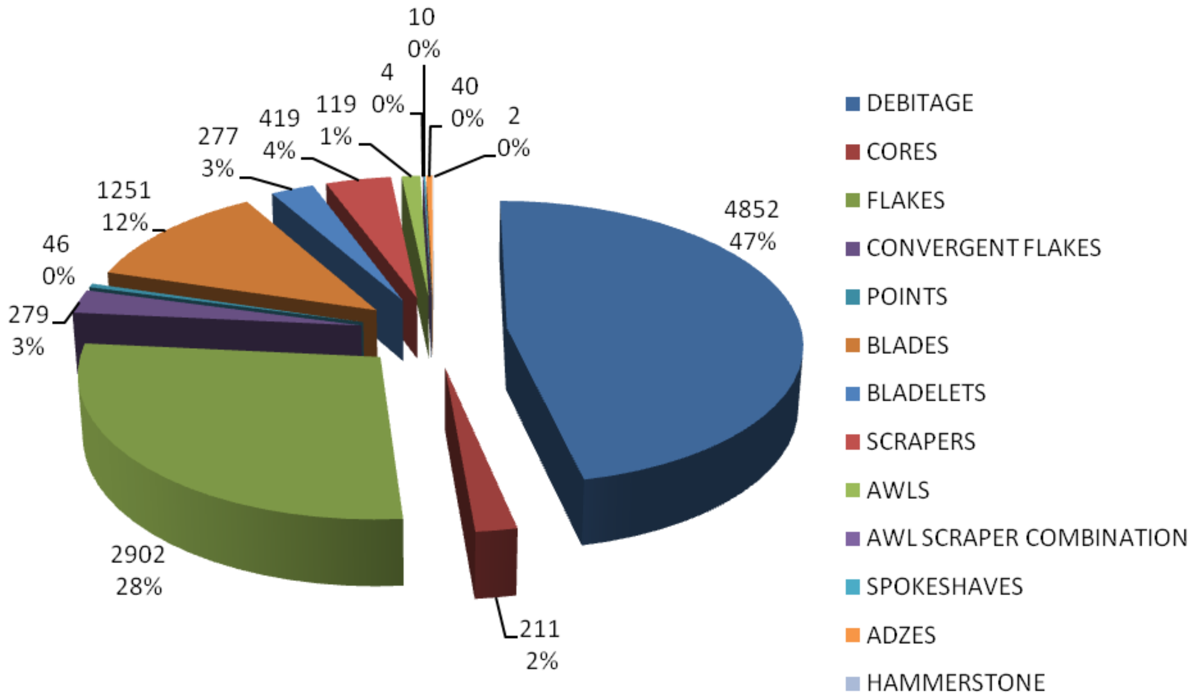


Figure 15 Relative percentages of all debitage, cores, flaked blanks and formal tool types of *only* the MSA lithics.

Note *that the numbers of ESA and LSA at ZKD collected from Ad hoc localities are so low that the removal of the lithics from these periods from the permutation* ***does not*** *make a real difference to the statistical analysis.*

6.2.2 The ZKD assemblages

The relative frequencies of stone tool types correspond with assemblages from MSA open sites elsewhere, with a larger number of detached pieces represented by mainly flake and blade blanks, and a relative low percentage of blank forms that had been shaped into formal tools. The analyzed assemblage consists of a total number of 10 617 lithics that comprise 46% of debitage (discarded material from the reduction process and from the shaping of tools), 2% cores (or objective pieces), 46% flaked blanks (detached pieces) and 6% formal stone tools.

Debitage

Debris from stone tool production, the reworking of primary blanks into tools and also resharpening of tools during maintenance generate waste and account for a large proportion of the lithics in any assemblage. It could be inferred that the figure of n = 4 916, 46% for the total chunks and waste from ZKD from all localities is somewhat skewed as the surface lithics clearly did not include all the discarded chunks and chips as is the case in a controlled excavation. This premise is substantiated by the excavated assemblage that reflects a higher relative index at 59% (n = 1587) of debitage against the total number of excavated lithics (n = 2779).

The excavation also delivered larger quantities of waste material in relation to the total number of lithic pieces. The following pie chart illustrates that the lithics from the excavation and the three main sampled areas are comparable, but that the total number of chunks/debitage from the excavation is somewhat higher at 32% (n = 1491) in relation to waste recovered from surface-sampled areas: Site 1A/21% (n = 954); Site 1B/21% (n = 946); Site 2/26% (n = 1215).

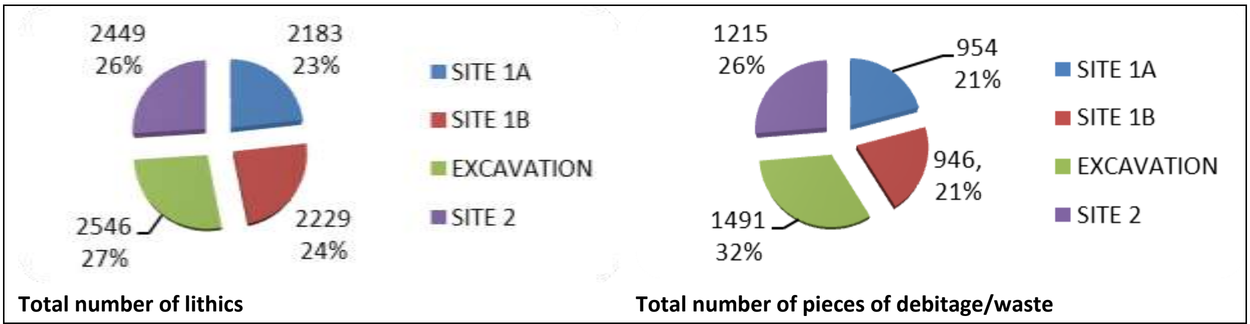


Figure 16 Relative percentages of lithics versus waste

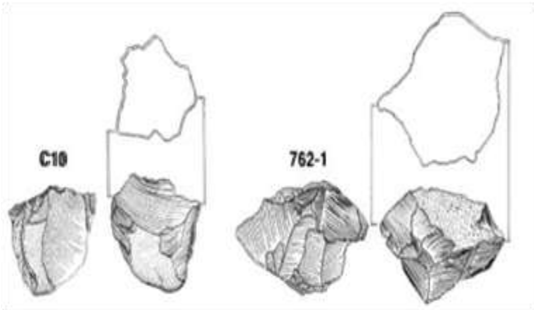
Debitage characteristics are influenced by the expertise of individual knappers, the technology selected (Williams and Andrefsky 2011) and also the specific activities, in the case of ZKD quarrying for flakeable stone. Artefact production is a reductive of subtractive process so that pieces of debitage become progressively smaller (Andrefsky 2005:98). At ZKD1_3017DD the process accounts for a higher mass in lithics from the subsurface excavation against surface collections. The excavated material occurred in a context where the source material was extracted, unwanted chunks were discarded on site and suitable pieces were preliminary knapped. The surface collection was subjected to subsequent stages of attrition where quarried material was shaped into cores that became progressively smaller, exhausted cores were discarded and only selected lithics were further trimmed. The outcome of technological processes in reduction is illustrated by a weight of 94 kg for the n = 2546 excavated pieces against a total mass of 77.5 kg for the surface-sampled A-B squares that yielded n = 4412 pieces. Sampling strategies can in part account for differential debitage frequencies.

- *Cores*

Cores (n = 236) account for 2% of all the lithics recovered through sampling and the excavation. At least three negative flake removal scars are required to classify a block of material as a core. Chunks that were modified or clearly used to obtain blanks but have less than three flake/blade removals consequently fall outside the core category. Stages of core reduction are represented in the amount of dorsal cortex on the core surface, core rejuvenation/preparation flakes and primary cortical flake and blade blanks. In core rejuvenation the striking platform is tidied for further knapping and this process produces core preparation/rejuvenation flakes. Such flakes are usually bulky with a number of flake scars from previous removals on the dorsal surface. Dorsal cortex results from chemical of mechanical weathering of the surface (Andrefsky 2005:103). Some of the ZKD core preparation flakes are very large.

The relative frequencies of cores recovered from the surface collections and the excavations are comparable. The slightly higher number of cores from the excavation is statistically insignificant.

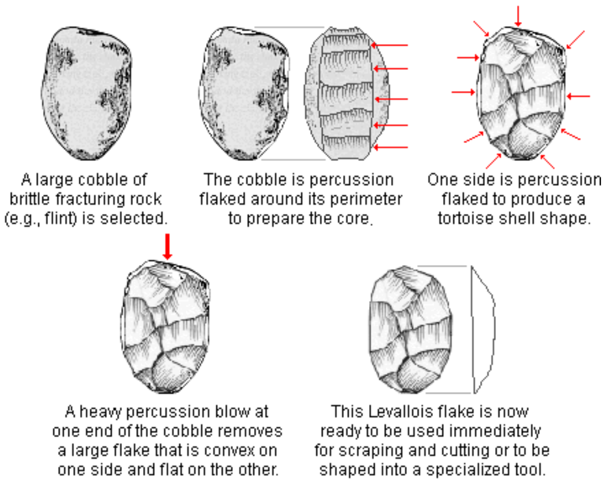
Multi-directional cores that exhibit scars where pieces were removed from several directions of both faces dominate the ZKD assemblage. Many of these retain some cortical surface.



Sketch 1 An example of multidirectional cores where several flakes have been removed.
http://www.californiaprehistory.com/reports01/rep0019.html

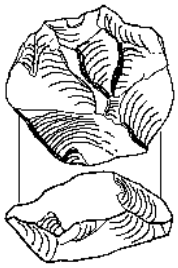
Prepared or Levallois cores are diagnostic MSA cores and are also integral to the ZKD MSA assemblages. Through this technique a core is shaped by the systematic removal of flakes from a pebble or a chunk of rock in order to produce a final product of one flake or multiple flakes. With the prepared technique cores were shaped through preliminary flaking to produce pre-determined shaped blanks that were subsequently used to manufacture different tool types. The characteristic triangular flakes obtained from Levallois and radial cores were often trimmed by invasive retouch to produce unifacial and bifacial pressure-flaked points (*see* Figure 35).

Levallois cores can be prepared for the removal of a single large flake from a prepared top surface as is demonstrated in the following example:



Sketch 2 An example of the shaping of a Levallois core to remove a single flake. The two flakes illustrated above were removed from a Levallois core shaped to produce a triangular or convergent flake.
http://anthro.palomar.edu/homo2/mod_homo_3.htm

In the *recurrent* Levallois technique multiple flakes can be removed from the upper surface before it requires reshaping. The latter technology represents a pattern of centripetal removal so that flakes are removed around the perimeter of a core towards the centre. Such cores are also termed radial or disk-shaped cores. Most of the prepared cores at ZKD are radial cores (*see* Figure 17).



Sketch 3 An example of a radial/disk-shaped core where multiple flakes have been removed.
http://archserve.id.ucsb.edu

Flakes and blades that have been removed from prepared cores often retain a characteristic multi-facetted platform showing small vertical scars that derive from the centripetal preparation of a core.

Whereas the assemblage has a significant blade component, a relatively small number of blade cores are present. Some of the multidirectional cores show evidence of blade removals.

Sketch 4 An example of a blade core.
http://www.pbs.org/wgbh/nova/stoneage/images/tool-bladecore.jpg

Figure 17 Prepared radial cores.

- *Hammer stones*

No implements that could have been used in the stone extraction process have been positively identified at ZKD. It is however likely that some of the very rough and large chunks with crushed edges recovered from the excavated area could have been applied in such a function. At ZKD1_3017DD/Square B4 two hammer stones were recovered during surface sampling. Two are of the local chalcedoneous material with one on quartz. These were probably used during the knapping process in the manufacture of stone tools. Another hammer stone was also recovered through surface sampling and with a collection of implements that included an ESA handaxe, radial cores and large scrapers (*see* Figure 18).

Hammer stones and punches function in stone tool knapping and retouch. Identifying criteria for hammer stones and punches include a regular spherical or oval morphology with impact scarring on surfaces or extremities. Impact fractures and scars on archaeological specimens resulted from deliberate, forceful contact between two surfaces, such as crushing and pounding with heavier stones, or through use of the rounded surface of small hammer stones in a pecking stroke to detach flakes (Van der Ryst 2006). The greater application of load with a stone hammer generally produces more impact on the objective piece than is the case with a softer and lighter bone percussion, and stone hammers are also used on a punch for indirect percussion (Andrefsky 2005:12). It should be noted that hammer stones were also used at extraction locales (Gopher and Barkai 2011:213).

Only one upper grinder used in the processing of food or pigments was recovered through surface collection.

**Figure 18 Hammer stones and an upper grinder at the bottom right.
The hammer stone at the top on the right is on quartz.**

- *Flaked products*

Flakes, bladelets and blades are the main products of any reduction process. Variability in flake morphology results from raw material differences, functional requirements and use-life (Andrefsky 2005:160). The 46% of all flaked products in the ZKD assemblages comprises n = 2978, 28% flakes and n = 283, 3% convergent flakes, n = 1259, 12% blades and n = 288, 3% bladelets. A flake is the detached section of rock removed from a core by percussion or pressure (Andrefsky 2005:255). Small flakes are also removed when a flake is secondary shaped into a formal tool. Flakes were undoubtedly applied in a variety of tasks on wood, meat and bone as suggested by artefact function studies and ethnographic accounts. Blade and flake blanks could be used without any further trimming. Others were shaped through secondary retouch to obtain specialized tool types.

Two main categories of flakes were used in the ZKD analysis, namely endstruck and sidestruck with relevant subdivisions. Sidestruck flakes are often end-products from the use of a prepared core technique to obtain pre-determined shapes (others are an oval flake, a convergent or pointed flake or a blade) (Kuman 2001:9). Some of the very large endstruck and sidestruck flakes in the collected sample are in excess of 100 mm. Many of the flakes exhibit utilization scars and miscellaneous retouch. An interesting element of the ZKD collection is the many utilized flakes with emphasis on the distal tip that suggest activities requiring a pointed tool (*see* Figure 34 where this tool type is illustrated and referred to as worn-out awls and the discussion on awls).

Figure 19 Sidestruck flakes.

The figure of n = 1259, 12% for blades as products of primary knapping represents a significant component of the MSA collection. A blade is a tool type with parallel or sub-parallel lateral margins and it is usually at least twice as long as it is wide (Andrefsky 200:253). Blades were manufactured during both the MSA and LSA, but are generally more prominent in MSA collections being frequently produced as blanks on which tools were fashioned (Deacon and Deacon 1999:97, 101). Both cortical and non-cortical blades in the ZKD collection often exhibit evidence of utilization or retouch.

At ZKD blades occur in a range of sizes (*see* Figures 20 to 21). Some of the blades are very large, up to 135 mm in length. Many of the broken blade sections are also particularly large, suggesting massive tools. The presence of very large blade sections may reflect a large blade industry (Mitchell 2008:53), which can suggest a somewhat earlier period of utilization of this locality. Blade-knives with regular retouch are rare in the ZKD assemblage (*see* Figure 22).

Figure 20 Blades.

Figure 21 Utilized blades.

Figure 22 Blade-knives.

The ZKD assemblages, in addition, contain many snapped thin blade sections that exhibit miscellaneous retouch.

Figure 23 Snapped blade sections with utilization and retouch.

Small bladelets were not as important in most MSA assemblages. At ZKD an index of 3% (n = 288) for bladelets signals a low significance. Some of the bladelets exhibit retouch or utilization (*see* Figure 24). Bladelets are often products of secondary retouch when a blank was shaped into a formal tool. It must also be borne in mind that surface collections represent various episodes of utilization and there are clearly also some microlithic LSA tools in such a sample. The LSA clusters that were sampled do contain bladelets, but not in large numbers.

Figure 24 Bladelets.

- *Formal tools*

Detached blanks can be shaped through secondary retouch into specialized tool types required for particular tasks. Secondary retouch on flaked products is generally restricted in MSA sequences, with the exception of the MSA microlithic Howiesons Poort. Most southern African assemblages exhibit a formal lithic component of <6%. The ZKD index of 6% for formal tools is therefore evidently consistent with other MSA assemblages. It could be argued that a significant proportion of the formal tool component derived from large-scale production at the source to obtain a supply of formal tools for future use at other localities. It is also feasible that some were manufactured with the view to pass them on through exchange networks. However, the many flakes with utilization damage and also scraper-like edges on numerous of the broken tools demonstrate localized subsistence activities that required the production of specialized lithic tool types for immediate use and probably also to accumulate a stock of fine-grained siliceous formal tool types as this material would not be available at other localities visited during the cycle of seasonal movement. Siliceous lithologies represent some of the preferred lithic sources for stone tools in view of their particular mechanical properties. The fracture toughness allows for more control over flaking and because of high strength properties tools can be used for working both soft and harder organic materials (Domanski et al. 1994; Webb and Domanski 2008). Tools on siliceous rocks also have an extended use of the cutting edge that would not be the case with more brittle rocks (Domanski et al. 1994).

It is also important to note that many of the flaked pieces >30 mm were indeed produced with the aim to manufacture scrapers, awls and other formal tool types through secondary flaking or retouch as demonstrated by the relative high numbers of these tool types that will be commented on in the following section. The ZKD assemblage, in addition, contains numerous snapped thin blade sections that have been used in the production of formal tools, for example an awl (recovered from block D2) or scrapers.

Note that the functions of the various classes of artefacts within each period are usually inferred by morphology and that lithic tool names typically imply use for a specific task, for example a scraper or an awl. A typomorphological term such as "scraper" refers to the shape or form as well as to a likely or inferred function for the artefact. Such functional interpretations are often correct, but the form of an artefact does not necessarily match its inferred function. Different shapes and sizes of tools, for instance scrapers, often result from use and the resharpening of implements rather than different mental templates. Lithic studies support multi-functional usage of tools, with form not always equating assumed function (Andrefsky 2005:201). (*See* also the Glossary and list of basic tool terminology for definitions of the major products of stone tool manufacture).

Scrapers are ubiquitous in any Stone Age collection. Ethnographic studies demonstrated a wide application for this tool type ranging from the production of wooden hafts for composite tools, other woodworking activities and, in particular, in leatherworking and the processing of skins. Scrapers are often not diagnostic to a particular period. The scrapers at ZKD (n = 427, 4% of assemblage) represent typical examples from the MSA and MSA/LSA interface. Large scrapers are integral to any MSA assemblage. Scraper sizes in the ZKD assemblage range from large to small but with much higher numbers of large scrapers (*see* Figures 25 to 29). Side scrapers dominate.

Figure 25 Large side scrapers.

Figure 26 **Large end and side scrapers. Note multifunctional application in some examples that display a pointed distal tip (*see* also Figure 31).**

Figure 27 **Medium side scrapers. The three scrapers in the last row to the right have scraper edges on both sides.**

Figure 28 Medium end and side scrapers.

Sidestruck flakes have been frequently used to produce very fine scrapers (*see* Figure 29). Some scrapers are also relatively informal, being made on flakes with the minimal secondary retouch applied in order to produce a convex scraper edge.

Figure 29 Scrapers produced on sidestruck flakes.

A number of notched scrapers form part of the ZKD assemblages (*see* Figure 30). Notched scrapers are also known as hollow scrapers or spokeshaves and possibly functioned alike to adzes (Deacon 1984). The characteristic concave edge may have facilitated wood shaving. The collection contains few adzes. Adzes generally display a steeper retouch than is found in scrapers. Spokeshaves are more customary in assemblages from the last 2000 years. Functional applications of these tool types were probably woodworking and the sharpening of implements, for example to shape armature wooden shafts and during the LSA, digging sticks (Stow 1910; Deacon and Deacon 1999).

Figure 30 Notched scrapers/Spokeshaves.

A number of scraper forms that have a convex scraper edge and also a pointed awl-like tip were evidently multi-functional tools (*see* Figure 31).

Figure 31 Scrapers with a pointed awl-like tip.

The ZKD assemblages contain a relative high number of awls in a range of shapes (*see* Figures 32 to 34). They differ to the extent that four classes of awls could be identified. Several awls were made on sidestruck flakes. These tool types, with focus on and retouch of the distal tip, were presumably used for a variety of tasks. Common ethnographic applications include their use as piercers in the manufacture of clothing, reed matting and to make holes in ornamental objects of bone and shell. A few awls are huge, for example at ZKD1_3017DD/Line 1/Square 8 a very large awl of 70 x 55 mm was collected.

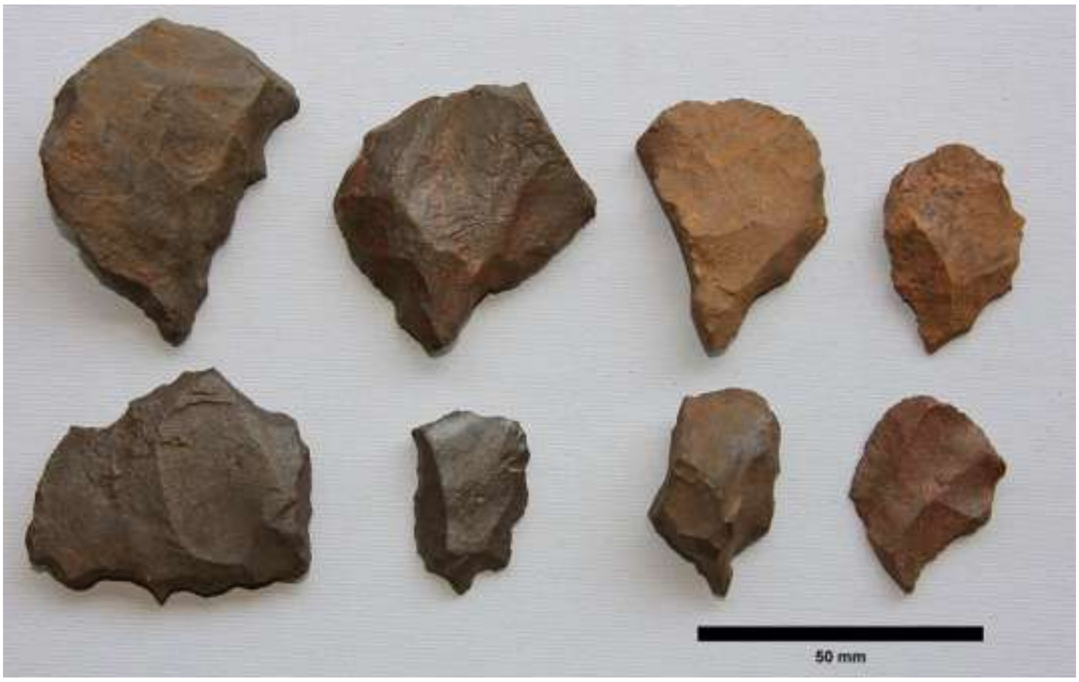


Figure 32 Awls.

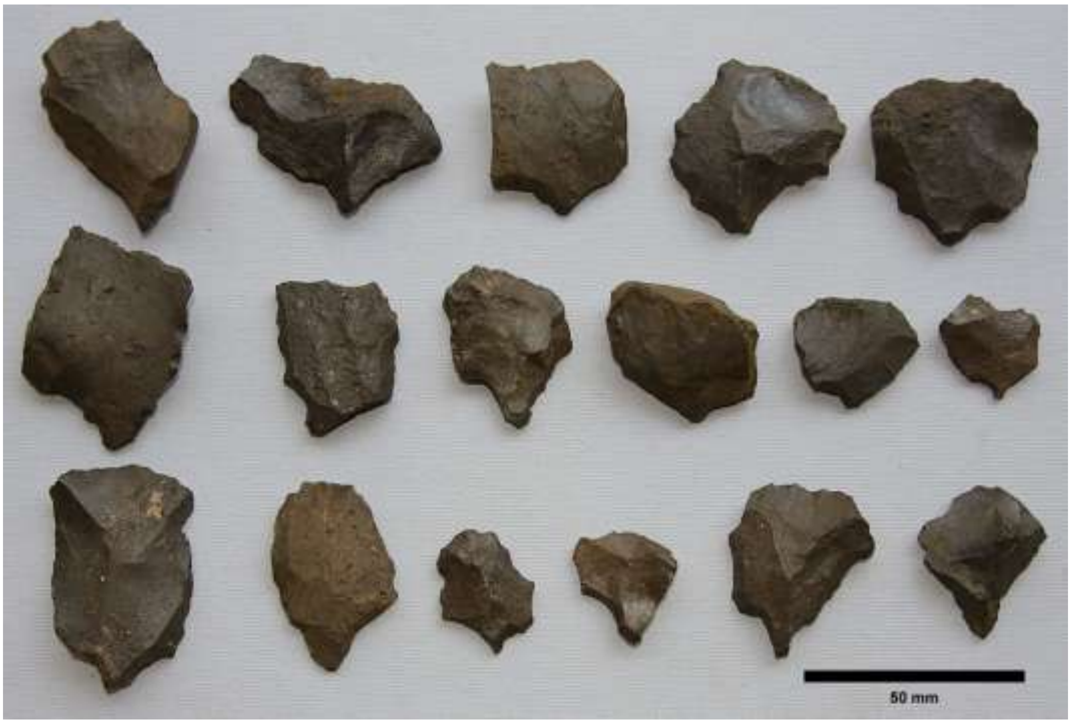


Figure 33 A selection of awl types.

Some of the awls are often quite rudimentary with a relatively small piercing edge. Some of these may be worn-out awls (*see* Figure 34). The morphology of these tool types vary, with some on parallel-sided endstruck flakes and others on broad sidestruck flakes. A pointed tip was obtained through the removal of a burin spall on one edge and some invasive retouch on the other edge.

Despite criticism typologies can still be applied to assess inter-assemblage variability. Formal variations in stone tool typology generally result from both style and function (Andrefsky 2005:202).The abundance of task-specific tools such as awls at ZKD may reflect the development of regional style during MSA3 that falls within Marine Isotope Stage 3 (~60 to 25 ka).

Figure 34 Worn-out awls. This awl type exhibits a burin spall on edge and invasive retouch on the other.

Convergent flakes and pressure-flaked unifacial or bifacial points produced on prepared cores are distinctive MSA tool types (*see* Figure 35). Points are not abundant in the ZKD assemblages. It would seem that some phases within the MSA chronology or various regional expressions do not contain many points or that these tool types may be absent. At an open-air site in southern Namaqualand numerous finely-worked bifacial points have been recovered (Mackay et al. 2010:84-95). These diagnostic tools are seen as a technological innovation and were presumably used as projectile points on wooden spears (Lombard et al. 2004). Microscopic studies on a sample of MSA points from Sibudu Cave in KwaZulu-Natal support this premise (Wadley et al. 2009).

Figure 35 Points and convergent flakes produced on prepared cores.

The presence of several formal tool types, and in particular the range of scrapers, suggests that other activities such as woodworking, possibly the working of skins and tool maintenance, took place at the ZKD locality. All the lithic artefacts would also have featured as subsistence tools and in activities such as food processing. Altogether the assemblage probably reflects relatively short seasonal visits over time by small groups of people.

- **The ESA at ZKD**

During the Phase 1 a rough proto-handaxe was identified (Webley and Halkett 2010). Two more handaxes were collected during the Phase 2 (*see* Figure 36). These handaxes were both collected from the same locality on Swartkop Hill near the water point. In association with the small handaxe we also found scrapers and prepared radial cores. This can arguably indicate a transitional industry at the interface of the ESA/MSA, namely the Fauresmith Industry. Then again the co-occurrence of these surface-collected tool types could be fortuitous. Small finely-made handaxes are diagnostic tool types of the Fauresmith. At Kathu in the Northern Cape the prepared core technique was used to produce spectacular small handaxes, long blades, convergent flakes/points and scrapers that form part of Fauresmith collections (Beaumont 2004). The Fauresmith assemblage at Wonderwerk Cave in the Northern Cape contains blades, large scrapers and prepared radial cores.

Based on our current knowledge of this industry Mitchell (2002) suggests that the Fauresmith is either transitory between the ESA and MSA or that it can form part of a fully developed MSA. Herries (2011:1) argues that Fauresmith assemblages, despite the occurrence of large cutting tools, 'include all the technological components characteristic of the MSA'. Some researchers accordingly consider such assemblages integral to the MSA in view of shared technological and typological elements whereas others see the Fauresmith as a transitional phase between the ESA (McBrearty 2001; McBrearty and Tryon 2005; Barham and Mitchell 2008; Herries 2011; Underhill 2011).

Large cutting tools (LCT) in the form of handaxes and cleavers are diagnostic tool types of the ESA and smaller handaxes occur towards the end of the ESA and the beginning of the MSA. LCT's made their appearance nearly synchronous with that of *Homo ergaster* at 1.8 mya (McNabb et al. 2004:653). These artefacts were made to a pattern and according to Deacon and Deacon (1999:79) they 'mark the beginnings of style'. The characteristic lithics of this period are collectively called bifaces as they show secondary flaking/retouch on both surfaces where flakes have been removed to shape and sharpen the tools. Pointed bifaces are known as **handaxes**, and bifaces with a wide, transverse cutting edge are termed **cleavers**. The handaxe is often a core tool made by removing many flakes of both sides of a pebble to produce a pear/almond-shaped tool with sharp cutting edges all the way around and having a pick-like point. They were also made on flakes, particular during the later phases. The handaxe was a versatile tool and probably used for many different functions.

Figure 36 ESA handaxes.

- ***The LSA at Zandkopsdrift***

The typology of the LSA at ZKD conforms to most assemblages from this period. The relative low numbers of lithics identified during the sampling are statistically insignificant and cannot be used to make inferences on any particular LSA industry. Various tool types were used to produce a representative range of formal stone tools. The ZKD formal LSA tool types are mostly represented in a range of scraper forms.

The Phase I recorded stone artefacts, ostrich eggshell fragments, pottery and two pieces of British refined earthenware at Site 31 (Webley and Halkett 2010). During the Phase 2 investigation Mr J Smits also pointed out a concentration of artefactual material close to the Rare Earth office complex where rodent burrowing activities unearthed archaeological remains, probably from a midden. Our investigation identified ashy midden material with a similar range of artefactual material as at Site 31, including earthenware, ostrich eggshell fragments and small sherds of thin-walled ceramics, of which one sherd is decorated with fine-line incisions (*see* Figure 37). These artefacts indicate a historic hunter-gatherer or herder presence on the landscape. Some ostrich eggshell and tortoise shell fragments were also recovered.

Figure 37 Hunter-herder ceramics.

The Phase 1 noted a number of LSA lithic scatters where quartz was utilized to manufacture the lithics (Webley and Halkett 2010). The Phase 2 AIA and specialist investigation also identified numerous scatters of quartz gravels across the landscape (*see* Figure 38). The concentrations of quartz comprise surface exposures of an underlying pebble line or horizon. We sampled several of these. Whereas most show some evidence of ephemeral knapping activities none of these localities were deemed to be of high significance. The quartz materials were expediently utilized and the scatters that were investigated did not present focused knapping sites.

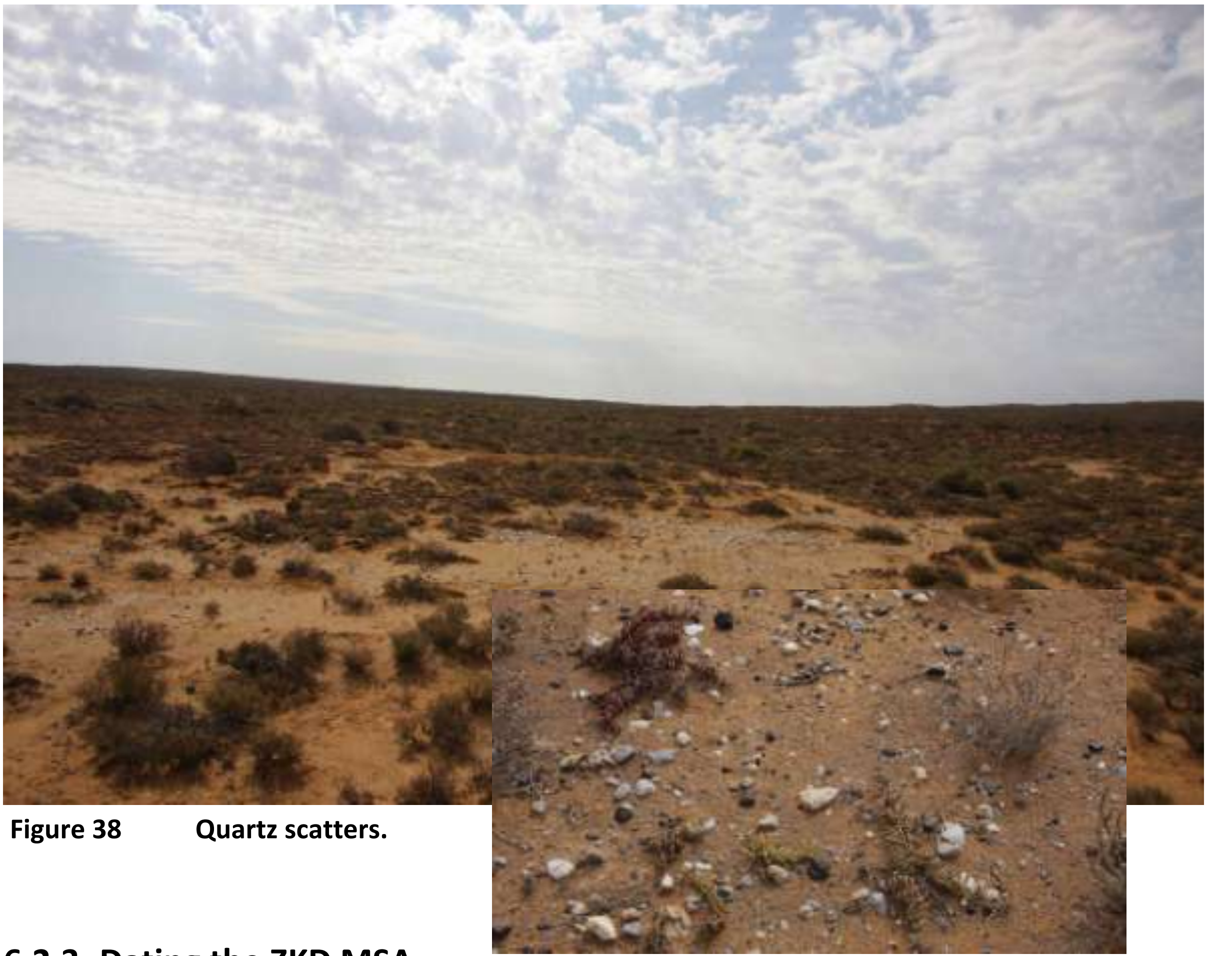


Figure 38 Quartz scatters.

6.2.3 Dating the ZKD MSA

The lithic assemblages from ZKD exhibit a predominant MSA character. Within the long span of the MSA older and younger assemblages are apparent. The earliest MSA assemblages date to around 250 000/200 000 years ago but are more widespread from the Last Interglacial (Oxygen Isotope Stage (OIS) 5) (Mitchell 2002:80). A fourfold chronological scheme is mostly used to describe subdivisions within the southern African MSA lithic assemblages (Singer and Wymer 1982) or, alternatively, Modes (Barham and Mitchell 2008:16). Artefacts characteristic of Mode 2 and Mode 3 are present in most MSA assemblages (*see* Appendix 1, Table 2 for explanatory notes on the different Modes). Mode 2 contains flaked tools produced from prepared cores, whereas Mode 3 refers to the production of punch-struck blades that may be retouched into various specialized tool types. Note that this classification system may be particularly applicable for Cultural Resource Management (CRM) purposes and perhaps easier to understand for people outside the field of archaeology.

A relative large lithic assemblage is required to date any MSA occurrence. From the analysis of the extensive ZKD sequence it is inferred that the surface material at this locality can most probably be assigned to a MSA3 sequence. The MSA3 falls within Marine Isotope Stage (MIS) 3. MIS 3 broadly covers the archaeological record during the period 60 000 to 25 000 years ago and the most recent MSA occurrences would fit into the latter part of MIS 3. There is much variability in the morphology of tools, stone tool typologies and stone-working techniques in the MSA 3 sequence, suggesting regional diversifications (Mitchell 2002:85). Palaeoenvironmental data and deep sea core records show that MIS 3 was marked by fluctuations in temperature and aridity (Mitchell 2008:53).

The marked changes in terms of the morphology of the tools from the excavated subsurface deposit at ZKD1_3017DD suggest that the lower levels can be much older than the surface collection. The subsurface material was also encrusted with a cortical skin. Such chemical transforms are caused by water passing through sediments, which dissolve organic and inorganic materials (Karkanas et al. 2000:916). Carbonate, being extremely mobile, is usually leached from surface deposits (Reitz et al. 1996:50). Evaporates in deposits and on tools suggest initial damp conditions, followed by aridity (Van der Ryst 2006).

6.2 Discussion

The high quality microcrystalline chalcedonies present at the naturally-exposed stone outcrops at ZKD1_3017DD and ZKD2_3017DD have been extensively quarried and used to produce stone tools. The large volumes of lithics that have been knapped and the many formal stone tools that were discarded attest to a long time span of lithic extraction and stone tool knapping activities. The sources were predominantly targeted during the MSA.

Transfers of raw material impact on home ranges, information exchange and incipient resource networks (Wilkins 2010:111). Stone materials, and specifically the haematite-based raw material used at ZKD, are heavy and restrict the load that could by carried over a long distance. The total mass of the lithics recovered through sampling and the excavations amounts to almost a quarter of a tonne. Constraints on carrying capacity among hunter-gatherer groups elsewhere call for innovative measures. In Australia Aborigines were observed to carry cores of stone in their hands, with numerous stone flakes tucked inside their hair (Gould 1978 quoted by Bamforth 2006:521). MSA groups at ZKD most likely optimised their procurement and removal strategies to avail themselves of premium loads that consisted of prepared cores, blanks and formal tools that they aimed to use themselves at other localities that were included in their seasonal round or the lithics could be exchanged with other communities.

Quarrying literature makes a distinction between direct procurement and embedded procurement. In direct procurement special trips were made to quarry and collect stone. Embedded procurement implies that extraction activities were part of a seasonal round of movement (Bamforth 2006:520). While it is not possible to attain a fine resolution in the reconstruction of prehistoric activities at ZKD, the relatively high frequencies of formal tool types and high levels of expediently-used flakes do suggest episodic embedded procurement. From the densities of stone material that occur over large portions of ZKD this locality was evidently targeted and exploited over a very long time up to the recent past.

Stone tool assemblages reflect human behaviour (Wilson 2011:163). Stone extraction and transport of roughouts and knapped products required organization and represented significant labour investment so that sources of stonetool were 'intimately connected' with the cyclic seasonal movements of the groups who quarried there (Odell 2000:271). A quarry location as a source of stone material represents a focal part of the prehistoric landscape. Specific behavioural and organizational strategies underlie stone procurement. Stone extraction localities are included in the highly seasonal round of nomadic groups and reflect their regional land-use patterns. Quarry sites therefore have the potential to contribute to our understanding of landscape-use by prehistoric nomadic groups (Bamforth 2006:511). Extracted materials are transported away from the geological source, are redeposited in other geographic and cultural contexts and traded through exchange networks (Doelman 2005:51). The attributes and specific composition of the ZKD chalcedonies make them readily identifiable so that artefacts originating from this locality could potentially be recognised at other sites within the region. It is however difficult to establish the degree of movement of material and tools in archaeological contexts and sourcing also require expensive and time-consuming destructive and non-destructive laboratory techniques (Bamforth 2006:523; Shackley 2008:196-197).

Extraction localities of high-quality stonetool materials and pigment substances were often considered as special places and represent social landscapes. Whereas ethnographic data cannot be extrapolated to interpret the MSA it is interesting to note that some of the southern African hunter-gatherer groups regarded ochre and specularite mines as powerful places where ritualized behaviour was required for protection before and during a quarrying trip (Bleek and Lloyd 1911:379; Van der Ryst 2006). At Ngwenya Mines in Swaziland ochre and specularite mining was also associated with ritualistic behaviour (Boshier 1969). It is therefore important that the cultural significance of and an investigation of human behaviour at extraction sites should be attempted (Cooney 2011:146; Gopher and Barkai 2011:211).

The analyses show some differences between the lithics sampled from the surface and those recovered from the excavations, particularly in the approximate size of the knapped material. This derives, to some extent, from attrition and the specific site formation processes through which the subsurface and surface materials accumulated. The subsurface excavated deposit is immediately adjacent to an outcrop where discarded quarried material probably accumulated, became gradually covered with soil and ultimately sealed. Preparation of the source rock and testing of chunks for good knapping properties generate quantities of waste material. This inference is supported by the relative higher frequencies of debitage recovered from the excavated deposit. It is also to be expected that the first stages of the production process would have delivered large chunks of raw materials, explaining the difference in size and weight between the surface material and those from the excavated deposit.

Conversely, previously discarded surface material would have been readily available for reuse. On subsequent visits suitable chunks of unused extracted material could be collected and knapped or utilized by people that visited the area during more recent times. We again point out that the carrying load of nomadic groups is severely restricted so that all suitable quarried and knapped material would not have been removed from the source locality. This also applies to detached flake and blade blanks that had been detached and then discarded. All these would have been available for reuse and further trimming on subsequent visits.

Overall the analyses of the two types of sampling highlight a distinct difference in that the flaked lithics from the lower levels of the excavation become exponentially larger. There are very large endstruck and sidestruck flakes in excess of 100 mm and blades up to 135 mm. Whereas the range of formal tool types remains representative of the surface material, the excavated subsurface deposit at ZKD1_3017DD similarly exhibits size-related changes. Flaked stone and formal tools from the lower layers generally have a much more robust appearance. It is likely that this trend may reflect an older phase of exploitation of the resources. It was also notable that lithics from layer 5, at a depth of approximately 400 to 500 mm, exhibited noticeably less encrustation precipitated by leaching of soluble through the deposit (discussed above). The formation of post-deposition concretions on lithics from some levels suggests differential environmental circumstances during successive depositional periods. It can accordingly be inferred that the accumulation of the ZKD MSA artefacts took place over a long period of time. Based on the data from the excavations we suggest that the outcrops were initially exploited during earlier phases of the MSA but primarily and more extensively during the more recent MSA3.

Nonetheless, it must be pointed out that the surface collection also delivered some very large artefacts, e.g. the sampling from Square 8 from Line 1 recovered an awl of 70 x 55 mm and the larger grid at ZKD1_3017DD/Square A6 delivered a multi-directional core of 150 x 135mm, a sidestruck flake of 113 x 110 mm and an endstruck flake of 120 x 70 mm. Taken as a whole the number of lithics from the excavation relative to the mass does demonstrate an exponential trend towards larger artefacts in that n = 2778 pieces of excavated stone had a mass of 94 kg, whereas the surface-sampled ZKD1_3017DD/A-B squares yielded n = 4412 pieces with a total mass of 77.5 kg. We again point out that whereas there is a real tendency towards larger tools in the lower levels of the excavation, the excavated material also contained relatively high numbers of primary knapping debris that contributed to an overall larger mass.

The range of tool types and also the relative frequencies of the surface-collected samples and the excavated subsurface deposits from ZKD are, however, comparable. The presence of formal tools such as awls and scrapers suggests that quarried chunks of material were subjected to initial stages of flaking and immediate tool production in the same area. The pattern also implies that the extraction activities were not spatially removed from ordinary subsistence activities. It is inferred that groups camped relatively close to the quarry. While some members would focus on the extraction and knapping of stone others collected plant foods, set up traps or actively hunted small and larger game animals. It is likely that micromammals, tortoises, hares and birds common to the Sandveld contributed significantly to the terrestrial protein component of MSA groups who scheduled visits to this area. The faunal data demonstrate that Namaqualand Stone Age populations relied on a broad subsistence strategy that included both high- and low-ranking terrestrial and marine species (Dewar and Orton *In press*:4).

The analyses of the different surface areas that were sampled demonstrate some degree of spatial patterning in the densities of lithic distribution. The sampling of line 1A that reflected density peaks and declining numbers, or overall decreasing frequencies, informed our decision to include additional outcrops in the grid. The density patterning is a product of knapping activities relative to distance from the source material. However, post-depositional movement of artefacts in the form of hill wash and gravity that transport, disperse or bury stone material is an important aspect of site formation processes at any locality. Care should be taken not to oversimplify artefact distributions because different post-depositional processes (cultural, as well as non-cultural) influence site formation (Stein 1992; Shott 1998, 2000; van der Ryst 2006). Surface materials were certainly available for reuse during more recent episodes of utilization, which would result in a redistribution of lithics.

No dateable material was recovered. The dating of prehistoric lithic quarries is problematic because they represent a palimpsest of activities and visits over time, the stratigraphic sequence is difficult to define and diagnostic formal tool types are absent or rare (Doelman2005:50). A non-distributional approach was used in the sampling and excavation of ZKD1_3017DD and ZKD2_3017DD in order to find and define spatial variation and to select areas that could deliver representative data samples. The technological analysis provided data on the extraction activities and the production and use of the lithic assemblage.

Whereas the signature of the ZKD assemblages at the quarry sites is clearly MSA, there is also a low incidence of microlithic tools such as small scrapers and bladelets. These may all form part of the MSA assemblage, but can also reflect an ephemeral LSA presence. During various periods worldwide bladelets were probably used in hunting and manufacturing contexts as indicated by microwear analysis (Blankholm 1996:32). The overlay of intermittent visits by nomadic groups over a very long period of time is to be expected at a quarrying locality such as ZKD.

7 Legislative framework

7.1 Archaeological resources

The National Heritage Resources Act (NHRA) (Act No. 25 of 1999, section 35) details the assessment and management of all heritage resources, including intangible heritage, in southern Africa. All archaeological remains, artificial features and structures older than 100 years and historic structures older than 60 years are protected by this Act. The legislation requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected (SAHRA2007:2). No archaeological artefact, assemblage or settlement (site) may be moved or destroyed without the necessary approval from the SAHRA.

Human remains older than 60 years are protected by the National Heritage Resources Act Section 36. Human remains that are less than 60 years old are protected by the Human Tissue Act (Act 65 of 1983 as amended).

The following sections of the South African Heritage Resources Act, 1999 (Act 25 of 1999) must be noted:

Structures

34. (1) No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

Archaeology, palaeontology and meteorite

35.(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which

assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

Burial grounds and graves
36.(3) No person may, without a permit issued by SAHRA or a provincial heritage resources authority—

(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
***(c)** bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals.*

8 Findings and recommendations

Swartkop Hill is situated within the Namaqualand succulent desert Sandveld area that lies between the Hardeveld and the Atlantic Ocean (Cowling and Pierce 2008:17). Archaeological sites within the Namaqualand context are mostly associated with the Hardeveld and coastal regions as sites in the Sandveld have a low archaeological visibility. However, we are increasingly gathering a better understanding of archaeological localities in Namaqualand through the development of commercial mines that commission heritage assessments within the broader ambit of environmental and heritage legislative requirements.

Swartkop Hill provided a geologically unique source of flakeable toolstone. Within the broader landscape context this is significant in that the underlying regional geology is dominated by Namaqualand gneiss that does not contain similar sources of material both in terms of quality and quantity that could be used for the production of stone tools. The extracted material in the form of reworked cores, flakes and formal tools would have been redeposited at other geographic localities at some distance from the geological source. It is also likely that exchange networks would contribute to the redistribution of some lithics. We again emphasize that ethnographic data cannot be used to make inferences on the MSA but it is likely that lithics would have been traded between groups. The attributes of the ZKD chalcedonies are readily identifiable and artefacts that originate from this geological unique locality could potentially be used as a marker at other sites within the broader region.

Potentially the relatively low frequencies of in particular cores and formal tools at Swartkop Hill can be explained through such a hypothesis. Source material and cores would have been prepared and carried to other localities to be used in the production of preferred formal lithics. This hypothesis is further supported by the fact that the Swartkop Hill locality and the immediate surrounds are not conducive to extended occupations and the utilization of an ecologically-constrained environment could rapidly become resource-depleted. Hunter-gatherers are well-informed on the carrying capacity of a region in terms of water and food resources and through a subsistence strategy of transhumance take care not to overexploit resources.

Swartkop Hill is situated within walking distance of the Groen River. In similar arid regions foraging along river beds is well-established. Subsistence activities would have included a broad corridor along drainage lines with visits to sites such as Swartkop Hill scheduled to take advantage of seasonallyabundant resources. Several open-air MSA scatters have been documented on the coast at the mouth of the Groen River (Jerardino et al. 1992; Halkett 2001a). It is highly likely that MSA populations would also target inland resources along the Groen River during cyclical trips.

Within the context of the above the Swartkop Hill MSA assemblage and associated sites are deemed highly significant at the local to regional scale. Unfortunately, as with most other open-air MSA localities, no other cultural material or substantial stratified archaeological deposits are associated with the assemblages. It is the considered opinion of the heritage team that the sample obtained through this Phase 2 assessment is representative and that further mitigation will not add more qualitative data. No additional further archaeological mitigation is recommended as this will merely increase the volumetric sample that has to be curated and stored.

Subject to the approval by SAHRA of this Phase 2 AIA report it is recommended that the application for a destruction permit should be approved in order for the development of the Zandkopsdrift (REE) Project to proceed.

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ANNEXURE 1

Archaeological context: sequence and definitions

Period	**Approximate dates**
Earlier Stone Age	more than 2 million years ago - 250 000/200 000 years ago
Middle Stone Age	200 000/250 000 years ago – around 20 000 years ago to even the Last Glacial Maximum (LGM) in some regions
Later Stone Age (Includes San Rock Art) Hunter-gatherer and herder groups	>20 000 – 200 years ago and up to historic times in certain areas

Chronological framework for the Stone Age of South Africa		
Cultural sequence	**Approximate dates**	**Characteristics**
Later Stone Age		**>30 000 BP up to the historic period**
Late Holocene assemblages with or without ceramics: • **Interior Wilton** • **Post-Wilton/ Post-classic Wilton** • **Smithfield**	2000 BP to historic times	*Hunter-gatherer assemblages:* • Stone tools are mostly microlithic and made on fine-grained stone materials. • The Interior and Post-Wilton have small scrapers with some backed bladelets but segments are rare. Adzes are relatively common. • The Smithfield contains long scrapers and backed bladelets. • May contain grass-tempered hunter-gatherer ceramics. Often contain farmer ceramics, metal objects and glass trade beads obtained through contact. • Bone, animal skin and wood and plant materials were used to produce weapons, household implements and ornaments and a range of tools were made to be used in the manufacture thereof. • Upper and lower grindstones, nutting stones, hammer stones, anvils and punches and groundstone objects such as bored stones and lithic rings. • Abundant ochre and specularite for secular, ceremonial and cosmetic use • Rock art. ***Khoekhoe assemblages*** • Marked by ceramics, often with spouts and conical bases. • Lithic tool assemblages contain mostly informal tools on coarse-grained stone • OES and shell ornaments • Ochre and grooved ochre grindstones • Khoekhoe finger-painted rock art
Interior Wilton **Post-Wilton** **Post-Classic Wilton**	4000-2000 BP	• No ceramics • Small scrapers, bladelets, a range of backed tools, lithic segments. • Most of the assemblages contain similar organics, groundstone, OES, bone tools, etc. such as mentioned above.
Wilton	8000-4000 BP	• Small scrapers, many bladelets, a range of backed tools, many lithic segments. • Most of the assemblages contain similar organics, groundstone, OES, ornaments, bone tools, etc. such as mentioned above
Oakhurst Regional industries include Albany, Kuruman and Lockshoek	12 000-8000 BP	• Mostly non-microlithic and on coarser-grained stone. • Characteristic large adzes and scrapers. Scrapers often D-shaped, or sidescrapers. • Knapping often on large in situ blocks of stone. • Few backed tools. • Many assemblages marked by a range of polished bone tools.
Robberg Mostly at coastal sites	<18 000-12 000 BP	• Unretouched bladelets. • Characteristic bladelet cores. • Some backed bladelets and few segments. • A small range of scrapers in an otherwise informal assemblage. • An otherwise informal assemblage with <5% retouch
Early Later Stone Age	<30 000-12 000 BP	• High variability with often a mix of LSA and MSA tool forms. Not all researchers acknowledge ELSA assemblages as an unambiguous expression of the LSA.

Middle Stone Age		**250 000 to <20 000 BP**
Marked by regional variability. Note that terms such as Still Bay, Mossel Bay, Klasies Rivier etc. are used for regional complexes. Prepared cores are commonly used and flaked products often retain the characteristic faceted striking platform that derives from this technique. Cognitive, cultural and physical modernity with the development of *Homo sapiens sapiens.*		
MSA3	60 000-<20 000 BP	Prepared cores, convergent flakes, blades. Formal tools include unifacial and bifacial points, scraper forms, awls, adzes. Common use of ochre.
Howiesons Poort	Around 60 000-65 000 BP	Microlithic with blade technology. Backed tools such as segments, and blades. Points are rare.
MSA2	60 000-<80 000 BP	Regional variability. Prepared cores, convergent flakes, large blades. Denticulate flakes are particularly abundant at coastal sites.
MSA1	<100 000-250 000 BP	Much regional variability. Prepared cores, large blades, convergent flakes.
Interface of the MSA/ESA: Transitional Fauresmith		**250 000/200 000 BP**
Small handaxes. Convergent flakes and blade forms produced on prepared cores. A range of formal tools.		
Earlier Stone Age		**>2 million-250 000/200 000 BP**
Hominins include the Australopithecine and Paranthropus species, *Homo habilis, Homo ergaster/erectus*, and archaic *Homo*.		
Acheulean	1.5-<250 000 BP	• **Large cutting tools or bifaces** such as handaxes, cleavers and picks. • A range of more formal tools that include many scraper forms. • Large numbers of flakes.
Oldowan	<2-1.5 million years BP	• Chopper tools on cobbles or pebbles. • Little control of design other than the reduction of cores. • Proto-handaxes. • A variety of flakes.

Modes of lithic technology (after JCD Clark 1969) (Barham and Mitchell 2008:16)

		Notes on different Modes
Mode 1	Pebble tool industries using choppers and simple flakes struck off pebbles	Mode 1 and 2: mostly **ESA**
Mode 2	Bifacially-worked tools (handaxes and cleavers) produced from large flakes and cores	**ESA Acheulean** Transitional industries such as the **Fauresmith:** a blend of Mode 2 and 3
Mode 3	Flake tools produced from prepared cores	Mode 3 and 4: mostly **MSA**
Mode 4	Punch-struck blades that may be retouched into various specialised tool types	
Mode 5	Microlithic components of composite artefacts, often backed or otherwise retouched	Mode 5: mostly **LSA**, elements of Mode 4, particularly during the early stages, are quite prominent

ANNEXURE 2

ZANDKOPSDRIFT PHASE2 MSA ANALYSIS: SITE 1 SURFACE SAMPLING

	SURFACE	
DEBITAGE		**7**
Chunks	7	
Chips	0	
CORES		**27**
Levallois (2 illustrate)	5	
Radial (1 illustrate)	11	
Multidirectional: Cortical	0	
Multidirectional: Non-cortical	9	
Pyramidal (illustrate)	2	
Blade	0	
FLAKES		**88**
Cortical endstruck >30 mm	0	
Endstruck >30 mm	15	
Endstruck >30 mm with utilisation	31	
Broken endstruck >30 mm	16	
Core rejuvenation flake >30 (1 illus)	2	
Cortical endstruck <30 mm	0	
Endstruck <30 mm	1	
Cortical endstruck <30 mm	0	
Endstruck <30 mm	0	
Cortical sidestruck >30 mm	0	
Sidestruck >30 mm	12	
Sidestruck >30 mm with utilisation (1 120 mm)	9	
Cortical sidestruck <30 mm	0	
Sidestruck <30 mm	2	
CONVERGENT FLAKES		**24**
Convergent flakes > 30 mm	8	
Convergent flakes > 30 mm with utilisation	11	
Convergent flakes > 30 mm broken	5	
POINTS		**0**
Points > 30 mm	0	
Points > 30 mm with retouch	0	
Points > 30 mm with utilisation	0	
Points< 30 mm	0	
BLADES		**100**
Primary Blades	36	
Blades with utilisation	30	
Blades with utilisation and retouch	1	
Broken blades	33	
BLADELETS		**0**
Primary Bladelets	0	
Bladelets with utilisation	0	
Bladelets with utilisation and retouch	0	
Broken bladelets	0	
SCRAPERS		**42**
LARGE		
End	7	
Side	21	
End and side	5	
Circular	3	
Scrapers on sidestruck flakes	4	
MEDIUM		
End	0	
Side	0	
End and side	0	
Circular	2	
AWLS (2 illustrate)	8	**8**
ADZES	0	**0**
HAMMER STONES	0	**0**
TOTAL	296	**296**

ZANDKOPSDRIFT PHASE2 MSA | SITE 1 SAMPLING LINE 1 1-SQUARE METRE BLOCKS

SITE 1 SAMPLING LINE 1	SQUARE 2		SQUARE 3		SQUARE 4		SQUARE 5		SQUARE 6		SQUARE 7		SQUARE 8		SQUARE 9		SQUARE 10		SQUARE 11	
DEBITAGE		**7**		**17**		**24**		**25**		**10**		**19**		**15**		**17**		**4**		**5**
Chunks	1		9		15		20		6		14		14		17		4		5	
Chips	6		8		9		5		4		5		1		0		0		0	
CORES		**0**		**0**		**1**		**1**		**0**		**0**		**3**		**0**		**0**		**3**
Levallois	0		0		0		0		0		0		0		0		0		0	
Radial	0		0		0		1		0		0		1		0		0		1	
Multidirectional: Cortical	0		0		1		0		0		0		0		0		0		0	
Multidirectional: Non-cortical	0		0		0		0		0		0		1		0		0		2	
Pyramidal	0		0		0		0		0		0		0		0		0		0	
Blade	0		0		0		0		0		0		1		0		0		0	
FLAKES		**20**		**13**		**41**		**26**		**11**		**19**		**6**		**17**		**11**		**6**
Cortical endstruck >30 mm	1		2		6		0		0		1		0		2		0		0	
Endstruck >30 mm	1		1		4		3		0		0		0		1		0		2	
Endstruck >30 mm with utilisation	2		1		1		2		0		2		4		6		2		0	
Broken endstruck >30 mm	5		4		12		9		3		9		1		5		5		1	
Core rejuvenation flake >30	0		0		0		0		0		0		0		0		0		0	
Cortical endstruck <30 mm	0		0		0		0		0		0		0		0		0		0	
Endstruck <30 mm	6		2	**0**	7		2		3		2		1		1		1		1	
Cortical endstruck <30 mm	3		0		4		5		1		0		0		0		2		1	
Utilised Endstruck <30 mm	1		2		4		1		1		2		0		1		1		0	
Broken endstruck <30 mm	0		1		2		3		3		1		0		1		0			
Cortical sidestruck >30 mm	0		0		0		0		0		0		0		0		0		0	
Sidestruck >30 mm	1		0		0		1		0		2		0		0		0		0	
Sidestruck >30 mm with utilisation	0		0		1		0		0		0		0		0		0		0	
Cortical sidestruck <30 mm	0		0		0		0		0		0		0		0		0		1	
CONVERGENT FLAKES		**5**		**3**		**5**		**1**		**1**		**1**		**0**		**0**		**0**		**0**
Convergent flakes > 30 mm	2		2		2		0		1		0		0		0		0		0	
Convergent flakes > 30 mm with utilisati	1		0		0		1		0		1		0		0		0		0	
Convergent flakes > 30 mm broken	2		1		3		0		0		0		0		0		0		0	
POINTS		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**
Points > 30 mm	0		0		0		0		0		0		0		0		0		0	
Points > 30 mm with retouch	0		0		0		0		0		0		0		0		0		0	
Points > 30 mm with utilisation	0		0		0		0		0		0		0		0		0		0	
Points< 30 mm	0		0		0		0		0		0		0		0		0		0	
BLADES		**6**		**5**		**10**		**19**		**7**		**1**		**5**		**6**		**3**		**3**
Primary Blades	3		1		1		5		4		1		1		0		1		1	
Cortical blades	0		0		0		1		0		0		0		0		0		0	
Snapped blade with utilisation	0		0		0		1		1		0		0		1		0		0	
Blades with utilisation and retouch	0		0		0		0		0		0		0		3		0		0	
Broken blades	3		4		9		12		2		0		4		2		2		2	
BLADELETS		**5**		**2**		**7**		**1**		**0**		**5**		**1**		**3**		**0**		**0**
Primary Bladelets	0		2		2		1		0		2		1		2		0		0	
Cortical bladelets	0		0		2		0		0		0		0		0		0		0	
Bladelets with utilisation and retouch	0		0		0		0		0		3		0		0		0		0	
Broken bladelets	5		0		3		0		0		0		0		1		0		0	
SCRAPERS		**1**		**2**		**6**		**2**		**4**		**4**		**7**		**3**		**2**		**0**
LARGE																				
End	0		0		1		0		0		1		1		0		0		0	
Side	0		0		3		1		1		2		5		3		0		0	
End and side	0		0		0		0		0		0		0		0		0		0	
Circular	0		0		0		0		0		0		0		0		0		0	
Scrapers on sidestruck flakes	0		0		0		0		3		0		0		0		1		0	
MEDIUM																				
End	0		0		0		0		0		0		0		0		0		0	
Side	1		2		2		1		0		1		1		0		1		0	
End and side	0		0		0		0		0		0		0		0		0		0	
Circular	0		0		0		0		0		0		0		0		0		0	
AWLS	0	**0**	4	**4**	0	**0**	1	**1**	1	**1**	3	**3**	2	**2**	1	**1**	1	**1**	1	**1**
AWL/SCRAPER COMBINATION	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
ADZE	0	**0**	0	**0**	3	**3**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
SPOKESHAVE	0	**0**	0	**0**	0	**0**	2	**2**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**	0	**0**
TOTAL	44	**44**	46	**46**	97	**97**	78	**78**	34	**34**	52	**52**	39	**39**	47	**47**	22	**22**	18	**18**

SITE 1 SAMPLING LINE 1	SQUARE 2	SQUARE 3	SQUARE 4	SQUARE 5	SQUARE 6	SQUARE 7	SQUARE 8	SQUARE 9	SQUARE 10	SQUARE 11
DEBITAGE	**7**	**17**	**24**	**25**	**10**	**19**	**15**	**17**	4	5
CORES	**0**	**0**	**1**	**1**	**0**	**0**	**3**	**0**	**0**	**3**
FLAKES	**20**	**13**	**41**	**26**	**11**	**19**	**6**	**17**	**11**	**6**
CONVERGENT FLAKES	**5**	**3**	**5**	**1**	**1**	**1**	**0**	**0**	**0**	**0**
POINTS	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
BLADES	**6**	**5**	**10**	**19**	**7**	**1**	**5**	**6**	**3**	**3**
BLADELETS	**5**	**2**	**7**	**1**	**0**	**5**	**1**	**3**	**0**	**0**
SCRAPERS	**1**	**2**	**6**	**2**	**4**	**4**	**7**	**3**	**2**	**0**
AWLS	**0**	**4**	**0**	**1**	**1**	**3**	**2**	**1**	**1**	**1**
AWL/SCRAPER COMBINATION	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ADZE	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SPOKESHAVE	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**
TOTAL	**44**	46	97	**78**	**34**	**52**	**39**	**47**	**22**	**18**
MASS OF LITHICS	**0.5**	**0.5**	**1**	**1**	**0.25**	**1**	**0.5**	**0.5**	**0.25**	**0.25**

ZANDKOPSDRIFT PHASE2 MSA ANALYSIS: SITE 1 EXCAVATION

SITE 1 EXCAVATION	D5/A	L1	D5/A	L2	D5/B	L1	D5/B	L2	D5/B	L3	D5/B	L4	D5/B	L5	D5/B	L6	D5 REMAINDER OF SQUARE	
DEBITAGE		**144**		**103**		**179**		**158**		**253**		**311**		**320**		**23**		**96**
Chunks	108		93		109		130		240		264		264		17		62	
Chips	36		10		70		28		13		47		56		6		34	
CORES		**6**		**13**		**5**		**8**		**7**		**4**		**2**		**0**		**1**
Levallois	0		1		0		0		0		0		0		0		0	
Radial	1		4		0		1		2		2		0		0		0	
Multidirectional: Cortical	0		3		1		2		1		0		0		0		0	
Multidirectional: Non-cortical	4		5		4		5		4		2		2		0		1	
Pyramidal	0		0		0		0		0		0		0		0		0	
Blade	1		0		0		0		0		0		0		0		0	
FLAKES		**97**		**55**		**140**		**77**		**84**		**56**		**83**		**11**		**65**
Cortical endstruck >30 mm	9		6		9		8		18		11		11		1		2	
Endstruck >30 mm	12		14		9		18		15		11		22		1		4	
Endstruck >30 mm with utilisation	15		15		9		8		5		6		0		0		8	
Broken endstruck >30 mm	30		13		48		22		32		19		38		8		17	
Core rejuvenation flake >30	0		0		5		7		7		6		1		0		0	
Endstruck <30 mm	16		2		12		2		2		0		3		0		4	
Broken endstruck <30 mm	5		1		19		1		0		0		0		0		12	
Cortical endstruck <30 mm	4		1		0		1		0		0		0		0		1	
Utilised endstruck <30 mm	0		0		7		0		0		1		0		0		7	
Cortical sidestruck >30 mm	2		2		14		4		0		2		4		0		4	
Sidestruck >30 mm	0		1		4		5		5		0		3		1		2	
Sidestruck >30 mm with utilisation	0		0		0		1		0		0		1		0		0	
Cortical sidestruck <30 mm	1		0		1		0		0		0		0		0		0	
Sidestruck <30 mm	3		0		3		0		0		0		0		0		4	
CONVERGENT FLAKES		**7**		**6**		**8**		**4**		**7**		**5**		**0**		**0**		**1**
Convergent flakes > 30 mm	3		6		3		2		7		3		0		0		0	
Convergent flakes > 30 mm with utilisation	2		0		3		1		0		0		0		0		1	
Convergent flakes > 30 mm broken	2		0		2		1		0		2		0		0		0	
POINTS		**1**		**0**		**10**		**0**		**0**		**0**		**0**		**0**		**0**
Points > 30 mm	0		0		10		0		0		0		0		0		0	
Points > 30 mm with retouch	1		0		0		0		0		0		0		0		0	
Points > 30 mm with utilisation	0		0		0		0		0		0		0		0		0	
Points< 30 mm	0		0		0		0		0		0		0		0		0	
BLADES		**47**		**36**		**47**		**31**		**40**		**21**		**25**		**9**		**42**
Primary Blades	10		7		5		5		21		8		6		3		5	
Cortical blades	5		9		6		8		5		3		2		3		0	
Blades with utilisation	4		5		6		1		3		1		2		0		7	
Snapped blades with retouch	1		0		0		0		0		0		0			**0**		**0**
Broken blades	27		15		30		17		11		9		15		3		30	
BLADELETS		**10**		**0**		**18**		**4**		**0**		**0**		**4**		**2**		**6**
Primary Bladelets	2		0		3		0		0		0		0		2		3	
Bladelets with utilisation	1		0		2		0		0		0		0		0		0	
Cortical bladelets	0		0		2		0		0		0		3		0		0	
Broken bladelets	7		0		11		4		0		0		1		0		3	
SCRAPERS		**11**		**7**		**14**		**7**		**2**		**0**		**3**		**1**		**16**
LARGE																		
End	2		0		0		1		0		0		0		0		0	
Side	0		6		1		5		1		0		3		0		2	
End and side	3		0		2		0		0		0		0		0		5	
Circular	0		0		0		0		0		0		0		0		0	
Scrapers on sidestruck flakes	0		1		1		1		0		0		0		0		0	
MEDIUM																		
End	2		0		5		0		0		0		0		0		1	
Side	2		0		5		0		1		0		0		1		3	
End and side	2		0		0		0		0		0		0		0		1	
SMALL	0		0		0		0		0		0		0		0		4	
AWLS	8	**8**	0	**0**	5	**5**	2	**2**	0	**0**	1	**1**	2	**2**	0	**0**	3	**3**
HEAVY DUTY IMPLEMENT WITH RETOUCH	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
AWL SCRAPER COMBINATION	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**
SPOKESHAVE	1	**1**	0	**0**	1	**1**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**
TOTAL	332	**332**	220	**220**	427	**427**	291	**291**	393	**393**	398	**398**	439	**439**	46	**46**	232	**232**

SITE 1 EXCAVATION	D5/A	L1	D5/A	L2	D5/B	L1	D5/B	L2	D5/B	L3	D5/B	L4	D5/B	L5	D5/B	L6	D5 REMAINDER OF SQUARE	
DEBITAGE		**144**		**103**		**179**		**158**		**253**		**311**		**320**		**23**		**96**
CORES		**6**		**13**		**5**		**8**		**7**		**4**		**2**		**0**		**1**
FLAKES		**97**		**55**		**140**		**77**		**84**		**56**		**83**		**11**		**65**
CONVERGENT FLAKES		**7**		**6**		**8**		**4**		**7**		**5**		**0**		**0**		**1**
POINTS		**1**		**0**		**10**		**0**		**0**		**0**		**0**		**0**		**0**
BLADES		**47**		**36**		**47**		**31**		**40**		**21**		**25**		**9**		**42**
BLADELETS		**10**		**0**		**18**		**4**		**0**		**0**		**4**		**2**		**6**
SCRAPERS		**11**		**7**		**14**		**7**		**2**		**0**		**3**		**1**		**16**
AWLS		**8**		**0**		**5**		**2**		**0**		**1**		**2**		**0**		**3**
ADZE		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**
AWL SCRAPER COMBINATION		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**1**
SPOKESHAVE		**1**		**0**		**1**		**0**		**0**		**0**		**0**		**0**		**1**
TOTAL		**332**		**220**		**427**		**291**		**393**		**398**		**439**		**46**		**232**

ZANDKOPSDRIFT PHASE2 MSA ANALYSIS SITE 1B SQUARES B1-B6 (2.5 SQUARE METRE BLOCKS)

SITE 1 SQUARES B1-B6	B1		B2		B3		B4		B5		B6	
DEBITAGE		**406**		**141**		**154**		**105**		**60**		**80**
Chunks	366		118		142		94		54		74	
Chips	40		23		12		11		6		6	
CORES		**6**		**8**		**6**		**5**		**10**		**5**
Levallois	1		0		0		0		1		0	
Radial	1		1		2		2		1		0	
Multidirectional: Cortical	2		3		0		1		7		1	
Multidirectional: Non-cortical	2		4		4		2		0		4	
Pyramidal	0		0		0		0		0		0	
Blade	0		0		0		0		1		0	
FLAKES		**155**		**86**		**171**		**99**		**109**		**94**
Cortical endstruck >30 mm	14		7		20		10		24		5	
Endstruck >30 mm	19		8		14		3		7		7	
Endstruck >30 mm with utilisation	27		12		15		10		9		12	
Broken endstruck >30 mm	51		20		68		45		21		34	
Core rejuvenation flake >30	4		5		1		0		1		1	
Cortical endstruck <30 mm	1		0		3		10		8		7	
Endstruck <30 mm	7		8		16		5		8		6	
Endstruck with utilisation <30 mm	4		6		9		7		10		7	
Broken endstruck <30 mm	12		8		7		5		11		4	
Cortical sidestruck >30 mm	0		2		5		3		1		2	
Sidestruck >30 mm	6		6		8		0		3		4	
Cortical sidestruck <30 mm	9		0		1		0		1		3	
Sidestruck <30 mm	1		4		3		1		5		1	
Sidestruck with utilisation >30 mm	0		0		1		0		0		1	
CONVERGENT		**7**		**9**		**23**		**9**		**7**		**6**
Convergent flakes	1		1		12		2		2		1	
Convergent flakes with utilisation/retouch	1		2		3		7		0		1	
Convergent flakes mm broken	5		6		8		0		5		4	
POINTS		**0**		**0**		**1**		**1**		**21**		**2**
Points > 30 mm	0		0		1		1		21		2	
Points > 30 mm with retouch	0		0		0		0		0		0	
Points > 30 mm with utilisation	0		0		0		0		0		0	
Points< 30 mm	0		0		0		0		0		0	
Unifacial point > 30 mm	0		0		0		0		0			
BLADES		**38**		**49**		**86**		**33**		**48**		**36**
Primary Blades	7		10		9		3		7		7	
Cortical blades	2		4		10		3		0		3	
Blades with utilisation and retouch	10		16		15		8		10		6	
Snapped blades - retouched	0		0		0		0		7		2	
Broken blades	19		19		52		19		24		18	
BLADELETS		**3**		**15**		**13**		**7**		**4**		**14**
Primary Bladelets	2		9		10		2		3		6	
Cortical Bladelet	0		1		0		0		0		1	
Bladelets with utilisation and retouch: broken	0		5		0		0		0		0	
Broken bladelets	1		0		3		5		1		7	
SCRAPERS		**6**		**3**		**15**		**11**		**14**		**14**
LARGE												
End	1		0		2		1		0		1	
Side	0		3		5		3		0		5	
End and side	0		0		1		0		0		0	
Circular	0		0		0		0		0		0	
Scrapers on sidestruck flakes	3		0		1		1		0		0	
MEDIUM											0	
End	0		0		1		0		3		1	
Side	2		0		5		6		6		4	
End and side	0		0		0		0		0		1	
Scrapers on sidestruck flakes	0		0		0		0		1			
SMALL											0	
End	0		0		0		0		0		2	
Side	0		0		0		0		3		0	
End and side	0		0		0		0		0		0	
Scrapers on sidestruck flakes	0		0		0		0		1		0	
AWLS	5	**5**	5	**5**	8	**8**	5	**5**	0	**0**	5	**5**
SPOKESHAVE	0	**0**	0	**0**	1	**1**	0	**0**	0	**0**	1	**1**
AWL/SCRAPER COMBINATION	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**
ADZES	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**
HAMMERSTONE							2	**2**				
TOTAL	626	**626**	316	**316**	478	**478**	277	**277**	273	**273**	259	**259**

SITE 1 SQUARES B1-B6	B1		B2		B3		B4		B5		B6	
DEBITAGE		**406**		**141**		**154**		**105**		**60**		**80**
CORES		**6**		**8**		**6**		**5**		**10**		**5**
FLAKES		**155**		**86**		**171**		**99**		**109**		**94**
CONVERGENT FLAKES		**7**		**9**		**23**		**9**		**7**		**6**
POINTS		**0**		**0**		**1**		**1**		**21**		**2**
BLADES		**38**		**49**		**86**		**33**		**48**		**36**
BLADELETS		**3**		**15**		**13**		**7**		**4**		**14**
SCRAPERS		**6**		**3**		**15**		**11**		**14**		**14**
AWLS		**5**		**5**		**8**		**5**		**0**		**5**
SPOKESHAVE		**0**		**0**		**1**		**0**		**0**		**1**
AWL/SCRAPER COMBINATION		**0**		**0**		**0**		**0**		**0**		**1**
ADZES		**0**		**0**		**0**		**0**		**0**		**1**
HAMMERSTONE								**2**				
TOTAL		**626**		**316**		**478**		**277**		**273**		**259**

ZANDKOPSDRIFT PHASE2 MSA ANALYSIS: AD HOC COLLECTIONS

	WINDPOMP		SURFACE CLOSE WIN		LOPIE NABY WINDP(		SCATTER CLOSE TO V		TRACK 4		TRACK 5		TRACK 6		MUISGAT KANTOOR	
DEBITAGE		**0**		**3**		**1**		**22**		**1**		**0**		**24**		**13**
Chunks	0		3		0		4		1		0		21		9	
Chips	0		0		1		18		0		0		3		4	
CORES		**2**		**3**		**2**		**0**		**1**		**5**		**10**		**2**
Levallois	1		0		0		0		0		0		0		0	
Radial	0		2		1		0		0		0		0		0	
Multidirectional: Cortical	1		0		0		0		0		5		0		0	
Multidirectional: Non-cortical	0		1		1		0		1		0		10		2	
Pyramidal	0		0		0		0		0		0		0		0	
Blade	0		0		0		0		0		0		0		0	
FLAKES		**8**		**3**		**8**		**25**		**7**		**3**		**13**		**9**
Cortical endstruck >30 mm	4		1		2		0		0		0		1		0	
Endstruck >30 mm	3		1		3		4		3		2		2		0	
Endstruck >30 mm with utilisation	1		1		0		0		1		1		0		0	
Broken endstruck >30 mm	0		0		1		1		0		0		0		3	
Core rejuvenation flake >30	0		0		0		0		0		0		0		0	
Cortical endstruck <30 mm	0		0		0		0		0		0		1		0	
Endstruck <30 mm	0		0		0		8		3		0		2		3	
Utilised endstruck <30 mm	0		0		0		2		0		0		4		0	
Broken endstruck <30 mm	0		0		2		10		0		0		3		2	
Cortical sidestruck >30 mm	0		0		0		0		0		0		0		0	
Sidestruck >30 mm	0		0		0		0		0		0		0		1	
Sidestruck >30 mm with utilisation	0		0		0		0		0		0		0		0	
Cortical sidestruck <30 mm	0		0		0		0		0		0		0		0	
Sidestruck <30 mm	0		0		0		0		0		0		0		0	
CONVERGENT FLAKES		**1**		**0**		**0**		**0**		**0**		**3**		**0**		**0**
Convergent flakes > 30 mm	1	**0**	0		0		0		0		3		0		0	
Convergent flakes > 30 mm with utilisation	0		0		0		0		0		0		0		0	
Convergent flakes > 30 mm broken	0		0		0		0		0		0		0		0	
POINTS		**2**		**1**		**0**		**0**		**0**		**0**		**0**		**0**
Points > 30 mm	0		0		0		0		0		0		0		0	
Handaxe	1		1		0		0		0		0		0		0	
Points > 30 mm with utilisation	0		0		0		0		0		0		0		0	
1 Quartz point	1		0		0		0		0		0		0		0	
BLADES		**2**		**0**		**2**		**0**		**1**		**0**		**3**		**0**
Primary Blades	1		0		1		0		1		0		0		0	
1 Quartz	0		0		0		0		0		0		0		0	
Blades with utilisation and retouch	1		0		0		0		0		0		0		0	
Broken blades	0		0		1		0		0		0		3		0	
BLADELETS		**0**		**0**		**0**		**3**		**0**		**0**		**1**		**2**
Primary Bladelets	0		0		0		0		0		0		0		1	
Cortical bladelets	0		0		0		0		0		0		1		0	
Bladelets with utilisation and retouch	0		0		0		0		0		0		0		0	
Broken bladelets	0		0		0		3		0		0		0		1	
SCRAPERS		**2**		**1**		**3**		**0**		**1**		**2**		**3**		**1**
LARGE																
End	0		0		0		0		0		0		0		0	
Side	0		0		3		0		0		2		0		0	
End and side	1		0		0		0		0		0		0		0	
Circular	1		0		0		0		0		0		0		0	
Scrapers on sidestruck flakes	0		0		0		0		0		0		0		0	
MEDIUM																
End	0		0		0		0		0		0		1		0	
Side	0	**0**	0		0		0		1		0		2		0	
End and side	0		1		0		0		0		0		0		1	
SMALL	0		0		0		0		0		0		0		0	
AWLS	1	**1**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	1	**1**	0	**0**
AWLS/SCRAPER COMBINATION	0	**0**	0	**0**	2	**2**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
HAMMERSTONE	1	**1**	0	**0**	0	**0**	0	**0**	1	**1**	0	**0**	0	**0**	0	**0**
SPOKESHAVE	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
TOTAL	19	**19**	11	**11**	18	**18**	50	**50**	12	**12**	13	**13**	55	**55**	27	**27**

	WINDPOMP		SURFACE CLOSE WIN		LOPIE NABY WINDP(		SCATTER CLOSE TO V		TRACK 4		TRACK 5		TRACK 6		MUISGAT KANTOOR	
DEBITAGE		**0**		**3**		**1**		**22**		**1**		**0**		**24**		**13**
CORES		**2**		**3**		**2**		**0**		**1**		**5**		**10**		**2**
FLAKES		**8**		**3**		**8**		**25**		**7**		**3**		**13**		**9**
CONVERGENT FLAKES		**1**		**0**		**0**		**0**		**0**		**3**		**0**		**0**
POINTS		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**
BLADES		**2**		**0**		**2**		**0**		**1**		**0**		**3**		**0**
BLADELETS		**0**		**0**		**3**		**3**		**0**		**2**		**1**		**2**
SCRAPERS		**2**		**1**		**0**		**0**		**1**		**0**		**3**		**1**
AWLS		**1**		**0**		**2**		**0**		**0**		**0**		**0**		**0**
HAMMERSTONE		**1**		**0**		**0**		**0**		**1**		**0**		**0**		**0**
SPOKESHAVE		0		0		**0**		0		0		0		1		0
HANDAXE		**1**		1		**0**		**0**		0		0		0		
TOTAL		**19**		**11**		**18**		**50**		**12**		**13**		**55**		**27**