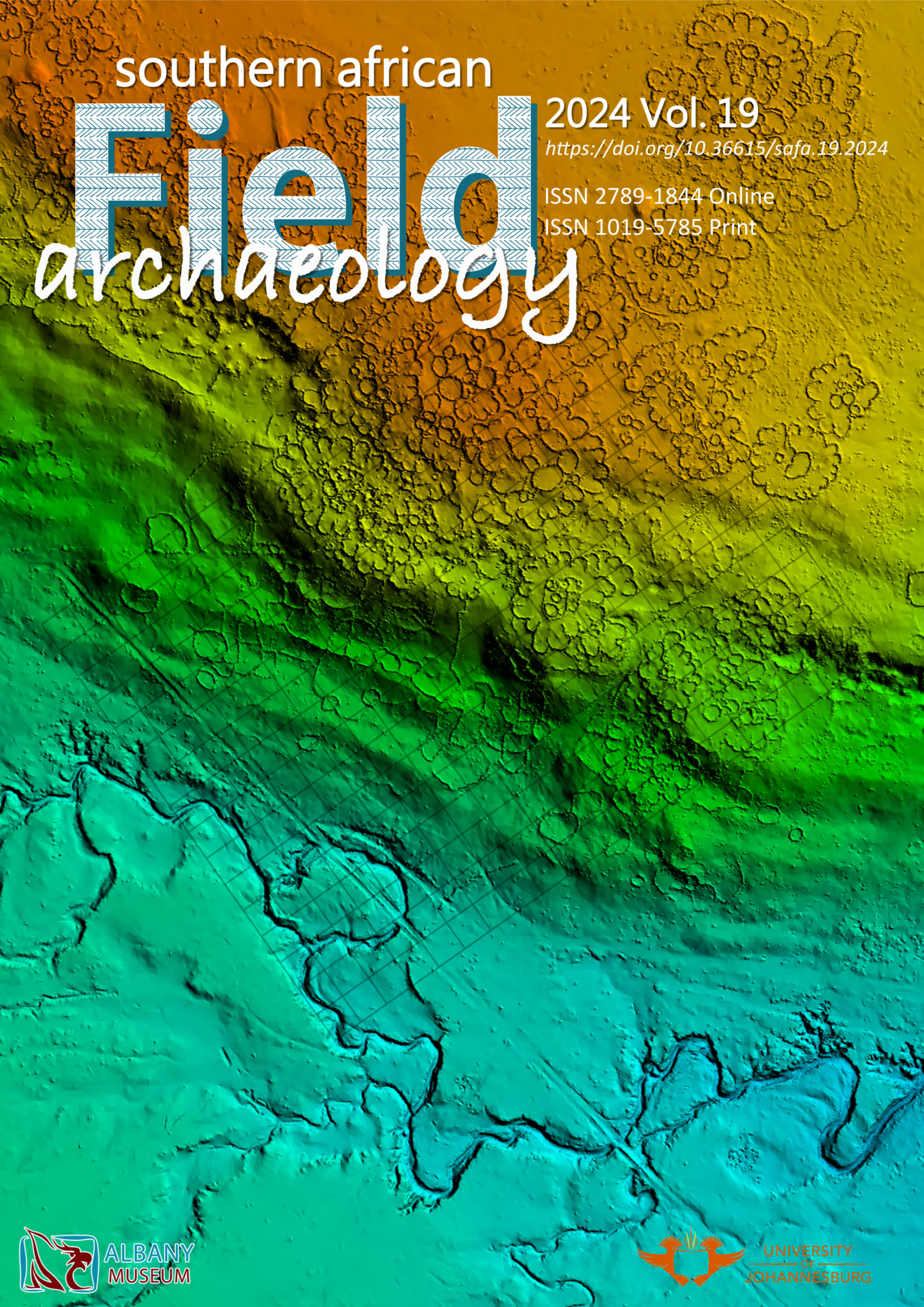
southern african Field archaeology

2024 Vol. 19

https://doi.org/10.36615/safa.19.2024

ISSN 2789-1844 Online

ISSN 1019-5785 Print



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Southern African Field Archaeology
2024 Vol. 19: Article 3010
Research report (peer-reviewed): Received February 2024; Revised April 2024; Published May 2024
DOI: https://doi.org/10.36615/safa.19.3010.2024

ISSN 1019-5785
ISSN 2789-1844

THE JOJOSI DONGAS: AN INTERDISCIPLINARY PROJECT TO STUDY THE EVOLUTION OF HUMAN BEHAVIOUR AND LANDSCAPES IN OPEN-AIR CONTEXTS

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ABSTRACT
Hunter-gatherer groups conduct most of their activities in open landscapes as they provide drinking water, food, and raw materials, and offer spaces for social gatherings. The remains left behind at such sites allow for unique archaeological insights into the spatial patterning of prehistoric behaviour. The Stone Age record in southern Africa remains best-known from sheltered sites. A paucity of stratified open-air localities precludes understanding the full spectrum of past hominin activities. Here we introduce an interdisciplinary project in KwaZulu-Natal to study the evolution of human behaviour and landscape dynamics during the Pleistocene in the open-air context of a stratified hillslope with sediments exposed in so-called dongas, a landform created by gully erosion. The project encompasses field and laboratory approaches, combining archaeological, geographical, geological, chronometric, and palaeoenvironmental data. After reviewing relevant open-air research in archaeology and geography, we identify the Jojosi Dongas as a promising research area. Our fieldwork results from 2022-2023 demonstrate the high archaeological, geographical, and geological potential of this landscape. Foot surveys found abundant MSA artefacts spread throughout the dongas, one area with ESA tools, but little to no traces of LSA or later material. Most finds lie on the surface with rarer stratified material occurring in exposed profiles. The surface MSA material is characterised by almost exclusive hornfels use, frequent cortical pieces, many large blanks and cores, and rare retouched tools. These features differ markedly from lithic trends observed in well-known shelter sites, likely the result of differences in site function. Based on the nature of the surface assemblages and the presence of a large outcrop of high-quality hornfels, we hypothesise that the Jojosi Dongas may have been a specialised quarry and workshop area. The stratified MSA occupations are the focus of ongoing excavations and further studies will aim to test our preliminary interpretations provided here.

Keywords: Middle Stone Age, Earlier Stone Age, open-air archaeology, geomorphology, survey

1. Introduction

The global Palaeolithic and Stone Age records are heavily influenced by taphonomic and post-depositional processes, with an increasing loss of information through time (Surovell et al. 2007; Perreault 2019). Site contexts from which archaeological data derive are among the many factors biasing the Pleistocene archaeological record. Pleistocene archaeology in many parts of the world is best known from caves and rock shelters with their favourable preservation and constrained topology.

Acting both as places of shelter and sediment traps, these contexts favour repeated human occupations and the accumulation of deep, albeit complex, stratified sediments that allow for diachronic analysis of behavioural change, and the construction of chrono-cultural sequences. At the same time, caves and rock shelters constitute small and peculiar morphological features within landscapes. They provide limited space for habitation and reflect only part of the full range of prehistoric behaviours. While allowing for good control of time and change, there is little resolution in space. In contrast, open-air sites allow for a unique understanding of spatial patterning of hominin behaviour across landscapes as they are less constrained by discrete physical zonation – indeed they raise the question of what constitutes a **site** (Foley 1981) – and may comprise contiguous areas covering many square kilometres. These sites can provide complementary information to sheltered locations as many places essential for the hunter-gatherer lifestyle exist only in this wider landscape context. They provide access to resources, such as drinking water (rivers, channels, lakes), food (migration routes and habitats of prey, edible plants), and raw materials (rock outcrops, trees), and also provide open spaces for large-scale aggregations of humans and animals (ritual places, gatherings of animals at waterholes).

Ethnographic research has shown that mobile hunter-gatherer groups spend much of their time in open-air locales with the majority of daily domestic and social activities taking place here (e.g., Gould 1968; Binford 2001; Kelly 2013). Studying the archaeology of these open-air sites has the potential to provide information on a wide array of past activities and their material traces, informing us on larger-scale patterns of mobility, settlement, and the very spatiality of behaviours among hunter-gatherer groups (Foley 1981; Isaac 1981; Conard 2001; Gamble & Porr 2005; Sharon et al. 2014; Tryon et al. 2014; Kindermann et al. 2018; Karlin & Julien 2019). Why, then, do we know much less about the global Stone Age from open-air contexts? The primary hindrance is the potential for the accumulation and preservation of archaeological material due to the effects of erosion, weathering, deflation, etc., and the added difficulty of finding such traces in a stratified or *in situ* context. Working on open-sites requires a firm understanding of their formation within the spatial and temporal framework of the landscape processes to which they were exposed. Typically, then, open-air archaeology draws on geomorphology and geological studies to understand the dynamics and evolution of the landscape, the specific site formation processes, and related sediment dynamics that contextualise the behavioural record (Tensorer et al. 2007; Malinsky-Buller et al. 2011; Sharon et al. 2014; Uthmeier & Chabai 2018). Whatever the challenges may be in a particular case, the foregoing discussion showcases that understanding the full spectrum of past actions and material culture in the Stone Age will have to include and integrate data from open-air sites.

Here, we present a new research project in the Jojosi Dongas that focuses on the little-known open-air archaeology in the eastern part of South Africa in the KwaZulu-Natal province (KZN), by following an interdisciplinary landscape-scale approach. After an overview of open-air archaeological and geographical research in South Africa, we introduce the Jojosi project within its local research context. We then report on initial results from our geographical and archaeological fieldwork in 2022 and 2023 and discuss the behavioural interpretation of these findings in the framework of ongoing investigations.

Open-air research in South Africa: archaeology and geography

Today, South African Stone Age archaeology is known worldwide for fossil and archaeological finds from the Earlier Stone Age (ESA) cave infill deposits within the UNESCO Cradle of Humankind or spectacular finds from Middle Stone Age (MSA) rock shelters that have transformed our understanding of the early cultural evolution of *Homo sapiens* (d'Errico et. al. 2005; Texier et al. 2010; Thompson et al. 2010; Villa et al. 2010; Henshilwood 2012; Wadley 2015; Rots et al. 2017; Backwell et al. 2022; Scerri & Will 2023). Open-air research has been less prominent over the past decades and with marked geographical differences. Initially it focused on large-scale survey activities in the Vaal River gravels and its tributaries, beginning in the early 20th century (Johnson 1907; Collins & Smith 1915; Goodwin 1928; Söhnge & van Riet Lowe 1937; van Riet Lowe 1952) and continuing ever since (Sampson 1985; Sampson et al. 2015; Kuman & Gibbon 2018; Leader et al. 2018; Ecker et al. 2021). Further landscape surveys and the identification of stratified open-air sites to understand land use and settlement patterns proceeded in the Western Cape (Oestmo et al. 2014; Mackay 2016; Shaw et al. 2019). Notable research has come from Elandsfontein (Klein 1978; Braun et al. 2013), Geelbek and Anyskop (Kandel et al.

2005; Kandel & Conard 2012) as well as Hoedjiespunt (Berger & Parkington 1995; Will et al. 2013). More recent work in the Tankwa Karoo and Cederberg regions has demonstrated flexible inhabitation of landscapes by highly mobile hunter-gatherer groups from various chronological periods in arid, marginal environments (Hallinan & Parkington 2017; Mackay et al. 2018; Shaw et al. 2019; Hallinan 2022). Since the 1990s, intense research at open-air sites has also been carried out in the Free State (see summaries in de Ruiter et al. 2011; Bousman et al. 2023a, b). Most recent archaeological work in the Lovedale dongas has shown task-specific site functions preserved within stratified deposits in open-air alluvial channel and floodplain settings exposed within erosional gullies (Wroth et al. 2022).

In the KZN province, the most intensely studied sites are located in the Southeastern Coastal Platform geomorphic province (Partridge et al. 2010). Here, the Indian Ocean Coastal Belt Biome comprises dense subtropical vegetation or large areas of modern sugar-cane fields, complicating survey work. Although archaeological investigations are documented in the late 19th and early 20th century, many of these endeavours have been non-systematic or destructive, some derive from surface collections or are poorly documented, and many sites are covered today by housing and road developments (Sanderson 1879; Feilden 1884; Lebzelter & Schmidt 1926; Lebzelter 1930; Malan 1948; Davies 1949; see also Bader & Will 2017). In this region – even more so than in others – modern Stone Age research has focused on excavating sheltered sites with an emphasis on the MSA, such as at Sibhudu, Border Cave, Umbeli Belli, and Umhlatuzana (Will et al. 2014; Bader et al. 2015; Bader et al. 2018; Sifogeorgaki et al. 2020; Backwell et al. 2022). These localities with long stratified sequences have been key for understanding the cultural stratigraphy and behavioural evolution of early modern humans in southern Africa (Lombard et al. 2012, 2022; Wurz 2016; Will et al. 2019), but provide only snapshots of behaviour limited in space and by ecology. This situation precludes assessments of regional landscape use and environmental adaptations over the Middle and Late Pleistocene which requires integration of rock shelter sequences with open-air data (Mackay 2016; Hallinan & Parkington 2017; Shaw et al. 2019; also see Chabai & Uthmeier 2018; Kindermann et al. 2018). The presence of key sites in KZN that are rich in MSA and LSA materials, however, speaks to the high potential for locating open-air sites. The Grassland and Savanna Biomes of the region's interior may in turn facilitate access to sediments and provide a different geographical focus. So far, the interior areas remain mostly unstudied and devoid of known stratified sites, particularly for the ESA and MSA (Fig. 1).

In contrast to archaeological work, many geomorphological, sedimentological, and geochronological studies have been conducted in the interior of KZN. In eastern South Africa, Quaternary sheetwash and gully-infill sediments attributed to the Masotcheni Formation provide ideal conditions for open-air archaeological preservation and exploration. These sediments are widespread in the region and diverse in substrate material, often found in colluvial settings within the Ladysmith Basin and adjacent Southeastern Coastal Hinterland geomorphic provinces (Botha 1996; Partridge et al. 2010; Botha et al. 2016). The deposits are commonly stratified, coarse to medium-grade, sandy sheetwash, representing palaeo-gully infill alluvial sediments that accumulated throughout the Late Pleistocene and Holocene (Botha & Fedoroff 1995; Wintle et al. 1995; Clarke et al. 2003; Temme et al. 2008; Keen-Zebert et al. 2013; Lyons et al. 2013; Bosino et al. 2021). The stratification is interpreted as reflecting cyclical fluctuations in landscape stability. During climatic and vegetation-cover conditions that favour degradation of soil on upper slopes by sheet and rill erosion, the sediment is transported mainly as unconfined sheetwash deposits that accrete on the lower footslopes (Botha et al. 1994). During phases of relative landscape stability, weathering of the surficial sediment results in soil development. Phases of instability remove topsoils and remnant subsoils are buried, leading to the accretion of a sedimentary succession comprising stratified colluvium and interbedded buried palaeosols (Botha et al. 1992; Botha & Fedoroff 1995). Both the erosion activity and pedogenesis reflect past environmental conditions, such as hydroclimatic changes between aridity and humidity, the changing vadose zone hydromorphic status of soils and underlying sediments, the type and density of associated vegetation cover, and changing local geomorphic processes. The impact and timing of palaeoenvironmental conditions have been studied using a range of research methods, including sedimentology, litho- and pedostratigraphy, micromorphology and geochemical techniques (e.g., Wintle et al. 1994; Botha & Fedoroff 1995; Clarke et al. 2003; Lyons et al. 2013; Tooth et al. 2013; Lyons et al. 2014), as well as through computational modelling (Temme et al. 2009; Temme & Veldkamp 2009). From an archaeological perspective, the stratified sediment bodies provide favourable conditions for preservation and the palaeosols permit interpretation of the palaeoenvironmental context, two important pre-requisites that render the Masotcheni Formation a suitable geo-archive for open-air archaeological research. Recent gully erosion, a common feature affecting the hillslope colluvial mantles in central KZN, also aids archaeological prospecting by exposing sedimentary units and interbedded archaeological materials in gully (donga) sidewalls.

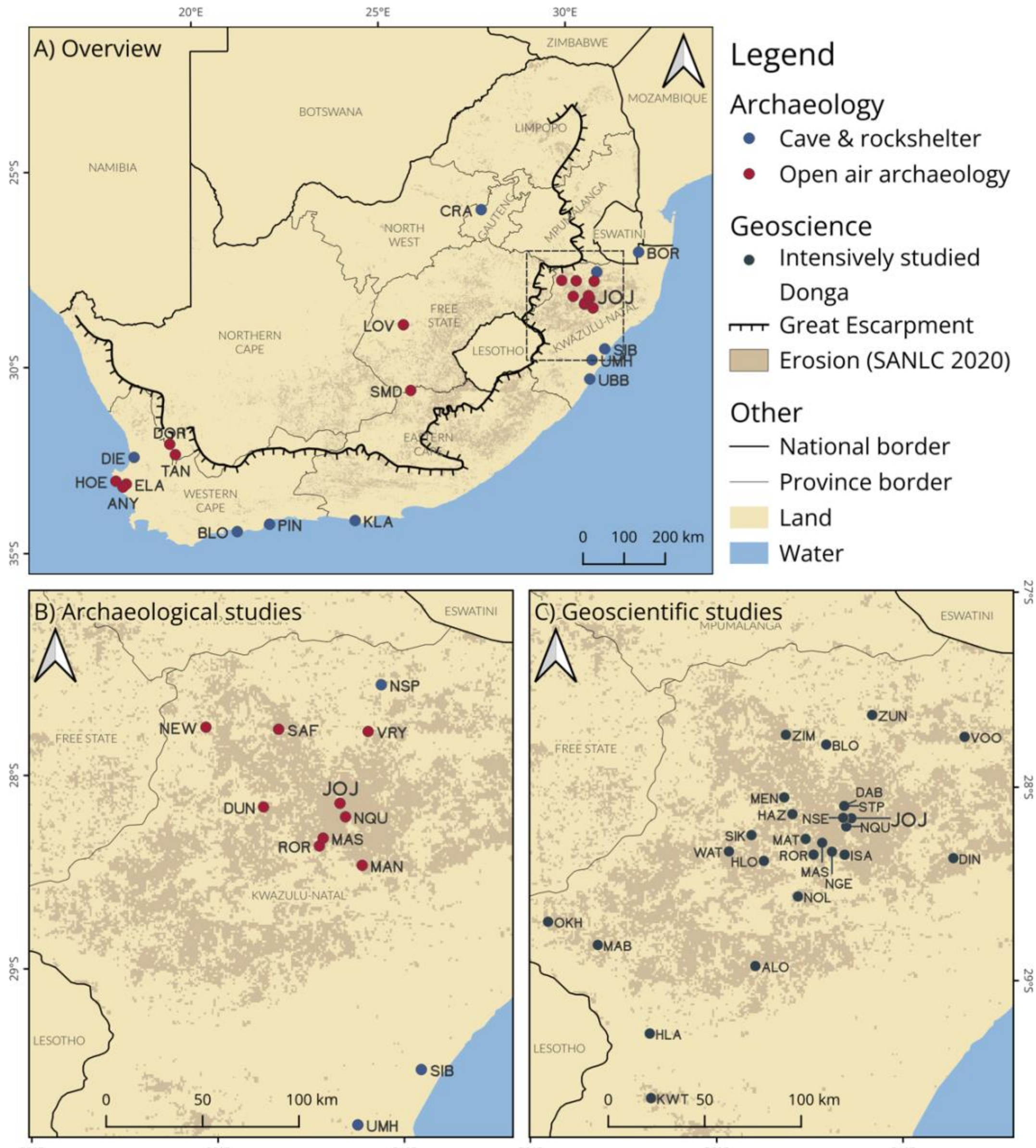

Figure 1. Sheltered and open-air localities in South Africa and KZN mentioned in text. Stone Age sites in South Africa (a) (HOE=Hoedjiespunt, ANY=Anyskop, ELA=Elandsfontein, DIE=Diepkloof Rock Shelter, DOR=Doring River, TAN=Tankwa Karoo, BLO=Bloemfontein, PIN=Pinnacle Point, KLA=Klasies River, LOV=Lovedale, CRA=Cradle of Humankind, SIB=Sibhudu, SMD=Smaldeel, UMH=Umhlatuzana, UBB=Umbeli Belli, BOR=Border Cave). Sites of archaeological relevance in the focus area of KZN (b) (NEW=Newcastle, DUN=Dundee, SAF=Sandspruit Farm, ROR=Rorke’s Drift, MAS=Masotcheni, JOJ=Jojosi, NQU=Nquthu, MAN=Mangeni Falls, VRY=Vryheid, NSP=Natalspa). Sites of geoscientific relevance (c) (OKH=Okhombe Valley, MAB=Mabhulesini, HLA=Hlatikulu, KWT=KwaThunzi, ALO=The Aloes, WAT=Waterkloof, SIK=Sikhunyana, HLO=Hlomohlomo, MEN=Menteith, HAZ=Hazeldene, MAT=Matatana, ROR=Rorke’s Drift, MAS=Masotcheni, NGE=Ngedla, ISA=Isandhlwana, NOL=Nolonka, NSE=Nsekwini, DAB=Dabekazi, STP=St Pauls, JOJ=Jojosi, NQU=Nquthu, ZIM=Zimbutu, BLO=Blood River, ZUN=Zungwini, VOO=Voordrag, DIN=Dingaanstad). Erosion features were derived from the South African National Land Cover (SANLC) Dataset (2020) provided by the Department of Environment, Forestry and Fisheries.

Donga is a local term used in southern Africa for a landform created by gully erosion, which describes the removal of soil or sediment by incising dendritic and linear channels through the concentrated flow of water (Poesen et al. 2003). Once initiated, dongas grow rapidly in length and depth and expand in area, making it the most destructive form of soil degradation (Sidorchuck 2021). Donga morphology is controlled by several environmental factors (e.g., landscape position, bedrock geology, sediment and soil types, climate and weather extremes, vegetation cover) and anthropogenic drivers (e.g., overstocking and overgrazing, land management practices such as slash and burn agriculture, field ploughing, and road cuts). In South Africa they occupy roughly 600 000 ha (Mararakanye & Le Roux 2012) and Olivier et al. (2023) estimate erosion rates of 30 to 123 t/ha per year in prone regions. Most dongas occur in the Eastern Cape and central KZN, stretching from the Great Escarpment foothills to the river basins of the coastal hinterland, with 0.9% of the land area affected (see Fig. 1). For this reason, donga erosion nowadays poses a major threat to agriculture and built infrastructure and has become the focus of conservation research, predictive modelling, and Earth observation systems. For archaeology, the phenomenon is both a blessing and a curse: on the one hand, erosion destroys archaeological sites beyond recovery, but on the other hand, exposure in the donga walls reveals otherwise deeply buried artefacts and sites. Ongoing donga expansion rejuvenates the outcrops, which facilitates repeated archaeological exploration within these landforms.

Open questions, current limitations, and research opportunities

Current research into the southern African Stone Age relies heavily on archaeological material from caves and rock shelters, particularly in KZN. There are few open-air sites that preserve undisturbed assemblages and even fewer sites where materials buried intact within stratified deposits are accessible using modern excavation techniques. What characterises the archaeology of Pleistocene open-air sites in KZN? Is it different from sheltered localities, and if so, why? What function did sites in open landscapes have during the Pleistocene? To what degree has the current Stone Age record in southern Africa, most well-known from sheltered sites, been impacted by the prevalence of specific occupation types and locational preferences? Answers to these questions, and a full understanding of past human adaptations and land use, require the incorporation of multiple localities of different types and functions. Only with more systematic surveys, fieldwork, sampling, and multidisciplinary data collection from open-air sites, followed by comparison with sheltered site data, can we then begin to answer these questions and realise the true significance of the KZN record.

Any such work in the Stone Age requires close collaboration between archaeologists, geographers, geomorphologists, and geologists. All steps of archaeological inquiry, from locating and mapping of sites to their excavation and interpretation, are strongly influenced by factors of sediment derivation, transport mechanisms, and depositional facies in response to the changing landscape dynamics, both past and present. What caused the phases of landscape activity, and can we learn anything about the environmental conditions encountered by early hunter-gatherers? Can we relate the sediment dynamics and timing of events to the successions exposed in nearby dongas, and can this help us to understand whether these events were active only locally or on a wider regional scale? What can current sediment dynamics tell us about the recent state of landscape stability? Is the transition from unstable conditions to landscape stability coeval across the land surface? Do the phases of donga growth followed by localised infill and greening of vegetation-stabilised dongas take place simultaneously across the region? Many of these questions can be tackled by close collaboration between the different disciplines listed above.

2. An interdisciplinary project in the Jojosi Dongas

Geographic and geological setting

The study area is situated in the uppermost reaches of the Jojosi River Valley, a tributary to the White Mfolozi River, at elevations of 1160-1200 m (28°08'30" S, 30°39'01" E; Fig. 2). The Jojosi River springs from the flank of a sandstone and dolerite escarpment separating two geomorphic provinces, the elevated plateau of the Ladysmith Basin to the west and the lower Southeastern Coastal Hinterland to the east (Partridge et al. 2010). The escarpment comprises resistant sandstone of the Vryheid Formation which also underlies large parts of the plateau. Below the scarp lies a dense dendritic drainage basin corresponding to a widespread dolerite sill exposure. A dominant sill rises above the valley, forming the watershed to the south, and Telzeni Hill, the watershed to the north (Fig. 3). The sites are located on the dolerite footslopes where the chemically weathered dolerite bedrock is buried by a complex sequence of Quaternary sheetwash and gully-infill sediments. The study area lies in the temperate climate zone with a subtropical highland climate (Köppen-Geiger class Cwb; Conradie 2012). Within this Summer Rainfall Zone, precipitation is highly seasonal, with humid summers and dry winters. The predominant vegetation type of the region is the Income Sandy Grassland, a part of the Sub-Escarpment Grassland Bioregion (Mucina & Rutherford 2006).

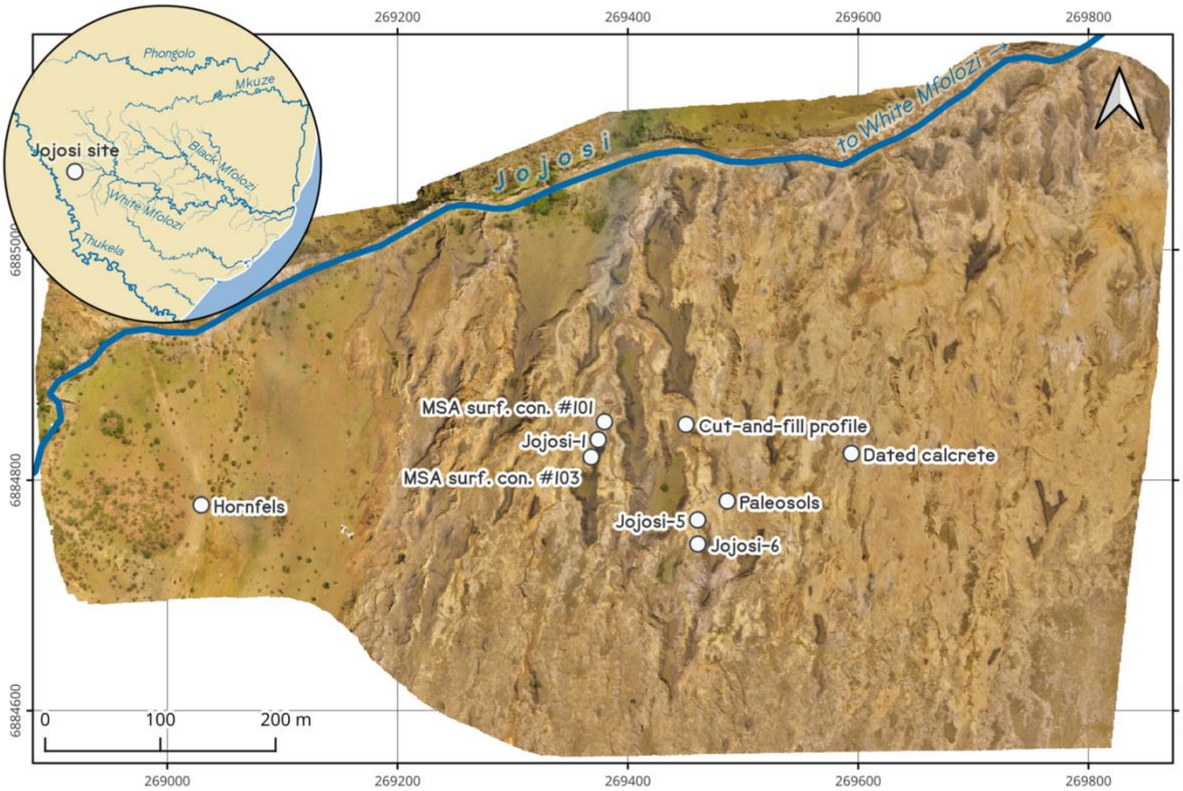

Figure 2. Detailed view of the main study area and important locations mentioned in the text. Go to https://skfb.ly/oyTSW for an interactive 3D view.

Previous research

The Southeastern Coastal Hinterland in the interior of KZN, north of the Thukela River and south of the Phongolo River, has seen widespread geoscientific exploration but little archaeological study. Here we summarise only the most important points with a focus on Jojosi. A detailed description on previous work in the broader area can be found in the Supplementary Online Material (SOM) 1.

Earlier studies with a geoscientific focus on the Jojosi site by Botha (1996) and Botha et al. (1994) describe several unconformity-bounded depositional units and illustrate multiple phases of cut-and-fill sediment bodies. However, the nature of the dolerite-derived sediment that predominates the Jojosi Basin precludes a direct correlation of palaeosols or sedimentary units here with those described from the surrounding region. The cut-and-fill profile mapped in Figure 2 and shown in Figure 3b is used in Boardman et al. (2012) as an illustrative depiction of gully-fill sequences, but it is not discussed any further. A unique hardpan calcrete profile interbedded within the Jojosi sedimentary succession yielded radiocarbon ages of ~37 ka and ~28 ka (Pta-5759, Pta-4927/4975), which allows a tentative chronological correlation with buried palaeosols exposed in the St Paul's, Nquthu and Menteith localities. Concerning the complex Jojosi palaeo-donga cut-and-infill succession, the question arises as to how this succession can be correlated directly with the luminescence chronology framework at surrounding locations. Successful dating of the landscape cyclicity inherent in the Jojosi colluvial succession will permit stratified archaeological finds to contribute to an enhanced understanding of the role of Stone Age cultures in the context of the long-term Masotcheni Formation accretion, using chronostratigraphic indexing and derived palaeoenvironmental insights.

Previous archaeological work in the northern interior of KZN has provided ample evidence of ESA, MSA, and some LSA artefacts in surface contexts scattered over wide areas (see SOM 1). These stone tools are predominantly associated with well-developed and well-studied sheetwash and alluvial sediments, and the material is commonly found in large numbers located on erosional donga surfaces. In fact, the earliest reports of Stone Age artefacts in KZN appear to go back to dongas (Feilden 1884). The few excavations in northern KZN conducted in sheltered sites have provided ample LSA material in their occupation sequences, but little MSA (Mazel 1996). The area of the Jojosi Valley was initially described during the systematic mapping and geological investigations by Greg A. Botha in the late 1980s. He first noticed the high archaeological potential of the Jojosi Donga complex (see Botha 1996: appendix 7.1). Based on his assessment, a project headed by Aron D. Mazel (then Natal Museum) performed the first and so-far only documented excavation of an open-air locality in KZN during a short campaign in 1991. Unpublished field notes and comprehensive photographic records by Mazel report distinct artefact concentrations eroding out of the profile walls of the dongas from lenticular-shaped features (Mazel 1991). He excavated four of these features, which we now call Jojosi 1-4. The lithic assemblages, all attributed to the MSA, were never studied in detail and the results of the excavations were not published except for a newspaper article (Unknown Author 1991) and a note (Botha 1996: appendix 7.1). The nature of these stone tools and the sedimentary context, geographical extent, and age of the purported MSA occurrences remained unknown. Among all known sites in the area and based on previous work, the Jojosi Dongas possess the highest potential for uncovering *in situ* material in stratified sediments from an open-air Stone Age context in KZN. After a visit to the site in 2021 and a first perusal of the Jojosi 1-4 collections stored at the KZN Museum, we decided to start a new large-scale field project in 2022.

Introducing the new project: scope, aims, and methods

The overarching goal of the Jojosi project is to study the evolution of human behaviour and landscapes in open-air contexts of southeastern Africa in the understudied region of KZN, during the late Middle and Late Pleistocene. This work will include the systematic survey, excavation, and analysis of stratified open-air Stone Age archaeological sites, and concern the acquisition of high-resolution, multidisciplinary data. From a geographical, geological, and geoarchaeological perspective, central research questions concern: 1) the formation of palaeo-donga infill deposits at Jojosi in their wider regional framework; and 2) the accumulation, embedding, and potential alteration of archaeological material. The archaeological scope of the project aims to understand the extent, age, recurrence, and nature of occupations in the Jojosi landscape, assessing their function and characterising technological and techno-economic behaviours. These data are contextualised with: 1) regional knowledge from sheltered sites in KZN to study the distinctiveness and culture-historical attribution of the archaeological signals at Jojosi; and 2) inter-regional information from open-air contexts to evaluate similarities and differences in the spatial use of southern African landscapes in the Late Pleistocene. Contrasting open-air and sheltered localities from distinct ecological and geological circumstances is a crucial step to assess the impact of different site functions and occupation types, for understanding specific behavioural repertoires including landscape use and mobility patterns. Finally, we are interested in the dynamic relationship between landscapes, environments, and humans, such as the extent to which both geological aspects and natural resources (i.e., raw materials, surface stability, grassland ecologies), climatic fluctuations, or self-induced changes to the surroundings (i.e., niche construction), influenced behavioural and occupational patterns.

Our methodological approach comprises an interdisciplinary framework, combining archaeological, geographical, geological, chronometric, and palaeoenvironmental data. In 2022 we initiated systematic survey and mapping of archaeological finds of the Jojosi landscape followed by targeted small-scale excavations in 2023, embedded in a wider geographical and geological study of the region. The ongoing field studies are facilitated by the traditional landowners, the Molefe Tribal Council, and the excavation permit issued by the KZN Amafa and Research Institute to MW (PermitID: 3848 REF: SAH22/18276 CaseID: 18276). For the purpose of introducing the research project here, we provide an overview of all the methods employed within this project, including those that will be scheduled for future analyses beyond the scope of this paper. We also provide the initial results from our fieldwork seasons in 2022 and 2023. Multidisciplinary analytical and laboratory work is currently underway, such as the study of excavated material, but it is not the subject of this contribution.

The archaeological work encompasses field-based and laboratory aspects. The large study area (>3 km²) necessitated initial foot surveys to understand the extent and nature of archaeological occurrences within the erosional landscape. The foot surveys followed the terrain due to its complex 3D morphology consisting of multiple gully and wall features (up to 10 m; Fig. 3) and aimed at rapid identification and mapping of relevant archaeological material. Teams of two archaeologists tracked their paths and identified specific archaeological occurrences via handheld GPS and the KoBo Toolbox (https://www.kobotoolbox.org/). The KoBo Toolbox is a free open-source tool for field data collection using mobile devices, supporting the full data cycle from design to collection, storage, and analysis. We used the system on mobile phones to gather textual, coordinate, and photographic data. No artefacts were collected. Attribution of surface material to a period (ESA/MSA/LSA) rested on appraisal of diagnostic artefacts and established typo-technological traits comparable to other surveys in South Africa (e.g., Hallinan & Parkington 2017). Handaxes, cleavers and clusters of large cores and/or flakes on coarse-grained raw material with minimal preparation were interpreted as ESA, whereas prepared and radial cores, flakes and/or blades with faceted platforms and retouched forms such as points, were regarded as markers for the MSA. Microlithic forms, bladelets and bipolar cores, particularly on quartz, were interpreted as being from the LSA. We note the limits of this approach, such as equifinality in lithic types and the coarse-grained resolution of this appraisal.

The surveys provided the basis for choosing excavation areas. We adapted archaeological excavations to the complex sediment geometry and the specific kinds of archaeological occurrences in the dongas, neither allowing large-scale digging of horizontal planes as usually done in an open-air setting. Instead, excavations consist of multiple, targeted explorations of outcropping archaeological material in small areas within the often non-contiguous sediment bodies. These occurrences receive individual numbers in ascending order (e.g., Jojosi-5) and are analytically treated as separate sites and assemblages. We measured the encountered artefacts >2 cm in size in 3D with a total station and an EDM programme in a local grid system associated with an Access database (e.g., Dibble & McPherron 1988; McPherron & Dibble 2007). All sediments are screened through a sieve of 10 mm and 1 mm to recover smaller archaeological finds. The material is stored and curated in the KZN Museum in Pietermaritzburg. Future laboratory work will cover quantitative and techno-typological analyses of excavated stone tools, but also refitting, spatial, morphometric, functional, and provenience studies. Blocks of intact sediment jacketed in plaster will allow micromorphological study to understand sediment formation around occupation zones.

Chronometric and palaeoenvironmental data were also collected during fieldwork. The almost complete lack of charcoal and organic material precludes the application of radiocarbon dating. Instead, we apply luminescence methods that have been implemented successfully on donga sediments elsewhere in the region (e.g., Botha et al. 1994; Botha 1996; Lyons et al. 2013; Colarossi et al. 2020). Our sampling strategy follows the dual goal of understanding the timing of sediment deposition but also the associated accumulation of the archaeological material. Optically stimulated luminescence (OSL) dating of natural minerals, such as quartz and feldspars, allows for constraining the depositional age of the sediments (e.g., Huntley et al. 1985; Hütt et al. 1988; see Rhodes 2011 for a review). Due to rare organic preservation, palaeoenvironmental analyses will rely on the collection of sediment samples for the study of phytoliths and detailed soil texture and chemical analyses. Rare, fossilised bone and teeth will be subject to standard zoological analyses.

To better understand the current (resource) landscape and its complex formation processes, we employ multiple geological and geographical approaches. In the field, we study the phenomenon of donga landscapes from a stratigraphic perspective, focusing on the formation of sedimentary bodies and relict palaeosols, thereby establishing an environmental context for the archaeological finds. We apply the method devised by Botha (1996), describing the Quaternary successions in terms of allo- and pedostratigraphy, which allows us to distinguish and capture sedimentological and pedological overprint properties complementarily. Sediment samples are analysed for texture and geochemistry by the KZN Department of Agriculture Laboratory. The Council for Geoscience laboratory in Silverton (Tshwane, Gauteng) will perform X-Ray Diffraction (XRD) analysis. We will apply visible-near-infrared (NIS-NIR) soil spectroscopy of 350-2500 nm wavelength to characterise the electromagnetic reflectance fingerprints of the stratigraphic units (Stenberg et al. 2010; Sommer 2021).

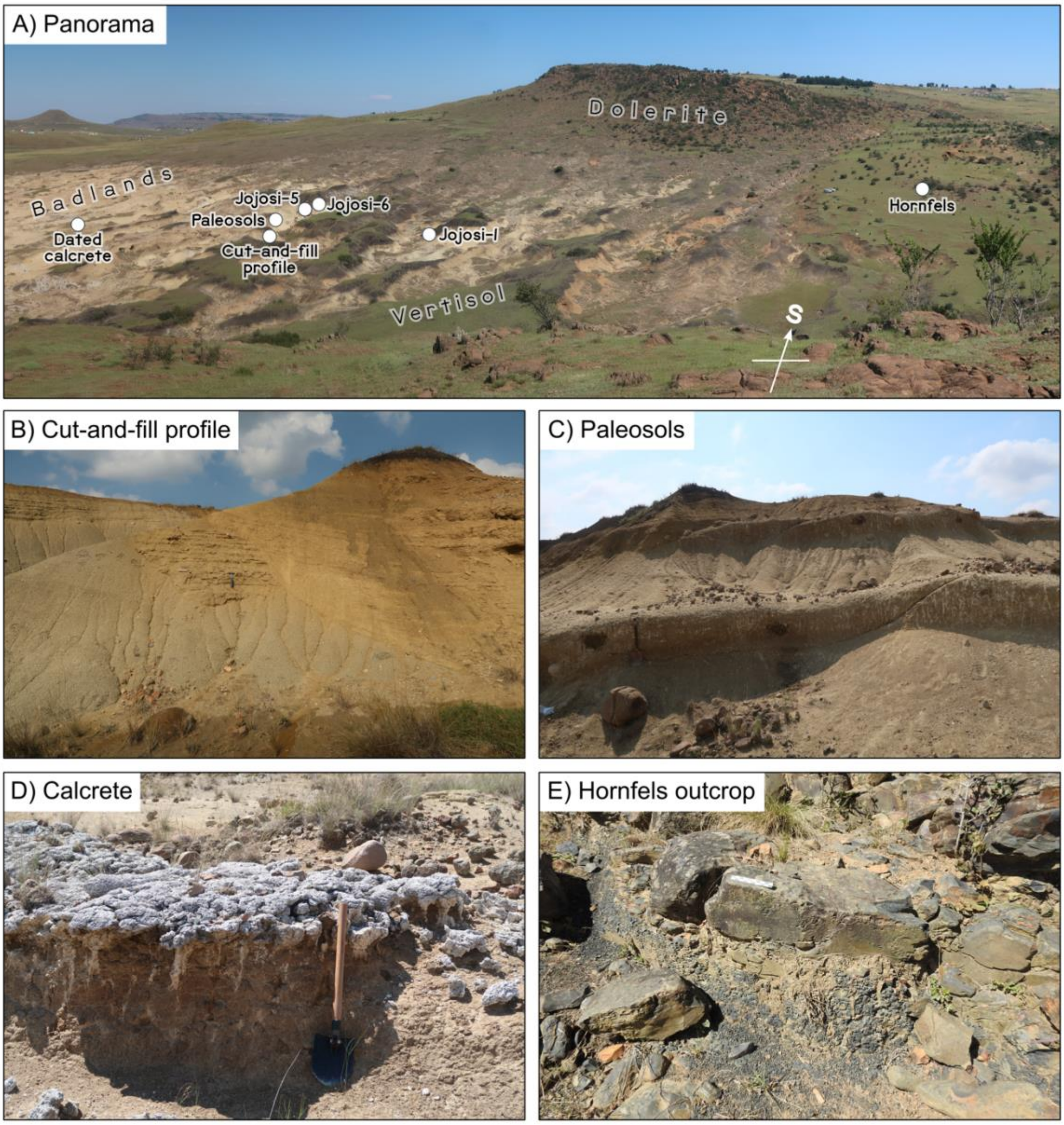

Figure 3. Overview of the study area and key sites. Panoramic overview of the upper Jojosi valley (a). Donga fill sediments display several phases of erosion and deposition (b). Two buried palaeosols (c) and calcrete (d) indicate phases of soil formation. Hornfels outcrop used as raw material source for stone tool manufacture (e). Go to https://skfb.ly/oyTSW for an interactive view.

Recent donga erosion is studied to understand the influence of natural and anthropogenic factors and the synchronicity of landscape activity. This work allows inferences to be made on the prehistoric evolution of dongas, but also their impact on modern land use and present-day communities. To this end, we create a regional inventory of existing donga types, quantify their extent, and derive their geographic properties from digital terrain models, topographic indices, and regional environmental data. We derive the dynamics of erosion from a time series analysis of historical aerial photographs dating back to the 1940s, orthophoto maps, and younger spaceborne imagery. Photogrammetry based on a UAV (unmanned aerial vehicle) survey of the Jojosi dongas in 2022 and 2023 helps in quantifying erosion rates at a small spatial and temporal scale. We feed the data into a regional geostatistical analysis to identify potential drivers of donga erosion and develop a predictive model to estimate the current potential for land degradation (Vanmaercke et al. 2021; Olivier et al. 2023).

3. Initial results from the field campaigns in 2022 and 2023

Initial findings from field work in 2022 and 2023 encompass the geographical and archaeological results from our systematic foot and UAV surveys – with an emphasis on the distribution, extent, and nature of archaeological surface material in the donga landscapes – and preliminary observations from the excavations. We also report on work concerning OSL sampling, connecting our research to the 1990s excavations of Jojosi 1-4, and processes of modern donga erosion. An overview of the key research areas and encountered features in the landscape is provided in Figure 3.

Field observations on the geography and geology of the (resource) landscape

We characterised the geoscientific and geographical nature of the area by mapping geomorphological features through both field observation and UAV survey, generating a 3D model that is publicly accessible at https://skfb.ly/oyTSW. In the field, we described sedimentological characteristics across the study area and at the relevant sites, namely the cut-and-fill profile (Fig. 3b), a paleosol profile (Fig. 3c) and Jojosi-5 (Figs 8-9). The sedimentological samples collected at these localities are currently under analysis.

Our topographic analysis indicates that the geographical setting of Jojosi is typical for the colluvial hillslope mantles of the Masotcheni Formation, accumulating as unconfined sheetwash sediment or palaeo-gully infill deposits on a footslope with an inclination of <10%. Mapping of sediment bodies at gully exposures revealed mixed sedimentary input from weathered and eroded Vryheid Formation sandstone and shale bedrock with limited sediment derived from weathered dolerite, the latter of which is usually indicated by reddening of the sediments (see Botha 1996). The Jojosi River Basin is unique in this respect as the entire ~30 km^2 area is underlain by a thick dolerite sheet. The colluvial sedimentary succession is derived from eroded dolerite saprolite exposed on the upper hillslopes. Our initial investigations of the colluvium indicate up to four stratigraphic units in the succession that can be correlated over larger areas, but can only be observed in direct contact at a few locations (see cut-and-fill profile, Fig. 3b). The underlying dolerite consists of bedrock in the upper parts of the footslope and is deeply weathered in the lower parts with a silty clay texture. The bedrock is covered by colluvial deposits >10 m thick which can be subdivided into three unconformity-bounded sedimentary units. These units vary considerably in thickness and lateral continuity. The stratified sediments are well-cemented and have higher sand content than the parent weathered rock and palaeosols, ranging from sand to clay-loam. The majority of sediment is unsorted, but there are also units with alternating bands with well-sorted sandy and silty channel deposits. The basal contacts of the units are often sharp and associated with cobbles and boulders, pointing at their erosive nature.

Typically for the donga fill stratigraphy, former donga walls and cross-sections are still visible in the outcrops. Such nested sediment bodies within the Quaternary succession suggest a cut-and-fill morphology caused by multiple episodes of erosion and deposition in a donga environment. In addition, sedimentary units also show some evidence of earlier soil formation, which is summarised in the Jojosi Pedocomplex, but could not be correlated with sites outside the study area (see Botha 1996). These include two clay-rich palaeosols that are recognisable by calcified root channels (Fig. 3c). Catenal variation in these calcisol profiles is evident from the development of carbonate nodules and a massive hardpan calcrete horizon that grades down into vermicular mottles (Fig. 3d), which indicate soil-forming processes in the subsoil. An earlier study by Botha (1994) provided radiocarbon dates indicating calcrete formation at ~37 and ~28 ka (minimum ages), which correlates with the Dabekazi Pedocomplex occurrences in the surrounding area, although the temporal relationship between the sediment deposition and calcrete formation remains unclear. We aim to answer these stratigraphic questions with further sediment analysis and luminescence dating.

Our observations on recent soil degradation show that donga erosion has transformed much of the study area into badlands. The current dongas reach depths of more than 10 m and are up to 30 m wide. Their cross-section is typically trapezoidal towards the mouth and V-shaped at the headcuts, according to the classification system by Weidelt (1976). In steeper parts, the headcuts no longer exist and the channels fade out onto saprolite or bare bedrock deprived of all sediment and soil cover. The gully drainage channel network was originally dendritic but it has since degraded as erosion has lowered the interfluve ridges, merging them into what Ireland et al.'s (1939) taxonomy defines as an extensive compound system. Where erosion has not yet degraded the land, vertisol is the predominant soil type (Dijkshoorn et al. 2008). This strongly structured soil type is rich in active clay minerals that swell or shrink under humid and arid conditions, forming cracks that make these soils very susceptible to erosion. In addition to the natural factors that facilitated donga erosion during the Quaternary, anthropogenic factors like small-scale crop farming and use as grazing land have driven recent land degradation.

An important observation from the perspective of prehistoric landscape use by humans is a large superficial outcrop of hornfels exposed along the dolerite/siltstone contact about 500 m west of the archaeological focus area (Fig. 3e). The argillaceous rocks were baked and physicochemically altered by contact-metamorphism with the hot igneous intrusions that formed the dolerite. Due to their favourable characteristics for knapping, such outcrops were commonly sought after as sources of raw material during the Stone Age. Heavily patinated artefacts surround this outcrop – including diagnostic MSA pieces like those found within the dongas – and testify to some exploitation of hornfels from this locality, though large parts of the exposure and other outcrops might still be covered by sediments today.

Archaeological fieldwork and preliminary results

Figure 4 shows the survey trails of the two archaeological teams exploring different areas of the donga sediments. In total, the foot surveys covered a distance of 41 km over an area of ~3.5 km². The UAV survey provided high-resolution photogrammetry (up to 1 cm resolution) over the ca. 1 km² of the main study area. Our foot surveys provide important insights into the nature and distribution of archaeological material in the erosional landscape. Discovered artefacts comprised lithics exclusively that were encountered in all parts of the survey area, but with variable frequency and clustering. The southwestern (main study area) and northern parts of the dongas revealed a marked surface spread of stone artefacts within the deeply incised gullies and on interfluve ridges consisting of intact soil-covered terraces. Here, the material can be described as a nearly contiguous scatter of stone tools of various sizes intermixed with (angular) hornfels blocks, sometimes forming pavements of stone flakes several layers deep (Fig. 5). We estimate the number of stone tools >2 cm to go into the millions. Most material is concentrated on a lag deposit on the floor of the erosional gullies with much less archaeological material visible on the profile walls. In contrast, longer reaches to the northeast and east were devoid of material, even in the gullies. The surveys and results are thus most detailed for the southwestern part and coarser for the other areas.

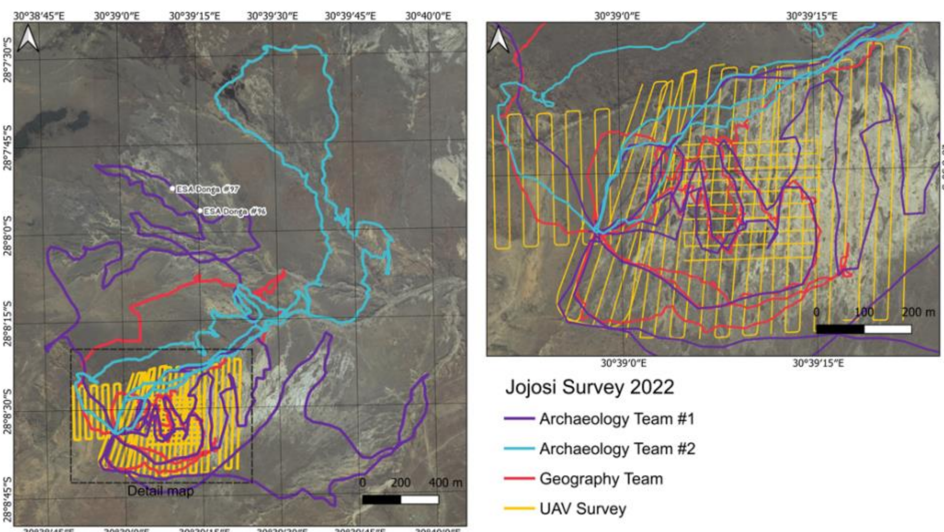

Figure 4. Survey tracks on foot and via UAV in the Jojosi Donga landscape in 2022. The donga area with frequent ESA material in the northern part of the survey area is marked by two dots. The detail map in the southwest shows the main study area of the dongas, where most sites of interest occur (shown in Figure 2).

Regarding the nature of the surface archaeological material, almost all artefacts (>99%) are made from hornfels, which is surprising considering the extensive dolerite outcrop just north of the dongas (Fig. 2). Fresh hornfels features grey, dark-grey and blue-blackish varieties with sharp edges. However, the majority of lithics display post-depositional alteration, with visibly varying stages of surface patination from prolonged exposure to the elements, including ferruginous varnish and light-grey to reddish discoloration (Fig. 5). Artefacts in the gullies with heavy patination display blunted edges and abraded dorsal ridges, but little edge chipping. Hornfels artefacts actively eroding from the donga profiles often feature sharp edges and little to no abrasion. Other encountered raw materials for stone tools include dolerite and rare chert, quartzite and quartz. Well-rounded pebbles or cobbles of quartzite occur sporadically and could represent manuports derived from areas of Dwyka tillite that are exposed several kilometres downstream in the Jojosi Valley. The find-rich areas are most strongly associated with hornfels whereas zones with fewer stone tools to the north and east feature other materials such as quartzite.

Based on a typo-technological reading in the field, the most commonly identifiable artefacts belong to the MSA which can be found almost anywhere in the landscape we surveyed (Fig. 4). We studied a few square metres of two high-density surface concentrations in the main area (GPS points #101 and #103; see Fig. 2) to get a better understanding of their technology (Fig. 5). Here, debitage products including both faceted flakes and blades represent the most frequent find category. They commonly preserve large amounts of cortex and include rejuvenation and preparation products such as core tablets. The blanks are often large, featuring many blades up to 100 mm as a conspicuous element (Fig. 6a). Various types of *Levallois* and platform cores, with prepared platforms for the production of flakes and blades, occur (Fig. 6d). Platform variants (n=22) are more frequent compared to *Levallois* (n=15) and occurred at both localities. Blade platform cores (n=12) outnumber those for flakes (n=10). Reduction usually proceeds unidirectionally on one main removal surface, but bifacial and bidirectional reduction occurs as well. Many cores are large (>100 mm) and discarded in a prepared but non-exhausted state. If present, retouched forms are rare (<1%) including unifacial points (n=3), scrapers (n=1), and laterally retouched blades (n=1; Fig. 6b). The surface material of these selected areas is typical for the main donga, but its nature precludes attribution to specific technocomplexes at this stage of analysis. Bifacial points or backed pieces are missing, suggesting an absence of the Still Bay and Howiesons Poort.

In contrast to the widespread MSA, ESA tools appear rarely and are concentrated in specific areas to the north (see below). While lithic scatters with mostly large flakes devoid of diagnostic core types could be attributed to a macrolithic LSA, the large number of sites exhibiting a clear MSA signal renders this possibility unlikely. We found no obvious LSA record apart from very rare microliths of chert or quartz closer to the river, fitting with the absence of any built structures, pottery, or metal artefacts encountered during our surveys. All in all, the Jojosi landscape is very rich in lithics of the Stone Age, but they reflect particular spatial and temporal patterns.

Based on the ubiquity and density of archaeological material, we decided not to map all individual stone tools or surface concentrations – which would be practically impossible – but focused instead on recording the much rarer material embedded in sediments and specific surface concentrations. Due to the complexity and size of the terrain, we do not claim comprehensiveness for these identifications. Our results showcase the scientific potential of this landscape and the nature of its archaeological occurrences. Moreover, the landscape remains dynamic with ongoing erosion in the area leading to the destruction of *in situ* material in the next decades, while at the same time uncovering evidence of currently invisible find concentrations. In total, our survey documented 22 occurrences (sites) with GPS points, photographs, and additional data recorded in the KoBo Toolbox. Of these sites, n=11 were identified as having stratified material with surface scatters eroding out from these profiles, n=4 as having stratified material without any actively eroding material, n=5 as having interesting surface scatters with special finds, and n=2 as Other. The interesting surface concentrations feature scarce agglomerations of ESA material or fresh hornfels MSA artefacts associated with high amounts of small debitage, indicating on-site knapping and recent erosion from their primary context.

Figure 5. Typical high-density scatters of stone tools encountered during the 2022 survey, within the Jojosi main study area, with the majority of material belonging either to the MSA or being undiagnostic (top). MSA surface concentration #101 with high density of material and fresh hornfels artefacts (bottom).

Stratified archaeological material was commonly identified as a thin stone line visible within the sedimentary profile. From visual inspection, we differentiated between three such occurrences embedded in palaeosols or parent sediments (Fig. 7): 1) *in situ* concentration of artefacts; 2) concentration of stone tools from secondary context; and 3) massive colluvium or lag deposits with accumulation of both artefacts and raw material blocks. Figures 7a and 7b show two of the potential *in situ* concentrations. In the field, we identified them based on the occurrence of a thin lens of exclusively hornfels artefacts including small debitage with fresh edges and grey colour. In n=11 cases, they are associated with a scatter of non-weathered artefacts eroding from right under this horizon, spreading from the steep sidewall until the gully floor. Secondary concentrations had a similar constricted horizontal and vertical appearance within the sedimentary profiles but included weathered hornfels finds, no small debitage and some non-artefactual material, likely deriving from the colluvium substrate

(Fig. 7c). We interpreted these localities as being characterised by the secondary deposition of artefacts after prolonged surface exposure. In two localities closer to the river, we noted massive deposits of large hornfels blocks (>30 cm) mingled with stone tools of different preservation stages, along with other pebbles and cobbles that are natural accumulations (Fig. 7d).

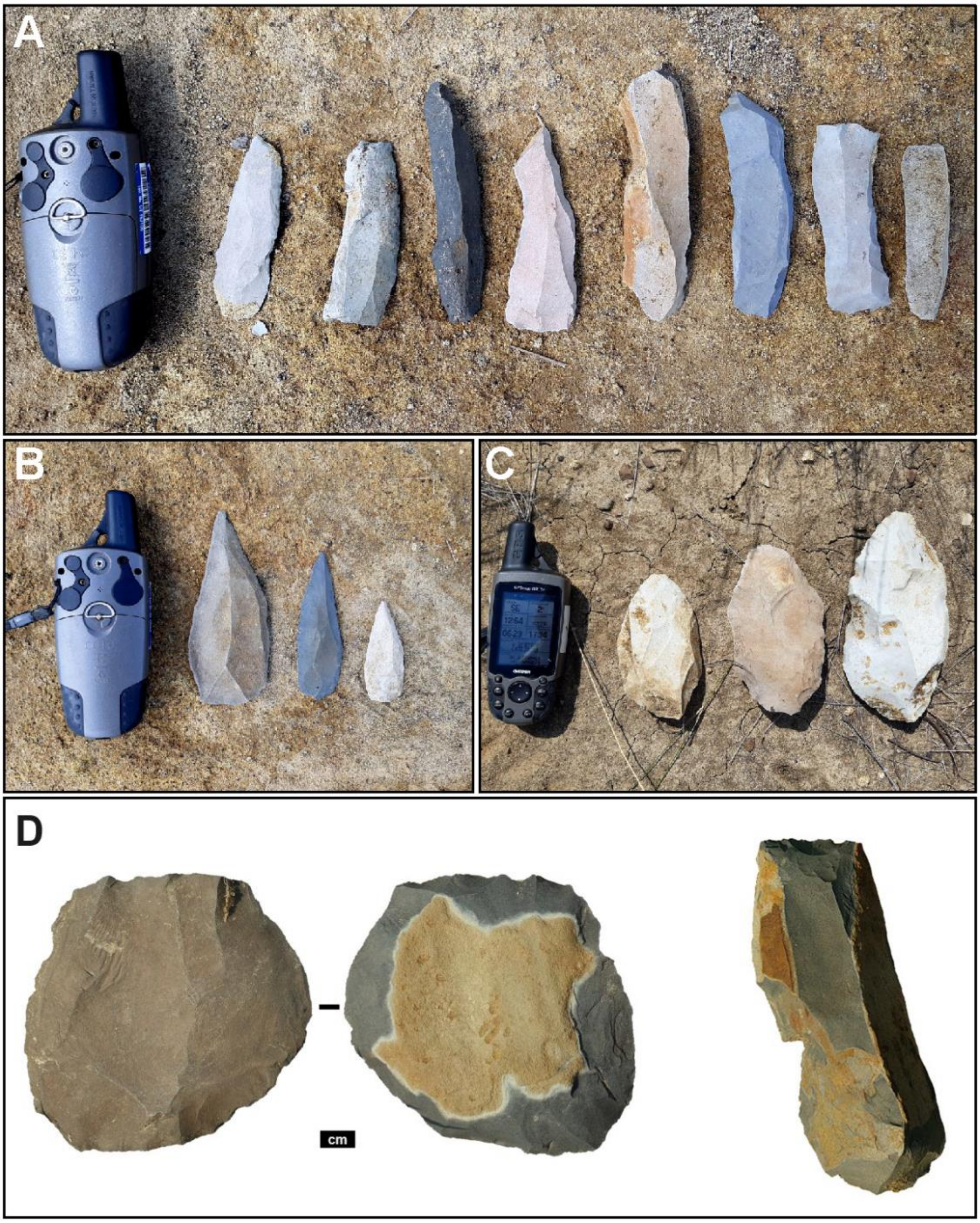

Figure 6. Selection of stone tools from the surface of the Jojosi Dongas with a handheld GPS for scale (height 15.5 cm). Large blades (a) and unifacial points (b) selected from MSA concentrations in the main study area. Handaxes from the ESA surface concentration in the northern part of the dongas (c). Large *Levallois* core (left) and unidirectional blade platform core (view of main removal surface) from surface concentrations #101 and #103 in the main study area (d). All artefacts are made on hornfels. Note the different stages of weathering and discoloration between but also within artefacts (e.g., upper surface of *Levallois* core with patination, lower surface without).

Figure 7. Selection of the three different kinds of material embedded in donga walls during surveys. Potential *in situ* MSA stone lens embedded in a typical primary donga wall (a), with freshly eroding artefacts visible in a close-up view (b). Note the tight cluster of artefacts on top of each other, with a thickness of a few centimetres, the grey colour and fresh edges of the hornfels, and the presence of small debitage. In 2023, this area was named Jojosi 6 and was partly excavated. Secondary stratified MSA hornfels artefacts within the topsoil (c). Note the occurrence of larger and small artefacts, but with the white discoloration of the hornfels. About 1 m thick, massive sheetwash or debris flow of large hornfels blocks and artefacts in the lower part of the donga close to the Jojosi River (d). Handheld GPS as a scale in the lower middle of the picture.

Some individual localities deserve further attention. In the northern part of the donga (purple survey path in Figure 4), find concentrations were generally high with similar carpets of surface MSA lithics compared to the main study area – though with much less stratified material and mostly in a secondary context. One of the dongas in this northern part, however, yielded the largest amount of ESA artefacts including numerous handaxes (Fig. 4). The handaxes are large and thick, mostly on hornfels, and intensively flaked on both sides, producing a variety of forms (Fig. 6c). Inspections of surface material found few picks and no cleavers. Our overall qualitative impression is one of a later Acheulean occurrence. Artefacts in this donga feature much less obvious MSA material and include large flakes (>80 mm) and cores without signs of preparation. While hornfels is still the most frequent rock type, other varieties such as quartzite appear in larger numbers. This northern part likely encompasses much older material and sediment when compared with the southwestern area. So far, we were not able to discern *in situ* concentrations of ESA material in the colluvial sediments, but additional target surveys are planned to understand the Acheulean occupation of this area. The northeastern part of the survey (blue survey path in Figure 4) yielded much less Stone Age material and only a few stratified MSA occurrences, exclusively from secondary context.

Fitting with the general distribution of archaeological surface material, the most interesting stratified occurrences were discovered in the southwestern donga (Figs 3 & 4). We used these findings to demarcate our main study area for the future, providing the basis for the first excavation campaign that took place over three weeks in 2023. It is also the area where initial excavations took place, by Aron Mazel in the 1990s (Jojosi 1-4). Here, MSA material is most abundant, often forming surface pavements in its western and most heavily eroded parts with a reduction in material to the east associated with less intense gullying and a more frequent formation of calcrete crusts. We found n=8 potential *in situ* occurrences of MSA hornfels artefacts in the main area, of which we classified n=3 as a prime target for excavation and another n=3 as high potential. This assessment was based on the clarity of the artefact lenses in the gully walls, the presence of small debitage, and an abundance of non-weathered artefacts in the gully directly below. These instances also feature artefacts eroding from the profiles, marking them as urgent objectives for recovery. We found such lenses clustered in two areas approximately 100 m apart. In one zone, we observed an extremely rich surface concentration of hundreds of fresh MSA hornfels artefacts directly associated with embedded material from which these stone tools were actively eroding (Fig. 8). In the field, one of the co-authors (G.A. Botha) confirmed that this feature was already identified by him during earlier surveys in the 1990s. Photographic evidence (Fig. 8b) demonstrates that these are in fact the same concentrations and that the stratified material has only eroded by a couple of centimetres in the last 30 years. This concentration and the stratified artefacts next to it were ranked as having the highest potential for recovering *in situ* material.

Figure 8. View of archaeological site Jojosi 5 during the 2022 survey. View of the dense surface concentration of actively eroding MSA hornfels artefacts, with fresh edges and grey colour (a). The artefacts erode out of the potential *in situ* lens indicated by a red oval. Photo taken by G.A. Botha during the early 1990s, taken ca. 30 years before the picture to the left, from a slightly different angle (b). Note the same stratified lens of hornfels artefacts in the top right corner (red oval) but with more of the sedimentary overburden still present. Close-up view of the potential *in situ* lens of MSA stone tools (c). Note the tight cluster of artefacts on top of each other, with a thickness of a few centimetres, the grey colour and fresh edges of the hornfels, and the presence of small debitage.

In April 2023, we collected this entire surface scatter (total n=8610; n=5250 pieces <20 mm) at this site, which we named Jojosi 5, and dug the stratified artefacts across ca. 2 m² with a sediment volume of 0.53 m³ (Fig. 9). After removal of the sterile overburden, archaeological material was encountered in two tightly constrained clusters of artefacts. While detailed studies are pending, Table 1 provides an overview of the surface collection and the measured, stratified finds >20 mm (n=246). Apart from three fragments of fossilised bone and teeth, the recovered material features exclusively stone tools indicative of MSA technology, comparable to the studied surface scatters. Like the unstratified lithics, unretouched blanks are most frequent, and small debitage (<2 cm) occurs in large amounts while tools are lacking. Site Jojosi 6 comprises a similar profile concentration noted only ~20 m northwest of this occurrence and likewise freshly eroding (Fig. 8a & 8b). To recover this material before being lost due to natural gully sidewall erosion, this area was targeted for the second excavation in 2023, although we could not finish the recovery of the entire artefact lens in that year. The material recovered from these trenches is currently being analysed and is the subject of a future publication.

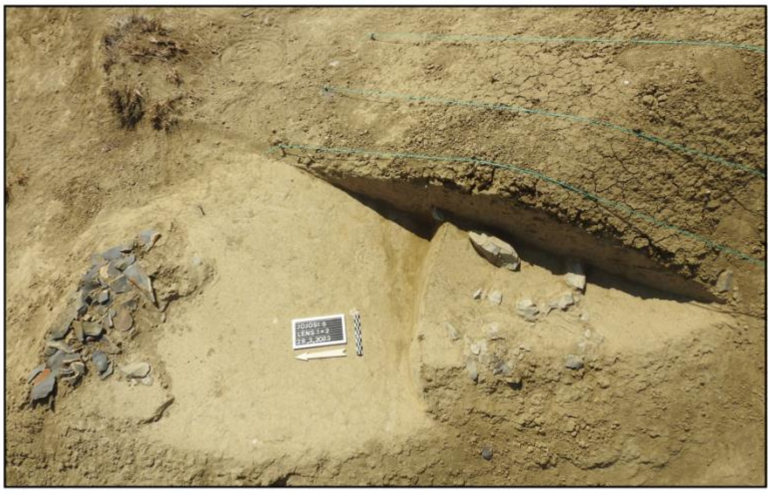

Figure 9. The Jojosi 5 excavation in March 2023 after removal of sediment overburden and with lithics left in place as encountered. Note the tight clustering of finds in two separate areas (lenses) and the exclusive presence of hornfels stone tools. Scale bar on right picture is 10 cm. No artefacts were found further to the east in the sediments.

Table 1. Archaeological material recovered from Jojosi 5, with surface finds derived from a systematic collection (see Fig. 8c). Excavated material recovered from stratified context in 2023 (Fig. 9) includes pieces measured in the field >20 mm as well as debitage <20 mm. Numbers are provisional, pending detailed analyses.

Find category	Surface (n)	Excavation (n)
Blank	2794	237
Core	14	4
Tool	3	-
Hammerstone/manuport	-	2
Small debitage <20 mm	5250	2093
Bone/tooth	-	3

Other work

The 2022 and 2023 campaigns also included an attempt to locate the old excavations of Jojosi 1 by A. Mazel, in addition to obtaining sediment samples for absolute dating, and conducting geographical work. G.H.D. Möller conducted a thorough study of the field notes and photographic documentation (Mazel 1991) to re-establish the location of Jojosi 1, so it could be dated via luminescence methods. These endeavours were supported by aerial reconnaissance with UAVs and a 3D terrain model with an early working version without full contextual information that can be accessed here (https://skfb.ly/oyTSW). Combining these efforts led to the successful relocation of Jojosi 1 in 2023. The lithic material, curated at the KZN Museum in Pietermaritzburg, was then assessed in a Masters Dissertation to revalorise these legacy collections. A qualitative and quantitative attribute analysis and refitting study aimed to understand the integrity of these assemblages and the techno-typological characteristics and underlying processes leading to their formation. The results provide initial insights into MSA landscape use and serve as a reference for further studies to be conducted on the newly excavated archaeological material. Due to their different focus and scale, the results will be published separately.

Our approach to establish geochronological control for the exposed donga sediments focuses on the dual objective of: 1) understanding the age and formation of the complex accretionary sedimentary succession that comprises at least five phases of gully incision and infill; and 2) situating the human occupations therein. We thus initiated comprehensive sediment sampling in various areas of the main study area for dating via luminescence methods. In 2022 and 2023, we took 26 sediment samples for luminescence dating at five locations within the Jojosi Donga catchment. Luminescence samples were either taken in opaque metal tubes or carved out as blocks, with the outer light-exposed material being removed under subdued red light conditions following sampling in the field. We took a series of luminescence samples in the sediment profiles from below, next to, and above the MSA material at Jojosi 1 (n=3) and Jojosi 5 (n=7). At Jojosi 6 (n=2) we bracketed the artefact lens with one sample above and below. Geomorphological samples were collected at two sites: 1) the cut-and-fill profile where four phases of palaeo-gully erosion and infill are exposed (n=5); and 2) a site that displays buried palaeosols within the hillslope deposits (n=8) (Fig. 2). This will allow us to constrain the ages of human activities as finely as possible but also, to understand the processes and rate of sediment accumulation. We also took a modern sample to investigate resetting of the luminescence signal during recent erosional events. This will inform us of the scatter expected in the single-grain luminescence data of the palaeosamples. The OSL dating is being conducted at the Cologne Luminescence Laboratory (CLL) by S. Riedesel. Analyses are currently ongoing and will be published alongside the excavated material. Initial tests demonstrate that the colluvial sediments can be dated using the infrared stimulated luminescence (IRSL) signal of feldspar minerals. Preliminary results support the initial attribution of the recovered stone tools at the excavated sites to the MSA, by constraining the human occupations to the late Middle and earlier Late Pleistocene.

To put Jojosi into a regional geological perspective, we investigated the forms and processes of modern donga erosion in an extended area of around 220 km² north of Nquthu. We used this extended area for our regional inventory and mapped more than 250 dongas and donga systems using current satellite imagery. We then manually categorised them following the six donga types introduced by Ireland et al. (1939). Within this extended study area, compound types are the most prominent with around 50% of the identified dongas consisting of more than one type. Around a quarter of the dongas are classified as dendritic, showing a pattern of several branching tributaries. When looking further at the compound class, the prominent type within compound dongas is again dendritic. In addition to type, we recorded donga activity. Orthophotos were compiled from georectified aerial photographs from 1944, 1956, 1981, and 2005, and current satellite imagery enables evaluating the landscape erosion over 80 years with time intervals of roughly two decades. The vast majority of the localised dongas are assumed to have been active since the first imagery from the 1944 flight campaign. These dongas show visible extension of their area and partial deepening (Fig. 10). Around 30 dongas and donga systems seem to have mainly stabilised within that period as indicated by a lack of gully growth and the presence of stabilising vegetation on previously bare, eroded areas. However, the formation of new dongas is also identifiable. We observed that their formation is likely linked to nearby road construction, with donga growth close to the roads, caused by runoff discharged by drainage pipes under the roads with the new gully expanding at a right angle, or following the course of former foot and cattle paths.

4. Discussion and conclusion

The Stone Age record of southern Africa remains best known from rock shelter and cave sites, despite the established importance of open landscapes for people with a hunter-gatherer lifestyle. Recent research efforts in the Western Cape, Northern Cape, and Free State underscore the importance and feasibility of open-air work (Sampson et al. 2015; Hallinan & Parkington 2017; Mackay et al. 2018; Shaw et al. 2019; Ecker et al. 2021; Hallinan 2022; Wroth et al. 2022; Bousman et al. 2023a, b). Until today, however, no comparable studies have been undertaken in KZN. Yet, the archaeological literature of the last 140 years, museum databases, and curated collections all testify to the presence and early recognition of open-air Stone Age material in the region (Feilden 1884; Lebzelter 1930; van Riet Lowe 1947; Malan 1948; Davies 1949, 1951). This previous work led us towards the dongas of central KZN. From a geographical and geological perspective, dongas have been well-studied and remain a focus of current research. Early collaboration of geologists (G.A. Botha) and archaeologists (A. Mazel) demonstrated the potential of one particular donga landscape in the Jojosi Valley, though the results were never published. The new interdisciplinary project in the Jojosi Dongas near Nquthu, introduced here, has the potential to provide unique information on the spatial patterning of the Stone Age record in KZN, facilitating a landscape-scale assessment of human behaviour. Starting with a renewed aerial and foot survey at Jojosi, we could confirm the wide extent of this specific land formation and its high archaeological potential. The land surface features ample traces of human occupation during the ESA and MSA, although not the LSA, as well as stratified MSA material in the donga profiles at about a dozen sites.

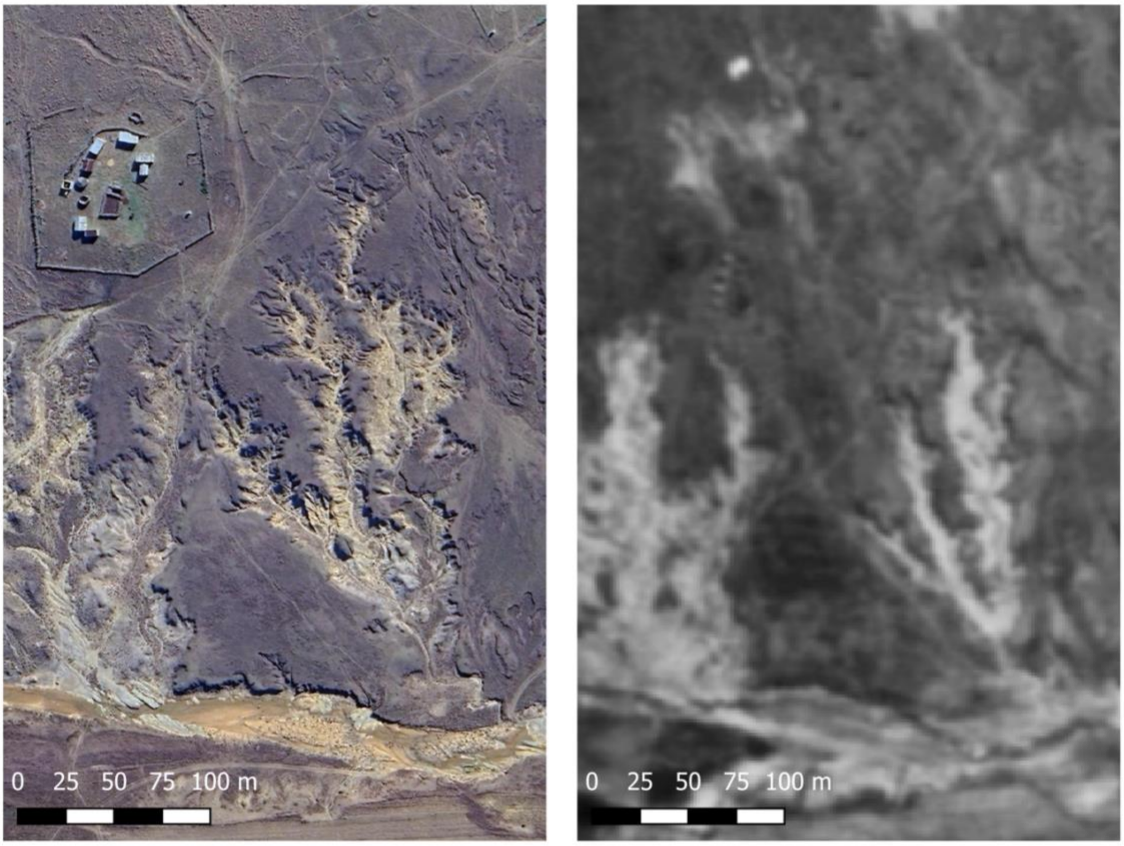

Figure 10. Extension of a dendritic donga at Magongoloza River identified from recent satellite imagery (left) (Google Maps/Airbus/Maxar) and a historical orthophoto from 1944 (right) (National Geo-spatial Information [NGI]).

Stone Age landscapes at Jojosi: spatial patterns and behavioural interpretations
The preliminary results here allow us to provide some summary statements on the surface archaeology and have further stimulated some initial hypotheses on spatial patterns, human behaviour and site use. Analyses of the excavated MSA material and the re-examination of Jojosi 1 will allow us to test these working hypotheses. The Jojosi Dongas comprise a dynamic landscape with complex archaeological signatures from multiple periods of occupation. As such, they provide rare insights into landscape-scale variation in hominin behaviour. We noted a non-uniform distribution of surface material throughout the erosional landscape. Although MSA material is by far the most widely spread throughout the landscape, concentrations vary and in some cases are completely absent, while other areas yield a strong ESA

signal. The MSA signal is strongest near the known outcrop of hornfels and south of the Jojosi River, whereas the ESA material appears some distance from this source and the river (Figs 2 & 4). Individual surface concentrations of fresh MSA material appear variable in constitution and technology. Rare LSA lithics were found closest to the current river. Understanding what drives this intra-landscape structure will be important when research proceeds on a larger scale. Potential causes behind these patterns may relate to diachronic differences and site use, but also the complex formation processes of the landscape and potential environmental change. As emphasised throughout this article, understanding the archaeology and behaviours at these sites requires an in-depth understanding of the overall landscape geomorphology but also, of site-specific contexts concerning sedimentary accretion and intact burial processes for the material embedded in sediments. The accretionary sedimentary succession accumulated through periodic gully incision, followed by sedimentary infill by sediment eroded from upslope. The fact that this landscape was unstable for long periods may at times have been an impediment to human occupations, although this was likely outbalanced by its attractive source of hornfels and the availability of perennial water.

MSA stone tools predominate the dongas and particularly our main study area. Yet, the material deviates in some important aspects from the well-known MSA archaeology of KZN sites, such as Sibhudu, Border Cave, Umbeli Belli, and Umhlatuzana (e.g., Will et al. 2014; Bader et al. 2015; Bader et. al. 2018; Sifogeorgaki et al. 2020; Backwell et al. 2022). Most conspicuously, the surface material differs from these sheltered sites in the almost exclusive use of hornfels, along with artefacts being predominated by debitage products. These artefacts are often large, include numerous long blades, and bear large proportions of cortex. In contrast to sheltered sites, cores feature more frequently at Jojosi whereas retouched pieces are rare. Modification is predominantly minimal, with the most identifiable pieces being unifacial points. All these characteristics render attributions to specific technocomplexes (Lombard et al. 2012, 2022) difficult. We did not observe any backed pieces or bifacial points attributable to the Howiesons Poort and Still Bay. An absence of these technocomplexes was also noted in the open-air sites of the Free State (e.g., Wroth et al. 2022), whereas the Western Cape sites generally lack Howiesons Poort but feature Still Bay occupations (Kandel & Conard 2012; Mackay 2016; Hallinan & Parkington 2017; Shaw et al. 2019).

Why are the assemblages so different from the known record of rock shelter and cave sites in KZN? Do they offer unique insights on human behaviour only available from an open-air setting? We propose three hypotheses: 1) temporal: Jojosi features MSA occupations that date to a different period – likely earlier – than the record in sheltered sites, which is mostly known from the Late Pleistocene; 2) ecological and spatial: the area around Jojosi is far removed from known sites to the north and south and is located in a different biome, with a so-far unknown archaeological signal and/or inciting different behavioural adaptations; and 3) functional: the site use of Jojosi differs from known sheltered sites based on its specific location in the wider landscape and the association with large outcrops of hornfels. While not mutually exclusive, these interpretations are closely connected to the question of the natural and cultural factors that led humans to choose this particular place on the landscape repeatedly (see e.g., Tryon et al. 2014 for the eastern African MSA). We currently favour a functional interpretation for Jojosi based on the large amounts of primary high-quality hornfels in the area and the nature of the archaeological material. Accordingly, the Jojosi landscape would reflect a specialised MSA quarry or provisioning site for acquiring hornfels. We would thus expect the stratified artefact concentrations to correspond to *in situ* knapping spots or workshops of MSA people reducing large blocks of hornfels found in the landscape or made accessible by erosion. This can be tested via dedicated refitting studies. Additional studies will need to test in what ways the temporal, geographical, and ecological factors influenced site occupation and assemblage composition.

The Jojosi Dongas in context: site integrity and regional comparisons

In addition to the ubiquitous surface archaeology at Jojosi, we also encountered multiple concentrations of stone tools within the sediment bodies. Are these stratified MSA occurrences time-averaged palimpsests due to complex post-depositional processes, or do they represent *in situ* short-term and contemporaneous activities in discrete zones (i.e., living floors; see e.g., Bailey 2007; Malinsky-Buller et al. 2011)? Our work supports previous observations by Mazel that these assemblages occur in narrow lenses within the sediment body and encompass artefacts of all sizes down to a millimetre. The sediment units hosting the archaeological finds are stratified layers of sandy clay-loam texture, suggesting steady and uninterrupted accretion under a low-energy sheetwash sediment transport environment. Occasional lenses of loamy sand with a thickness of <5 cm elsewhere in the unit indicate a low degree of sorting by flowing water. We currently interpret the formation of this sediment unit surrounding the artefact lens as a series of palaeo-donga infill deposits that accumulated during a transitional phase leading to periods of relative landscape stability. Such a scenario allows for a high resolution and integrity of buried MSA knapping floors that fits with initial observations on the excavated lithic assemblages. We aim to test these hypotheses based on complete analytical data from Jojosi 1, 5 and 6, for the latter two also including recorded 3D data on the dips and inclinations of artefacts.

How do these initial observations of MSA open-air surface archaeology at Jojosi compare with recent findings in other areas of South Africa? While a complete assessment will have to wait for the detailed lithic, geological and geochronological data, we note both similarities and important differences. The large-scale study of human activities along the alluvial river terraces of the Doring River in the Western Cape found numerous spatio-temporally constrained open-air occupations of the MSA and LSA in proximity to freshwater and raw material sources (Mackay 2018; Shaw et al. 2019). In contrast to the surface finds of Jojosi, the Doring River sites feature large numbers of retouched elements and diagnostic pieces from technocomplexes such as the Still Bay and later phases of the MSA and LSA, reflecting repeated occupations and multiple activities in fluvial settings rich in diverse rock types. The findings from the Lovedale Donga in the Free State, albeit located in a comparable geomorphological setting of stratified deposits exposed in erosional gullies, differ in yet another aspect. Excavations here found typologically distinct implements from chrono-cultural stages post-dating MIS 5, with MSA humans using these sites for task-specific occupations such as hunting stations in open-air, fluvial wetland environments (Wroth et al. 2022). Being of a potentially similar site function as Jojosi, Swartkop Hill in the Namaqualand region (van der Ryst & Küsel 2013) constitutes a rare case study assessing the distinct technological characteristics of MSA quarrying activities. The site features broadly comparable traces of primary raw material reduction to Jojosi, but the lithic assemblages represent (secondary) artefact scatters of prolonged surface exposure that are loosely associated with later phases of the MSA based on typological comparisons. These assemblages also come from different, highly variable lithological zones around a landmark hill feature that attracted repeated visits. For now, our initial work suggests that the MSA lithic material of Jojosi is marked by a unique combination of archaeological and geological characteristics that complement the composition of its lithic assemblages, likely related to a specialised site function of raw material quarrying and primary processing. A comparison with well-known quarry sites of similar ages in other areas of Africa, such as for chert in Egypt (e.g., van Peer et al. 2010), will provide additional avenues for understanding Jojosi.

Future work in the Jojosi Dongas

Many questions remain about landscape formation, the archaeological record, and human behaviour in the Jojosi Dongas. Much of this work is ongoing or planned for the coming years. Additional excavation is required to better grasp the nature of the archaeological record but also its intra-landscape structure. Key areas for excavation concern the stratified MSA artefacts and associated surface concentrations spotted close to Jojosi 5 and 6. Detailed assessments of the recovered lithics will be based on quantitative attributes but also techno-typological, refitting, and use-wear studies. These analyses will be crucial to reconstruct MSA technological behaviours and verify site functions based on the nature, composition, and use of the assemblages (e.g., for comparison see van Peer et al. 2010; Ekshtain et al. 2012; Bisson et al. 2014; Gopher & Barkai 2014). Through refitting we can also support the integrity of some of our identified surface concentrations and establish direct connections between stratified material and recently eroded artefacts on the surface (e.g., Foley et al. 2017). In addition, we intend to explore the reasons for the potential absence of LSA material while also assessing the present ESA record with additional surveys in the parts of the dongas with abundant handaxes, to try to locate *in situ* material. If successful, this would render Jojosi the first stratified ESA site in the KZN province. Here we note an interesting parallel to ESA quarry sites for hornfels in the Karoo (Sampson et al. 2015) and the site of Smaldeel 3, in the flood basin of the Gariep Dam, which Sampson (2006) describes as an

Acheulean hornfels quarry where large blanks were produced but mostly lacked handaxes or even preforms.

In terms of methodology, we plan to add further geoscientific methods to the area (e.g., soil geochemistry, near-infrared soil spectroscopy) and compare the timing of gullied landscape formation and sediment accretion to other dongas in the area (e.g., the reference profile at St. Pauls). A study of recent donga erosion using an inventory of donga types will complement the assessment of landscape activity derived from remote sensing sources. The assessment of erosion rates from UAV-based structure-from-motion can help to understand both past changes but also ongoing erosion that impacts the quality of landscapes and traditional land-use dynamics with regards to changes in soil quality, farmland, and pasture (Le Roux et al. 2020; Olivier et al. 2023). Another relevant aspect of future work will lie in the sourcing and geochemical tracing of hornfels in the study area, both of natural outcrops and artefacts (for South Africa see, e.g., Jarvis 2000; Sampson 2006; Sifogeorgaki et al. 2023), to understand patterns of raw material transport and circulation in KZN more generally.

On a more theoretical level, we intend to embed the findings into the perspective of the potential long-term effects of Pleistocene human niche construction. Here we will focus on the effects on local landscapes, resource distributions, and behavioural trajectories (Boivin et al. 2016; Hussain & Will 2021; Roebroeks et al. 2021; Thompson et al. 2021; Stock et al. 2023). The Jojosi Dongas will be an excellent case study for such ideas as it provides evidence of a constructed lithic landscape (see Foley & Lahr 2015; Pope 2017) whose appearance and structure have been strongly modified by human agency. Repeated human visits and material input over time led to the re-distribution of raw material from natural outcrops into the landscape, likely entrenching this area in a wider settlement system (Haas & Kuhn 2019; Hussain & Will 2021). The Jojosi Dongas can provide an ideal testing ground for the application of interdisciplinary methods and theories to answer questions about behavioural adaptations and the material culture of early modern humans in the framework of changing landscapes in understudied open-air contexts in southern Africa.

Acknowledgements

We like to express our gratitude toward Morena Molefe of Batlokoa Ba Molefe and the Tribal Council for granting us permission to do the research in their traditional authority area and for their ongoing support of our work. We are indebted to Gavin Whitelaw and the staff of the KZN Museum in Pietermaritzburg for their constant help in accessing literature and collections and for providing working space. We thank A. Mazel for productive exchange on the original excavations and his endorsement of our new work at Jojosi. The team acknowledges the manifold contributions to the field surveys by Leah Böttger in 2022. The project is funded by the Deutsche Forschungsgemeinschaft (grant number WI 4978/3-1) and the Heidelberg Academy of Sciences and Humanities in the context of the research project "The Role of Culture in Early Expansions of Humans".

Supplementary online material

Will et al. Supplementary Online Material File 1

References

Backwell, L., Wadley, L., d'Errico, F., et al. 2022. Border Cave: A 227,000-year-old archive from the southern African interior. Quaternary Science Reviews, 291: 107597. https://doi.org/10.1016/j.quascirev.2022.107597

Bader, G.D., Tribolo, C. & Conard, N.J. 2018. A return to Umbeli Belli: New insights of recent excavations and implications for the final MSA of eastern South Africa. Journal of Archaeological Science: Reports, 21: 733-757. https://doi.org/10.1016/j.jasrep.2018.08.043

Bader, G.D. & Will, M. 2017. Recent research on the MSA in KwaZulu-Natal, South Africa. Mitteilungen der Gesellschaft für Urgeschichte, 26: 53-82.

Bailey, G. 2007. Time perspectives, palimpsests and the archaeology of time. Journal of Anthropological Archaeology, 26: 198-223. https://doi.org/10.1016/j.jaa.2006.08.002

Berger, L.R. & Parkington, J.E. 1995. Brief communication: A new Pleistocene hominid-bearing locality at Hoedjiespunt, South Africa. American Journal of Physical Anthropology, 98: 601-609. https://doi.org/10.1002/ajpa.1330980415

Binford, L.R. 2001. Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Hunter-gatherer and Environmental Data Sets. Berkeley: University of California Press.
Bisson, M.S., Nowell, A., Cordova, C., et al. 2014. Dissecting palimpsests in a Late Lower and Middle Paleolithic flint acquisition site on the Madaba Plateau, Jordan. Quaternary International, 331: 74-94. https://doi.org/10.1016/j.quaint.2013.05.031
Boardman, J., Hoffman, M.T., Holmes, P.J., et al. 2012. Soil erosion and land degradation. In: Holmes, P. & Meadows, M. (eds) Southern African Geomorphology: Recent Trends and New Directions: 307-328. Bloemfontein: Sun Press.
Boivin, N.L., Zeder, M.A., Fuller, D.Q., et al. 2016. Ecological consequences of human niche construction: Examining long-term anthropogenic shaping of global species distributions. Proceedings of the National Academy of Sciences of the United States of America, 113: 6388-6396. https://doi.org/10.1073/pnas.1525200113
Bosino, A., Bernini, A., Botha, G.A., et al. 2021. Geomorphology of the upper Mkhomazi River basin, KwaZulu-Natal, South Africa, with emphasis on late Pleistocene colluvial deposits. Journal of Maps, 17: 5-16. https://doi.org/10.1080/17445647.2020.1790435
Botha, G.A. 1996. The Geology and Palaeopedology of Late Quaternary Colluvial Sediments in Northern Kwazulu Natal (Memoir of the Geological Survey of South Africa, Volume 83). Pretoria: Council for Geoscience.
Botha, G.A. & Fedoroff, N. 1995. Palaeosols in Late Quaternary colluvium, northern KwaZulu-Natal, South Africa. Journal of African Earth Sciences, 21: 291-311. https://doi.org/10.1016/0899-5362(95)00072-2
Botha, G.A., Scott, L., Vogel, J.C., et al. 1992. Palaeosols and palaeoenvironments during the Late Pleistocene Hypothermal in northern Natal. South African Journal of Science, 88: 508-512. https://journals.co.za/doi/pdf/10.10520/AJA00382353_9916
Botha, G.A., Temme, A.J. & Singh, R.G. 2016. Colluvial deposits and slope instability. In: Knight, J. & Grab, S.W. (eds) Quaternary Environmental Change in Southern Africa: 137-152. Cambridge: Cambridge University Press.
Botha, G.A., Wintle, A.G. & Vogel, J.C. 1994. Episodic late quaternary palaeogully erosion in northern KwaZulu-Natal, South Africa. Catena, 23: 327-340. https://doi.org/10.1016/0341-8162(94)90076-0
Bousman, B., Brink, J., Rossouw, L., et al. 2023. Erfkroon, South Africa. In: Beyin, A., Wright, D.K., Wilkins, J., et al. (eds) Handbook of Pleistocene Archaeology of Africa: Hominin Behavior, Geography, and Chronology: 1431-1450. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-20290-2_92
Bousman, B., Codron, D., Gowlett, J., et al. 2023. Cornelia-Uitzoek, South Africa. In: Beyin, A., Wright, D.K., Wilkins, J., et al. (eds) Handbook of Pleistocene Archaeology of Africa : Hominin Behavior, Geography, and Chronology: 1327-1347. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-20290-2_86
Braun, D.R., Levin, N.E., Stynder, D., et al. 2013. Mid-Pleistocene Hominin occupation at Elandsfontein, Western Cape, South Africa. Quaternary Science Reviews, 82: 145-166. https://doi.org/10.1016/j.quascirev.2013.09.027
Clarke, M., Vogel, J., Botha, G., et al. 2003. Late Quaternary hillslope evolution recorded in eastern South African colluvial badlands. Palaeogeography, Palaeoclimatology, Palaeoecology, 197: 199-212. https://doi.org/10.1016/S0031-0182(03)00461-9
Colarossi, D., Duller, G., Roberts, H.M., et al. 2020. A comparison of multiple luminescence chronometers at Voordrag, South Africa. Quaternary Geochronology, 60: 101094. https://doi.org/10.1016/j.quageo.2020.101094
Collins, E.R. & Smith, R.A. 1915. Stone implements from South African gravels. The Journal of the Royal Anthropological Institute of Great Britain and Ireland, 45: 79-91. https://doi.org/10.2307/2843388
Conard, N.J. 2001. Settlement Dynamics of the Middle Paleolithic and Middle Stone Age (Tübingen Publications in Prehistory). Tübingen: Kerns.
Conradie, D.C.U. 2012 South Africa's Climatic Zones: Today, Tomorrow. International Green Building Conference and Exhibition: Future trends and issues impacting on the built environment, July 25-26, Sandton, South Africa. Available from: https://researchspace.csir.co.za/dspace/handle/10204/6064 (Accessed: 2023).
de Ruiter, D.J., Churchill, S.E., Brophy, J.K., et al. 2011. Regional survey of Middle Stone Age fossil vertebrate deposits in the Virginia-Theunissen area of the Free State, South Africa. Navorsinge van die Nasionale Museum Bloemfontein, 27(1): 1-20.
Davies, O. 1949. Notes from Natal. The South African Archaeological Bulletin, 4: 87-94. https://doi.org/10.2307/3886426
Davies, O. 1951. Notes from Natal. The South African Archaeological Bulletin, 6: 112-115. https://doi.org/10.2307/3886806

Department of Environment, Forestry and Fisheries (DEFF) 2020. South African National Landcover 2020. Available from: https://egis.environment.gov.za/sa_national_land_cover_datasets (Accessed: 2024).
d'Errico, F., Henshilwood, C., Vanhaeren, M., et al. 2005. *Nassarius kraussianus* shell beads from Blombos Cave: Evidence for symbolic behaviour in the Middle Stone Age. Journal of Human Evolution, 48: 3-24. https://doi.org/10.1016/j.jhevol.2004.09.002
Dibble, H.L. & McPherron, S.P. 1988. On the computerization of archaeological projects. Journal of Field Archaeology, 15: 431-440. https://doi.org/10.1179/jfa.1988.15.4.431
Dijkshoorn, J.A., van Engelen, V.W.P. & Hunting, J.R.M. 2008. Global assessment of land degradation. Soil and landform properties for LADA partner countries (Argentina, China, Cuba, Senegal and The Gambia, South Africa and Tunisia). Unpublished report compiled for World Soil Information (ISRIC) and the Food and Agriculture Organization of the United Nations (FAO), ISRIC report 2008/06 and GLADA report 2008/03: 1-23. Available from: https://www.isric.org/documents/document-type/isric-report-200806-glada-report-200803-global-assessment-land-degradation
Ecker, M., Bank, C-G., Chazan, M., et al. 2021. Revisiting Pniel 6: The 2017-2019 excavations. The South African Archaeological Bulletin, 76(214): 57-69. https://www.jstor.org/stable/27086147
Ekshtain, R., Barzilai, O., Inbar, M., et al. 2011. Givat Rabi East. A new Middle Paleolithic knapping site in the lower Galilee (Israel). Paléo, 37: 107-122. https://doi.org/10.3406/paleo.2011.5426
Feilden, H.W. 1884. Notes on stone implements from South Africa. The Journal of the Anthropological Institute of Great Britain and Ireland, 13: 162. https://doi.org/10.2307/2841721
Foley, E., Spry, C. & Stern, N. 2017. Establishing the integrity and stratigraphic origin of stone artefact scatters on the surface of the Lake Mungo lunette in south-eastern Australia. Journal of Archaeological Science: Reports, 13: 547-557. https://doi.org/10.1016/j.jasrep.2017.05.002
Foley, R.A. 1981. Off-site archaeology: An alternative approach for the short-sited. In: Hodder, I., Isaac, G. & Hammond, N. (eds) Pattern of the Past: Studies in Honour of David Clarke: 157-183. Cambridge: Cambridge University Press.
Foley, R.A. & Lahr, M.M. 2015. Lithic landscapes: Early human impact from stone tool production on the central Saharan environment. PLoS ONE, 10: e0116482. https://doi.org/10.1371/journal.pone.0116482
Gamble, C. & Porr, M. 2005. The Hominid Individual in Context: Archaeological Investigations of Lower and Middle Palaeolithic Landscapes, Locales and Artefacts. London: Routledge.
Goodwin, A.J.H. 1928. The archaeology of the Vaal River gravels. Transactions of the Royal Society of South Africa, 16: 77-102. https://doi.org/10.1080/00359192809519659
Gopher, A. & Barkai, R. 2014. Middle Paleolithic open-air industrial areas in the Galilee, Israel: The challenging study of flint extraction and reduction complexes. Quaternary International, 331: 95-102. https://doi.org/10.1016/j.quaint.2013.08.025
Goren-Inbar, N. & Sharon, G. (eds) 2006. Axe Age: Acheulian Tool-making from Quarry to Discard. London: Equinox.
Gould, R.A. 1968. Living archaeology: The Ngatatjara of Western Australia. Southwestern Journal of Anthropology, 24(2): 101-122. https://www.jstor.org/stable/3629417
Haas, R. & Kuhn, S.L. 2019. Forager mobility in constructed environments. Current Anthropology, 60: 499-535. https://doi.org/10.1086/704710
Hallinan, E. 2022. “A survey of surveys” revisited: Current approaches to landscape and surface archaeology in southern Africa. African Archaeological Review, 39: 79-111. https://doi.org/10.1007/s10437-021-09469-z
Hallinan, E. & Parkington, J. 2017. Stone Age landscape use in the Olifants River Valley, Clanwilliam, Western Cape, South Africa. Azania: Archaeological Research in Africa, 52: 324-372. https://doi.org/10.1080/0067270X.2017.1365438
Henshilwood, C.S. 2012. Late Pleistocene techno-traditions in southern Africa: A review of the Still Bay and Howiesons Poort, c. 75-59 ka. Journal of World Prehistory, 25: 205-237. https://doi.org/10.1007/s10963-012-9060-3
Huntley, D.J., Godfrey-Smith, D.I. & Thewalt, M.L.W. 1985. Optical dating of sediments. Nature, 313: 105-107. https://doi.org/10.1038/313105a0
Hussain, S.T. & Will, M. 2021. Materiality, agency and evolution of lithic technology: An integrated perspective for Palaeolithic archaeology. Journal of Archaeological Method and Theory, 28: 617-670. https://doi.org/10.1007/s10816-020-09483-6
Hütt, G., Jaek, I. & Tchonka, J. 1988. Optical dating: K-feldspars optical response stimulation spectra. Quaternary Science Reviews, 7: 381-385. https://doi.org/10.1016/0277-3791(88)90033-9
Ireland, H.A., Sharpe, C.F.S. & Eargle, D.H. 1939. Principles of gully erosion in the Piedmont of South Carolina. Technical Bulletin, United States Department of Agriculture, 633: 1-143.
Isaac, G. 1981. Stone Age visiting cards: Approaches to the study of early land use patterns. In Hodder, I., Isaac, G. & Hammond, N. (eds) Pattern of the Past: Studies in Honour of David Clarke: 131-155). Cambridge:

Cambridge University Press.
Jarvis, W.H. 2000. Lithic sourcing and the detection of territoriality among Later Stone Age hunter-gatherers in South Africa. Doctoral Thesis. Buffalo: State University of New York at Buffalo.
Johnson, J.P. 1907. The Stone Implements of South Africa. London: Longmans, Green.
Kandel, A.W. & Conard, N.J. 2012. Settlement patterns during the Earlier and Middle Stone Age around Langebaan Lagoon, Western Cape (South Africa). Quaternary International, 270: 15-29. https://doi.org/10.1016/j.quaint.2011.06.038
Kandel, A.W., Dietl, H. & Conard, N.J. 2005. Middle Stone Age settlement and land use at the open-air sites Geelbek and Anyskop, South Africa. Journal of African Archaeology, 3: 231-242. https://doi.org/10.3213/1612-1651-10052
Karlin, C. & Julien, M. 2019. An autumn at Pincevent (Seine-et-Marne, France): Refitting for an ethnographic approach of a Magdalenian settlement. Archaeological and Anthropological Sciences, 11: 4437-4465. https://doi.org/10.1007/s12520-019-00860-1
Keen-Zebert, A., Tooth, S., Rodnight, H., et al. 2013. Late Quaternary floodplain reworking and the preservation of alluvial sedimentary archives in unconfined and confined river valleys in the eastern interior of South Africa. Geomorphology, 185: 54-66. https://doi.org/10.1016/j.geomorph.2012.12.004
Kelly, R.L. 2013. The Lifeways of Hunter-Gatherers: The Foraging Spectrum. Cambridge: Cambridge University Press.
Kindermann, K., Kehl, M., Hauck, T., et al. 2018. Inside – outside: Integrating cave and open-air archives. Quaternary International, 485: 1-3. https://doi.org/10.1016/j.quaint.2018.06.001
Klein, R.G. 1978. The fauna and overall interpretation of the “Cutting 10” Acheulean site at Elandsfontein (Hopefield), Southwestern Cape Province, South Africa. Quaternary Research, 10: 69-83. https://doi.org/10.1016/0033-5894(78)90014-5
Kuman, K. & Gibbon, R. J. 2018. The Rietputs 15 site and early Acheulean in South Africa. Quaternary International, 480: 4-15. https://doi.org/10.1016/j.quaint.2016.12.031
Le Roux, J. J. & van der Waal, B. 2020. Gully erosion susceptibility modelling to support avoided degradation planning. South African Geographic Journal, 102(3): 406-420. https://doi.org/10.1080/03736245.2020.1786444
Le Tensorer, J-M., Jagher, R., Rentzel, P., et al. 2007. Long-term site formation processes at the natural springs Nadaouiyeh and Hummal in the El Kowm Oasis, Central Syria. Geoarchaeology, 22: 621-640. https://doi.org/10.1002/gea.20177
Leader, G. M., Kuman, K., Gibbon, R. J., et al. 2018. Early Acheulean organised core knapping strategies ca. 1.3 Ma at Rietputs 15, Northern Cape Province, South Africa. Quaternary International, 480: 16-28. https://doi.org/10.1016/j.quaint.2016.08.046
Lebzelter, V. 1930. Die Vorgeschichte von Süd- und Südwestafrika: Wissenschaftliche Ergebnisse einer Forschungsreise nach Süd- und Südwestafrika in den Jahren 1926-1928. Leipzig: Karl W. Hiersemann.
Lebzelter, V. & Schmidt, P.W. 1926. Eine expedition zur umfassenden Erforschung der Buschmänner in Südafrika. Anthropos, 21(5/6): 952-958.
Lombard, M., Bradfield, J., Caruana, M., et al. 2022. The Southern African Stone Age sequence updated (II). The South African Archaeological Bulletin, 77: 172-212. https://www.jstor.org/stable/27200587
Lombard, M., Wadley, L., Deacon, J., et al. 2012. South African and Lesotho Stone Age sequence updated. The South African Archaeological Bulletin, 67(195): 123-144. https://www.jstor.org/stable/23631399
Lyons, R., Tooth, S. & Duller, G.A.T. 2013. Chronology and controls of donga (gully) formation in the upper Blood River catchment, KwaZulu-Natal, South Africa: Evidence for a climatic driver of erosion. The Holocene, 23: 1875-1887. https://doi.org/10.1177/0959683613508157
Lyons, R., Tooth, S. & Duller, G.A.T. 2014. Late Quaternary climatic changes revealed by luminescence dating, mineral magnetism and diffuse reflectance spectroscopy of river terrace palaeosols: A new form of geoproxy data for the southern African interior. Quaternary Science Reviews, 95: 43-59. https://doi.org/10.1016/j.quascirev.2014.04.021
Mackay, A. 2016. Three arcs: Observations on the archaeology of the Elands Bay and northern Cederberg landscapes. Southern African Humanities, 29(1): 1-15. https://hdl.handle.net/10520/EJC-55bb97862
Mackay, A., Hallinan, E. & Steele, T.E. 2018. Provisioning responses to environmental change in South Africa's winter rainfall zone: MIS 5-2. In: Robinson, E. & Sellet, F. (eds) Lithic Technological Organization and Paleoenvironmental Change: 13-36. Cham: Springer. https://doi.org/10.1007/978-3-319-64407-3_2
Malan, B.D. 1948. New Middle Stone Age sites near Utrecht, Natal. The South African Archaeological Bulletin, 3: 89-95. https://doi.org/10.2307/3887241
Malinsky-Buller, A., Hovers, E. & Marder, O. 2011. Making time: ‘Living floors’, ‘palimpsests’ and site formation processes – a perspective from the open-air Lower Paleolithic site of Revadim Quarry, Israel. Journal of Anthropological Archaeology, 30: 89-101. https://doi.org/10.1016/j.jaa.2010.11.002
Mararakanye, N. & Le Roux, J.J. 2012. Gully location mapping at a national scale for South Africa. South African

Geographical Journal, 94: 208-218. https://doi.org/10.1080/03736245.2012.742786
Mazel, A.D. 1991. Excavation diary of the excavations at the Jojosi dongas. Unpublished report compiled for the Natal Museum Pietermaritzburg.
Mazel, A.D. 1996. Maqonqo Shelter: The excavation of Holocene deposits in the eastern Biggarsberg, Thukela Basin, South Africa. Southern African Humanities, 8: 1-39. https://www.sahumanities.org/index.php/sah/article/view/287
McPherron, S.P. & Dibble, H.L. 2007. Artifact orientations from total station proveniences. In: Figueiredo, A. & Velho, G. (eds) The World is in Your Eyes – CAA2005 – Computer Applications and Quantitative Methods in Archaeology: Proceedings of the 33rd Conference, Tomar, March 2005: 161-166. Tomar: CAAPortugal.
Mucina, L. & Rutherford, M.C. 2006. The Vegetation of South Africa, Lesotho and Swaziland (Strelitzia, Volume 19). Pretoria: South African National Biodiversity Institute.
Oestmo, S., Schoville, B.J., Wilkins, J., et al. 2014. A Middle Stone Age paleoscape near the Pinnacle Point caves, Vleesbaai, South Africa. Quaternary International, 350: 147-168. https://doi.org/10.1016/j.quaint.2014.07.043
Olivier, G., van de Wiel, M.J. & Clercq, W.P. 2023. Intersecting views of gully erosion in South Africa. Earth Surface Processes and Landforms, 48: 119-142. https://doi.org/10.1002/esp.5525
Partridge, T.C., Dollar, E., Moolman, J., et al. 2010. The geomorphic provinces of South Africa, Lesotho and Swaziland: A physiographic subdivision for earth and environmental scientists. Transactions of the Royal Society of South Africa, 65: 1-47. https://doi.org/10.1080/00359191003652033
Perreault, C. 2019. The Quality of the Archaeological Record. Chicago: The University of Chicago Press.
Poesen, J., Nachtergaele, J., Verstraeten, G., et al. 2003. Gully erosion and environmental change: Importance and research needs. Catena, 50: 91-133. https://doi.org/10.1016/S0341-8162(02)00143-1
Pope, M. 2017. Thresholds in behaviour, thresholds of visibility: Landscape processes, asymmetries in landscape records and niche construction in the formation of the Palaeolithic Record. In: Pope, M., McNabb, J. & Gamble, C. (eds) Crossing the Human Threshold: Dynamic Transformation and Persistent Places During the Middle Pleistocene (First Edition, Frames and Debates in Deep Human History): 24-39. Milton: Taylor and Francis. https://discovery.ucl.ac.uk/id/eprint/10038759/
Rhodes, E.J. 2011. Optically stimulated luminescence dating of sediments over the past 200,000 years. Annual Review of Earth and Planetary Sciences, 39: 461-488. https://doi.org/10.1146/annurev-earth-040610-133425
Roebroeks, W., MacDonald, K., Scherjon, F., et al. 2021. Landscape modification by Last Interglacial Neanderthals. Science Advances, 7: eabj5567. https://doi.org/10.1126/sciadv.abj5567
Rots, V., Lentfer, C., Schmid, V.C., et al. 2017. Pressure flaking to serrate bifacial points for the hunt during the MIS5 at Sibudu Cave (South Africa). PloS ONE, 12: e0175151. https://doi.org/10.1371/journal.pone.0175151
Sampson, C.G. 1985. Atlas of Stone Age Settlement in the Central and Upper Seacow Valley (National Museum Memoirs, Volume 18). Bloemfontein: National Museum.
Sampson, C.G. 2006. Acheulian quarries at hornfels outcrops in the Upper Karoo region of South Africa. In: Goren-Inbar, N. & Sharon, G. (eds) Axe Age: Acheulian Tool-making from Quarry to Discard: 75-108. London: Equinox.
Sampson, C.G., Moore, V., Bousman, C.B., et al. 2015. A GIS analysis of the Zeekoe Valley Stone Age archaeological record in South Africa. Journal of African Archaeology, 13(2): 167-185. https://www.jstor.org/stable/44295209
Sanderson, J. 1879. Notes in connection with stone implements from Natal. Journal of the Anthropological Institute of Great Britain and Ireland, 8: 15-21. https://doi.org/10.2307/2841186
Scerri, E.M.L. & Will, M. 2023. The revolution that still isn't: The origins of behavioral complexity in Homo sapiens. Journal of Human Evolution, 179: 103358. https://doi.org/10.1016/j.jhevol.2023.103358
Sharon, G., Zaidner, Y. & Hovers, E. 2014. Opportunities, problems and future directions in the study of open-air Middle Paleolithic sites. Quaternary International, 331: 1-5. https://doi.org/10.1016/j.quaint.2014.03.055
Shaw, M., Ames, C., Phillips, N., et al. 2019. The Doring River Archaeology Project: Approaching the evolution of human land use patterns in the Western Cape, South Africa. PaleoAnthropology, 2019: 400-422. https://paleoanthropology.org/ojs/index.php/paleo/article/view/793/754
Sidorchuk, A. 2021. Models of gully erosion by water. Water, 13(22): 3293. https://doi.org/10.3390/w13223293
Sifogeorgaki, I., Klinkenberg, V., Esteban, I., et al. 2020. New excavations at Umhlatuzana Rockshelter, KwaZulu-Natal, South Africa: A stratigraphic and taphonomic evaluation. African Archaeological Review, 37: 551-578. https://doi.org/10.1007/s10437-020-09410-w
Sifogeorgaki, I., Schmid, V.C., van Os, B., et al. 2023. Two methods on one stone: Integrating visual and analytical techniques to clarify lithic raw material utilization in the Middle and Later Stone Age at

Umhlatuzana rockshelter (South Africa). Journal of Archaeological Science: Reports, 48: 103890. https://doi.org/10.1016/j.jasrep.2023.103890
Söhnge, P.G. & van Riet Lowe, C. 1937. The Geology and Archaeology of the Vaal River Basin (Memoir of the Geological Survey of South Africa, Volume 35). Pretoria: Government Print.
Sommer, C. 2021. Reconstruction of the Pleistocene landscape of southern KwaZulu-Natal, South Africa by means of GIS, remote sensing and geomorphological techniques. Doctoral Thesis. Tuebingen: Eberhard Karls Universitaet. https://doi.org/10.15496/publikation-63042
Stenberg, B., Viscarra Rossel, R.A., Mouazen, A.M., et al. 2010. Visible and near infrared spectroscopy in soil science. In: Sparks, D.L. (ed.) Advances in Agronomy, 107: 163-215. Amsterdam: Academic Press.
Stock, J., Will, M. & Wells, J.C.K. 2023. The extended evolutionary synthesis and distributed adaptation in the genus Homo: Phenotypic plasticity and behavioral adaptability. PaleoAnthropology, 2023(2): 205-233. https://doi.org/10.48738/2023.ISS2.123
Surovell, T.A. & Brantingham, P.J. 2007. A note on the use of temporal frequency distributions in studies of prehistoric demography. Journal of Archaeological Science, 34: 1868-1877. https://doi.org/10.1016/j.jas.2007.01.003
Telfer, M.W. & Hesse, P.P. 2013. Palaeoenvironmental reconstructions from linear dunefields: Recent progress, current challenges and future directions. Quaternary Science Reviews, 78: 1-21. https://doi.org/10.1016/j.quascirev.2013.07.007
Temme, A.J.A.M., Baartman, J., Botha, G.A., et al. 2008. Climate controls on late Pleistocene landscape evolution of the Okhombe valley, KwaZulu-Natal, South Africa. Geomorphology, 99: 280-295. https://doi.org/10.1016/j.geomorph.2007.11.006
Temme, A.J.A.M., Baartman, J. & Schoorl, J.M. 2009. Can uncertain landscape evolution models discriminate between landscape responses to stable and changing future climate? A millennial-scale test. Global and Planetary Change, 69: 48-58. https://doi.org/10.1016/j.gloplacha.2009.08.001
Temme, A.J.A.M. & Veldkamp, A. 2009. Multi-process Late Quaternary landscape evolution modelling reveals lags in climate response over small spatial scales. Earth Surface Processes and Landforms, 34: 573-589. https://doi.org/10.1002/esp.1758
Texier, P-J., Porraz, G., Parkington, J., et al. 2010. A Howiesons Poort tradition of engraving ostrich eggshell containers dated to 60,000 years ago at Diepkloof Rock Shelter, South Africa. Proceedings of the National Academy of Sciences of the United States of America, 107: 6180-6185. https://doi.org/10.1073/pnas.0913047107
Thompson, E., Williams, H.M. & Minichillo, T. 2010. Middle and late Pleistocene Middle Stone Age lithic technology from Pinnacle Point 13B (Mossel Bay, Western Cape Province, South Africa). Journal of Human Evolution, 59: 358-377. https://doi.org/10.1016/j.jhevol.2010.07.009
Thompson, J.C., Wright, D.K., Ivory, S.J., et al. 2021. Early human impacts and ecosystem reorganization in southern-central Africa. Science Advances, 7: eabf9776. https://doi.org/10.1126/sciadv.abf9776
Tooth, S., Hancox, P.J., Brandt, D., et al. 2013. Controls on the genesis, sedimentary architecture, and preservation potential of dryland alluvial successions in stable continental interiors: Insights from the incising Modder River, South Africa. Journal of Sedimentary Research, 83: 541-561. https://doi.org/10.2110/jsr.2013.46
Tryon, C.A., Faith, J.T., Peppe, D.J., et al. 2014. Sites on the landscape: Paleoenvironmental context of late Pleistocene archaeological sites from the Lake Victoria basin, equatorial East Africa. Quaternary International, 331: 20-30. https://doi.org/10.1016/j.quaint.2013.05.038
Unknown Author. 1991. Artefacts from Stone Age found in Natal. Natal Witness. 3 October 1991.
Uthmeier, T. & Chabai, V. 2018. Formation processes at sites with high-resolution sequences in the Crimean Middle Paleolithic: The Kabazi V rock shelter and the open-air site of Kabazi II compared. Quaternary International, 485: 44-67. https://doi.org/10.1016/j.quaint.2018.01.017
van der Ryst, M. & Küsel, S. 2013. Middle Stone Age technological organisation: Lithic extraction at Swartkop Hill in the interior of Namaqualand, Northern Cape, South Africa. Azania: Archaeological Research in Africa, 48(3): 403-425. https://doi.org/10.1080/0067270X.2013.785238
van Peer, P., Vermeersch, P.M., & Paulissen, E. 2010. Chert quarrying, lithic technology and a modern human burial at the palaeolithic site of Taramsa 1, Upper Egypt (Egyptian prehistory monographs, Volume 5). Leuven: Leuven University Press.
van Riet Lowe, C. 1947. A brief account of an archaeological reconnaissance of Natal. The South African Archaeological Bulletin, 2: 68. https://doi.org/10.2307/3886549
van Riet Lowe, C. 1952. The Vaal River chronology: An up-to-date summary. The South African Archaeological Bulletin, 7: 135. https://doi.org/10.2307/3887341
Vanmaercke, M., Panagos, P., Vanwalleghem, T., et al. 2021. Measuring, modelling and managing gully erosion at large scales: A state of the art. Earth-Science Reviews, 218: 103637. https://doi.org/10.1016/j.earscirev.2021.103637
Villa, P., Soriano, S., Teyssandier, N., et al. 2010. The Howiesons Poort and MSA III at Klasies River main site,

Cave 1A. Journal of Archaeological Science, 37: 630-655. https://doi.org/10.1016/j.jas.2009.10.028
Wadley, L. 2015. Those marvellous millennia: The Middle Stone Age of southern Africa. Azania: Archaeological Research in Africa, 50: 155-226. https://doi.org/10.1080/0067270X.2015.1039236
Watson, A., Price-Williams, D. & Goudie, A.S. 1984. The palaeoenvironmental interpretation of colluvial sediments and palaeosols of the late pleistocene hypothermal in southern Africa. Palaeogeography, Palaeoclimatology, Palaeoecology, 45: 225-249. https://doi.org/10.1016/0031-0182(84)90008-7
Weidelt, H.J. (ed.) 1976. Manual of Reforestation and Erosion Control for the Philippines. Eschborn: German Agency for Technical Cooperation.
Will, M., Bader, G.D. & Conard, N.J. 2014. Characterizing the late Pleistocene MSA lithic technology of Sibudu, KwaZulu-Natal, South Africa. PloS ONE, 9: e98359. https://doi.org/10.1371/journal.pone.0098359
Will, M., Conard, N.J. & Tryon, C.A. 2019. Timing and trajectory of cultural evolution on the African continent 200,000-30,000 years ago. In: Sahle, Y., Reyes-Centeno, H. & Bentz, C. (eds) Modern Human Origins and Dispersal: 25-72. Tübingen: Kerns Verlag.
Will, M., Parkington, J.E., Kandel, A.W., et al. 2013. Coastal adaptations and the Middle Stone Age lithic assemblages from Hoedjiespunt 1 in the Western Cape, South Africa. Journal of Human Evolution, 64: 518-537. https://doi.org/10.1016/j.jhevol.2013.02.012
Wintle, A.G., Botha, G.A., Li, S.H., et al. 1995. A chronological framework for colluviation during the last 110 kyr in KwaZulu/Natal. South African Journal of Science, 91: 134-139. https://journals.co.za/doi/pdf/10.10520/AJA00382353_10232
Wroth, K., Tribolo, C., Bousman, C.B., et al. 2022. Human occupation of the semi-arid grasslands of South Africa during MIS 4: New archaeological and paleoecological evidence from Lovedale, Free State. Quaternary Science Reviews, 283: 107455. https://doi.org/10.1016/j.quascirev.2022.107455
Wurz, S. 2016. Development of the archaeological record during the Middle Stone Age of South Africa. In: Knight, J. & Grab, S.W. (eds) Quaternary Environmental Change in Southern Africa: Physical and Human Dimensions: 371-384. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781107295483.022

Southern African Field Archaeology
2024 Vol. 19: Article 2720
Research report (peer-reviewed): Received September 2023; Revised April 2024; Published May 2024
DOI: https://doi.org/10.36615/safa.19.2720.2024

ISSN 1019-5785
ISSN 2789-1844

FEMALE FIGURINES IN SUDAN FROM THE NEOLITHIC TO MEROITIC PERIOD (4600 BC TO 350 AD): A REVIEW OF THEIR CHRONOLOGICAL AND TYPOLOGICAL DEVELOPMENT

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ABSTRACT
Clay female figurines recovered from central and northern Sudan suggest there are cultural similarities between the Neolithic (5000-2800 BC) and Meroitic periods (400 BC-AD 350). Female figurines were recovered from several Meroitic sites, including from the elite cemeteries in el-Bagrawwaya west, the domestic strata in the royal city of Meroe, the Meroitic settlement in Karanog at lower Nubia, and at el-Muweis south of the Meroitic Town. Here, I argue that female forms in the Meroitic period, like some of the Neolithic samples, and their continuation in the archaeological record, show the social importance of females across the cultural history of ancient Sudan. The paper describes the figurines and uses a comparative method to study and reassess the Meroitic female figurines according to their similarities with other samples from the Neolithic and prehistoric periods.

Keywords: Meroe, Neolithic, female figurines, central Sudan, cultural similarities

1. Introduction

The female form has been a subject of figurative sculpture, using naturalistic or stylistic representations, since the Paleolithic period (Abramova 1967; Conkey 1987; Bahn & Vertut 1988). These figurines are found across Europe, Asia, and Africa, and are central to our understanding of the perceptions of women in ancient periods (Hamilton 1996). Unsurprisingly, they have been the subject of broad academic debate in archaeology and other fields. Of course, not all figurines are female – many represent men and animals – but this paper will focus solely on the portrayals of female bodies, henceforth referred to as female figurines.

It is uncertain why representations of the human body were first made and what function they may have served in early societies (Conkey 1983). It is also unclear why there was a preference for female forms, and numerous hypotheses have been put forward. For example, the prominence of the hips and breasts has led scholars to suggest these items portrayed the aesthetic ideal of larger-bodied women, promoted fertility, or served magic-religious functions (e.g., Guthrie 1984; Hutton 1997). Some argue that their artistic expression seems to suggest their link with an early type of spirituality (Maringer 1966); however, there is little consensus among scholars regarding what this may have been in practice (Hamilton 1996).

Female forms became a popular feature across the ancient Near East during the Neolithic period (12000-6500 BC). The earliest appearance of these figurines in the Middle Nile Region dates to the early Khartoum culture, the Mesolithic period that was characterised by bone working, a microlithic industry, and use of pottery. However, these early examples were fragmented, making it difficult to confirm whether they were females or males. In the Neolithic period, female figurines became common with examples found across north and central Sudan (e.g., at Kadruka, Shaheinab, Kadero, Geili, Kadada, and el-Sour) where the Neolithic dates to between the 6th and 3rd millennium BC (Arkell 1953; Geus 1984; Caneva 1988; Reinold 2001; Sadig 2005). Their popularity continued with examples known from A-group cultural contexts, which refers to sites from the first powerful culture in Northern Sudan at

Lower Nubia that developed during the Copper Age, between the 4th and 3rd millennium BC. They occur mostly in its cemeteries, at Khor Risqalla, Dakka, Sayala, Halfa Degheim, Serra East, and possibly at Faras (Reisner 1910; Firth 1915, 1927; Säve-Söderbergh 1968; Nordstrøm 1972). At the end of the A-group period, female figurines disappeared from the archaeological record for approximately 1000 years before reappearing again with C-group cultural sites. These arose during the Bronze Age, after the A-group sites, between the 3rd and 2nd millennium BC over the same area (e.g., at Dakka, Koshtamna, Kubban, Wadi Alaqi, and Aniba) (Woolley & Randal MacIver 1910; Firth 1915, 1927; Hofmann 1977). No evidence, however, was found of female figurines dating to Kerma sites (from upper Nubia, in parts of present-day northern and central Sudan; 2800-1480 BC), but they were present during the Egyptian occupation of Nubia, which began with the collapse of the Kerma kingdom in 1480 BC and continued approximately until the decline of the New Egyptian Kingdom. In addition, there was no evidence of female figurines in the early Napatan phases of the Kingdom of Kush (950 BC). After this long hiatus, female figurines are again found in excavations of sites dating to the Meroitic period (350 BC-AD 350).

Of course, this reappearance does not mean a continuation in figurine style or symbolism as associated with the earlier forms, even if other Neolithic features reappeared during the Meroitic period, despite a gap of nearly 3000 years. These included a continued presence of pastoralists and agro-pastoralist cultures in the same region, as well as similar patterns in burial practices. The handmade ceramic industry in both periods also showed remarkable similarities, including the use of coiling techniques, deoxidisation of vessels, and decoration styles including comb and punctate impressions and cross-hatching (cf. Clark 1973). Body decorations and accessories, including ostrich eggshell and stone beads, and lip plugs (which occur in all periods), are common across both eras.

In this paper, I assess similarities between the female figurines of the Neolithic, Copper Age, Bronze Age, and Meroitic, and consequently argue that they indicate periods when special meanings were accorded to women in the Middle Nile Region. The paper describes and compares examples of female forms from these three contexts before comparing them to analogous material found in other contemporary contexts to reassess their potential meaning/s.

2. A review of figurines, site contexts, and chronologies of the study region

The start of the Neolithic in the Near East was associated with the revival of cultural symbolism, not unlike the cultural revival that marked the start of the Upper Paleolithic in Europe. Early Neolithic sites such as Göbekli Tepe, Çayönü, Nevali Çori, and Ain Ghazal in modern Turkey, for example, have features that led Cauvin et al. (2001) to assume the birth of both agriculture and divinity.

Cauvin (1972) highlighted the importance of contemporary socio-cultural changes behind the Neolithic Revolution. He concluded that the emergence of symbolic material in the 10th millennium BC preceded the development of the agricultural economy in the Near East in the 9th millennium BC, suggesting that cognitive changes preceded economic transformation (Cauvin 1972). Cauvin et al. (2001; and see Hodder 2001) have since agreed with this premise, noting that the cultural, symbolic, and psychological aspects of the Neolithic Revolution were an integral part of it. However, they must be understood as practical parts of lived reality, not just abstract ideas.

Placing the development of the female figurines alongside these aspects of the Neolithic Revolution can be informative about their potential symbolism. In later Neolithic contexts, pregnant women were linked with the fertility of the land (Otto 1924; Al-Sawwah 1994), which may have originated in the socio-economic changes we see during the Neolithic Revolution.

In terms of the characteristics of the figurines themselves, in examples from the European Palaeolithic, and Neolithic of the Near and Middle East (cf. Fig. 1a & b), their typical size and shape is: 1) a palm-sized, nude, full-figured woman with a faceless and usually down-turned head, and thin arms that commonly end or disappear under the breasts but occasionally cross over them; 2) an abnormally thin upper torso carrying voluminous and pendulous breasts; 3) exaggeratedly large or elevated buttocks often splayed laterally but sometimes distended rearward; 4) a prominent, possibly pregnant or adipose abdomen with a large elliptical navel; and 5) what often appears to be oddly bent, unnaturally short tapering legs, which end in either a rounded point or disproportionately tiny feet (cf. McDermott 1996).

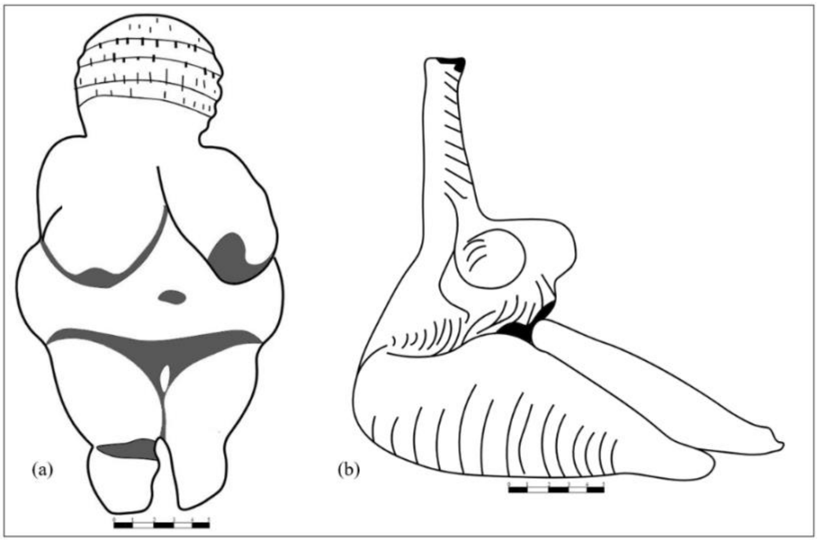

Figure 1. Palaeolithic female figurine Venus of Willendrof (a), Natural History Museum, Vienna, and Neolithic female figurine (b) from Iran (Al-Sawwah 1994). Drawings by Ammar Awad (2022).

Two subtypes of female figurines are known. The first has a conical and tapered lower half that would allow it to be set into the ground, which suggests their possible use in open-air rituals. The second is pyramidal, with a flat end, meaning they could place it on a flat surface with the figure sitting on their buttocks. The purpose of these latter figurines may go back to blessing or protection in a domestic setting, where they were placed in a prominent position (Al-Sawwah 1994). Figurines are often small and carved from stone, bone, and ivory, with a few early examples modelled in fired clay (Vandiver et al. 1989; Soffer et al. 1993).

Archaeological contexts of the Nile Valley

Similar figurines are also present throughout the Nile Valley. Within this group, the most common subjects are either humans or animals, although some animal features occur. These may suggest the development of similar symbolism across the region as the reliance on agriculture increased (Arkell 1953; Nordstrøm 1972).

Egypt's female figurines

Data about female figurines from early archaeological sites in Egypt are scarce. However, their presence increased in the Neolithic and Chalcolithic (Stevenson 2017). These again come from communities where we see at least a partial reliance on agriculture. For example, several female figurines painted in red and dated to ca. 4800 BC come from the site of Merimde Beni Salama, whose contemporaneous population was sedentary, practised agriculture, and kept livestock while also hunting and fishing. In Mata's (2014) unique study about the possible parallels between Egyptian and Sudanese Neolithic figurines and other contemporaneous examples coming from the Near Eastern Area, she suggested that these figurines seem to have been associated with magical rites, likely relating to fertility magic or initiation practices (Mata 2014).

However, such figurines were neither ubiquitous nor integral to ritual practice in pre-dynastic Egypt, or those periods before recorded history from the Palaeolithic and Neolithic Age, or those leading to the rise of the first Pharaonic dynasty. They were restricted to particular spaces and activities, occurring in both settlements and rich burial contexts. In both cases, they were likely used in emotionally engaging gatherings designed to solidify social relationships through rituals and practices focused on the body (Stevenson 2017), suggesting these figurines held similar symbolism. Figurines of nude females are known from most periods of Pharaonic Egyptian history and occurred in various contexts. These were fashioned from clay, faience, ivory, stone, and wood (cf. Waraksa 2018).

Sudan's female figurines

Female figurines in the Middle Nile region date from the late Mesolithic or early Neolithic periods. Their distribution is concentrated in the northern and central parts of the area (Fig. 2). The use of these figurines continued until the Meroitic period, suggesting their ongoing relevance within deep-seated traditions in the region.

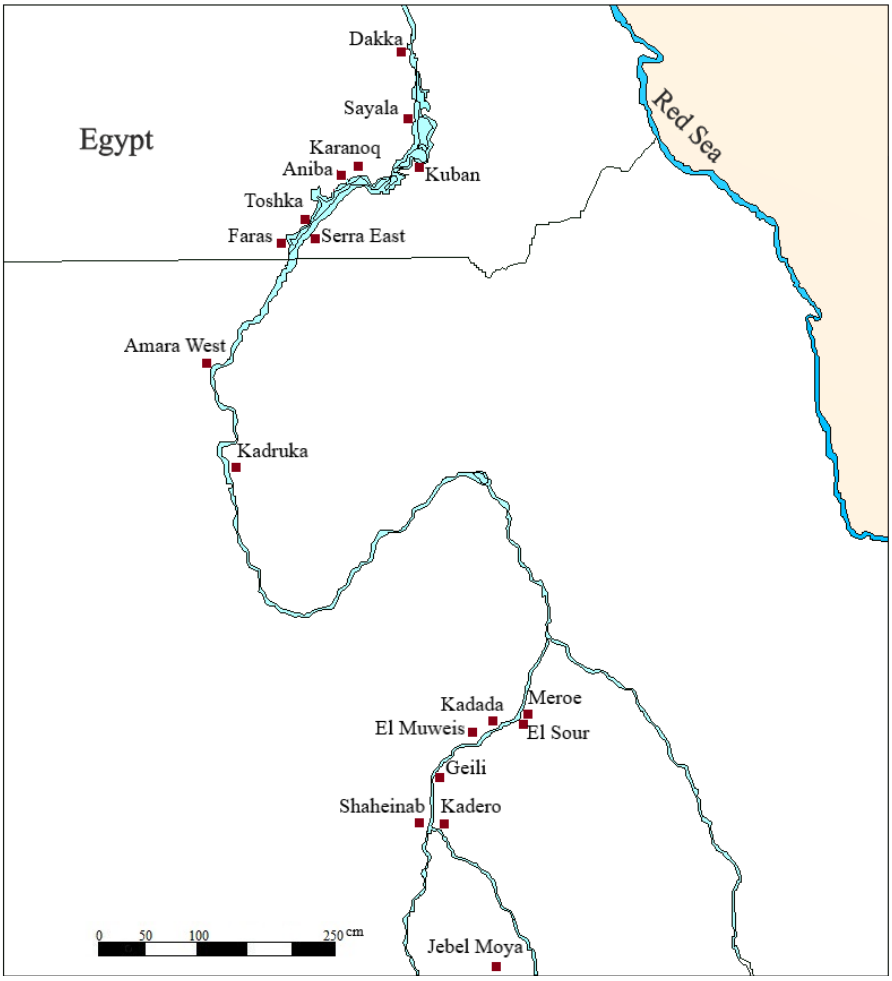

Figure 2. Location of female figurines across Ancient Sudan. Map by Ammar Awad (2022).

Neolithic figurines

The earliest dated figurines come from the early Khartoum Mesolithic (Khartoum Hospital site), dated to ca. 5000 BC, and were found by Arkell in 1949. These samples were, unfortunately, very fragmentary, including 11 simply made figurines comprising legs or arms and eight fragments of heads and faces in clay (Arkell 1949: pl. 56, figs 2-4), and so their relevance here is tentative. These figurines were associated with over 200 small objects comprising animal heads, including hippopotamus or crocodiles, and Arkell (1949) suggested they were used as magic for hunting.

Two samples come from Kadruka, just south of Kerma, a site that spans over a thousand years (4600-3200 BC) (Reinold 2001). The first figurines were found in a burial dating to the first half of the 5th millennium BC, in Cemetery KDK1. It was carved in Nubian sandstone and was deposited in the burial equipment of a ca. 40-year-old adult male, along with a pair of bucrania bracelets, a diorite palette, and calceiform vases, evidence indicating to Reinold (2000) that this man could have been a tribal chief. The second figurines came from Cemetery KDK 21, and are also made of Nubian sandstone. These stylised figurines did not emphasise any specific part/s except for a pair of lines marked on the abdomen, thus making it difficult to determine its female nature (Reinold 2000). Both examples had a finely polished surface and a conical, pointed base, likely to fix them in the ground to perform open-air rituals (e.g., Fig. 3a).

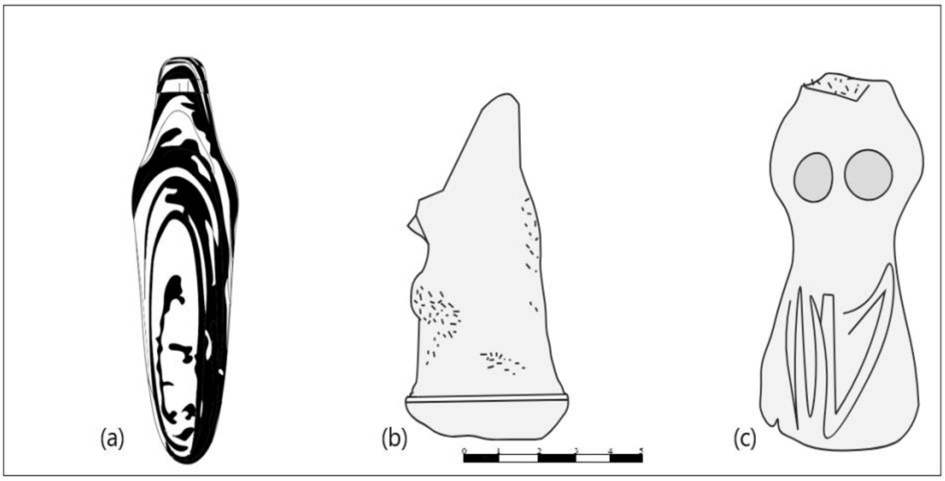

Figure 3. Nubian sandstone female figurine from Kadruka (a), after Reinold (2000). Burned clay female figurine from Shaheinab (b), after Arkell (1953). Neolithic clay female figurines, from Geili (c), after Caneva (1988). Drawings by Ammar Awad (2022).

In contrast to those made on Nubian sandstone, most figurines are made using fired clay. In the Neolithic site of Shaheinab, dating ca. 4440 BC, a complete female clay figurine was recovered from a burial associated with proto-dynastic material at the site (Arkell 1953: pl. 41: 7). Arkell (1953) suggested that the potters who had made the vessels in the proto-dynastic burials at Shaheinab had also made this (Fig. 3b).

Three examples of figurines were found in the Neolithic site of Kadero, dating from ca. 4200 BC, and again they were made using fired clay. Three figurines were decorated with incised lines on the torso, which could suggest tattoo designs. Another example showed dotted marks on the front and back, again perhaps representing tattoos (Reinold 2000). The severed head of another figurine has rough, prominent facial features marking the eyes, nose, mouth, and hair or a cap made from vegetal material or fabric, such as linen. Another torso showed frontal and back tattoos made through dotted marks, so many of the marks on these figurines could be understood to represent tattoos (Rampersad 1999).

In the early and classic Neolithic levels at Geili, north of Khartoum, two fragmentary female figurines and several other unidentifiable fragments, including a head, body fragments with marked breasts, and clay phalli, were recovered (Caneva 1988: figs 17 & 18) (Fig. 3c).

Additional female figurines were found at the Neolithic site of el-Kadada, dating from ca. 4015 BC. Here, the figurines vary in form, some highly stylised with noticeable breasts, stomachs, and buttocks. One rich grave with a substantial amount of goods contained fragments of six heads of female figurines with elaborate hairstyles (Geus 1984). Another figurine found in a child's grave was also made using fired clay, possibly representing a pregnant woman and serving as a symbol of fertility (Fig. 4a). A dozen similar figurines from different cemeteries at el-Kadada (Fig. 4b & c), and two more figurines from Shaheinab and Geili, further suggest the importance of this symbolism in the area (Reinold 2000).

Two further fragments found at el-Sour were again linked to a child's grave (Sadig 2005). The first one is a human head, with no prominent features, but is similar to examples found at el-Kadada (Geus 1984). The hair of the figurine is decorated with a hard, rippled decoration. The second is an incomplete human figurine comprising the torso of a female. Unfortunately, the upper and lower parts of the figurine were lost (Fig. 5), and there was no other decoration on the body. Sadig (2005) has suggested that these forms had a religious purpose.

About 496 human and animal figurines were recovered during the excavations at Jebel Moya (Addison 1949). Of these, the human figurines are both male and female and highly stylised, and are made of unfired clay. Such figurines became more common in the later periods at the site (1^{st} millennium BC-1^{st} millennium AD). The prevalence of many simple, almost phallic types, looking like rough cones of clay, may point to different symbolisms around figurines at this site. Addison (1949) suggested that the animal figurines represent children's toys, while the human figurines seem to differ in character from the animal types. The latter are model animals with legs, horns, tails, etc., all realistically reproduced, or at least reproduced as well as their makers knew how, but no attempt was made to model a human. Sexual characteristics are often indicated, and sometimes there is a suggestion of arms, but in no single case is there any effort to show separate legs, and only occasionally are features suggested by a mere pinching of the clay.

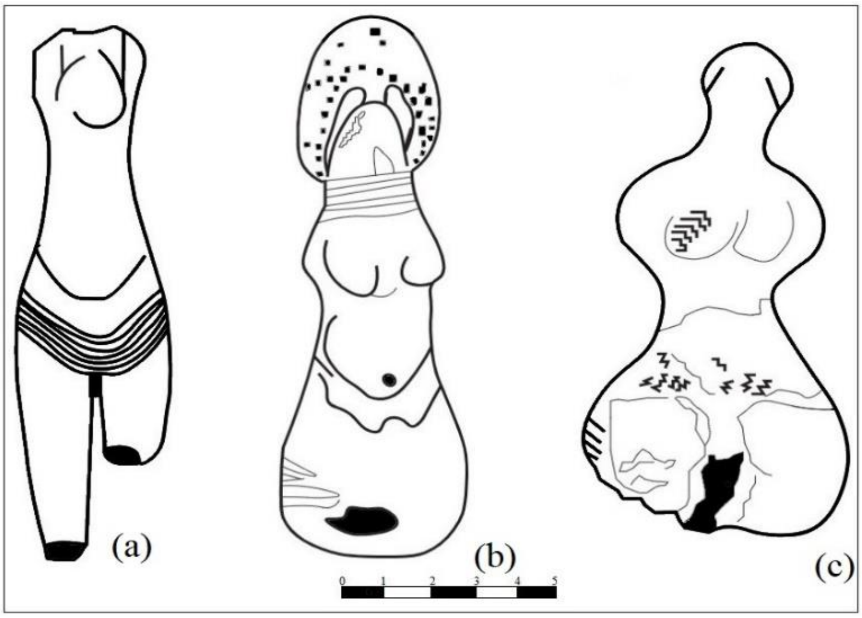

Figure 4. A group of female figurines, from el-Kadada. Drawings by Ammar Awad (2022).

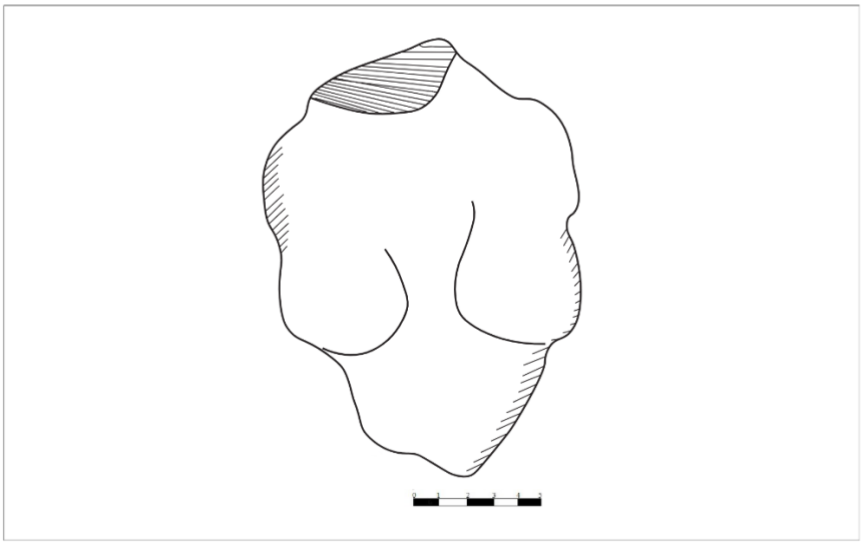

Figure 5. Fragments of the female figurine from El-Sour, after Sadig (2005). Drawing by Ammar Awad (2022).

The earliest evidence of female forms in the A-group in lower Nubia began with the first archaeological survey of Nubia (1907-1911). Several female figurines were discovered in the first stage of the survey (1907-1908) in Cemetery 30 at Khor Risqalla. They were made of fired clay; almost all were headless, without hands or legs (Reisner 1910: fig. 291). The second stage of the survey (1908-1909) located a group of female forms from Cemetery 102 at Dakka, characterised by a seated posture and outstretched legs, and at least one of them was associated with a female child's grave (Firth 1915: pl. 11) (Fig. 6a). The last stage of the first survey (1910-1911) located an additional female figurine in Cemetery 130, Grave 311 at Sayala, which belonged to a young girl. The figurine is made of clay, nearly straight in its upper body, and has a head like a bird but no thighs or breasts (Fig. 6b).

Two samples of female figurines belonging to the A-group cemetery were found associated with the burials of an adult woman and a child in Tomb 16b at Site 277, between Halfa Degheim and Khor Musa (Fig. 6c). The accompanying figurines mirror the human remains, with one figurine being a mature woman and the other a young girl with a short, slender body and small breasts (Säve-Söderbergh 1968: pl. XLIII). The modelled incisive ripples from the lower abdomen to above the knees seem to depict a garment, perhaps a loincloth (Nordstrøm 1972). Säve-Söderbergh (1968) suggested that these were intended to restore the vitality of the deceased individuals rather than being related to fertility.

In the settlement complex of A-group at Serra-East, Site 303, Area 2, was a sample of a female figurine, approximately 6 cm high, with a long, thin neck and attached head, and with short arms. The nipples and navels were indicated by indented points, and the eyes and eyebrows were indicated by indented lines (Säve-Söderbergh 1968) (Fig. 6d).

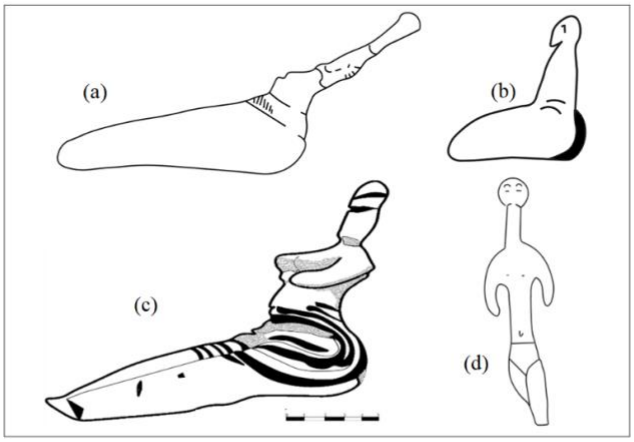

Figure 6. A-Group female figurine from Dakka (a), after Firth (1915). A-Group female figurine from Sayala (b), after Firth (1927). A-Group female figurine from Khor Musa (c), after Nordstrøm (1972). A-Group female figurine from Serra East (d), after Nordstrøm (1972). Drawings by Ammar Awad (2022).

Bronze Age

Cemetery 87 of Koshtamna contained the skeleton of a female child in Grave 66. There were a series of clay female figurines, seated and with unarticulated legs, and the upper body more or less bent back. (Fig. 7a). Numerous female figurines belong to C-group cemeteries found at Dakka, and all of the figurines were in seated positions (Firth 1912: pl. 39). An additional group of female figurines was discovered at the Kubban cemetery (Graves 1, 2, 7, 43, 46, 82, & 244) (Firth 1927).

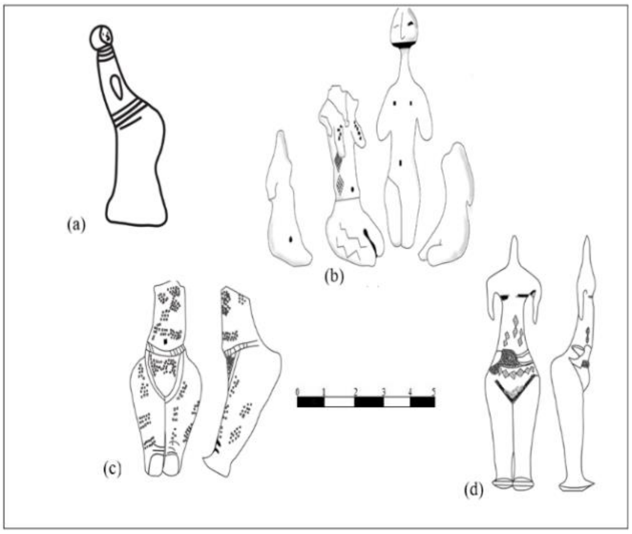

Figure 7. C-group figurine from Koshtamna (a), after Firth (1915), drawing by Ammar Awad (2022). Group of fired clay female figurines from Aniba C-group (b), National Sudan Museum, drawing by Ammar Awad (2022). C-group female figure from Toshka (c & d), drawing by Butterworth (2018).

A group of female figurines was recovered from the site of Aniba, where the largest consternation graves occur for the C-group. Across five graves (677, 390, 249, 133, & 99), nine samples of female figurines were recovered, and they were made of fired clay in the seated position with short arms. The absence of breasts also distinguished all the figurines, except for one that seemed unique; it had a long and distinctive conical breast and a set of sunken scars that might show a tattoo (Fig. 7b). The other figurines are also females because they have the same female features in their bodies, e.g., their seated position, tapering legs, buttocks, and short arms.

Three samples were collected from C-group cemeteries at Toshka. Two of them were in a seated position, marked with dotted and other motifs representing human tattoos (Fig. 7c). The third stands upright, is headless with a long, thin neck, and has short arms. The upper body is narrow and the chest has two horizontal cuts, while the abdomen protrudes and is covered with tattoos. It also has thick legs, separated from each other at the bottom, so that it stands on two flat feet. (Fig. 7d).

During the Egypt Exploration Society (EES) excavations at the site from 1938 to 1939 and 1948 to 1950, sixteen female figurines were recovered from in and around the walled town of Amara West (Spencer 1997). Further fragments of 21 examples were found again in the same area during the 2008-2014 seasons of the British Museum, recovered within the walled Ramesside Period town and adjacent extramural settlement, which continued in the New Egyptian Kingdom.

Most of the recovered figurines are flat, plaque-shaped, hand-modelled in clay, with a small number that have been rounded. The figurines are naked, often with the pubic triangle, breasts, or navel marked, while those rounded figurines tend to have very prominent buttocks. Tattoos or scarifications occur on figurines of both shapes (Stevenson 2017).

The re-emergence of female figurines in the Kushite kingdom

The Kushite kingdom saw the re-emergence of female figurines as an important artefact category. In particular, four sites were found: two in the Meroe area, the third in el-Muweis to the south, and the fourth in Karanog in lower Nubia.

Reisner (1910) recovered three samples of clay female figurines in Meroe during the excavations in el Bagrawwaya West, all of which were made of clay. The first was a crude mud steatopygous female figurine with no head or arms, with a height of 16.5 cm (Fig. 8a); the second and third were crude mud male figurines ca. 100 AD (Dunham 1963).

During excavations in the city of Meroe in the 1980s, a female figurine with no arms or head, measuring 165 mm in height and comprising an uneven surface texture, was found in Grave W. 323, accompanied by three crude male figurines. All were made of fired clay. The head of the complete male figurine was attached with a wooden dowel so that the missing female head may have been similarly attached (Dunham 1963) (Fig. 8b).

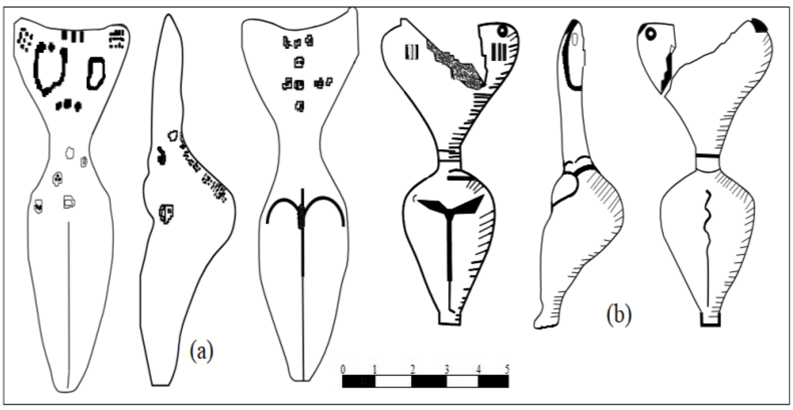

Figure 8. Crude mud steatopagous female figurine (a), from Bagrawwaya West, after Dunham (1963). Crude mud female figurine (b), from Royal City, after Shinnie & Bradly (1980). Drawings by Ammar Awad (2022).

Several fragments of an unknown number of human figurines were also found during the Meroe city excavations, including pieces of legs, torsos, buttocks, heads, and a complete female torso. The faces often show the three vertical cuts on the cheek known from other Meroitic representations of the human face, which are still common amongst the modern Jaaliyin population of the area. All these fragments were made of fired clay (Shinnie & Bradly 1980: figs 70-72), and many cattle figurines were also found (Fig. 9a-c). Visible perforations on the figurine shoulders were perhaps used to hang them within houses for protection, or blessings. However, this may have been confined to members of the royal class only, and access to similarly important roles for non-royal women remains unknown.

In a Meroitic site at Mouweis south of the capital, this pottery workshop dumpsite contains an unfired clay female figurine with punctuated decoration on the abdomen, including a triangle. It dates to the 1st-4th century AD (Fig. 9d).

North of the kingdom in lower Nubia, at the cemetery of Karanog, a low-rank male grave (G 300) contains a clay female figurine with a plant-shaped motif punctuated in axial position on the abdomen, ca. 3rd century AD (Woolley & Randall Maclver 1910: pl. 96, no. 7662).

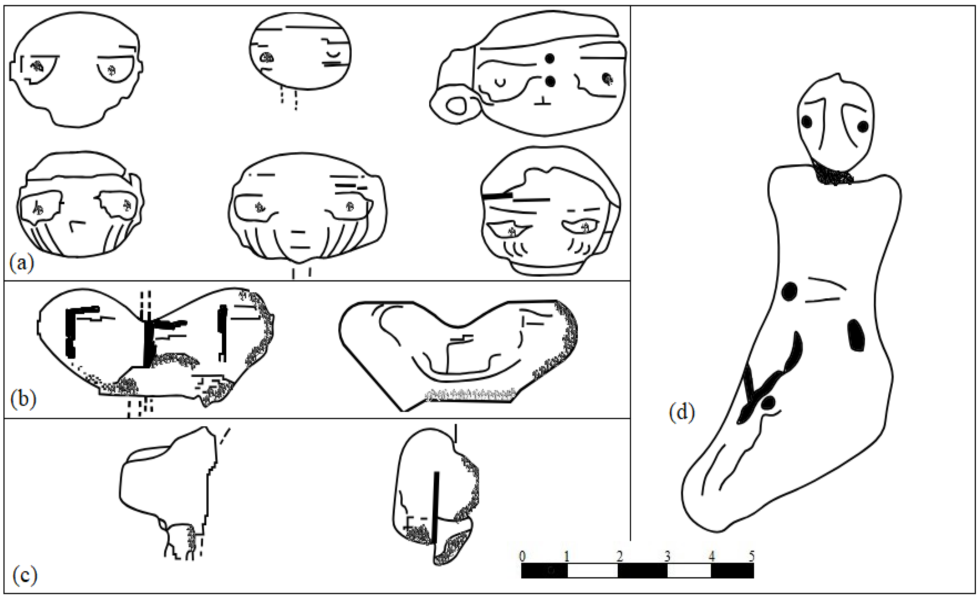

Figure 9. Cluster of human heads, and several fragments from the Royal City of Meroe (a-c), after Shinnie & Bradly (1980). Mouweis, female figurine, National Sudan Museum (d). Drawings by Ammar Awad (2022).

3. Discussion

Archaeologically, female figurines in Sudan first appear in the Neolithic period and then they began to occur in the archaeological record from time to time in specific contexts: the A-group, C-group, and Meroitic periods (4500 BC-AD 350) (see Table 1). It appears that their most prominent and common characteristic is their naturalistic dimension, which characterise the samples throughout the different stages of cultural development. It gives the impression that the human body had embedded meaning. The focus in Neolithic samples in central Sudan on a specific area of the body such as the breasts, which may have been more important, further attests to the importance of the body.

Table 1. Details of the female forms across the different periods.

Period	**Neolithic (5000-2800 BC)**	**A-group (3800-2900 BC)**	**C-group (3100-2100 BC)**	**Meroe (350 BC-AD 350)**
Area	Nubia & centre of Sudan	Lower Nubia	Lower Nubia	Lower Nubia & centre of Sudan
Raw material	Stone, fired & unfired clay	Fired clay	Fired clay	Fired & unfired clay
Posture	Mostly standing	Mostly sitting	Mostly sitting	Mostly standing
Tattoos	Existent	Existent	Existent	Existent
Style	Naturalistic	Naturalistic	Naturalistic	Naturalistic

Neolithic sites in the Sudan, where female figurines were found, demonstrate variation in socio-economic structures across the Nile Valley, showing different ways of exploiting natural resources (cf. Arkell 1953; Haaland 1987; Caneva 1988; Magid 1989; Reinold 2001; Jesse 2008; Sadig 2010). These differences are reflected in the diversity of material culture found across this period. Some Neolithic groups were focused on hunting and fishing subsistence. In contrast, others were more sedentary and may have practised agriculture and domestication (Mohammed-Ali 1973). The burials at Kadruka, for example, point to a homogenous population in which social hierarchies are clear (Reinold 2001), perhaps suggesting the development of chiefdoms. The dominance of cattle bones and bucrania shows that pastoralism was important (Haaland & Haaland 2017). We see social differentiation and differences in wealth in the burials of men, women, and children at Kadero (Sadig 2009). In contrast, the Neolithic community at Geili represented a group of hunter-gatherers and pastoralists who used large semi-permanent camps near the Nile (Caneva 1988). Despite the similarities in style and raw materials among the Neolithic samples of figurines, we do not see significant standardisation in the female forms. This may go back to differentiation in space and time between the Neolithic cultures in Sudan.

The Neolithic female figurines in Sudan also differ from those observed in other contemporary sites across the Near East in that we see little concern for sexual details, e.g., no voluminous, pendulous breasts or exaggeratedly large or elevated buttocks. The prominent abdomen is also missing, a key aspect of other female figurines. The Sudanese Neolithic samples seem more representative of actual human female characters, even though they rarely have a head or legs. Their main aim appears to have been to reflect specific functional aspects, as seen in the discussion below. According to the distribution of these forms across time and space in Sudan, we can see that quantities of female figurines were highest in the Neolithic period and C-Group. However, the Neolithic period witnessed the birth of this phenomenon in Sudan. In the Bronze Age, small communities of farmers and pastoralists were scattered in Lower Nubia along the banks of the Nile during the C-Group culture, and they were in constant contact with neighbouring Egypt. Their level of political stratification, however, was much lower (Renaut 2020).

The female figurines in Sudan are characterised by several features, including a diversity of raw materials used in their production, ranging between fired and unfired clay and stone. In most cases, they are also characterised by their standing position and an absence of peripheral parts (appendages), such as arms and legs (except for the example from el-Kadada, shown in Figure 4a, and C-group examples).

Decoration typically features horizontal and vertical lines around the thigh and leg areas, which may symbolise clothing, or strings made of leather that almost cover the part between the waist and the upper thigh; in some cases, comprising ostrich eggshell. This clothing style continued in the Meroitic period among the non-elite class, and it looked very similar to contemporary styles of dress among the Rahat, where young girls would wear a kind of leather skirt (a tradition that continued until the beginning of the previous century). Habitually, this covered the lower part of the body while leaving the upper parts, including the breasts, naked (Fig. 10a & b).

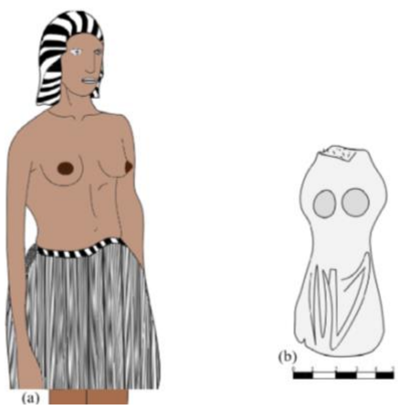

Figure 10. Model of a Sudanese Girl wearing Rahat (a), and Neolithic clay female figurine from Geili (b), after Caneva (1988). Drawings by Ammar Awad (2022).

Archaeologically, the Neolithic female figurines in the Sudan seem to have been included in elite funerary rites since they are found in the burials of wealthy men, women, and children. However, their meaning is still unclear. Their presence in burials may point to their use relating to spiritual beliefs around the afterlife, fertility, childbearing, and medical aspects. Some of their details may suggest that they were representations of primitive deities, or at least symbolic embodiments of them (El-Atta 2000).

Haaland and Haaland (2017) have suggested these female figurines are a way to understand the role of women in pre-state communities. Such figurines portray the importance of a mother-child relationship, which is a useful anchor to forge solidarity within a given society. Furthermore, this emphasises the important role of women in the stabilisation of communities as they transition from a mobile to a more sedentary lifestyle (Haaland 1997).

We see, for example, similarities between A-Group figurines and those found at Late Halaf sites in north-eastern Syria dating to ca. 6th millennium BC, as well as with slightly later Naqadan figurines in southern Egypt dating to ca. 4th millennium BC. The A-Group examples are very similar to the late Halaf examples, especially in how the hands and arms cradle the ample breasts, and in the use of regular stripes for decoration (Graham 2020). The Nubian A-Group was contemporaneous with the Naqada civilisation (45 km to the north) in Upper Egypt. This tells us that there was an exchange of goods and ideas at this time along the Nile and into the Levant (Hofmann 1977).

The long gap between the disappearance of female figurines in the late A-group period and their reappearance in the C-group period, and the continued use of female forms during the Bronze Age, reflects the persistence of the imagined symbolism of women from earlier traditions. Stylistically, the type of seated position of figurines, the short arms, the long necks, the inarticulate legs, and tattoos, were common features on figurines in the graves of both periods. A new introduction was the standing position, which appears to have been preferred in the settlements of the C-group. This may relate to a change in the location of rituals around the objects, with no need for them to be pushed into the ground. However, the body decoration has been constant. Furthermore, the breasts are rarely shaped in the C-group, depicted instead by holes or lines.

The examples from the Aniba C-group may have been used in ritual practice. Hafsaas (2006) suggested they were used in a female puberty rite, and she assumed a correlation between the adult (with scarification) and immature (blank) female body, reflecting this transition to womanhood perhaps in preparation for marriage, pregnancy, and childbirth.

Also, the parallels between some aspects of the C-group and the New Egyptian settlement in Amara West and Aaskut are notable (cf. Smith 2003; Stevenson 2017). The female figurines in the Pharaonic period were considered components of magico-medical rites to protect and heal. However, recent research suggests a broader and more active function for these figurines, including evidence for their deliberate destruction in various healing and apotropaic rites. This uniformity, together with their decoration in various media, suggests mass production at a state-supplied workshop.

Female figurines have been found in the full range of excavated sites in Egypt, from houses, temples, and tombs in the Nile Valley, to cemeteries in the western oases, mining sites in the Eastern Desert and Sinai Peninsula, and Nubian forts (cf. Waraksa 2018). Their breakage is sometimes indicative of deliberate destruction, which most likely occurred at the conclusion of a rite before the figurine was discarded. Combined with the frequent occurrence of the figurines in refuse zones, this breakage highlights their temporary utility (Kemp 1995; Waraksa 2007).

However, in Kushite contexts, we see the frequency of female figurines rise again. These occur in both the elite cemetery and domestic strata in the royal city at Meroe, as well as in a low-ranking burial of a male at Karanog and in a pottery workshop at Muweis (the latter unlikely to be the intended final position). Some significant parallels can thus be identified between the Neolithic and C-group site figurines.

First, the style of the figurines has reverted back to that seen in Neolithic contexts, particularly as seen at el-Kadada and C-group (Fig. 10b). Figurines are again armless and headless in a standing position. Furthermore, markings denoting tattoos appear on the Meroitic examples across the thighs, abdomen, and neck. These are similar to those figurines from Neolithic sites such as Geili and el-Kadada.

The Meroitic female figurines were found in an elite context in the Meroe area. Furthermore, they were shown in lower-ranking classes outside Meroe (Karanog and Mouweis). However, no female figurines have been found in a royal tomb. This may indicate differences in the cultural traditions between the royal, elite, and other low ranks in Meroitic society. The differences in cultural traditions are noticeable across the Meroitic cemeteries in the north and south (Adams 1977; Edward 1989; Kuckertz & Lohwasser 2019).

What can the use of female figurines tell us about the role of women in the Middle Nile Valley? The women of the Sudan Neolithic period played an important role in managing the number of group members through their reproductive control. This was effectively connected with the female function as the productive member in society, with their ability to increase group numbers. The completed figurines of females, which were collected from numerous Neolithic sites in central Sudan and which were characterised by standing body positions and erected breasts (e.g., in el-Geili, Kadero, Shaheinab, and Kadada), were almost exclusively associated with pastoral contexts and domesticated animals. The focus on the chest area, without the rest of the body, refers to the concern for its functional importance as a milk producer. This symbolism is close to the mobile agro-pastoralist cultures in these areas, where animals play a central role in people's socio-economic lives. This is also notable among the figurines of Jebel Moya, the most significant agro-pastoral community on these plains.

In the Meroitic period, similar such symbolism can be observed in the drawing on a copper vessel at the Karanog cemetery, preserved now in the Cairo Museum (item number JE 41017), which presents the pastoral process in Meroitic Nubia. The representation consists of two women appearing in front of the entrance of a local Sudanese hut called a Qotteia. Both of them are naked in the upper part of their chest while facing a group of cattle being milked (Kendall 1984). One woman is sitting on the ground, but the other is younger, standing behind her back. Both women have been drawn with erect nipples (Fig. 11).

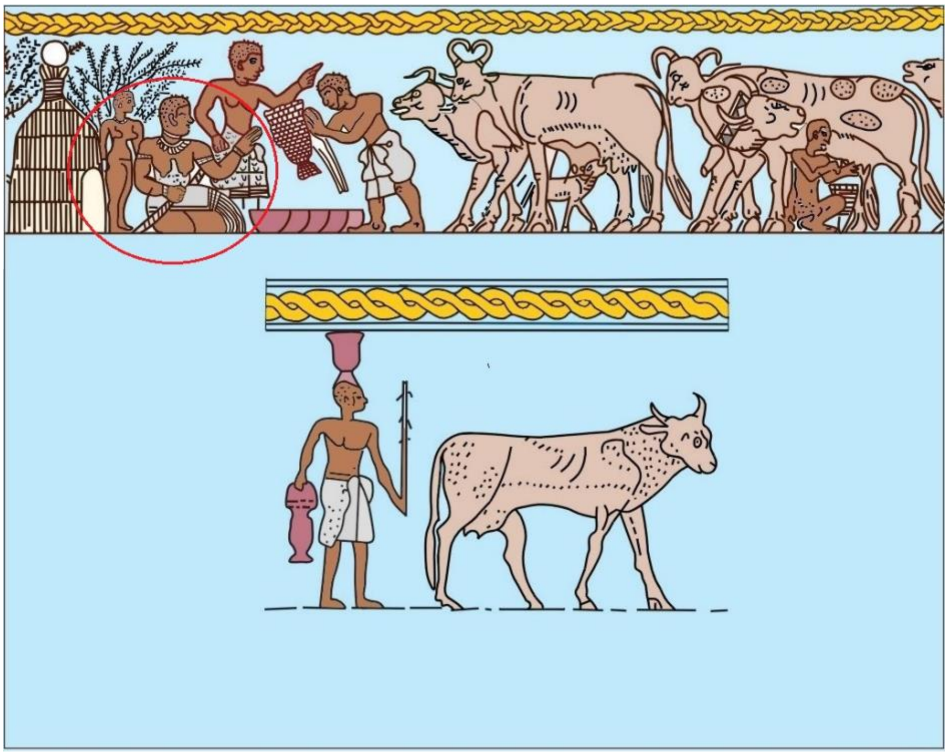

Figure 11. Meroitic drawing on bronze vessel from Karanog, after Woolley and Randall Maclver (1910). Drawing by Ammar Awad (2022).

The Meroitic period appears to comprise a riverine environment because many urban centres were established across the Nile River for more than 1000 km. However, settlements spread more into the plains than in the riverine areas, where pastoral communities dominated in the areas of Butana, Gizera, and the White Nile area to the south of Khartoum. The pastoralists appear more archaeologically in the burials than in the settlements; however, this is likely related to problems of excavation and site identification. According to the classical writer Strabo (see Eide et al. 1998), the island of Meroe was populated partly by nomads, partly by hunters, and partly by farmers.

We know that women occupied important positions in the Kingdom of Kush. The role of the priestess was extremely important in Meroitic religion, and the positions of Queen and Queen Mother were politically significant. Execration texts suggest this importance was of very long duration and point to this being a cultural norm for the area. Royal women who held cultic roles wielded considerable power as King's Mothers, King's Sisters, and King's Daughters (Lohwasser 2001; Phillips 2016).

For the elite women, these roles were not isolated from the general socio-economic contexts for the non-elite women in Meroitic life, which had not been evident archaeologically. Although the figurines fit standard body styles in Meroitic art, they do not look like the women in the reliefs. However, the emphasis on rounded hips and breasts and the interest in full-figured women occur in both, which is considered a beauty standard among the Sudanese. The continuing use of female figurines in this period refers to the constant importance of females in some symbolic aspects.

4. Conclusion

This article reviewed some of the common cultural aspects reflected by female figurines across the different cultural contexts in ancient Sudan, focusing on the Neolithic and Meroitic periods. Previous literature has focused on addressing these objects within the cultural contexts to which they belong without looking for potential similarities regarding continuity and change. The ongoing appearance of female figurines points to the important position afforded to women across history in the Middle Nile region. However, their prominence during the Neolithic and Meroitic periods points to the continued importance of female roles during these specific periods. Female figurines in ancient African contexts have been created and used as devices to help ensure married couples are able to procreate (NOMA 2021). In addition, they are presently linked with ancestral values and traditions, where carved figurines are used in ceremonial functions. For example, during the filling of storage grains (Siwiba) in the Nuba Mountains region of Sudan, where the Sippr is one of the festivals of Nuba and is associated with agriculture and its religious rites. The Sippr of el-Siwiba represents one important rite in Damik. It occurs when the farmer intends to fill the Siwiba with grain. The farmer then notifies the Kugur, who blesses this work with special prayers. The process occurs after decorating the el-Siwiba building on its external side and painting it in black, red and white. Some sticks are also tied around the body of the Siwiba to prevent it from cracking after being filled with grain. Human and animal figurines are then installed on the front side of the el-Siwiba building (Gandul 2015). The discovery of more female figurines in future investigations will shed more light on the continuity and change surrounding the role of women across history in this area.

Acknowledgements

I would like to thank the reviewers for their valuable comments and for providing additional references that strengthened the paper. I am also deeply thankful for the assistance and patience of the Editors at Southern African Field Archaeology.

References

Abramova, I. 1967. Palaeolithic art. U.S.S.R. Arctic Anthropology, 17: 1-179.
Adams, W. 1977. Nubia: Corridor to Africa. London: Allen Lane.
Addison, F. 1949. Wellcome Excavations in the Sudan: I, Jebel Moya 1910-1914. London: Oxford University Press.
Al-Sawwah, F. 1994. The Religion of Man. Damascus: Aladdin Publications (in Arabic).
Arkell, A. 1949. Early Khartoum. London: Oxford University Press.
Arkell, A. 1953. Shaheinab. London: Oxford University Press.

Bahn, P. & Vertut, J. 1988. Images of the Ice Age. New York: Facts on File.
Caneva, I. 1988. El-Geili: The History of a Middle Nile Environment 7000 BC-AD 1500. BAR International Series 424. Cambridge Monographs in African Archaeology 29. Oxford: Oxford University Press.
Cauvin, J. 1972. Religion Neolithgues. Paris: Centre de Recherches d Ecologie et de Prehistoire.
Cauvin, J., Hodder, I., Rollefson, G. et al. 2001. The birth of the Gods and the origins of agriculture: "Review Feature". Cambridge Archaeological Journal, 11(1): 105-121.
Clark, D. 1973. Preliminary Report: Archaeological and Geomorphological Survey in the Central Sudan, January-March 1973. Berkeley: Mimeographed.
Conkey, M. 1983. On the origin of Paleolithic art: A review and some critical thoughts. In: Trinkaus, E. (ed.) The Mousterian Legacy: Human Biocultural Change in the Upper Pleistocene: 201-227. Oxford: BAR Publishing.
Conkey, M. 1987. New approaches in the search for meaning: A review of research in Palaeolithic art. Journal of Field Archaeology, 14 (4): 13-30.
Dunham, D. 1963. The Royal Cemetery of Kush 5 (the West and South Cemeteries at Meroe). The west and south cemeteries at Meroë: Excavated by the late George Andrew Reisner. Boston: Museum of Fine Arts.
Edward, D. 1989. Archaeology and Settlement in Upper Nubia in the First Millennium AD. Cambridge Monographs in African Archaeology, BAR International Series 537. Cambridge: Cambridge University Press.
Eide, T., Hägg, T., Pierce, R. H., et al. (eds) 1998. Fontes Historiae Nubiorum: Textual Sources for the History of the Middle Nile Region Between the Eighth Century BC and the Sixth Century AD. Volume 3: From the First to the Sixth Century AD. Bergen: Bergen University, Institute for klassisk filologi.
El-Atta, H. 2000. The Neolithic and Bronze Age female figurines of Sudan 4th-1st millennium BC. Analyzing the data through Agency. Masters Dissertation. Cambridge: University of Cambridge.
Firth, C. 1912. The Archaeological Survey of Nubia, Report for 1908-1909. Cairo: Government Press.
Firth. C. 1915. The Archaeological Survey of Nubia, Report for 1909-1910. Cairo: Government Press.
Firth. C. 1927. The Archaeological Survey of Nubia, Report for 1910-1911. Cairo: Government Press.
Gandul, G. 2015. Approach to Study the Rophic Tribe: The Socio-cultural and Religious Life in Nuba Mountains, Sudan. London: MBJ (INT).
Geus, F. 1984. Excavations at El Kadada and the Neolithic of the Central Nile. In: Krzyzaniak, L. & Kobusiewicz, M. (eds) Origin and Early Development of Food-producing Cultures in North-eastern Africa: 361-372. Poznan: Archaeological Commission of the Polish Academy of Sciences.
Graham, L. 2020. Similarities among North Mesopotamian (late Halaf), Egyptian (Naqada), and Nubian (A-Group) female figurines of the 6-4th Millennia BCE. Journal of Ancient Egyptian Interconnections, 27: 24-37.
Guthrie, R. 1984. Ethological observations from Palaeolithic art. In: Bandi, H.G., Huber, W., Sauter, M.R., et al. (eds) La Contribution de la Zoologie et de 1'Ethologie al'Interpretation de l'Art des Peuples Chasseurs Prehistoriques "3e Colloque de la Societe Suisse des Sciences Humaines": 35-73. Fribourg: Editions Universitaires.
Haaland, R. 1987. Socio-economic Differentiation in the Neolithic Sudan. British Archaeological Reports International Series 350. Oxford: Archaeopress.
Haaland, R. 1997. Emergence of sedentism: New ways of living, new ways of symbolizing. Antiquity, 71 (374): 385.
Haaland, R. & Haaland, G. 2017. Prehistoric figurines in Sudan. In: Insoll, T. (ed.) Oxford Handbook of Prehistoric Figurines: 85-104. Oxford: Oxford University Press.
Hafsaas, H. 2006. Cattle Pastoralists in a Multicultural Setting. The C-Group People of Lower Nubia 2500-1500 BCE. The Lower Jordan River Basin Programme Publications 10. Ramallah: University of Bergen & Bir Zeit University.
Hamilton, N. 1996. Can we interpret figurines? Cambridge Archaeological Journal, 6 (2): 281-307.
Hodder, I. 2001. Symbolism and the origins of agriculture in the Near East "Review feature". Cambridge Archaeological Journal, 11(1): 105-121.
Hofmann, I. 1977. Die Grosse Gottin des Ostmittelmeerraumes im Meroitischen Reich. Studien zur Altägyptischen Kultur, 5: 79-121.
Hutton, R. 1997. The Neolithic great goddess: A study in modern tradition. Antiquity, 71: 91-99.
Jesse, F. 2008. Time of experimentation? The fourth & third millennia BC in Lower Wadi Howar, Northwestern Sudan. In: Godlewski, W. & Łajtar, A. (eds) Between the Cataracts. Proceedings of the 11th Conference for Nubian Studies: 49-74. Warsaw: Warsaw University.
Kemp, B. 1995. How religious were the ancient Egyptians? Cambridge Archaeological Journal, 5(1): 25-54.
Kendall, T. 1984. Ethnoarchaeology in Meroitic Studies. Fifth International Conference for Meroitic Studies. Berlin: Akademie-Verlag.
Kuckertz, J. & Lohwasser, A. 2019. Introduction to the Religion of Kush. Dettelbach: Verlag J.H. Röll.

Lohwasser, A. 2001. Queenship in Kush: States, Role, and Ideology of Royal Women. Journal of American Research Center in Egypt, 38: 61-78.
Maringer, J. 1966. The Gods of Prehistoric Man. London: Weidenfeld Nicolson.
Magid, A. 1989. Plant Domestication in the Middle Nile Basin: An Archaeo-ethnobotanical Case Study. British Archaeological Reports International Series 523. Oxford: Archaeopress.
Mata, P. 2014. Possible parallels between Egyptian and Sudanese Neolithic figurines and other contemporaneous ones coming from the Near Eastern Area. Boletín de la Asociación Española de Orientalistas, XL: 135-147.
McDermott, L. 1996. Self-representation in Upper Palaeolithic female figurines. Current Anthropology, 37(2): 227-275.
Mohammed-Ali, A. 1973. A re-assessment of the Neolithic Period in the Sudan. Masters Dissertation. Alberta: University of Calgary.
New Orleans Museum of Arts (NOMA) 2021. Maternity figures in African Arts. Available from: https://noma.org/maternity-figures-in-african-art/ (Accessed: 2023).
Nordstrøm, H. 1972. Neolithic and A-Group Sites: Scandinavian Joint Expedition to Sudanese Nubia. Oslo: Norwegian University Press.
Otto, R. 1924. The idea of the Holy. Translated by John W. Harvey. Available from: http://mod.oprsees.ru/main.php?q=rudolf-otto-the-idea-of-the-holy-pdf (Accessed: 2023).
Phillips, J. 2016. Women in ancient Nubia. In: Budin, S.L. & Turfa, J.M. (eds) Women in Antiquity: Real Women from Across the Ancient World: 280-298. Oxfordshire: Routledge.
Rampersad, S. 1999. The origin and relationships of the Nubian A-Group. Doctoral Thesis. Toronto: University of Toronto.
Reinold, J. 2000. Archéologie au Soudan. Les Civilisations de Nubie. Paris: Editions Errance.
Reinold, J. 2001. Kadruka and the Neolithic in the Northern Dongola Reach. Sudan & Nubia, 5: 2-10.
Reisner, G. 1910. The Archaeological Survey of Nubia, Report for 1907-1908. Cairo: Government Press.
Renaut, L. 2020. Tattooed women from Nubia and Egypt: Flesh and bones. In: Alice, M. & Turnhout, B. (eds) The Individual and His Body in the Ancient Mediterranean Basin: 67-87. Belgium: Brepols Press.
Sadig, A. 2005. Es-Sour: A Late Neolithic site near Meroe. Sudan & Nubia, 9: 26-40.
Sadig, A. 2009. Neolithic Adaptations and Subsistence Economy in the Middle Nile Region, Sudan. Bergen: Nile Basin Research Program.
Sadig, A. 2010. The Neolithic of the Middle Nile Region. An Archaeology of Central Sudan and Nubia. Kampala: Fountain Publishers.
Säve-Söderbergh, T. 1968. Preliminary report of the Scandinavian joint expedition. Archaeological investigations between Faras and Gemai: November 1963 to March 1964. Kush, 15: 211-250.
Shinnie, P. & Bradley, R. 1980. The Capital of Kush 1 (Meroe excavations 1965-1972), Meroitica. Berlin: Akademic-verlag.
Smith, S.T. 2003. Wretched Kush: Ethnic Identities and Boundaries in Egypt's Nubian Empire. London: Routledge.
Soffer, O., Vandiver, P., Klima, B., et al. 1993. The pyrotechnology of performance art: Moravian Venusesand wolverines. In: Knecht, H., Pike-Tay, A. & White, R. (eds) Before Lascaux: The Complex Record of the Early Upper Paleolithic: 259-275. Boca Raton: CRC Press.
Spencer, P. 1997. Amara West I. The Architectural Report. London: Egypt Exploration Society.
Stevenson, A. 2017. Predynastic Egyptian figurines. In: Insoll, T. (ed.) The Oxford Handbook of Prehistoric Figurines: 1-24. Oxford: Oxford University Press.
Vandiver, P., Soffer, R., Klima, B., et al. 1989. The origins of ceramic technology at Dolni Vestonice, Czechoslovakia. Science, 246 (4933): 1002-1008.
Waraksa, E. 2007. Female figurines from the Mut Precinct: Context and ritual function. Doctoral Thesis. Baltimore: Johns Hopkins University.
Waraksa, E. 2018. Female figurines (Pharaonic Period). In: Wendrich, W. (ed) UCLA Encyclopedia of Egyptology: 1-6. Los Angeles: UEE.
Woolley, C. & Randall Maclver, D. 1910. Karanog: The Romano-Nubian Cemetery. Philadelphia: University Museum Press.

Southern African Field Archaeology
2024 Vol. 19: Article 3144
Research report (peer-reviewed): Received April 2023; Revised June 2024; Published June 2024
DOI: https://doi.org/10.36615/safa.19.3144.2024

ISSN 1019-5785
ISSN 2789-1844

MIDDLE STONE AGE FAUNA FROM THE RS SUB-MEMBER (MSA I) AT CAVE 1B, KLASIES RIVER MAIN SITE, SOUTH AFRICA

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ABSTRACT
Klasies River is an important site for the study of the evolution of *Homo sapiens*, understanding modern behaviour and human interaction with the environment during the Middle Stone Age. The faunal sample from the RS sub-member in Cave 1B (MSA I), dating to ca. 115 000 years ago and older, was recently analysed. The results indicate that humans were hunting a variety of prey. The most common taxa in the sample are indeterminate medium birds, indeterminate small mammals, rock hyraxes, and indeterminate medium mammals. Based on multiple lines of evidence including the presence of: cultural artefacts, shellfish, tortoises, large mammals, butchery marks, and burnt specimens; and, a lack of carnivore taxa compared to ungulates (as reflected in the low carnivore-ungulate ratio), hyena coprolites and beak damage, coupled with infrequent baboons and the absence of leopards (as reflected in the low leopard index), it is apparent that humans were the main agent of accumulation of the fauna. However, other agents of accumulation such as brown hyenas, leopards and raptors likely contributed some faunal remains, especially of smaller taxa.

Keywords: zooarchaeology, taphonomy, marine isotope stage 5d-e, Klasies Pattern, butchery marks

1. Introduction

The Middle Stone Age (MSA) is an important period for understanding the origins of innovation and complex cognition of *Homo sapiens*. In southern Africa, the MSA dates to between about 300 000 and 40 000 years ago (e.g., Vogel 2001; Wadley 2015; Lombard et al. 2022; Wurz 2024 and references therein). One of the most significant MSA sites in South Africa is the Klasies River Main site (KRM). KRM (34.06° S, 24.24° E; Fig. 1) is located on the Tsitsikamma coast in the Eastern Cape province of South Africa (Singer & Wymer 1982) and situated towards the far south-eastern end of the Greater Cape Floristic Region (GCFR). This region is characterised by non-seasonal rainfall (Van Wijk et al. 2017). KRM has a long sequence of Late Pleistocene deposits and has yielded some of the oldest fossil evidence for anatomically modern humans in South Africa (Singer & Wymer 1982; Deacon & Geleijnse 1988; Grine et al. 2017, 2020). The Main site consists of Caves 1, 1A, 1B and 2. The MSA layers at KRM are dated to between ca. 115 and 48 ka (Wurz et al. 2018, 2022). The MSA at KRM is subdivided into the MSA I, MSA II/Mossel Bay, Howiesons Poort (HP), MSA III and MSA IV industries, occurring within several stratigraphic members (Deacon & Geleijnse 1988). The MSA I layers, related to the fauna investigated here, are associated with the production of regular and relatively long quartzite blades and elongated points, some of which have distinctive platform preparation in the form of thinning and rubbing (Wurz 2023).

John Wymer conducted the first excavations at KRM in 1967 and 1968 in Caves 1, 1A, 1B and 2 (Singer & Wymer 1982). The layers from Cave 1B (layers 1-15) were originally placed in the MSA I, but subsequently some of these layers have been found to be associated with the MSA II (Morrissey et al. 2023). A mesh size of 1x0.5 inches (25x13 mm) was used, and smaller specimens and those considered unidentifiable were discarded at the time (Klein 1976). Later, Hilary Deacon excavated Cave 1B starting in 1984 (Deacon 1989), using stacked sieves with mesh sizes of 3 and 2 mm, and retained all faunal specimens.

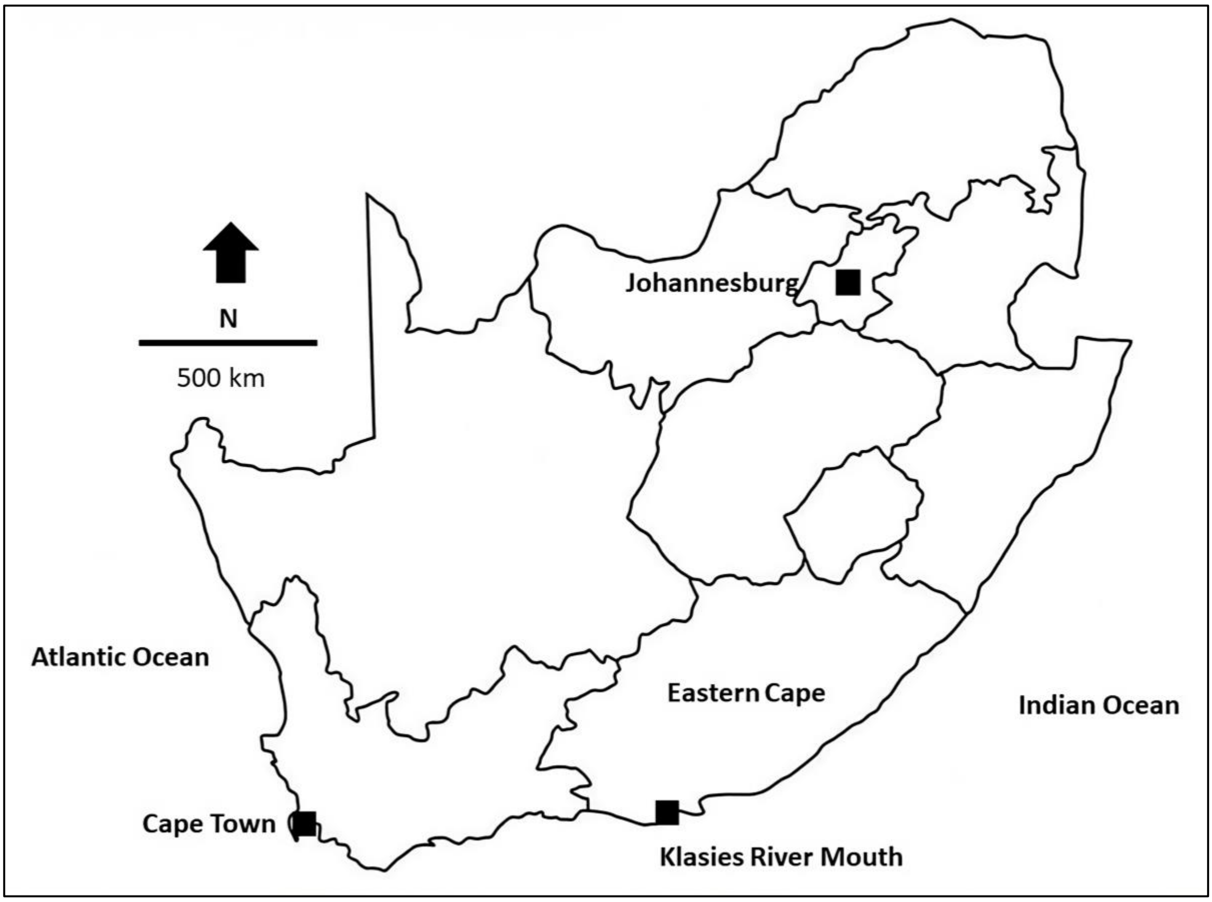

Figure 1. The location of the KRM site in South Africa.

The LBS (Light Brown Sand) member associated with the MSA I industry has been dated to 108.6±3.4 ka (Vogel 2001) in Cave 1, and 106.8±12.6 ka in Cave 1/1A (the area where Caves 1 and 1A intersect) (Feathers 2002). The overlying SAS (Sand and Shell) stratigraphic member with sub-members associated with the MSA II technocomplex is the thickest depositional unit; it dates to between 100.8±2.1 and 85±2.1 ka in Cave 1 (Vogel 2001). The base of the SASL sub-member in Cave 1 has recently been dated to older than 110 ka (Wurz et al. 2022); therefore, the MSA I in Cave 1 and 1B must be older than ca. 115 ka. The faunal sample analysed here comes from the RS (Rubble Sand) sub-member in Cave 1B and is equivalent to the LBS member in Cave 1 (Fig. 2; Morrissey et al. 2023), and thus dates to older than ca. 115 ka. The RS sub-member contains relatively less anthropogenic material compared to the DC (Dark Carbonised) member, although lithics, pebbles, shellfish and animal bones are present (Morrissey et al. 2023). This overlying DC sub-member, equivalent to parts of the SAS member, is dated to ca. 110 ka and corresponds to the MSA II/Mossel Bay technocomplex (Figs 2-3; Wurz 2002).

The animal remains from KRM have been influential in several debates in MSA archaeology, notably focusing on the proficiency of early hunters (e.g., Binford 1984; Thackeray 1990; Milo 1998; Outram 2001; Faith 2008; Dusseldorp 2012; Clark & Kandel 2013) and the Klasies Pattern. Klein (1976; Klein & Cruz-Uribe 1996) argued, based on evidence such as the lack of flying birds, fish, and the presence of docile prey like eland (*Taurotragus oryx*), that MSA humans were less successful hunters when compared with hunters during the Later Stone Age. Today, however, it is widely accepted that MSA humans were successfully hunting large, dangerous prey (e.g., Faith 2008; Dusseldorp 2010, 2012; also see Weaver et al. 2011). The Klasies Pattern refers to the underrepresentation of proximal limb elements like femora and humeri of large bovids relative to more anatomically complete small bovids, a trend first identified by Klein (1976) at KRM. The Klasies Pattern sparked debates as to the cause of the pattern, including scavenging versus hunting (Binford 1984), the *schlepp* effect (Klein 1976), excavator's bias (Turner 1989), and a combination of post-depositional damage, marrow extraction, or agent of accumulation (Bartram & Marean 1999). In this study, the fauna from the RS sub-member excavated by Deacon from Cave 1B was analysed. The aim of the study is to contribute to an understanding of the agent(s) responsible for accumulating the fauna, to assess the prey selection behaviours of humans during the MSA I, to infer aspects of the palaeoenvironment, and to establish if the Klasies Pattern is present in the sample.

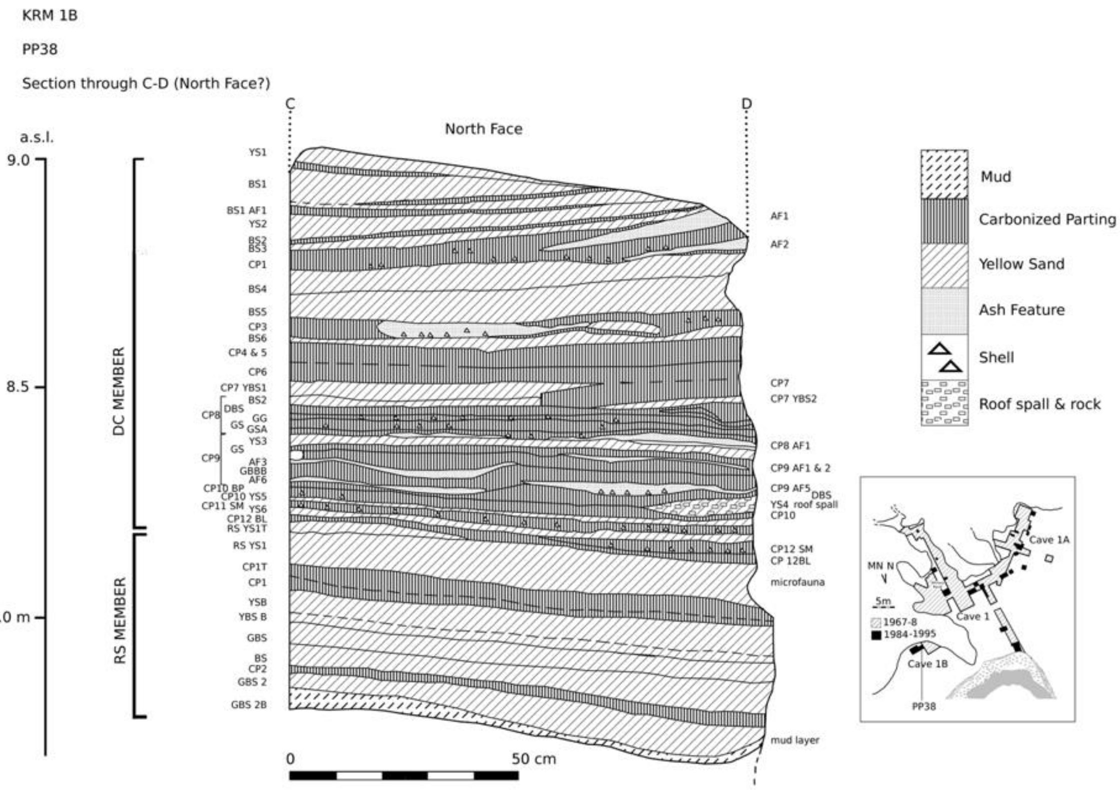

Figure 2. The RS sub-member from KRM Cave 1B, north face (stratigraphic drawing from the Deacon archive of field notes). Note that not all the layers appear on this drawing (see Morrissey et al. 2023 table 3 for a full description of the RS sub-member layers).

2. MSA I fauna and palaeoenvironment

There are very few sites in the southern Cape that relate to the period older than 110 ka. An exception is Pinnacle Point Cave 13B, where small assemblages date to this period (Brenner et al. 2022). Fauna from sites and samples dating from the later MSA II show variability, especially in the Eastern and Western Cape provinces of South Africa. At some sites, such as Blombos Cave (M3 phase) and Diepkloof (lower MSA), humans focused on smaller game, notably rock hyraxes (*Procavia capensis*; Badenhorst et al. 2016) and Cape dune molerats (*Bathyergus suillus*; Steele & Klein 2013), whereas at others, the focus was on small ungulates, such as at Diepkloof (Early HP, Pre-SB Lynn units; Steele & Klein 2013). Common species at coastal sites during the MSA II include hares (Leporidae), Cape dune molerats, rock hyraxes, Cape fur seals (*Arctocephalus pusillus*) and Cape grysbok/steenbok (*Raphicerus* sp.), with a diversity of small, medium and large ungulates (Steele & Klein 2013; Badenhorst et al. 2016).

Previous faunal analyses from the MSA I layers at KRM (Table 1) show that rock hyraxes, Cape fur seals and a variety of ungulates are present (Klein 1976; Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020), in addition to shellfish (Klein 1976; Thackeray 1988; Langejans et al. 2017), fish (von den Driesch 2004; Van Niekerk 2011), micromammals (Nel et al. 2018) and birds (Klein 1976; Avery

1987). Cape dune molerats are absent from the MSA I at KRM. The birds present in the MSA I sample from Cave 1 include great cormorants (*Phalacrocorax carbo*), Cape cormorants (*Phalacrocorax capensis),* gannet (*Morus capensis*), African barn owl (*Tyto capensis*), spotted eagle owl (*Bubo africanus*) and penguins (*Spheniscus demersus*; Klein 1976). There are 82 species of fish from 47 different genera/family. The fish families present in the MSA I LBS from the Cave 1/1A layers are Clinidae, Sparidae, Gobiesocidae with the inclusion of Mugilidae, Carangidae, Teraponidae and Engraulidae (von den Driesch 2004).

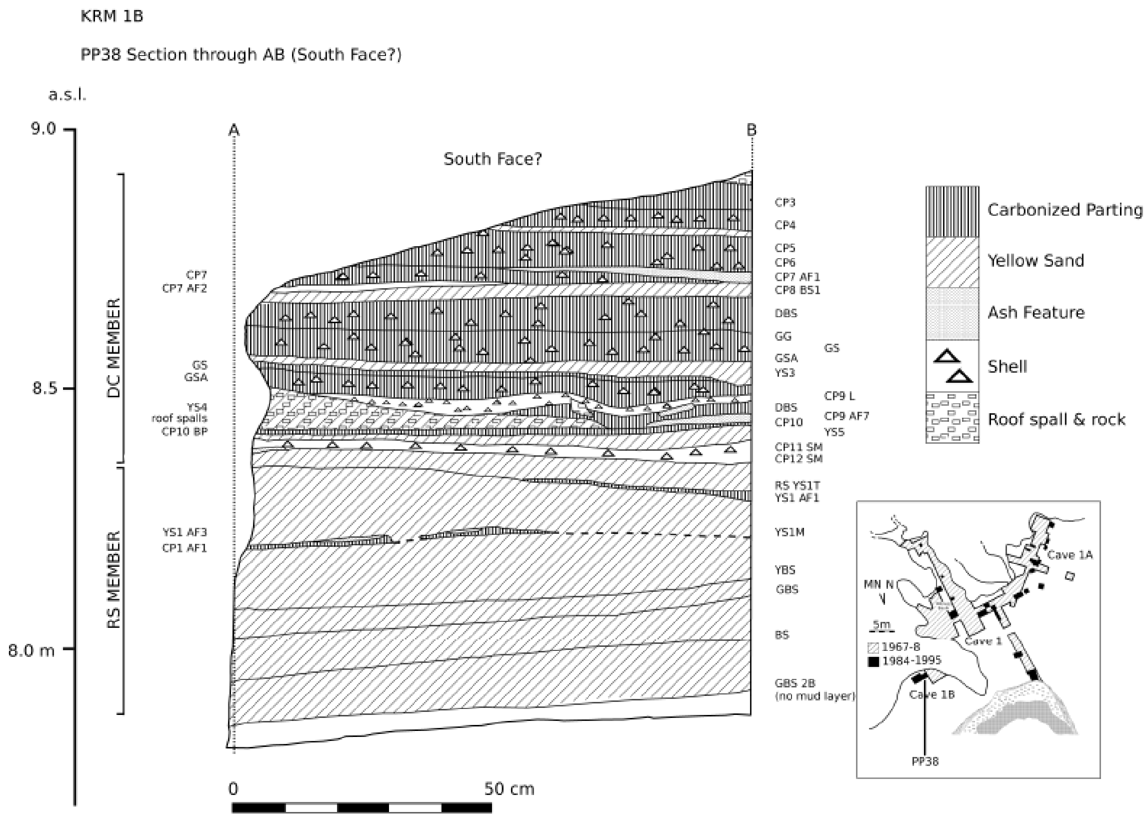

Figure 3. The RS sub-member from KRM Cave 1B, south face (stratigraphic drawing from the Deacon archive of field notes).

At KRM, the MSA I is broadly associated with the Last Interglacial, MIS 5e (Deacon & Geleijnse 1988), although re-dating studies might expand this temporal association (Wurz et al. 2022). This climatic phase, dated to between 130 and 115 ka, was characterised by high sea levels and relatively warm temperatures. The world-wide temperatures during this period were drier and warmer than at present (Langejans et al. 2017; Loftus et al. 2019). The abundance of grazers during the MSA I at KRM suggests grassland environments (Reynard & Wurz 2020; Reynard 2021).

3. Agents of accumulation

Determining the agent(s) of faunal accumulation at cave sites requires multiple lines of evidence and numerous methods have been proposed. Raptors often feed on smaller species, including rock hyraxes, Cape dune molerats and Cape grysbok/steenbok. Raptors often roost in caves and shelters (Klein & Cruz-Uribe 2000). Raptors such as the Cape eagle owls (*Bubo capensis*) feed on the Cape dune molerat, and large quantities of these small mammals may indicate raptor activity. In addition, the predominance of maxillae detached from brain cases, mandibles, and complete long bones as well as digested remains, may further suggest eagle owls (Klein & Cruz-Uribe 2000). Similar patterns for rock hyraxes and hares also suggest raptors as agents of accumulation (Henshilwood et al. 2001; Steele & Klein 2013).

Anthropogenic accumulations are usually inferred by the presence of lithics, hearths, ornamentation, butchery marks, burnt bone, a high fragmentation of long bones, spiral fractures, and a general faunal composition that includes large ungulates and shellfish (Brain 1981; Thompson & Henshilwood 2011). For smaller taxa such as rock hyrax, forelimbs outnumbering hind-limbs, post-crania outnumbering crania (Cruz-Uribe & Klein 1998), and the high fragmentation of long bones (Badenhorst et al. 2014), all indicate human consumption. While the diet niches of hominins overlapped with those of carnivores, the former were able to regularly bring down large and potentially dangerous prey (e.g., Klein & Cruz-Uribe 2000; Van Pletzen 2000; Avery et al. 2008; Rector & Reed 2010; Steele & Klein 2013; Reynard et al. 2016a, b; Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020).

Table 1. Mammal fauna from the MSA I layers at Caves 1, 1/1A and 1B (Klein 1976; Van Pletzen-Vos et al. 2019). * Note that these counts include MSA II taxa.

Taxa (common name)	**Cave 1 (37-39) (MNI)**	**Cave 1B (1-15) (MNI)***	**Cave 1/1A (NISP)**
Procavia capensis (rock hyrax)	4	14	29
Lepus capensis (Cape hare)	-	1	-
Hystrix africaeaustralis (porcupine)	3	1	-
Papio ursinus (chacma baboon)	1	1	-
Homo sapiens (human)	2	1	-
Panthera pardus (leopard)	1	-	-
Atilax paludinosus (water mongoose)	1	1	-
Lupulella mesomelas (black-backed jackal)	-	1	-
Aonyx capensis (clawless otter)	1	-	-
Arctocephalus pusillus (Cape fur seal)	11	21	13
Indeterminate carnivore	-	-	2
Diceros bicornis (black rhinoceros)	1	-	-
Equus cf. *quagga* (zebra/quagga)	2	-	2
Delphinidae (dolphin)	3	-	-
Cetacea (whale)	2	-	-
Indeterminate Cetacea (whale/dolphin)	-	-	1
Potamochoerus larvatus (bushpig)	4	1	-
Phacochoerus africanus (warthog)	2	-	-
Suid sp. (bushpig/warthog)	-	-	1
Hippopotamus amphibius (hippopotamus)	6	2	5
Syncerus caffer (Cape buffalo)	11	1	3
Pelorovis antiquus (giant buffalo)	18	1	5
Tragelaphus strepsiceros (greater kudu)	3	-	1
Tragelaphus scriptus (bushbuck)	3	1	-
Taurotragus oryx (eland)	21	9	5
Connochaetes sp. (wildebeest)	5	2	-
Alcelaphus buselaphus (hartebeest)	3	2	-
Alcelaphus/Connochaetes (hartebeest/wildebeest)	-	-	3
Pelea capreolus (grey rhebok)	-	-	4
Hippotragus leucophaeus (blue antelope)	16	-	-
Redunca arundinum (southern reedbuck)	4	-	-
Redunca fulvorufula (mountain reedbuck)	4	1	-
Sylvicapra grimmia (common duiker)	-	-	2
Raphicerus melanotis (Cape grysbok)	4	-	-
Raphicerus sp. (Cape grysbok/steenbok)	-	-	1
Indeterminate bovid	-	-	9
Large	-	-	34
Large medium	-	-	73
Small medium	-	-	48
Small	-	-	26
Indeterminate mammal	-	-	24
Total	**136**	**61**	**291**

It is conceivable that carnivores, in particular brown hyenas (*Hyeana brunnea*), as well as leopards (*Panthera pardus*) made use of shelters as lairs (Brain 1981; Skinner & Chimimba 2005; Reynard & Henshilwood 2019) when humans were not occupying them. Carnivores could have left remains of their prey in these caves, and such remains would have eventually become incorporated with anthropogenic accumulations. In fact, some MSA samples from the Eastern and Western Cape do show some ephemeral carnivore activity, especially in accumulating some small ungulate remains (e.g., Marean et al. 2000; Thompson 2010; Thompson & Henshilwood 2011; Faith 2013; Reynard & Henshilwood 2017, 2019). Bone deposits from caves and shelters that have been accumulated by brown hyenas often have certain characteristics, such as chew marks (Blumenschine 1988), the presence of juvenile hyena remains (Kuhn et al. 2010), hyena coprolites (Cruz-Uribe 1991) and a lack of cultural artefacts (Scott & Klein 1981). Moreover, a high ratio of carnivore versus ungulate remains (based on either the Number of Identified Specimens [NISP] or the Minimum Number of Individuals [MNI]) is also indicative of hyena activity, since brown hyenas frequently prey on other carnivores (Scott & Klein 1981; Kuhn et al. 2010). Samples accumulated by brown hyenas also often show a great diversity of carnivore remains (e.g., Scott & Klein 1981; Pickering 2002). For example, Kuhn et al. (2010) suggested that a high MNI value of 30% or more carnivores, compared to ungulates, indicate brown hyena assemblages. Hominins consumed and interacted less frequently with carnivores (Scott & Klein 1981; also see Val et al. 2020). Transverse breakage on long bones and bone showing digestive damage also indicate carnivore activity (Brain 1981). Leopards often prey on medium-sized ungulates, baboons (*Papio ursinus*) and rock hyraxes (*Procavia capensis*) (Brain 1981; Thackeray 1990; Badenhorst et al. 2014), and the presence of these animals, especially baboons, may be an indicator of leopard activity.

As discussed previously (e.g., Badenhorst & Kimambo 2020; Badenhorst et al. 2021, 2022b, and references therein), these criteria often have several limitations. Considering the frequency of butchery marks, various ethno-archaeological and actualistic studies have found that smaller animals were usually brought back to sites intact, where they were roasted whole over fires leaving little or no butchering evidence on carcasses (e.g., Lee 1979; Harako 1981; Bartram et al. 1991; Jones 1993; Badenhorst et al. 2014; Clark 2019). In fact, even specimens of larger mammals may show little evidence of butchery despite slaughtering (Parsons & Badenhorst 2004). Moreover, the frequencies of butchery marks are influenced by the size, species, sex and preparation of the animal butchered, the type and characteristic of the tools used, and the skill and experience of the butcher (see summary in Badenhorst & Kimambo 2020).

Detailed taphonomic studies using magnification have been able to increase the observed frequencies of butchery and carnivore marks on specimens (e.g., Reynard et al. 2014; Armstrong 2016), although such studies have their limitations. This is because the meaning of higher observed frequencies (or relative abundance of a modification compared to another abundance of a modification; Thompson et al. 2017), is complicated by various factors, especially when applied to small mammals. Differential preservation of skeletal elements and other taphonomic factors (Brain 1967) further complicates any frequency study of taphonomic modifications. While digested bones of small mammals are usually considered to be the result of carnivore or raptor activity, humans would also often swallow skeletal remains (Clary 1987; Dewar & Jerardino 2007; Reinhard et al. 2007; Badenhorst et al. 2016; Clark 2019). Similar factors affect the frequency of carnivore marks. While the frequency of chew marks is high in bone collections of modern dens of brown hyenas (often 50% or more; Kuhn et al. 2010), for fossil samples however, this frequency is often quite low. The frequency of chew marks left by brown hyenas is influenced by various factors, including the size of the prey, bone density, length of fragment, the size of clans and the time spent to access a carcass (Faith 2007; Fourvel et al. 2015). For example, at Deelpan in the Free State province of South Africa, a Late Holocene sample occurs that lacks cultural artefacts but contains hyena coprolites, and only 2% of the fauna showed chew marks (Scott & Klein 1981). Humans consuming meat can also leave tooth marks on bones (Brain 1967; Romero et al. 2016). The size of the hyena tooth marks (Pobiner 2008) on bones overlaps with other carnivores such as lions (*Panthera leo*; Delaney-Rivera et al. 2009).

While the carnivore-ungulate ratio is useful for samples that were quantified using the same method, such as NISP or MNI, comparing results quantified using different methods is more problematic (i.e., NISP vs. MNI; see Badenhorst et al. 2021). Often, like in the case of many MSA sites from the Eastern and Western Cape in South Africa, the Cape fur seal makes up a substantial proportion of the fauna (e.g., Klein 1976; Grine & Klein 1993; Klein & Cruz-Uribe 2000; Van Pletzen 2000; Avery et al. 2008; Rector & Reed 2010; Badenhorst et al. 2016; Reynard & Wurz 2020), thus potentially masking the role of other agents of accumulation (for this reason, Badenhorst et al. 2021 excluded seals from their carnivore-ungulate calculations). All these factors highlight the notion that different approaches have unique strengths and limitations, and multiple lines of evidence are often the best approach to infer the role of various potential agents of accumulation.

4. Materials and methods

Deacon (1989) excavated the fauna from square PP38 in Cave 1B (Fig. 4) as part of the RS sub-member. The excavation area was 1x1 m in size, although the lowermost section was not fully excavated (Morrissey et al. 2023). The faunal identification method suggested by Driver (2005) was used for this study. According to this method, all specimens are considered identifiable when the element can be determined. The remaining specimens are considered unidentified. The identifications were done using the collections housed at the Evolutionary Studies Institute of the University of the Witwatersrand, and the Ditsong National Museum of Natural History in Tshwane. The layers are treated as a single unit in this paper but were originally analysed separately (see Ezeimo 2022 for fauna per layer). The indeterminate bovid size classes follow Brain (1974), and specimens identified to an indeterminate size class were counted separately from specimens identified to species or genera (e.g., Badenhorst & Plug 2012; also see Klein 1976). Teeth of rock hyraxes were aged using criteria established by Steyn and Hanks (1983). The NISP is the most commonly used method of quantification used by zooarchaeologists (e.g., Grayson 1984; Plug & Plug 1990; Lyman 2008) and it is used in this study. Teeth embedded in mandibles and maxillae are considered as separate elements in NISP calculations. The MNI is a highly problematic method of quantification (e.g., Plug & Plug 1990; O'Connor 2000), which also applies to the derivatives of this method – the Minimum Number of Elements (MNE) and the Minimum Animal Units (MAU, %MAU; Binford 1984; Lyman 2008); none were used in this study. However, we used a normed NISP for bovid skeletal part representation. This was calculated by using the NISP of an element, and dividing this by the number of times the particular element occurs in a bovid skeleton (Reynard & Henshilwood 2017).

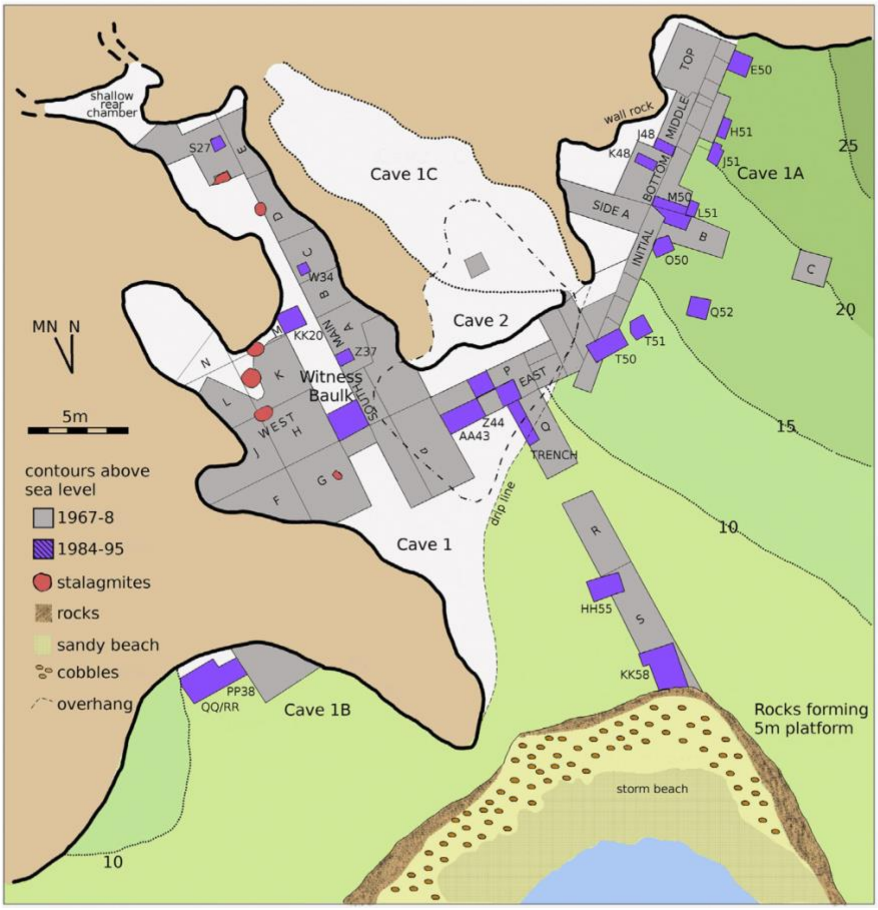

Figure 4. The location of the excavations in Cave 1B (from Wurz et al. 2018).

Taking the caveats of determining the agent(s) of faunal accumulation into consideration (as discussed above), we used the following approaches: first, we recorded all visible taphonomy using naked-eye observations. Second, we subjected a random sample of 100 unidentified specimens to microscopic analyses using an Olympuz SZ51 microscope with 40x magnification. Third, we used the carnivore-ungulate and leopard ratios to infer the role of hyenas and leopards (Klein 1975; Brain 1981; Thackeray 1979, 1990; Badenhorst et al. 2022a). The carnivore-ungulate ratio is calculated by using the carnivore NISP (without Cape fur seals, following Badenhorst et al. 2021) divided by the total ungulates, and multiplied by 100. The leopard index is calculated by adding leopard and baboon NISPs, and dividing it by the total ungulate NISP, multiplied by 100 (Thackeray 1990). Fourth, we used the skeletal part representation of rock hyraxes to infer the role of humans, leopards and raptors as potential agents of accumulation (Klein & Cruz-Uribe 2000).

5. Results

Sample size

The total faunal sample consists of 19 255 specimens from the different layers of the RS sub-member, of which 1219 (6%) were identified (Table 2). Most of the identified specimens (n=1016, or 82%) are between 0.1 and 3 cm in length, indicating a highly fragmented sample (Fig. 5).

Table 2. The faunal sample from the RS sub-member (see Morrissey et al. 2023 table 3, for layer descriptions).

Layer	Identified specimens	Unidentified specimens	Total	% Identified specimens
BR	14	20	**34**	41%
BRAF	3	33	**36**	8%
BRU	9	158	**167**	5%
BSH2	68	164	**232**	29%
BYS1	4	2	**6**	67%
BSH1	32	116	**148**	22%
BSH2BH	15	66	**81**	19%
BCH	89	712	**801**	11%
Y/SH	37	262	**299**	12%
DRU	35	536	**571**	6%
YRU	75	966	**1041**	7%
GBS2B	100	1066	**1166**	9%
GBS2	101	1267	**1368**	7%
CP2	20	413	**433**	5%
CP2T	42	1460	**1502**	3%
BS	66	1376	**1442**	5%
GBS	28	487	**515**	5%
YBSB	57	689	**746**	8%
YBS	157	1858	**2015**	8%
CP1	17	1511	**1528**	1%
CP1T	8	194	**202**	4%
YS1	22	88	**110**	20%
YS1M	177	3455	**3632**	5%
YS1T	46	1134	**1180**	4%
Total	**1222**	**18 033**	**19 255**	**6%**

Taxa present

The sample contains mammals, birds, reptiles, amphibians, and fish (Table 3). The most common taxa are indeterminate medium birds (21%), indeterminate small mammals (12%), rock hyraxes (11%) and indeterminate medium mammals (9%). Bovids include Cape grysbok/steenbok, which are present in most layers (Ezeimo 2022), as well as mountain (*Redunca fulvorufula*) and southern reedbuck (*Redunca arundinum*), oribi (*Ourebia ourebia*), grey rhebok (*Pelea capreolus*), roan/sable/blue antelope (*Hippotragus* sp.), wildebeest/hartebeest (Alcelaphaline sp.), eland, Cape buffalo (*Syncerus caffer*) and giant buffalo (*Syncerus antiquus*). The indeterminate Bovid I specimens are likely Cape grysbok/steenbok. Many of the indeterminate small mammals are likely rock hyrax. The single baboon specimen is a first phalanx. The only rodent taxa identified is the vlei rat (*Otomys* sp.). There are three vertebrae that are potentially from dolphins or whales. Bird remains consist of penguin, the Cape cormorant and the eagle owl (*Bubo* sp.). Many of the indeterminate medium birds are most likely penguins. Other taxa include tortoise/turtle (Testudinidae sp.), toad or frog, and only seven fish vertebrae specimens.

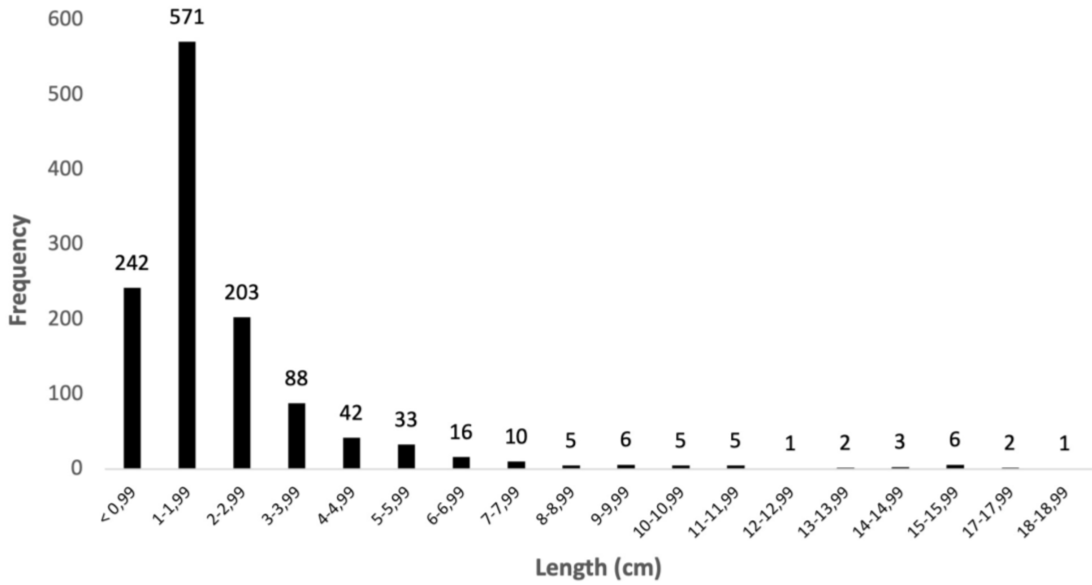

Figure 5. Length categories of the identified specimens (NISP).

The identified sample is sufficiently large to be representative of the original animal population (Fig. 6; Badenhorst et al. 2022b). The carnivore-ungulate ratio, using the entire sample, is very low (0.43), which is much lower than the average anthropogenic carnivore-ungulate ratio for MSA sites in the Eastern and Western Cape of South Africa (3.10). Moreover, this ratio is also well below hyena samples from the same region, which averages 18.58 (Badenhorst et al. 2021). The leopard index is equally very low (0.43) for the RS sub-member, and similar to other MSA anthropogenic accumulations in the Eastern and Western Cape (average of 0.25), and well below the average for leopard samples (10.47; Badenhorst et al. 2021). The low carnivore-ungulate and leopard ratios suggest that the RS sub-member has very low probabilities of hyena or leopard activity.

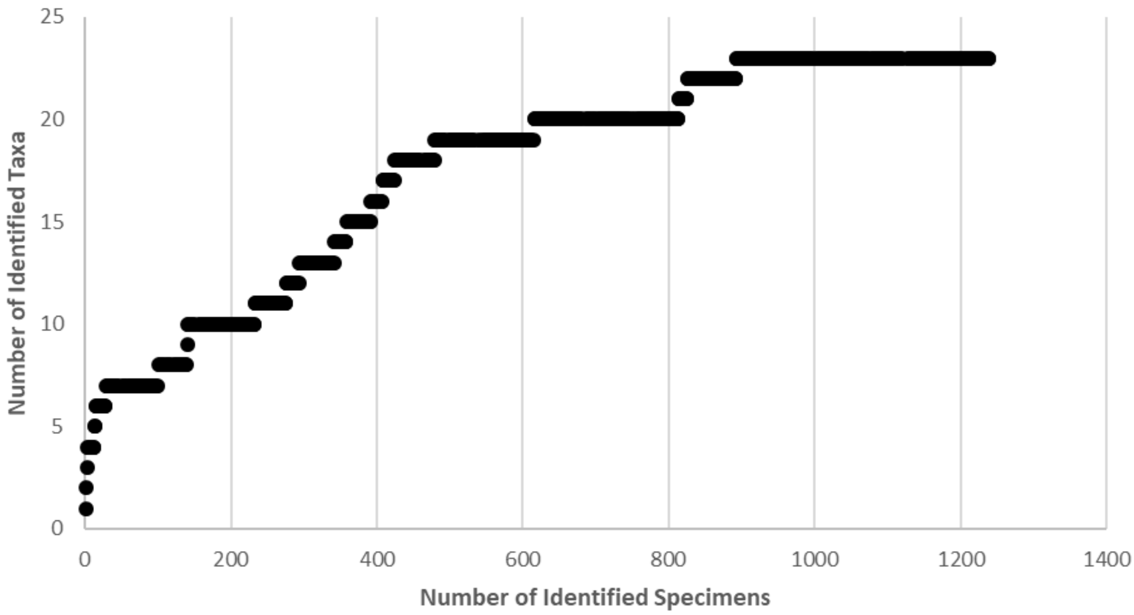

Figure 6. Taxa accumulation curve of the sample (calculated using NISP and nTaxa).

Table 3. The NISP of identified taxa from the RS sub-member. The order of the mammals follows Skinner and Chimimba (2005).

Taxa (common name)	Total NISP	%NISP
Otomys sp. (vlei rat)	8	1%
Small rodent	43	4%
Procavia capensis (rock hyrax)	133	11%
cf. *Procavia capensis* (possibly rock hyrax)	3	<1%
Papio ursinus (chacma baboon)	1	<1%
Arctocephalus pusillus (Cape fur seal)	57	5%
Small carnivore	1	<1%
Cetacea (dolphin/whale)	3	<1%
Syncerus caffer (Cape buffalo)	3	<1%
cf. *Syncerus caffer* (possibly Cape buffalo)	1	<1%
Syncerus antiquus (giant buffalo)	2	<1%
Taurotragus oryx (eland)	3	<1%
Alcelaphaline sp. (hartebeest/wildebeest)	4	<1%
Pelea capreolus (grey rhebok)	1	<1%
Hippotragus sp. (roan/sable/blue antelope)	8	1%
Redunca arundinum (southern reedbuck)	1	<1%
Redunca fulvorufula (mountain reedbuck)	7	1%
Redunca sp. (southern/mountain reedbuck)	9	1%
cf. *Redunca* sp. (possibly southern/mountain reedbuck)	1	<1%
Ourebia ourebia (oribi)	1	<1%
Raphicerus sp. (Cape grysbok/steenbok)	27	2%
cf. *Raphicerus* sp. (possibly Cape grysbok/steenbok)	1	<1%
Bovid I	64	5%
Bovid II	41	3%
Bovid II/III	2	<1%
Bovid III	50	4%
Bovid III/IV	2	<1%
Bovid IV	1	<1%
Small mammal	152	12%
Small/medium mammal	2	<1%
Medium mammal	116	9%
Large mammal	34	3%
Bubo sp. (eagle owl)	17	1%
Phalacrocorax capensis (Cape sea gull)	5	<1%
Spheniscus demersus (African penguin)	38	3%
Small bird	71	6%
Small/medium bird	13	1%
Medium bird	258	21%
Testudinidae sp. (tortoise/turtle)	27	2%
Amphibian sp. (frog/toad)	1	<1%
Fish	7	1%
Total NISP	**1219**	**-**

Taphonomy

Burnt specimens are indicative of hominin involvement in accumulating the fauna. Most of the layers contain burnt specimens (Table 4), and 13% of the total sample is burnt. A variety of colours were observed, including brown (Fig. 7), black, grey and white, of which black, grey and brown colouring are most common; white colouring is not common. One shell fragment of a tortoise/turtle from layer GBS2B had localised, black burning on it.

Most layers contain evidence for butchery (Table 5; Fig. 8) indicating hominin involvement in accumulating the fauna. While the microscopic analysis of the unidentified specimens was able to increase the frequency of butchery marks, overall, only less than 1% of the total sample contains such evidence. The taxa with butchery evidence include Cape fur seal (n=1), medium carnivore (n=1), Bovid I (n=3), Bovid II (n=5), Bovid III (n=2), large mammal (n=1), as well as unidentified specimens (n=41).

Table 4. The number of burnt specimens per colour for each layer.

Layer	Burnt brown	Burnt black	Burnt grey	Burnt white	Total burnt	Total faunal sample	% burnt
BR	0	2	3	1	**6**	34	18%
BRAF	0	0	9	2	**11**	36	31%
BRU	1	21	9	2	**33**	167	20%
BSH2	0	29	8	9	**46**	232	20%
BSH2BH	0	16	1	3	**20**	81	25%
BSH1	5	8	4	11	**28**	148	19%
BCH	26	55	11	12	**104**	801	13%
Y/SH	12	28	2	7	**49**	299	16%
DRU	42	77	8	23	**150**	571	26%
YRU	15	60	12	50	**137**	1041	13%
GBS2B	0	22	296	28	**346**	1166	30%
GBS2	0	356	0	2	**358**	1368	26%
CP2	1	11	69	11	**92**	433	21%
CP2T	41	51	92	3	**187**	1502	12%
BS	0	60	0	0	**60**	1442	4%
YBSB	38	30	6	10	**84**	746	11%
YBS	120	27	48	12	**207**	2015	10%
CP1	0	5	0	1	**6**	1528	<1%
CP1T	16	27	47	8	**98**	202	49%
YS1	0	3	1	4	**8**	110	7%
YS1M	126	68	83	27	**304**	3632	8%
YS1T	92	8	0	7	**107**	1180	9%
Total	**535**	**964**	**709**	**233**	**2441**	**18 734**	-
%	**22%**	**39%**	**29%**	**10%**	**13%**	-	-

Table 5. The number of specimens with macro- and microscopically-identified marks for each layer.

Layers	Cut marks	Microscopic cut marks	Chop marks	Microscopic chop mark	Total butchery	Total sample	% sample
BS	2	1	1	2	**6**	1442	<1%
BRU	1	0	1	0	**2**	167	1%
BSH2	0	0	2	0	**2**	232	1%
BYS1	1	0	0	0	**1**	6	17%
BCH	4	1	4	0	**9**	801	1%
Y/SH	0	0	1	0	**1**	299	<1%
DRU	0	1	2	0	**3**	571	1%
YRU	2	0	1	0	**3**	1041	<1%
GBS2B	3	2	1	1	**7**	1166	1%
GBS2	1	1	0	0	**2**	1368	<1%
CP2	0	1	2	0	**3**	433	1%
GBS	0	3	0	0	**3**	515	1%
YBSB	0	1	0	0	**1**	746	<1%
YBS	0	1	2	0	**3**	2015	<1%
CP1	0	1	0	0	**1**	1528	<1%
CP1T	0	1	0	0	**1**	202	<1%
YS1	0	1	0	0	**1**	110	1%
YS1M	2	1	0	2	**5**	3632	<1%
Total	**16**	**16**	**17**	**5**	**54**	**16 274**	-
%	**29%**	**29%**	**31%**	**9%**	**<1%**	-	-

The bone surface of three specimens has a polished appearance (Table 6; Fig. 9), possibly caused by use-wear or trampling.

Table 6. Specimens with a polished cortical surface.

Layer	Length	Description
DRU	17.1 mm	Bone fragment with polished surface
CP2T	16.3 mm	Bone flake with polished surface
YS1M	104.5 mm	Bone flake with polished surface

Figure 7. A burnt distal tarsometatarsus (approx. 3 cm long) of an indeterminate medium bird.

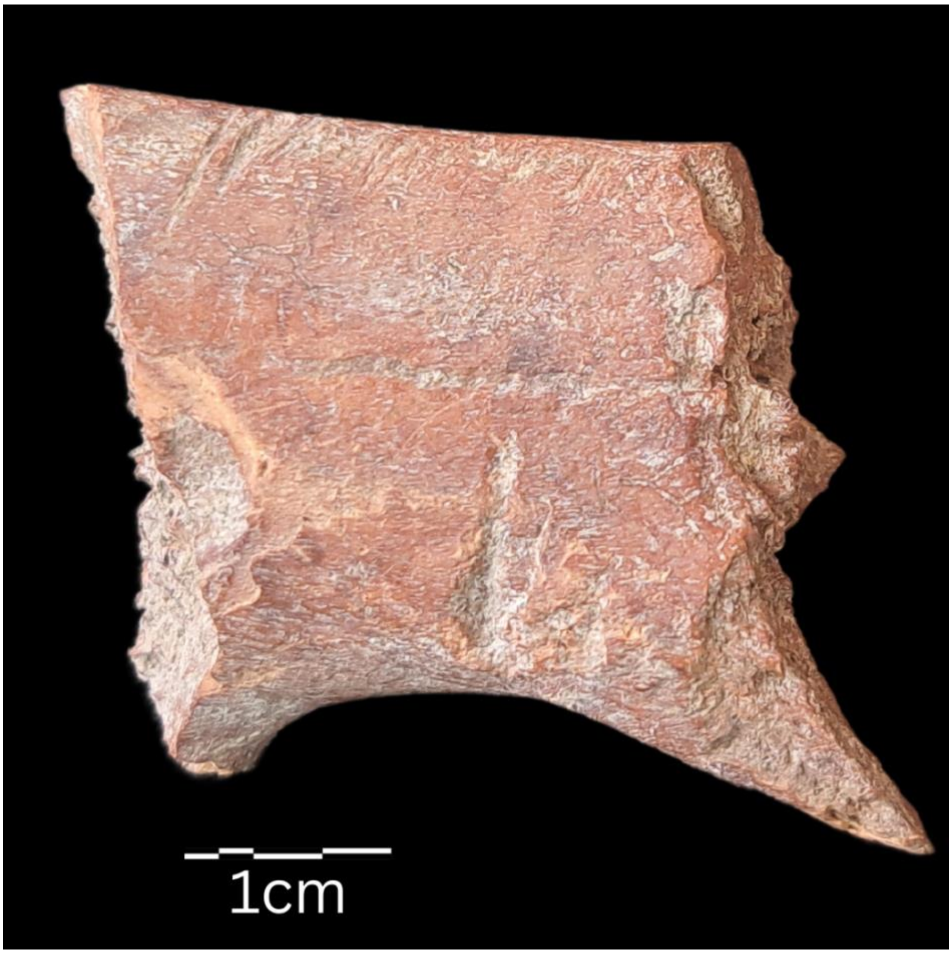

Figure 8. Various butchery marks on a Bovid II pelvis.

Figure 9. Bone flake with a polished surface from layer YS1M.

The breakage of identified long bones (humerus, radius, ulna, metacarpal, femur, tibia, metatarsal and metapodial) indicate that irregular fractures are most common, suggesting dry breaks. This is followed by spiral and transverse breaks (Table 7). Fractures caused by carnivores are uncommon, amounting to less than 1% of the long bones.

Table 7. The number of specimens per fracture type identified on long bones.

Elements	Spiral	Transverse	Irregular	Carnivore	Excavation
Humerus	17	9	49	0	0
Radius	4	0	18	0	0
Ulna	5	1	15	0	1
Carpal	0	3	1	0	0
Metacarpal	3	1	8	0	0
Femur	7	5	45	0	0
Tibia	3	5	12	0	0
Metatarsal	8	8	39	0	0
Metapodial	6	1	20	0	0
Calcaneus	0	0	1	0	0
Tarsals	0	0	1	0	0
First phalanx	8	3	25	0	0
Second phalanx	6	4	22	0	0
Third phalanx	1	1	10	0	0
Phalanx	1	1	18	2	0
Total	**69**	**42**	**284**	**2**	**1**
Percentage	**18%**	**10%**	**71%**	**<1%**	**<1%**

Carnivore chew marks were noted in many layers on the specimens (Table 8), indicating that carnivores were involved in accumulating some fauna. However, carnivore chew marks were found on less than 1% of the total faunal sample. The microscopic analysis of the 100 unidentified specimens did not yield any chew marks. Taxa with carnivore chew marks include Bovid III (n=1), medium mammal (n=2), penguin (n=1), as well as on an unidentified specimen (n=1). Digested remains are also not common and amount to less than 1% of the total faunal sample. Taxa that were digested include small rodent (n=1), rock hyrax (n=5), Cape fur seal (n=3), Cape grysbok/steenbok (n=4), Bovid I (n=2), Bovid II (n=2), small mammal (n=5), medium mammal (n=3), medium bird (n=2), fish (n=1), as well as unidentified specimens (n=6).

Table 8. The number of specimens that show evidence of carnivore chew marks and the number of digested specimens.

Layer	Carnivore chew marks	Digested remains	Total faunal sample	% of total faunal sample
BSH2	0	2	232	1%
BCH	1	1	801	<1%
Y/SH	0	3	299	1%
DRU	0	2	571	<1%
YRU	1	4	1041	<1%
GBS2B	0	1	1166	<1%
GBS2	0	1	1368	<1%
CP2T	1	0	1502	<1%
BS	0	1	1442	<1%
YBSB	0	1	746	<1%
YBS	0	8	2015	<1%
CP1	1	0	1528	<1%
YS1	0	2	110	2%
YS1M	0	6	3632	<1%
YS1T	1	2	1180	<1%
Total	**5**	**34**	**17 633**	-
Percentage of total sample	**<1%**	**<1%**	-	-

A total of seven specimens, amounting to less than 1% of the total sample, showed evidence of rodent gnaw marks. Evidence for rodent gnawing was found in layers BCH (n=1), BSH2 (n=1), YBSB (n=1), YBS (n=2) and YRU (n=2).

Skeletal part representation

The bovid skeletal part representation indicates that Bovid I specimens are most common, followed by Bovid II, Bovid III and only a few Bovid IV elements (Table 9). Combined, most skeletal elements are present (Fig. 10). Lower limbs are particularly common, especially metacarpals, metatarsals, metapodia and tarsals, which are also dense elements that tend to preserve well (e.g., Brain 1981).

Table 9. Bovid skeletal part representation (NISP and normed NISP).

Elements	Bov I	Bov II	Bov II/III	Bov III	Bov III/IV	Bov IV	Total	Normed NISP
Crania								
Horn core	0	0	0	2	1	0	**3**	**2**
Occipital	1	0	0	0	0	0	**1**	**1**
Maxilla	0	2	0	0	0	0	**2**	**1**
Mandible	1	2	0	1	0	0	**4**	**2**
Premolar	2	2	0	0	0	0	**4**	**0**
Molar	0	0	0	1	0	0	**1**	**0**
Tooth fragment	1	1	0	1	0	0	**3**	**-**
Upper limbs								
Scapula	0	0	0	1	0	0	**1**	**1**
Humerus	1	2	0	1	0	0	**4**	**2**
Pelvis	0	2	0	0	0	0	**2**	**1**
Femur	2	3	0	1	0	0	**6**	**3**
Patella	1	0	0	0	0	0	**1**	**1**
Lower limbs								
Radius	4	0	1	0	0	0	**5**	**3**
Ulna	1	2	0	1	0	0	**4**	**2**
Carpal	1	3	0	0	0	3	**7**	**1**
Metacarpal	1	1	0	0	0	0	**2**	**1**
Tibia	3	2	0	0	0	0	**5**	**3**
Metatarsal	0	0	0	0	0	1	**1**	**1**
Metapodial	8	7	0	6	0	0	**21**	**5**
Tarsal	3	2	0	2	0	0	**7**	**4**
Astragalus	4	0	0	1	0	0	**5**	**3**
Calcaneus	2	1	0	1	0	0	**4**	**2**
Sesamoid	4	1	1	4	0	0	**10**	**0**
First phalanx	6	2	0	3	0	0	**11**	**1**
Second phalanx	10	0	0	3	0	0	**13**	**2**
Third phalanx	7	3	0	1	0	0	**11**	**1**
Total	**63**	**38**	**2**	**30**	**1**	**4**	**138**	**-**
%	**46%**	**28%**	**1%**	**22%**	**1%**	**3%**	**-**	**-**

For rock hyraxes, the front (n=26) and hind limb (n=23) are nearly equally represented, but the crania (n=71, excluding teeth) outnumber the post-crania (n=50). The predominance of crania may suggest that some of the rock hyrax remains were accumulated by raptors such as black eagles, or by leopards (Cruz-Uribe & Klein 1998).

Aging

Most bovid specimens are from adult individuals (Ezeimo 2022). However, based on long bone fusion, some neonates are present for Bovid I (n=2), Bovid II (n=1) and Bovid III (n=1), as well as juveniles (Bovid I, n=11; Bovid II, n=5; Bovid III, n=3). For Cape fur seals, most specimens are from adult individuals (Ezeimo 2022), although some juveniles (n=11) and sub-adults (n=1) are present. Using October as the birth peak of rock hyraxes (Skinner & Chimimba 2005), those specimens that could be aged do not show a particular season of death (Table 10).

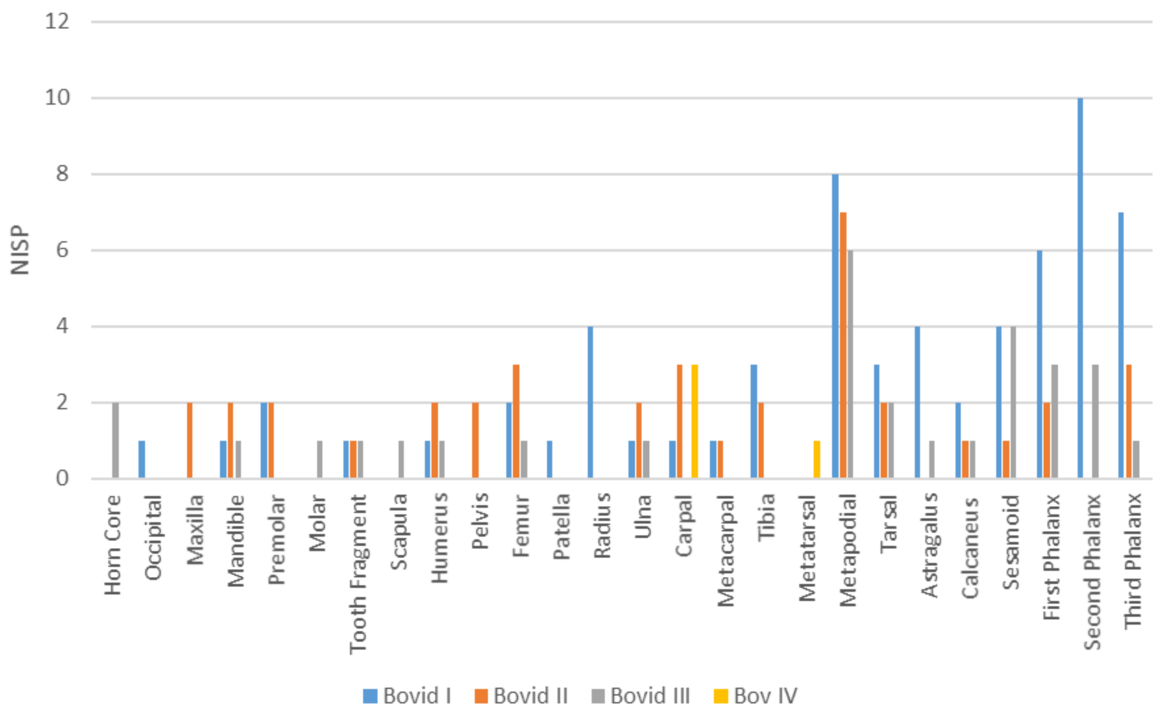

Figure 10. Bovid skeletal part representation for Bovid I, II, III and IV (NISP).

Table 10. Rock hyrax age at death.

Element	Layer	Age class	Age at death range (months)	Month of death
Mandible	YSB	I	0-4	October-January
Mandible	YSB	III	8-10	June-July
Maxilla	GBS2	V	17-19	March-April
Mandible	YS1T	VI	20-22	June-July
Maxilla	GBS	VII	23-27	September-December
Mandible	GBS2B	VII	23-27	September-December

6. Discussion and conclusion

MSA faunal samples from southern Africa, including those from KRM, are usually heavily fragmented (e.g., Marean et al. 2000; Reynard et al. 2016b). For example, the MSA II/Mossel Bay fauna from the Witness Baulk at KRM Cave 1 excavated by Deacon yielded 43% identified specimens, although not all fragments may have been included in the count (Van Pletzen-Vos et al. 2019). From the fauna from squares C1 and B2 in Cave 1 from the Wurz excavation for older MSA II layers, only 6% could be identified (Lap 2020), which is similar to the level of fragmentation in this study. There are several possible reasons for the high level of fragmentation in the RS sample. The most likely causes include burning, butchery and post-depositional fragmentation (cf. Stiner et al. 1995). The sample size used in this study, consisting of a full range of vertebrates, is relatively large (Badenhorst et al. 2022b) indicating it is substantial enough to provide information about the agents of accumulation and subsistence patterns.

Several types of evidence indicate that hominins contributed faunal remains to the RS sub-sample, notably: a presence of cultural artefacts; shellfish remains (Thackeray 1988, 2019); the remains of tortoises, seals and other large mammals (cf. Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020); butchery marks; burnt specimens; the lack of diversity of carnivore taxa compared to ungulates (as reflected in the very low carnivore-ungulate ratio); and a very low number of baboons (as reflected in the very low leopard index; Badenhorst et al. 2021). The values of these two ratios are similar to other MSA sites in the Eastern and Western Cape that were accumulated primarily by humans. Moreover, the sample lacks any beak marks or hyena coprolites. Taken together, the role of humans as an agent of accumulation of the RS sub-sample is beyond any doubt.

However, it is also very likely that other agents, notably carnivores, accumulated at least some of the fauna from the RS sample, especially some of the smaller taxa. This is based on the presence of carnivore chew marks and digested remains (although it is possible for humans to also inflict these types of modifications). Some of the digested remains include Cape grysbok/steenbok. These small bovids are common in both anthropogenic (Klein 1976; Henshilwood et al. 2001; Faith 2011; Badenhorst et al. 2016), hyena (Grine & Klein 1993) and leopard (Klein 1978; Faith 2013) accumulations in the Eastern and Western Cape. Baboon remains are frequently associated with leopard accumulations (see summary in Badenhorst 2022), but it is uncertain if the single baboon phalanx in the sample necessarily implies the involvement of this predator. This may well represent a natural death of a baboon. The skeletal part representation of rock hyraxes suggests the remains were accumulated by either leopards or raptors (Cruz-Uribe & Klein 1998). Brown hyenas often consume fish (Kuhn et al. 2008), and the presence of digested fish may suggest that these carnivores were responsible for their presence.

In addition to the involvement of carnivores in accumulating the RS sub-member, there is also potential evidence for raptor activities. The remains of raptors themselves in the RS faunal sample may represent natural deaths, as they often nest above rock shelters (Taylor 2003). However, the RS faunal sample lacks beak marks (Brain 1981) and some birds were likely accumulated by carnivores, as reflected in the digested remains. The rodent remains may either represent natural intrusions, or prey of raptors (Andrews 1990; Matthews et al. 2009, 2011; Nel & Henshilwood 2021) or carnivores.

The fauna from the RS sample is similar to what has previously been identified from the MSA I at KRM in Cave 1 (Klein 1976) and Cave 1/1A (Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020). The range of larger ungulates from the MSA I at KRM suggest humans were capable hunters (Dusseldorp 2010; Thompson 2010; Thompson & Henshilwood 2011; Clark & Kandel 2013; Dusseldorp & Reynard 2021) using a variety of hunting techniques to acquire prey (Klein 1978; Milo 1998; Dusseldorp 2010; Clark & Kandel 2013). The Game Index, which measures the ratio of small to large game in samples (Badenhorst 2015; Badenhorst et al. 2022a), indicates a sample predominated by ungulates (value of 0.37, considering that the rock hyraxes were likely accumulated by a non-human agent). The Game Index value of the RS sub-sample is higher than other faunal samples from KRM, including Cave 1A MSA III (0.23), Cave 1A SAS Base (0.21), Cave 1A MSA II L (0.17), Cave 1A Upper (0.17), Cave 1A SAS Middle (0.11) and Cave 1A MSA II U (0.09; Badenhorst et al. 2022a). Nevertheless, the overall pattern, based on the Game Index, is that humans at KRM were focusing on hunting larger game animals, notably Cape grysbok/steenbok (although some of these bovids were possibly accumulated by carnivores). Interestingly, the Game Index values are lower for samples accumulated (exclusively or largely) by brown hyenas from the Eastern and Western Cape during the Middle to Late Pleistocene (Pinnacle Point Cave PP30, Sea Harvest, Swartklip, Duinefontein 2, Elandsfontein Bone Circle, and Hoedjiespunt), averaging 0.13 (range of 0.01-0.56; Badenhorst et al. 2022a). This indicates that brown hyenas feed infrequently on small animals such as hares and rock hyraxes.

The Cape fur seal would have been speared from a close distance or clubbed to death (Klein & Cruz-Uribe 1996). However, the presence of digested seal remains in the RS sub-sample suggest that carnivores such as brown hyenas, which frequently consume seals (Kuhn et al. 2008), also contributed specimens of this taxon to the sample. Tortoises, on the other hand, were obtained easily (Henshilwood et al. 2001; Thompson & Henshilwood 2014) and based on historical accounts, tortoises were often cooked whole in their shell (Speth & Tchernov 2002). It is uncertain if the single tortoise/turtle shell from the RS sample, with localised burning, reflects such a cooking method.

Grazing taxa are common during the MSA I at KRM (Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020), suggesting an open environment in the vicinity (also see Reynard 2021). This is also supported by the presence of Cape and giant buffalo in samples from the RS sub-sample in Cave 1B. The open environment is also reflected in the Modified Degree of Vegetation Cover Index (MDVC; Greenacre & Vrba 1984; Thackeray 1990; Badenhorst et al. 2022a), which measures the ratio between kudu (*Tragelaphus strepsiceros*), bushbuck (*Tragelaphus sylvaticus*) and steenbok/grysbok to the total ungulates in a sample. Kudu, bushbuck and Cape grysbok/steenbok prefer closed habitats (Skinner & Chimimba 2005). While the first two ungulates are absent from the RS sub-sample, the MDVC value is relatively high (12). The MDVC values are slightly lower for other MSA samples from KRM, including Cave 1A SAS Base (7), Cave 1A MSA II L (6), Cave 1A SAS Middle (4), Cave 1A MSA II U (3), Cave 1A Upper (3) and Cave 1A MSA III (3; Badenhorst et al. 2022a). Overall, the MDVC values from KRM show that Cape grysbok/steenbok make up a large proportion of the ungulates during the MSA. Both the Cape grysbok and steenbok prefer open environments, provided there is dense cover (Skinner & Chimimba 2005).

MSA humans used rock shelters sporadically, often due to favourable environmental conditions and available resources (Jacobs et al. 2008). The neonate Bovid I specimens from the RS sub-member are most likely Cape grysbok/steenbok, the most common small ungulate in the sample. Cape grysbok give birth throughout the year, but peak between September and December (Novellie et al. 1984; Skinner & Chimimba 2005). The birthing peak of steenbok is also during November-December (Smithers 1971; Skinner & Chimimba 2005), thus suggesting an early summer accumulation for at least part of the RS sub-member. The presence of young Cape fur seals further support occupation during these months. In November, female Cape fur seals are present along the coastline to deliver their pups (Kirkman 2010), and mortality rates of juveniles are high during this time because of predation, trampling, starvation and drowning (De Villiers & Roux 1992).

The Klasies Pattern was heavily debated for several years (e.g., Klein 1976; Bartram & Marean 1999) because the pattern resulted from unidentifiable long bone shaft fragments that were discarded during the Singer-Wymer excavations (Turner 1989; Bartram & Marean 1999; Van Pletzen-Vos et al. 2019; Reynard & Wurz 2020). The Klasies Pattern is present for bovids when all the RS sample layers are combined. Most of the RS sub-sample consists of unidentified specimens. As a result, skeletal part representation usually only indicates patterns within a sub-sample of a faunal assemblage (Badenhorst & Plug 2011).

The fauna from the RS sub-member excavated from Cave 1B at KRM consists of mammals, birds, reptiles, amphibians and fish. Overall, there are convincing indications that humans accumulated a substantial portion of the fauna. MSA humans were able to hunt and obtain a variety of animals. However, there are also indications that some taxa, many of which are smaller in body size, were accumulated by agents such as carnivores and raptors. The fauna suggests the presence of open environments close to KRM during MIS5.

Acknowledgements
The support of the DSI-NRF Centre of Excellence in Palaeosciences (CoE-Pal) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the CoE. We thank staff from the Evolutionary Studies Institute at Wits and the Ditsong National Museum of Natural History for access to collections.

References

Andrews, P. 1990. Owls, Caves and Fossils: Predation, Preservation and Accumulation of Small Mammal Bones in Caves, with an Analysis of the Pleistocene Cave Faunas from Westbury-sub-Mendip, Somerset, U.K. Chicago: University of Chicago Press.

Armstrong, A. 2016. Small mammal utilization by Middle Stone Age humans at Die Kelders cave 1 and Pinnacle Point site 5-6, Western Cape Province, South Africa. Journal of Human Evolution, 101: 17-44.

Avery, G. 1987. Coastal birds and prehistory in the Western Cape. In: Parkington, J. & Hall, M. (ed.) Papers in the Prehistory of the Western Cape, South Africa: 164-191. Oxford: British Archaeological Reports International Series.

Avery, G., Halkett, D., Orton, J., et al. 2008. The Ysterfontein 1 Middle Stone Age Rock Shelter and the evolution of coastal foraging. South African Archaeological Society Goodwin Series, 10: 66-89.

Badenhorst, S. 2015. Intensive hunting during the Iron Age of southern Africa. Environmental Archaeology, 20(1): 41-51.

Badenhorst, S. 2022. Citizens of the savanna: An account of three million years of interaction between baboons and hominins in South Africa. In: Urbani, B., Youlatos, D. & Antczak, A.T. (eds) World Archaeoprimatology: Interconnections of Humans and Nonhuman Primates in the Past: 375-392. Cambridge: Cambridge University Press.

Badenhorst, S. & Kimambo, J.S. 2020. The frequency of butchery marks on goat (Capra hircus) remains from pastoral Khoekhoe villages at Gobabeb, Namibia. Indago, 36: 1-12.

Badenhorst, S., Ezeimo, J., Lebatla, L.T., et al. 2022a. Variability in hunting behaviour during the Middle Stone Age in the Eastern and Western Cape of South Africa. Journal of Archaeological Science: Reports, 44: 103527.

Badenhorst, S., Ezeimo, J., Van Niekerk, K.L., et al. 2021. Differential accumulation of large mammal remains by carnivores and humans during the Middle Stone Age in the Eastern and Western Cape, South Africa. Journal of Archaeological Science: Reports, 35: 102752.

Badenhorst, S., Mthombothi, N., Van Niekerk, K.L., et al. 2022b. An initial assessment of zooarchaeological assemblage sizes from South Africa. Revue de Paléobiologie, 41(1): 1-10.

Badenhorst, S. & Plug, I. 2011. Unidentified specimens in zooarchaeology. Palaeontologica Africana, 46: 89-92.

Badenhorst, S. & Plug, I. 2012. The faunal remains from the Middle Stone Age levels of Bushman Rock Shelter in South Africa. South African Archaeological Bulletin, 16: 16-31.

Badenhorst, S., Van Niekerk, K.L. & Henshilwood, C.S. 2014. Rock hyraxes (Procavia capensis) from Middle Stone Age Levels at Blombos Cave, South Africa. African Archaeological Review, 31: 25-43.

Badenhorst, S., Van Niekerk, K.L. & Henshilwood, C.S. 2016. Large mammal remains from the 100 ka Middle Stone Age layers of Blombos Cave, South Africa. South African Archaeological Bulletin, 71: 46-52.

Bartram, J.L. & Marean, C.W. 1999. Explaining the "Klasies Pattern": Kua ethnoarchaeology, the Die Kelders Middle Stone Age archaeofauna, long bone fragmentation and carnivore ravaging. Journal of Archaeological Science, 26: 9-29.

Bartram, L.E., Kroll, E.M. & Bunn, H.T. 1991. Variability in camp structure and bone food refuse patterning at Kua San hunter-gatherer camps. In: Kroll, E.M. & Price, T.D. (eds) The Interpretation of Archaeological Spatial Patterning: 77-148. New York: Plenum.

Binford, L.R. 1984. Faunal Remains from Klasies River Mouth. New York: Academic Press.

Blumenschine, R.J. 1988. An experimental model of the timing of hominid and carnivore influence on archaeological bone assemblages. Journal of Archaeological Science, 15: 483-502.

Brain, C.K. 1967. Hottentot food remains and their bearing on the interpretation of fossil bone assemblages. Scientific Papers of the Namib Desert Research Station, 32: 1-7.

Brain, C.K. 1974. Some suggested procedures in the analysis of bone accumulations from southern African Quaternary sites. Annals of the Transvaal Museum, 29: 1-8.

Brain, C.K. 1981. The Hunters or the Hunted? An Introduction to African Cave Taphonomy. Chicago: University of Chicago Press.

Brenner, M., Ryano, K. & Wurz, S. 2022. Coastal adaptation at Klasies River main site during MIS 5c/d (93-110 000 years ago) from a southern Cape Perspective. Journal of Island & Coastal Archaeology, 17(2): 218-245.

Clark, J.L. 2019. The Still Bay and pre-Still Bay fauna from Sibudu Cave: Taphonomic and taxonomic analysis of the macromammal remains from the Wadley excavations. Journal of Paleolithic Archaeology, 2: 26-73.

Clark, J.L. & Kandel, A.W. 2013. The evolutionary implications of variation in human hunting strategies and diet breadth during the Middle Stone Age of southern Africa. Current Anthropology, 54: 269-287.

Clary, K.H. 1987. Coprolites from Pueblo Alto. In: Mathien, F.J. & Windes, T.C. (eds) Investigations at the Pueblo Alto Complex, Chaco Canyon, New Mexico, 1975-1979. Volume III, Part 2, Artifactual and Biological Analyses: 785-788. Santa Fe: National Park Service.

Cruz-Uribe, K. 1991. Distinguishing hyena from hominid bone accumulations. Journal of Field Archaeology, 18(4): 467-486.

Cruz-Uribe, K. & Klein, R.G. 1998. Hyrax and hare bones from modern South African eagle roosts and the detection of eagle involvement in fossil bone assemblages. Journal of Archaeological Science, 25: 135-147.

De Villiers, D.J. & Roux, J.P. 1992. Mortality of newborn pups of the South African fur seal Arctocephalus pusillus pusillus in Namibia. South African Journal of Marine Science, 12: 881-889.

Deacon, H.J. 1989. Late Pleistocene palaeoecology and archaeology in the southern Cape, South Africa. In: Mellars, P. & Stinger, C.B. (eds) The Human Revolution: 547-564. Edinburgh: Edinburgh University Press.

Deacon, H.J. & Geleijnse, V.B. 1988. The stratigraphy and sedimentology of the main site sequence, Klasies River, South Africa. South African Archaeological Bulletin, 43: 5-14.

Delaney-Rivera, C., Plummer, T.W., Hodgson, J.A., et al. 2009. Pits and pitfalls: Taxonomic variability and patterning in tooth mark dimensions. Journal of Archaeological Science, 36: 2597-2608.

Dewar, G. & Jerardino, A. 2007. Micromammals: When humans are the hunters. Journal of Taphonomy, 5(1): 1-14.

Driver, J.C. 2005. Manual for description of vertebrate remains. Unpublished manual compiled for the Crow

Canyon Archaeological Center.
Dusseldorp, G.L. 2010. Prey choice during the South African Middle Stone Age: Avoiding dangerous prey or maximising returns? African Archaeological Review, 27: 107-133.
Dusseldorp, G.L. 2012. Studying prehistoric hunting proficiency: Applying Optimal Foraging Theory to the Middle Palaeolithic and Middle Stone Age. Quaternary International, 252: 3-15.
Dusseldorp, G. & Reynard, J. 2021. Faunal exploitation strategies during the Later Pleistocene in southern Africa. Oxford Research Encyclopaedia of Anthropology. Available from: https://doi.org/10.1093/acrefore/9780190854584.013.599 (Accessed: 2024).
Ezeimo, J. 2022. Faunal exploitation and the palaeoenvironment during the Middle Stone Age at Klasies River Cave 1B. Masters Dissertation. Johannesburg: University of Witwatersrand.
Faith, J.T. 2007. Sources of variation in carnivore tooth-mark frequencies in a modern spotted hyena (Crocuta crocuta) den assemblage, Amboseli Park, Kenya. Journal of Archaeological Science, 34(10): 1601-1609.
Faith, J.T. 2008. Eland, buffalo, and wild pigs: Were Middle Stone Age humans ineffective hunters? Journal of Human Evolution, 55: 24-36.
Faith, J.T. 2011. Late Quaternary dietary shifts of the Cape grysbok (Raphicerus melanotis) in southern Africa. Quaternary Research, 75: 159-165.
Faith, J.T. 2013. Taphonomic and paleoecological change in the large mammal sequence from Boomplaas Cave, Western Cape, South Africa. Journal of Human Evolution, 65: 715-730.
Feathers, J. 2002. Luminescence dating in less than ideal conditions: Case studies from Klasies River Main Site and Duinefontein, South Africa. Journal of Archaeological Science, 29: 177-194.
Fourvel, J-B., Fosse, P. & Avery, G. 2015. Spotted, striped or brown? Taphonomic studies at dens of extant hyaenas in eastern and southern Africa. Quaternary International, 369: 38-50.
Grayson, D.K. 1984. Quantitative Zooarchaeology. San Diego: Academic Press.
Greenacre, M.J. & Vrba, E.S. 1984. Graphical display and interpretation of antelope census data in African wildlife areas, using correspondence analysis. Ecology, 65: 984-997.
Grine, F.E. & Klein, R. 1993. Late Pleistocene human remains from the Sea Harvest Site, Saldanha Bay, South Africa. South African Journal of Science, 89: 145-152.
Grine, F.E., Marean, C.W., Faith, J.T., et al. 2017. Further human fossils from the Middle Stone Age deposits of Die Kelders Cave 1, Western Cape Province, South Africa. Journal of Human Evolution, 109: 70-78.
Grine, F.E., Mongle, C.S., Smith, S.L., et al. 2020. Human manual distal phalanges from the Middle Stone Age deposits of Klasies River Main Site, Western Cape Province, South Africa. Journal of Human Evolution, 146: 102849.
Harako, R. 1981. The cultural ecology of hunting behavior among Mbuti Pygmies in the Ituri Forest, Zaire. In: Harding, R.S.O. & Teleki, G. (eds) Omnivorous Primates: 499-555. New York: Columbia University Press.
Henshilwood, C.S., Sealy, J.C., Yates, R., et al. 2001. Blombos Cave, southern Cape, South Africa: Preliminary report on the 1992-1999 excavations of the Middle Stone Age levels. Journal of Archaeological Science, 28(4): 421-448.
Jacobs, Z., Roberts, R.G., Galbraith, R.F., et al. 2008. Ages for the Middle Stone Age of southern Africa: Implications for human behavior and dispersal. Science, 322: 733-735.
Jones, K.T. 1993. The archaeological structure of a short-term camp. In: Hudson, J. (ed.) From Bones to Behavior: Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains, Center for Archaeological Investigations, Occasional Paper No. 21: 101-114. Carbondale: Southern Illinois University.
Kirkman, S.P. 2010. The Cape fur seal: Monitoring and management in the Benguela Current ecosystem. Doctoral Thesis. Cape Town: University of Cape Town.
Klein, R.G. 1975. Paleoanthropological implications of the non-archaeological bone assemblage from Swartklip 1, South-Western Cape Province, South Africa. Quaternary Research, 5: 275-288.
Klein, R.G. 1976. The mammalian fauna of the Klasies River Mouth sites, southern Cape Province, South Africa. South African Archaeological Bulletin, 31: 75-98.
Klein, R.G. 1978. A preliminary report on the larger mammals from the Boomplaas Stone Age cave site, Cango Valley, Oudtshoorn District, South Africa. South African Archaeological Bulletin, 33: 66-75.
Klein, R.G. & Cruz-Uribe, K. 1996. Exploitation of large bovids and seals at Middle and Later Stone Age sites in South Africa. Journal of Human Evolution, 31: 315-334.
Klein, R.G. & Cruz-Uribe, K. 2000. Middle and Later Stone Age large mammal and tortoise remains from Die Kelders Cave 1, Western Cape Province, South Africa. Journal of Human Evolution, 38: 169-195.
Kuhn, B.F., Berger, L.R. & Skinner, J.D. 2010. Examining criteria for identifying and differentiating fossil faunal assemblages accumulated by hyenas and hominins using extant hyenid accumulations. International Journal of Osteoarchaeology, 20(1): 15-35.
Kuhn, B.F, Wiesel, I. & Skinner, J.D. 2008. Diet of brown hyaenas (Parahyaena brunnea) on the Namibian coast.

Transactions of the Royal Society of South Africa, 63(2): 150-159.
Langejans, G.H., Dusseldorp, G.L. & Thackeray, J.F. 2017. Pleistocene molluscs from Klasies River (South Africa): Reconstructing the local coastal environment. Quaternary International, 427: 59-84.
Lap, A. 2020. Bones for thought: A taphonomic study of the faunal remains from early MIS 5 at Klasies River main site. Masters Dissertation. Johannesburg: University of Witwatersrand.
Lee, R.B. 1979. The !Kung San: Men, Women and Work in a Foraging Society. Cambridge: Cambridge University Press.
Loftus, E., Lee-Thorp, J., Leng, M., et al. 2019. Seasonal scheduling of shellfish collection in the Middle and Later Stone Ages of southern Africa. Journal of Human Evolution, 128: 1-16.
Lombard, M., Bradfield, J., Caruana, M.V., et al. 2022. The southern African Stone Age sequence updated (II). South African Archaeological Bulletin, 77(217): 172-212.
Lyman, R.L. 2008. Quantitative Paleozoology. Cambridge: Cambridge University Press.
Marean, C.W., Abe, Y., Frey, C.J., et al. 2000. Zooarchaeological and taphonomic analysis of the Die Kelders Cave 1 Layers 10 and 11 Middle Stone Age larger mammal fauna. Journal of Human Evolution, 38: 197-233.
Matthews, T., Marean, C. & Nilssen, P. 2009. Micromammals from the Middle Stone Age (92-167 ka) at Cave PP13B, Pinnacle Point, south coast, South Africa. Palaeontologia Africana, 44: 112-120.
Matthews, T., Rector, A., Jacobs, Z., et al. 2011. Environmental implications of micromammals accumulated close to the MIS 6 to MIS 5 transition at Pinnacle Point Cave 9 (Mossel Bay, Western Cape Province, South Africa). Palaeogeography, Palaeoclimatology, Palaeoecology, 302: 213-229.
Milo, R.G. 1998. Evidence for hominid predation at Klasies River Mouth, South Africa, and its implications for the behaviour of early modern humans. Journal of Archaeological Science, 25: 99-133.
Morrissey, P., Mentzer, S.M. & Wurz, S. 2023. The stratigraphy and formation of Middle Stone Age deposits in Cave 1B, Klasies River Main site, South Africa, with implications for the context, age, and cultural association of the KRM 41815/SAM-AP 6222 human mandible. Journal of Human Evolution, 183: 103414.
Nel, T.H. & Henshilwood, C.S. 2021. The 100,000-77,000-year old Middle Stone Age micromammal sequence from Blombos Cave, South Africa: Local climatic stability or a tale of predator bias? African Archaeological Review, 38: 443-476.
Nel, T.H., Wurz, S. & Henshilwood, C.S. 2018. Small mammals from Marine Isotope Stage 5 at Klasies River, South Africa – reconstructing the local palaeoenvironment. Quaternary International, 471: 6-20.
Novellie, P.A., Manson, J. & Bigalke, R.E. 1984. Behavioural ecology and communication in the Cape grysbok. African Zoology, 19: 22-30.
O'Connor, T. 2000. The Archaeology of Animal Bones. Gloucestershire: Sutton Publishing.
Outram, A.K. 2001. The scapula representation could be the key: A further contribution to the 'Klasies Pattern' debate. Journal of Archaeological Science, 28: 1259-1263.
Parsons, I. & Badenhorst, S. 2004. Analysis of lesions generated by replicated Middle Stone Age lithic points on selected skeletal elements. South African Journal of Science, 100: 384-387.
Pickering, T.R. 2002. Reconsideration of criteria for differentiating faunal assemblages accumulated by hyenas and hominids. International Journal of Osteoarchaeology, 12: 127-141.
Plug, C. & Plug, I. 1990. MNI counts as estimates of species abundance. South African Archaeological Bulletin, 45: 53-57.
Pobiner, B. 2008. Paleoecological information in predator tooth marks. Journal of Taphonomy, 6(3-4): 373-397.
Rector, A.L. & Reed, K.E. 2010. Middle and late Pleistocene faunas of Pinnacle Point and their paleoecological implications. Journal of Human Evolution, 59: 340-357.
Reinhard, K.J., Ambler, J.R. & Szuter, C.R. 2007. Hunter-gatherer use of small animal food resources: Coprolite evidence. International Journal of Osteoarchaeology, 17: 416-428.
Reynard, J.P. 2021. Paradise lost: Large mammal remains as a proxy for environmental change from MIS 6 to the Holocene in southern Africa. South African Journal of Geology, 124(4): 1055-1072.
Reynard, J.P., Badenhorst, S. & Henshilwood, C.S. 2014. Inferring animal size from the unidentified long bone fragments from Middle Stone Age layers at Blombos Cave, South Africa. Annals of the Ditsong National Museum of Natural History, 4: 9-25.
Reynard, J.P., Discamps, E., Badenhorst, S., et al. 2016a. Subsistence strategies in the southern Cape during the Howiesons Poort: Taphonomic and zooarchaeological analyses of Klipdrift Shelter, South Africa. Quaternary International, 404: 2-19.
Reynard, J.P., Discamps, E., Wurz, S., et al. 2016b. Occupation intensity and environmental changes at Klipdrift Shelter, southern Cape, South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology, 449: 349-364.
Reynard, J.R. & Henshilwood, C.S. 2017. Subsistence strategies during the later Middle Stone Age in the southern Cape of South Africa: Comparing the Still Bay of Blombos Cave with the Howiesons Poort of Klipdrift

Shelter. Journal of Human Evolution, 108: 110-130.
Reynard, J.P. & Henshilwood, C.S. 2019. Environment versus behaviour: Zooarchaeological and taphonomic analyses of fauna from the Still Bay layers at Blombos Cave, South Africa. Quaternary International, 500: 159-171.
Reynard, J.P. & Wurz, S. 2020. The palaeoecology of Klasies River, South Africa: An analysis of the large mammal remains from the 1984-1995 excavations of Cave 1 and 1A. Quaternary Science Reviews, 237: 1-17.
Romero, A.J., Díez, J.C. & Saladié, P. 2016. Mammal bone surface alteration during human consumption: An experimental approach. Journal of Archaeological Science: Reports, 8: 82-89.
Scott, L. & Klein, R.G. 1981. A hyena-accumulated bone assemblage from late Holocene deposits at Deelpan, Orange Free State. Annals of the South African Museum, 86(6): 217-227.
Singer, R. & Wymer, J. 1982. The Middle Stone Age at Klasies River Mouth in South Africa. Chicago: Chicago University Press.
Skinner, J. & Chimimba, C. 2005. The Mammals of the Southern African Subregion. Cambridge: Cambridge University Press.
Smithers, R.H. 1971. The Mammals of Botswana. Salisbury: Trustees of the National Museums of Rhodesia.
Speth, J.D. & Tchernov, E. 2002. Middle Paleolithic tortoise use at Kebara Cave (Israel). Journal of Archaeological Science, 29: 471-483.
Steele, T.E. & Klein, R.G. 2013. The Middle and Later Stone Age faunal remains from Diepkloof Rock Shelter, Western Cape, South Africa. Journal of Archaeological Science, 40(9): 3453-3462.
Steyn, D. & Hanks, J. 1983. Age determination and growth in the hyrax Procavia capensis (Mammalia: Procaviidae). Journal of Zoology, 201: 247-257.
Stiner, M.C., Kuhn, S.L., Weiner, S., et al. 1995. Differential burning, recrystallization, and fragmentation of archaeological bone. Journal of Archaeological Science, 22: 223-237.
Taylor, I. 2003. Barn Owls: Predator-Prey Relationships and Conservation. Cambridge: Cambridge University Press.
Thackeray, J.F. 1979. An analysis of faunal remains from archaeological sites in southwestern South West Africa (Namibia). South African Archaeological Bulletin, 34(129): 18-33.
Thackeray, J.F. 1988. Molluscan fauna from Klasies River, South Africa. South African Archaeological Bulletin, 43: 27-32.
Thackeray, J.F. 1990. Carnivore activity at Klasies River Mouth: A response to Binford. Palaeontologica Africana, 27: 101-109.
Thackeray, J.F. 2019. A 40-year reflection on Klasies River research projects (1977-2017). South African Archaeological Bulletin, 74: 86-90.
Thompson, J.C. 2010. Taphonomic analysis of the Middle Stone Age faunal assemblage from Pinnacle Point Cave 13B, Western Cape, South Africa. Journal of Human Evolution, 59: 321-339.
Thompson, J.C., Faith, J.T., Cleghorn, N., et al. 2017. Identifying the accumulator: Making the most of bone surface modification data. Journal of Archaeological Science, 85: 105-113.
Thompson, J.C. & Henshilwood, C.S. 2011. Taphonomic analysis of the Middle Stone Age larger mammal faunal assemblage from Blombos Cave, southern Cape, South Africa. Journal of Human Evolution, 60: 746-767.
Thompson, J.C. & Henshilwood, C.S. 2014. Tortoise taphonomy and tortoise butchery patterns at Blombos Cave, South Africa. Journal of Archaeological Science, 41: 214-229.
Turner, A. 1989. Sample selection, schlepp effects and scavenging: The implications of partial recovery for interpretations of the terrestrial mammal assemblage from Klasies River Mouth. Journal of Archaeological Science, 16: 1-11.
Val, A., Porraz, G., Texier, P-J., et al. 2020. Human exploitation of nocturnal felines at Diepkloof Rock Shelter provides further evidence for symbolic behaviours during the Middle Stone Age. Scientific Reports, 10: 6424.
Van Niekerk, K. 2011. Marine fish exploitation during the Middle and Later Stone Age of South Africa. Doctoral Thesis. Cape Town: University of Cape Town.
Van Pletzen, L.V. 2000. The large mammal fauna from Klasies River. Doctoral Thesis. Stellenbosch: Stellenbosch University.
Van Pletzen-Vos, L.V., Brink, J., Reynard, J.P., et al. 2019. Revisiting Klasies River: A report on the large mammal remains from the Deacon excavations of Klasies River Main site, South Africa. South African Archaeological Bulletin, 74: 127-137.
Van Wijk, Y., Tusenius, M.L., Rust, R., et al. 2017. Modern vegetation at the Klasies River archaeological sites, Tsitsikamma coast, south-eastern Cape, South Africa: A reference collection. Plant Ecology and Evolution, 150: 13-34.
Vogel, J.C. 2001. Radiometric dates for the Middle Stone Age in South Africa. In: Tobias, P.V, Raath, M.A.,

Moggi-Cecchi, J., et al. (eds) Humanity from African Naissance to Coming Millennia: 261-268. Firenze: Firenze University Press.

von den Driesch, A. 2004. Middle Stone Age fish fauna from the Klasies River main site, South Africa. Anthropozoologica, 39: 33-59.

Wadley, L. 2015. Those marvelous millennia: The Middle Stone Age of southern Africa. Azania: Archaeological Research in Africa, 50(2): 155-226.

Weaver, T.D., Steele, T.E., Klein, R.G. 2011. The abundance of eland, buffalo, and wild pigs in Middle and Later Stone Age sites. Journal of Human Evolution, 60: 309-314.

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

Wurz, S. 2023. Klasies River main site. In: Wright, D., Wilkins, J., Bouzouggar, A., et al. (eds) Handbook of Pleistocene Archaeology of Africa: Hominin Behavior, Geography, and Chronology: 1531-1547. Cham: Springer.

Wurz, S. 2024. Southern African Middle Stone Age. Oxford Research Encyclopaedia of African History. Available from: https://doi.org/10.1093/acrefore/9780190277734.013.65 (Accessed: 2024).

Wurz, S., Bentsen, S.E., Reynard, J., et al. 2018. Connections, culture and environments around 100 000 years ago at Klasies River main site. Quaternary International, 495: 102-115.

Wurz, S., Pickering, R., Mentzer, S.M. 2022. U-Th dating, taphonomy, and taxonomy of shell middens at Klasies River main site indicate stable and systematic coastal exploitation by MIS 5c-d. Frontiers in Earth Sciences, 10: 1-25.

Southern African Field Archaeology
2024 Vol. 19: Article 3061
Research report (peer-reviewed): Received March 2024; Revised June 2024; Published July 2024
DOI: https://doi.org/10.36615/safa.19.3061.2024

ISSN 1019-5785
ISSN 2789-1844

OSTRICH EGGSHELL BEADS FROM LITTLE MUCK SHELTER, SOUTHERN AFRICA: FIRST IMPRESSIONS AND REGIONAL PERSPECTIVES

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ABSTRACT
Hunting and gathering communities in southern Africa produced ostrich eggshell (OES) beads for personal ornamentation, trade and exchange, and various forms of symbolism. OES beads convey information related to not only technological processes, but also social histories, making them useful tools for investigating these processes in the archaeological record. In the middle Limpopo Valley, hunter-gatherers produced beads from periods that predated the arrival of farmer societies, before ca. AD 150, until the decline of the Mapungubwe capital, AD 1300. Their analysis may therefore lead to insights into local economies, craft activities, trade and exchange, and social roles. However, no study in the middle Limpopo Valley has sufficiently investigated these beads and their status within forager society. In this paper we study the manufacture of OES beads from one of the excavated forager-occupied shelters in the valley, Little Muck. This study is the first of its kind from a hunter-gatherer context in the region. It shows that Little Muck's beads were standardised but produced in varying frequencies across temporal periods, and made following different production strategies. Use-wear analysis hints that some of the beads were pigmented and possibly altered using heat treatment. As an initial foray into a forager bead assemblage of the region, this study demonstrates the value such an approach may yield, and it aids in guiding future attempts. It also compares Little Muck's bead assemblage with those from other sites across a much wider region where such studies have taken place. The findings demonstrate similar patterns to other parts of southern and eastern Africa, but also illustrate local shifts in bead production that follow changes in local socio-political dynamics.

Keywords: ostrich eggshell beads, bead production techniques, Little Muck Shelter, Later Stone Age, middle Limpopo Valley.

1. Introduction

The production of ostrich eggshell (OES) beads extends back in Africa to the late Pleistocene (McBrearty & Brooks 2000; Miller 2012; Miller & Wang 2022). Their production and use are known through many studies across the continent, looking at technological approaches, production strategies, identities, and interactions, among other topics (e.g., Jacobson 1987; Kandel & Conard 2005; Orton 2008; d'Errico et al. 2012; Dayet et al. 2017; Hatton et al. 2022; Mouton & Antonites 2023; Mitchell & Stewart 2024). Studying bead presence, production and occurrence in archaeological contexts, across time, space and between people, also provides an opportunity to examine interactions between different groups, economies, and social hierarchies (Stewart et al. 2020; Klehm 2021; Hatton et al. 2022; Miller & Wang 2022). Ethnographic studies demonstrate the importance of beads, and, as such, they are hermeneutic packages that we can unlock (Mitchell 2003). The potential of doing so in the middle Limpopo Valley is particularly important due to the socio-political developments that took place in the region, and the continued production of OES beads from before contact through to the decline of the Mapungubwe capital, ca. AD 1300, generally regarded to be southern Africa's earliest state-level society (Huffman 2015).

The middle Limpopo Valley is located along a stretch of the Limpopo River where the modern international borders of Botswana, South Africa and Zimbabwe are located (Fig. 1). Prior to the BC/AD transition, only foragers lived in the region (Forssman 2020). These forager groups produced finely worked stone and bone tools, subsisted on local wildlife and plants, painted and engraved a variety of motifs, and made jewellery including OES beads (van Doornum 2005; Forssman 2014, 2020). It is debated whether herders arrived in the region, and when, but if they did there is presently no evidence other than finger paintings that are ascribed to them by many scholars (Eastwood & Smith 2005). However, in the first centuries AD, farmer groups passed through the region and possibly settled the valley in small numbers. By at least AD 900, a widespread Zhizo ceramic-using farmer community settled the region and lived in open-air, fixed settlements, produced metal items, cultivated crops, possessed domestic livestock, and also manufactured their own OES beads (Huffman 2000; Mouton & Antonites 2023). Changes in local socio-political structures, which include the arrival of new farmer communities and the emergence of long-distance trade, all contributed to the appearance of Mapungubwe (Huffman 2015). OES beads were produced throughout this period, under different social frameworks, and by multiple groups, and potentially store information relating to technology, use, interaction, exchange, and trade.

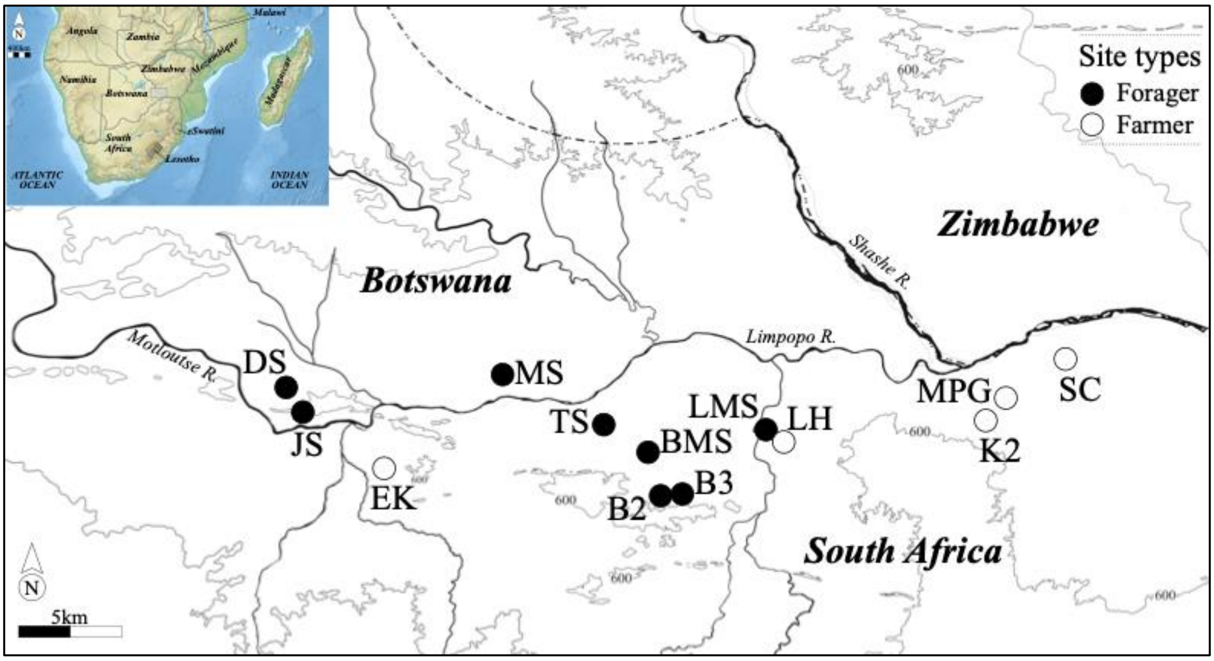

Figure 1. The location of the middle Limpopo Valley in southern Africa and significant forager (black) and farmer (white) sites in the region (B2, Balerno Shelter 2; B3, Balerno Shelter 3; BMS, Balerno Main Shelter; DS, Dzombo Shelter; EK, Euphorbia Kop; JS, João Shelter; K2, Bambandyanalo; KC, Kambaku Camp; LH, Leokwe Hill; LMS, Little Muck Shelter; MPG, Mapungubwe; MS, Mafunyane Shelter [also Tuli Lodge]; SC, Schroda; and TS, Tshisiku Shelter).

Since little research has been conducted on OES beads in the valley, we chose to examine an assemblage from Little Muck Shelter. Little Muck is a rock shelter that was occupied by forager groups from the last centuries BC throughout the period of state-level development (Forssman et al. 2023). During this period, resident foragers traded goods with farmers to obtain items including glass beads, ceramics and metal (Forssman et al. 2023; Sherwood & Forssman 2023). Therefore, the site presents an opportunity to examine bead assemblages and their potential significance during a period of socio-political upheaval. In this paper, we present the morphological and technological features of the site's bead assemblage and place them into a regional context. Our investigation shows that two recognised manufacturing techniques were utilised, but with a preference for drilling unshaped fragments first, followed by rounding them (pathway 1; see Orton 2008). However, this changes both over time and across space at the site. Our study provides a baseline for investigating variability within the region and a foundation for ongoing studies in the valley and beyond that should include experimental approaches. We are nonetheless reluctant at this stage to over interpret our findings until a larger body of evidence, that allows for greater integration of more social histories based on bead analyses, and other kinds of evidence, is produced.

2. The context, production, and use of ostrich eggshell beads

The earliest OES beads date to the late Pleistocene. Early examples were identified at Mumba Rock Shelter, Tanzania, and date to ca. 52 000 BP (McBrearty & Brooks 2000; Miller & Willoughby 2014), as well as from Enkapune ya Muto, Kenya, dating to between 37 000 and 39 900 BP (Ambrose 1998). Somewhat later than in East Africa, in South Africa OES beads appear at Border Cave, at 44 000-41 000 BP (d'Errico et al. 2012). Although earlier preforms have been found at Spitzkloof, South Africa, dating to >51 000 BP, they number only two and are difficult to interpret (Dewar & Stewart 2012, 2016). From the Pleistocene into the Holocene, bead frequencies increase, as do the number of Stone Age sites containing them across Africa (Miller & Sawchuk 2019). Not only were complete beads preserved, but also broken beads and preforms (incompletely produced beads) in different stages of manufacture, demonstrating production strategies.

The first phase of making a bead is obtaining shell material, which ethnographic accounts indicate might have been achieved through collections made at ostrich nests or from recycling broken shell flasks (Silberbauer 1981). From the eggs, roughly shaped fragments were produced by snapping the edges of shell pieces. Following this, two strategies, called pathways, were employed: either the perforation was drilled before trimming (pathway 1) or afterwards (pathway 2). Trimming the fragment, in both strategies, involved further snapping of its edges into a more rounded shape followed then by grinding of the shell disc/preform into a more uniformly rounded shape (Orton 2008). It is possible to discern which strategy was opted for in the archaeological sequence, depending on whether the bead has a perforation prior to rounding or not, and sites tend to exhibit both. For instance, Orton (2008) documented sites in South Africa's Northern Cape Province dominated by pathway 1, whereas at Bushman Rock Shelter in Limpopo Province, there was evidence of both approaches (Plug 1982; Dayet et al. 2017). These stages have not only been constructed using archaeological remains but were also recorded by Kalahari ethnographers (Wiessner 1977; Lee 1979; Silberbauer 1981). However, they are not limited to sites in southern Africa (e.g., Wei et al. 2017). The experimental work conducted by Wang et al. (2009) showed that this method is preferred as it reduces the chances of the fragment breaking, since the inner mammillary layer of an eggshell is much softer than the outer cuticle (Werner & Miller 2018).

Beads and fragments sometimes occur in colours that are not typical of ostrich eggshell. This alteration is likely the result of heat exposure or contact with pigments (Craig et al. 2020, 2023). It may be that heat and pigments were intentionally applied to alter the aesthetic of the bead or to convey symbolic information (Martí et al. 2017). In their study of pigmented beads from Bushman Rock Shelter, Dayet et al. (2017) noted variability in mineral resources used as pigments, and they concluded that this was either an indication of personal preference by the wearer, the conveyance of symbolic meaning, or the result of regional interactions since some of the minerals originated from locations far from the shelter. Heat treatment is less clearly linked to symbolic or other explanations than the intentional application of a pigment. Heating shell during the manufacturing process was seldom recorded ethnographically (Craig et al. 2020). However, experimental work on shell assemblages shows that it was a method used in the past, although in some instances natural heating could not be excluded (see Craig et al. 2020; Diehl et al. 2022). More research into heat-related colour variation is necessary to assist with understanding and interpreting this process (Collins & Steele 2017).

The value of beads in the archaeological assemblage goes beyond technological approaches and decision making; they are linked with notions of identity and beliefs. Early work by Jacobson (1987) examined bead-size variability in central Namibian sites and identified three bead categories organised around size. He concluded that each was produced by a different ethnic group. Small beads were made by San-ancestral foragers, medium-to-large beads by herder groups, and large beads by Iron Age farmers (see Smith et al. 1991; Tapela 2001; Kandel & Conard 2005; Orton 2008). In another study that compared 31 sites in eastern and southern Africa, largescale exchange networks have been suggested (Miller & Wang 2022), although this requires further examination and a larger sample size (1516 beads were analysed). As such, beads may facilitate the identification of specific groups, stylistic changes (Jacobson 1987; Yates 1995), and social networks over vast geographic landscapes (Miller & Wang 2022).

In daily life, OES beads were used to decorate clothing items such as headbands, skirts, and bags (Miller 2012). However, they were also important social and spiritual devices, such as playing a role in the creation of myths, possessing supernatural potency, and being used as important exchange items (Mitchell & Stewart 2024). Among San groups in the Kalahari Desert, beads were used as gift items (Wiessner 1982). For example, Ju/'hoansi foragers practised a reciprocal gift-giving system called *hxaro* whereby they exchanged items with partners to establish social networks. OES beads were one of the exchanged items and were largely regarded as the most important (Wiessner 1982; Dowson 1989). It is also the most readily identified item archaeologically that was recorded in the *hxaro* system. Not all San groups practised this form of exchange (Mitchell 2003) and other groups exchanged with one another following different conventions. The Nharo from north-eastern Botswana, by way of an example, practised *//ai*, which entailed the exchange of various consumable items but not in a reciprocal manner (Barnard 1992). The time-depth of such exchange practices is of course difficult to ascertain but a recent study of strontium in OES beads from Sehonghong and Melikane, Lesotho, dating as far back as ca. 33 000 BP showed that some have a provenance of up to 300 km away (Stewart et al. 2020). While this does not definitively show exchange it certainly indicates its possibility, if not likelihood. OES is not only symbolically important when in bead form but also while used as water containers. At Diepkloof Rock Shelter, Western Cape Province, Middle Stone Age occupants engraved eggshells likely for both stylistic and symbolic reasons (Texier et al. 2010) and, where farmers settled elsewhere in the subcontinent, beads might have become identity markers during the late Holocene (Carden et al. 2024). Both OES containers and beads feature in rock art, thus indicating their likely spiritual association, and shamans often wore beaded items while performing trance rituals (Dowson 1989).

Beads were imbued with meaning in both the physical and spiritual realms. Studying their context, production and use provides insight into several important avenues of life, including trade, access to resources, decision-making, economies, and spirituality. Thus, on a landscape like the middle Limpopo Valley upon which significant social change was orchestrated by multiple ethnic groups, the potential insight one might gather from studying OES beads cannot be overlooked.

3. Materials and methods

Site and excavation context

Little Muck was first excavated by Hall and Smith (2000) in the late 1990s. The aim of their study was to investigate forager-farmer relations in the middle Limpopo Valley, and they chose this particular shelter to begin with due to its proximity to a nearby prominent farmer settlement, called Leokwe Hill, that was occupied from the beginning of the first millennium AD. The excavators established two 1x2 m trenches, one inside the shelter (L-M42) and another nine metres away in the open area outside (J-M33). Their excavations revealed an occupation sequence marked by four phases that spanned the last few centuries BC until the second millennium AD. With renewed interest in the forager archaeology of the middle Limpopo Valley, the Hunter-Gatherer Archaeological Project (led by TF) initiated excavations at the shelter in October 2020. At first, 1x1 m squares (P-Q 43 & Q 44) were excavated on the western side of the shelter, and later nearer to Hall and Smith's (2000) L-M42 squares (Fig. 2). Over the following two years, additional excavation squares were opened in the eastern portion of the shelter and in the areas outside.

The site's stratigraphy has been divided into four phases (van Doornum 2005, 2008). The first of these is the precontact phase that predates AD 150 with an unknown initial date but likely within the last centuries BC. Capping this is the first millennium AD contact period that predates AD 900, at which point the Zhizo phase begins. Following this is the Leopard's Kopje phase, which includes the K2 (AD 1000-1220) and Mapungubwe (AD 1220-1300) phases. Renewed excavations identified additional strata not reported in Hall and Smith's (2000) study, and these are subsequently being subjected to both relative and absolute (radiocarbon) dating assessments. The result of this work is a refined assessment of the site's chronology and an improved understanding of the stratigraphic sequence. Following this, eight periods have been identified, with one being uncertain (either Zhizo or Happy Rest). We combine the relevant strata into the following eight periods using the ceramics facies to name them, where possible, for convenience; we prefer the use of phases (numeric) to avoid cultural associations. Having eight phases is confusing so we use their numerals only in the tables (Table 1). It should be noted, however, that the stratigraphic sequence is complex and a review of this is forthcoming, but a summary is available in Forssman et al. (2023). However, squares Q and P (with relevant numbers) have not been subjected to a full assessment, but it is suspected, based on a range of modern items found in these units, that they are historic.

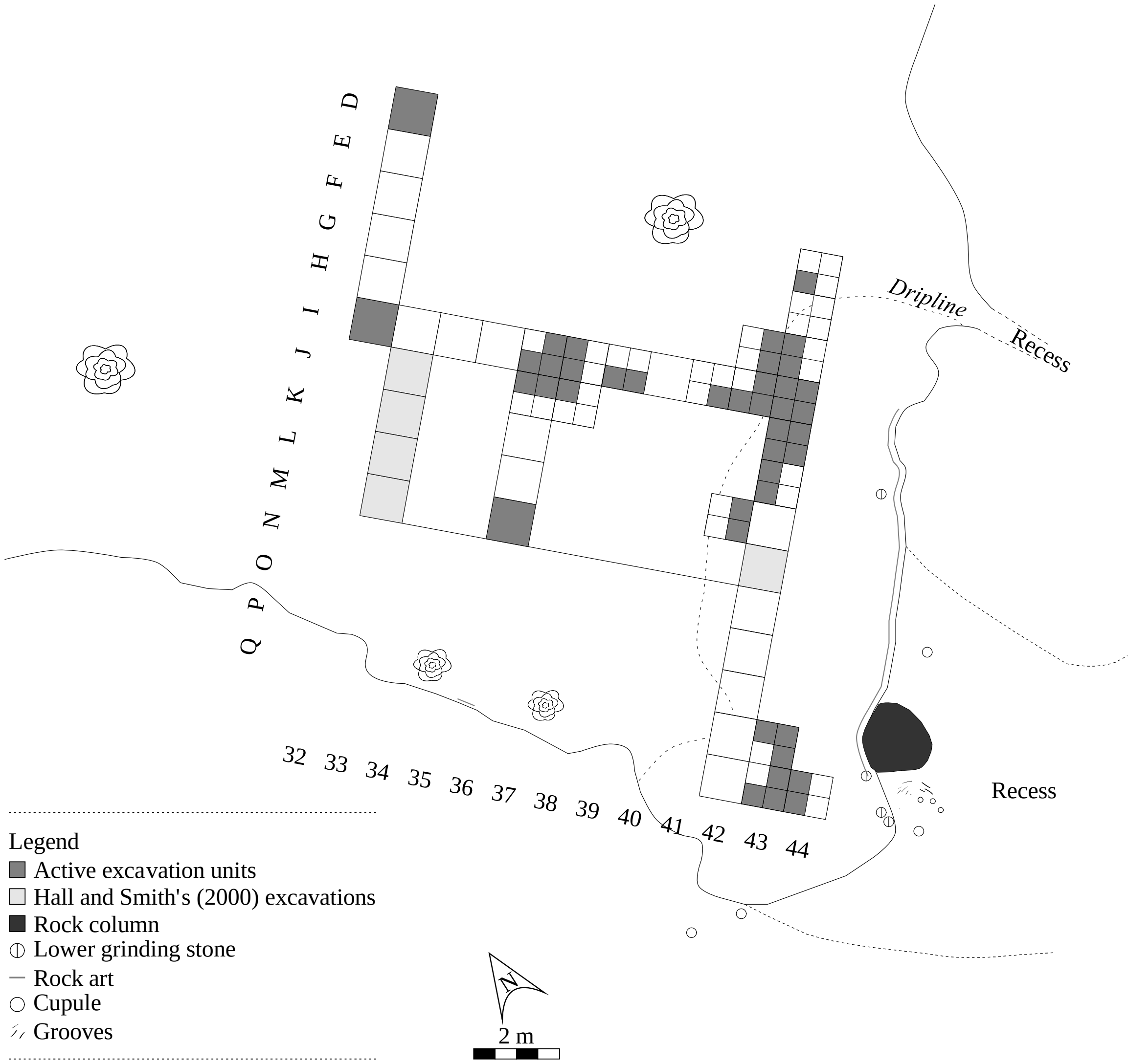

Figure 2. The excavation plan for Little Muck Shelter showing Hall and Smith's (2000) (light grey) and the Hunter-Gatherer Archaeological Project's excavation squares (dark grey) relative to the unexcavated grid (white).

Table 1. The phases at Little Muck Shelter with their corresponding names and periods.

Phase no.	Name	Period
8	Historic	18^{th} century
7	Mapungubwe and TK2	AD 1220-1300
6	K2/Leokwe	AD 1000-1220
5	Zhizo	AD 900-1000
4	Happy Rest/Zhizo	AD 450-900
3	Happy Rest	AD 450-600
2	Bambata/pre-Happy Rest	AD 150-450
1	Pre-ceramic	Pre-AD 150

Ostrich eggshell bead analysis

The analysed OES assemblage, which includes both beads and fragments, is from squares J42, H42, I42, I36-38, I40-41, P43 and Q43-44. The assemblage was investigated following standard procedures used in other studies (e.g., Plug 1982; Kandel & Conard 2005; Orton 2008). For each bead, the minimum aperture diameter, maximum external diameter, and maximum thickness were measured using a Neiko Digital Calliper®. Furthermore, beads were categorised into two different processes of production called pathways, following Orton (2008). Pathway 1 begins with selecting a piece of unmodified OES (stage I), followed by partly drilling (stage II) and then completely drilling a hole (stage III), partly trimming (stage IV) and completely trimming the edges (stage V), and finally partly grounding (stage VI) and completely grounding (stage VII). Pathway 2 also begins with blank selection (stage I) but is followed by the trimming of the OES fragment into a sub-circular or circular shape (stages II & III), and only then by perforation (stages IV & V), and lastly by grinding (stages VI & VII). As such, the distinguishing factor between pathways 1 and 2 is the stage at which drilling takes place, either before trimming or after. It must be emphasised that it is not possible to determine which pathway was used when analysing completed beads since the sequence of production strategies cannot be established. It is only from specimens in stages II to IV that a pathway can be identified. Each stage is also classed as unbroken or broken, with 'a' or 'b' placed after the stage's roman numeral, respectively (Orton 2008). Additionally, beads were categorised following three size classes: small (<5 mm), medium (≥5-6 mm), and large (≥6 mm) (following Orton 2008). The maximum thickness was measured for preforms, including those which are broken and with ≥50% of their external circumference remaining.

The assemblage was also analysed with a handheld LED+UV Triplet Loupe (10x mm), and beads with notable features were further examined with a Nikon SMZ 745 T stereomicroscope (10-300x magnification). For the beads, the surface was investigated for evidence of grinding or trimming (e.g., striations), post-production finishing (e.g., polishing), the presence of residue (e.g., pigment), and evidence of heating (e.g., discolouration). The side of perforation (inside, outside, or both) was also investigated as well as bead shape (i.e., polygonal, roughly circular, oval, or circular) along with the shape of the aperture, aperture position, and lastly, the degree of abrasion. This analysis was conducted following the methodologies of Miller (2019) and Craig et al. (2020). Finally, beads were also categorised into a colour using the Munsell colour chart, following Miller (2012). The Munsell value was used because, under microscopic inspection, the beads could not be classified into normative colour categories due to variability. Using a Munsell value compensates for this variability although also problematically standardises colour.

For unmodified OES fragments, maximum width, length, thickness, and weight, were measured and colour was identified. In addition, fragments were also categorised into shape, which could either be polygonal or triangular (Hatton et al. 2022), but a quadrilateral shape category was formulated since some of the fragments exhibit four perfect vertices and edges with an approximate internal angle of 90º. Quadrilateral fragments from Little Muck were deemed distinctive enough to warrant this specific sub-category.

4. Results

In total, 56 complete beads and 24 preforms were examined (Table 2). The mean aperture diameter for complete beads is 1.9 mm with a range of 0.9-3.1 mm (SD=0.6 mm), whereas the mean external diameter is 5.1 mm with a range of 2.1-14 mm (SD=2.5 mm). In total, the beads have a mean thickness of 1.7 mm. In terms of size, most of the complete beads are small (n=23), followed by large (n=11) and medium (n=9). The colours of the beads and preforms include white (n=28, 35%), yellow (n=16, 20%), grey (n=9, 11.25%), black (n=7, 8.75%), brown (n=7, 8.75%), pale brown (n=6, 7.5%), yellowish brown (n=2, 2.5%), brownish yellow (n=2, 2.5%), very pale brown (n=2, 2.5%), and very dark greyish brown (n=1, 1.25%), all of which are likely the result of heating (Fig. 3a); these colours are to be expected for OES materials that have been exposed to heat. The abovementioned colours generally range within the spectrum of the primary colours of yellow, brown, and grey which are characteristic of oxidising conditions, whereas reduction conditions result in black (Dayet et al. 2017).

Table 2. Little Muck Shelter bead data (n=80 specimens) (Quad=quadrant, S=small, M=medium, L=large), where internal and external refer to diameter and 'a' in stage indicates unbroken while 'b' indicates breakage. See Table 1 for phases (where a phase number is coupled with '?', this denotes the most likely phase).

Square	Phase	Spit	Quad	Internal	External	Size	Thickness	Pathway	Stage
H41	6	13	C				0.1	1	VIIb
I36	7	6/7	A				1.9	1	Vb
I36	7	9	A				2	1	Vb
I38	7	9	C	0.1	6.8	L	1.5	1	Va
I38	7	9	C				1	1	VIb
I38	7	7	C	0.5	4.9	S	1	1	VIIa
I38	7	8	A				2	2	IIb
I38	?		C	1.2	5.1	S	1.9	1	VIIa
I40	6	11	C	1	4.9	S	1.1	1	VIIa
I40	7	9	C	2	5	S	1.2	1	VIa
I40	7	9	C	2	5	M	0.9	1	VIIa
I40	7	9	C	1.1	4.9	S	1.1	1	VIIa
I42	2	25	C				1.9	1	IIb
I42	2	23	C				1.9	1	IVb
I42	2	22	C				1.2	2	IIIb
I42	2	20	C				1.9	1	IIb
I42	2	20	C	2	4.7	S	1.2	1	VIIa
I42	2	20	C	2.1	3.7	S	1.1	1	VIIa
I42	7	12	A				1.9	1	IIIb
I42	7	11	D	1.1	4.2	S	1.1	1	VIIa
I42	7	9	B				2	1	VIIb
I42	2/3	19	C				2	1	IIb
I42	2/3	19	C				1.8	1	VIIb
I42	2/3	18	C				1.9	1	IIb
I42	2/3	18	C	1.1	4.1	S	1.9	1	VIIa
J36	7	10	D				2	1	Vb
J42	2	19	D				2	1	IVb
J42	2	20	C				1.9	1	IIb
J42	2	20	A	1.9	5.1	S	1.7	1	VIIa
J42	3	18	D	2			1.9	1	IIb
J42	8	13	C	2.1	5.2	M	1.9	1	Via
J42	8	8	C				1.9	2	IIIb
J42	7	13	B	2			2	1	IIIb
J42	7	9	B	2.2	6.3	M	1.7	1	IVa
J42	7	9	B	2	5.1	M	2	1	Va
J42	7	9	D				2	1	Vb
J42	7	12	A	2	4.5	M	2	1	Va
J42	7	11/12	C	1.5	4.5	S	2	1	VIa
J42	7	13	B	2	4.5	S	2	1	VIIa
J42	7	9	B	2	3.1	S	2	1	VIIa
J42	7	10	D	1.9	3.1	S	1.9	1	VIIa
J42	6	15	A				2	1	IIb
J42	6	14	D				1.8	1	Vb
J42	6	15	B	2	7.1	M	1.8	1	VIa
J42	6	13	B	1.9	4	S	2	1	VII
J42	5	18	B	2.9	6.6	L	1.4	1	VII
J42	5	18	B	1.5	2.4	S	1.6	1	VII
J42	5	18	B	2	6.8	M	1.7	1	VII
J42	1	21	C				1.9	1	IVb
J42	2/3	21	B	3.1	7.9	M	1.9	1	VIIa
J42	2/3	21	B	1.2	4	S	2	1	VIIa

Square	Phase	Spit	Quad	Internal	External	Size	Thickness	Pathway	Stage
P43	8?	7	D				2	1	IVb
P43	8?	7	C	2	14	L	2	1	VIIa
P43	8?	6	C				2	2	IIIb
P43	8?	7	B		9		2	2	IIIb
P43	8?	7	B		9.5		3.8	2	IIIa
Q43	8?	5	A	1	4	S	1.5	1	VIIa
Q43	8?	4	A	1	8	L	1.2	1	Va
Q43	8?	4	C				1.5	1	Vb
Q43	8?	4	D	1	4	S	1.1	1	VIIa
Q43	8?	4	C		8.8		2.9	2	IIb
Q43	8?	4	C		7		1.9	2	IIIb
Q43	8?	6	D	1	8	L	1.5	1	Va
Q43	8?	7	D	2	10	L	1.5	1	Va
Q43	8?	6	D		11	L	2	1	Vb
Q43	8?	7	A	1.5	4.9	S	1	1	VIIa
Q43	8?	5	A	1.5	4.9	S	1.1	1	VIIa
Q43	8?	7	A	1.8	7.9	L	1.2	1	VIIa
Q43	8?	5	A				1.5	1	VIIb
Q43	8?	7	A				2	2	IIIb
Q43	8?		B				2	1	IIb
Q44	8?		A	2	6.1	M	2	1	VIIa
Q44	8?		B	2	6	M	2	1	Va
Q44	8?		B	1	4	S	1.5	1	VIIa
Q44	8?		B	1.1	5	S	1	1	VIIa
Q44	8?	10	A	3	6.1	L	1.2	1	Va
Q44	8?	9	A	2	6.5	M	2	1	VIIa
Q44	8?	8	A				1	1	VIIb
Q44	8?	9	A				1.5	1	VIIb
Q44	8?		A				2	1	IVb

Most of the beads were manufactured following pathway 1 and almost all stages of production are present in the assemblage (Fig. 3a; Table 3). Stage VII predominates (43%) and phase 7 (stratum GB2) shows the greatest variety of beads and preforms (Fig. 3c). The most common method of drilling is from the inside of the eggshell (n=43), followed by both sides (n=15), while none were drilled first from the outside (Fig. 3d; Table 2). The method of drilling appears to have a connection with the shape of the aperture. Beads drilled from both sides have a bi-conical aperture shape (n=13), whereas those drilled from the inside either have a cylindrical (n=22) or conical (n=21) shape. Of the drilled beads, more have a centred aperture (n=40, 71%) than an uncentred one (n=16, 29%). However, at Little Muck there seems to be no relationship between aperture position and production technique. Orton (2008) noted that aperture position could be altered by several factors such as excessive usage and weathering. The latter, however, does not seem to be the case at Little Muck since only a small number of beads (n=3, 5%) are heavily weathered around the aperture.

A total of nine preforms were manufactured following pathway 2 (Fig. 4). Pathway 2 beads are generally rare, and once they are in advanced stages of manufacture (e.g., V-VII; Fig. 5) it is difficult to distinguish them from pathway 1 beads. Orton (2008) reported fewer pathway 2 beads compared to those following pathway 1 in the Northern Cape, possibly reflecting production preference patterns. Nevertheless, of the nine pathway 2 specimens, seven of them are in stage III while two are in stage II. Beads in stage II are characterised by partly trimmed edges, while those in stage III are completely circular. None of the pathway 2 beads are broken or completely drilled and all of them are circular, which is the most common shape for pathway 2 beads (Orton 2008) (Fig. 4).

When observed under magnification, parallel striations were recorded on 18 beads (20%) and a further eight had perpendicular striations (13%) along the outer circumference. The striations were most likely the result of abrasion against a hard material, such as a stone, and this action could have resulted in scars parallel to the outer surface of the beads' lateral edge. Little can be said of surface striations without further experimentation.

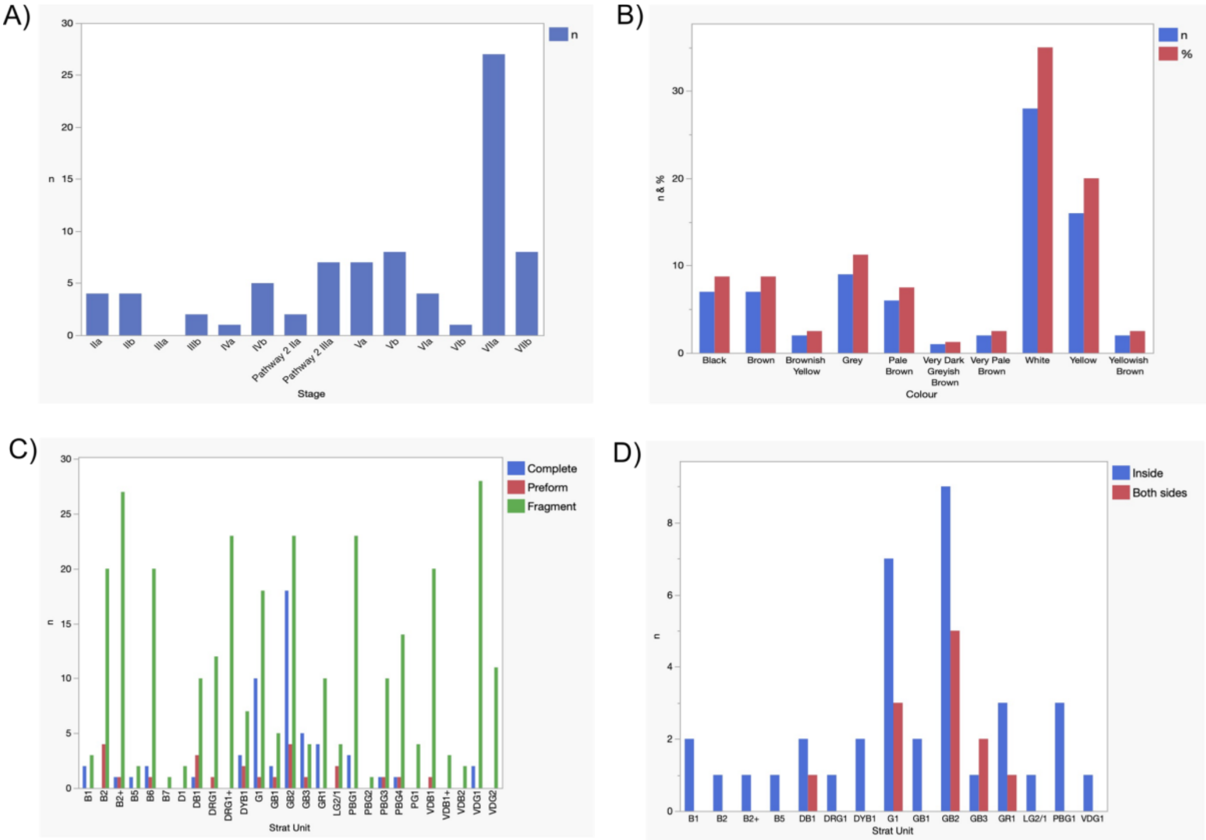

Figure 3. The number of beads according to stages of production (a). The number and percentage of different bead colours (b). The distribution of beads, preforms, and unmodified fragments across the different stratigraphic layers (c). Stratigraphic bead distribution according to the direction of perforation (d).

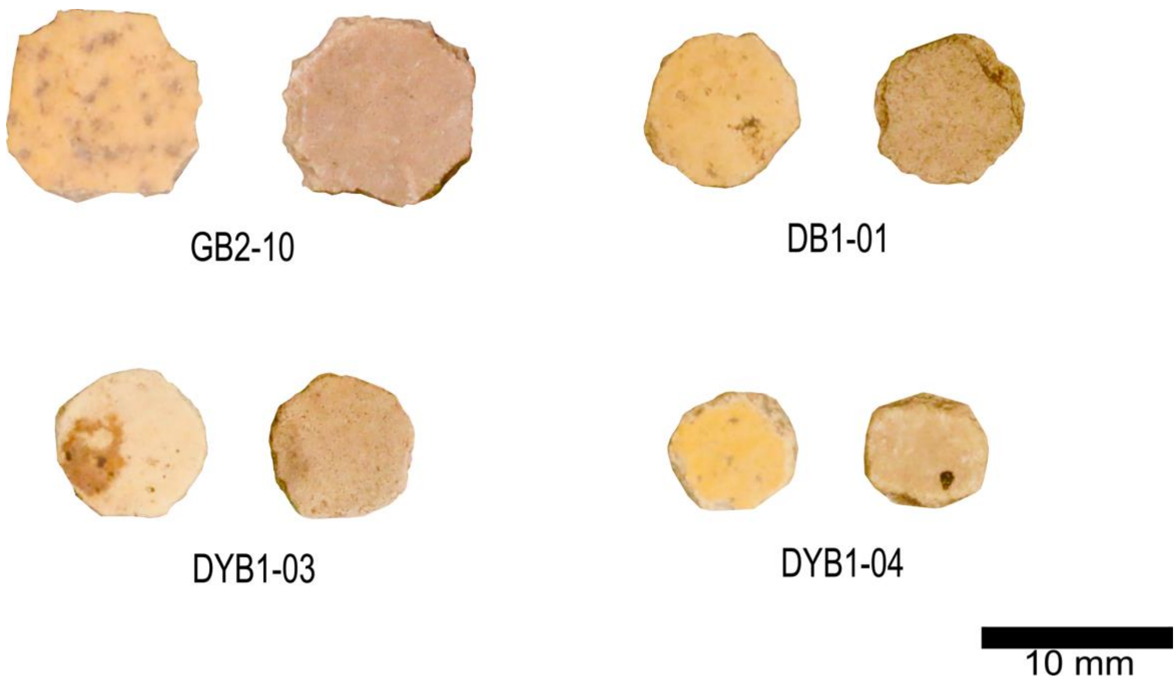

Figure 4. Examples of pathway 2 beads.

Table 3. Summary of manufacturing related features, by phase (where Indet.=indeterminate, NA=not applicable).

Striations	**Phase 2**	**Phase 4**	**Phase 5**	**Phase 6**	**Phase 7**	**Phase 8**
Horizontal	1	0	1	2	4	5
Vertical	2	0	1	0	1	4
Both	0	1	1	0	1	5
Indet.	2	1	2	3	10	17
Finishing						
Yes	3	0	3	4	10	23
No	2	2	2	1	6	7
Unknown	0	0	0	0	0	1
Shape						
Roughly circular	1	0	0	2	3	4
Circular	3	2	5	2	11	20
Polygonal	0	0	0	1	2	6
Oval	1	0	0	0	0	1
Perforation						
Inside	4	2	4	3	10	20
Both	0	0	1	2	5	5
NA	1	0	0	0	1	6
Aperture shape						
Conical	2	1	3	1	2	10
Bi-conical	1	0	1	2	5	6
Cylindrical	1	1	1	2	8	9
NA	1	0	0	0	1	6
Aperture location						
Centre	4	1	4	4	11	16
Off centre	0	1	1	1	4	9
NA	1	0	0	0	1	6
Weathering						
None	3	1	2	2	12	12
Moderate	1	1	1	0	1	4
Light	1	0	2	3	2	13
Heavy	0	0	0	0	1	2

Figure 5. Examples of beads of different sizes and different production stages (stage II: GB3-03; stages III-IV: GB2-05, GB2-06 & G1-04; stage V: DYB1-05; stages VI-VII: PBG1-03, GB2-01, B1-01, DB1-03, B5-01, B2+/01, GR1-01, GR1-02, DB1-06, G1-08 & G1-02).

Some of the beads have evidence of polish and use-wear (n=10, 16%) (Table 4), and the reddish residue on all of the observed specimens might be ochre (Fig. 6). Without conducting chemical analysis on the residues, their composition remains tentative, as does our interpretation of whether they were intentionally applied or transferred through contact with clothing, skin, or from chemicals in the sediment (Martí et al. 2017). Another reason for the presence of the red residue could be the usage of ochre for grinding, as opposed to its intentional application for aesthetic or symbolic purposes (Orton 2008; Collins et al. 2020).

Seventy-two of the beads were heated. Following Collins and Steele (2017), and based on the colours identified in this study compared to theirs, most of the heated beads were exposed to temperatures in excess of 550°C (n=29, 45.3%), followed by 15 heated to between ca. 300 and 350°C (23.4%), nine ca. 200°C (14.1%), eight unknown (12.5%), and a further three between ca. 200 and 350°C (4.7%) (Fig. 7). Seven black beads and a very dark greyish brown bead were heated to unknown temperatures. Although Collins and Steele (2017) do not currently know what temperature range might produce black burning, Diehl et al. (2022) suggest over 900°C. However, at this stage it is not possible to confidently determine whether the heating was deliberate or post-depositional, although no evidence of post-depositional burning in the deposit was recorded in the excavations.

Table 4. Colour, heating (°C range), and residue evidence, by phase.

Colour	**Phase 2**	**Phase 4**	**Phase 5**	**Phase 6**	**Phase 7**	**Phase 8**
Brown	1	0	0	0	0	6
Brownish yellow	1	0	0	0	0	1
Grey	0	1	0	2	5	1
Pale brown	0	0	0	0	1	5
Very pale brown	0	0	0	0	0	2
White	3	1	4	2	5	5
Yellow	0	0	1	0	4	3
Black	0	0	0	0	1	6
Very dark greyish brown	0	0	0	0	0	1
Yellowish brown	0	0	0	1	0	1
°C range						
~200	1	0	1	0	4	3
~200-350	0	0	0	1	0	2
~300-350	1	0	0	0	1	13
>550	3	2	4	4	10	6
Unknown	0	0	0	0	1	7
Residue						
Yes	0	0	0	2	0	3
No	5	2	4	3	15	25
Ochre?	0	0	1	0	1	3

Lastly, bead shape varies with oval, circular, roughly circular, and polygonal all being recorded. While Miller (2012) has suggested that bead shape is not always intended to be circular, at Little Muck circular beads predominate the assemblage (n=45, 67%), followed by roughly circular (n=8, 16%), polygonal (n=9, 14%) and oval (n=2, 3%).

A total of 307 unmodified OES fragments were examined. The most frequent shape is polygonal (n=265, 86%), followed by triangular (n=36, 12%) and quadrilateral (n=6, 2%). Altogether, the fragments weigh 276 g and have a mean width and length of 8.4 (range: 1.2-19.5 mm, SD: 3.97) and 13.2 mm (range: 4.3-26 mm, SD: 5.14), respectively. The mean thickness is 2 mm (SD: 0.29). Five colour categories were identified on the OES fragments. Most of the fragments are unburnt (n=167, 54.4%). This contrasts with the beads which exhibit regular heat exposure across a variety of temperature ranges. Of the heated fragments, grey-white (28%, >550°C) was most common, followed by yellow (9.5%, ~200°C), red (5.9%, ~300-350°C) and lastly black (2.3%, unknown temperature, but possibly >900°C). None of the fragments are iridescent. Furthermore, under microscopic investigation, some of the fragments have striations (i.e., random scratches and marks) on the cuticle.

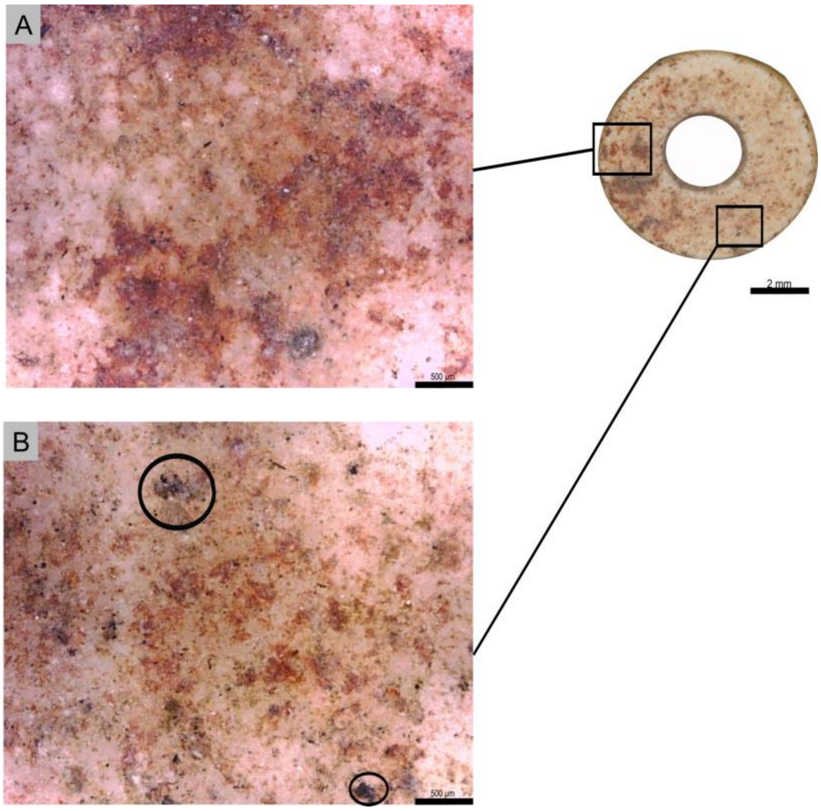

Figure 6. Example of an ochre-pigmented bead (B1-01a). The black circles (b) show possible traces of specularite.

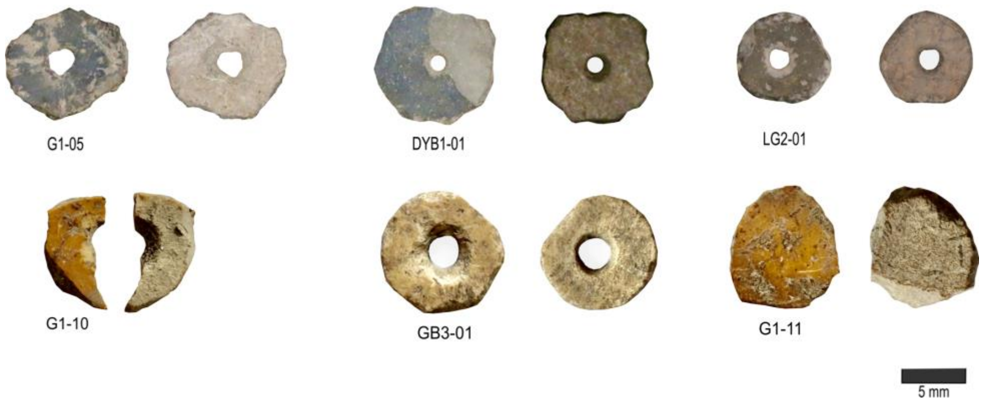

Figure 7. Examples of heat-exposed beads.

The production of OES beads at the shelter appears to have been spatially organised. The outside area (area A: squares I32-8, J36; see Fig. 8 for area locations) has the least number of fragments (n=13), preforms (n=1), and complete beads (n=6) (Fig. 9). The western section of the shelter (area C: squares Q43, 44, P43) contains more beads (n=20), preforms (n=9) and fragments (n=54); however, it is the eastern section of the shelter (area B: squares J42, I40-2, H41-2, 140-2) that contains the most beads (n=28), preforms (n=16), and fragments (n=240). Area B also contains the highest frequencies of all other categories of material culture recovered at the shelter (Forssman et al. 2023). As such, most of the bead processing and production at Little Muck appears to have occurred in area B along with other domestic forager activities. These differences might be related to periodic shifts or different activity patterns over time. For example, bead production is absent during phase 1 (pre-AD 150) with only two OES fragments. However, during phases 2-4 (AD 100-900) there is an increase in the number of complete beads, preforms, and fragments with a slight decrease in preforms and fragments in phase 5 (AD 900-1000). The most intense production of beads took place during phases 6-7 (AD 1000-1300), which is also a period when production seems to have been spatially organised between areas B and C, with a preference for the former.

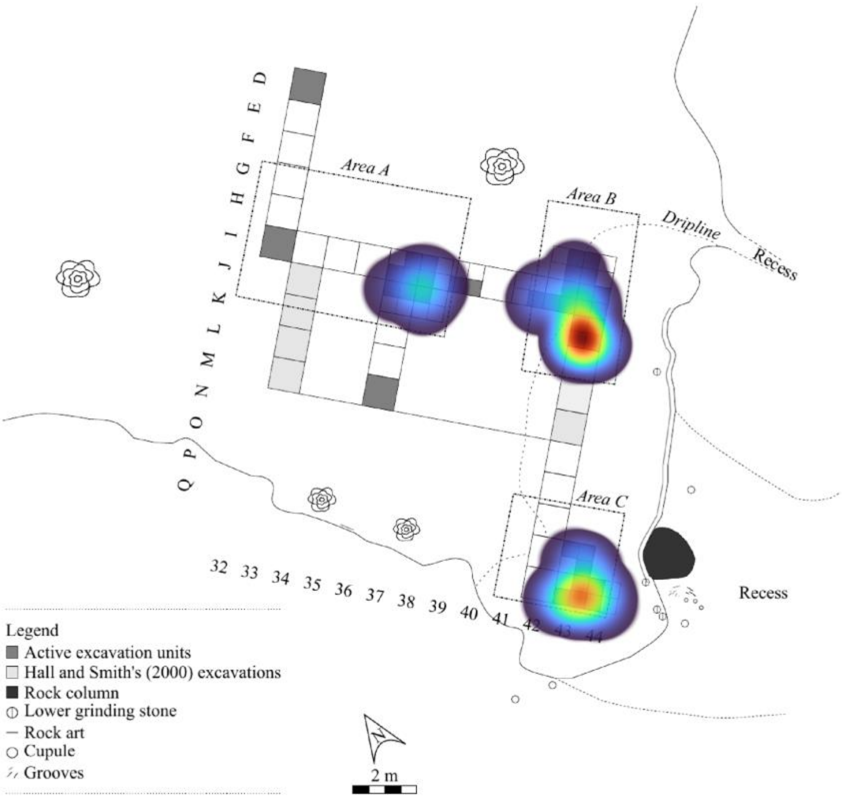

Figure 8. Spatial distribution of beads at Little Muck (where dark red is the highest density and black the lowest).

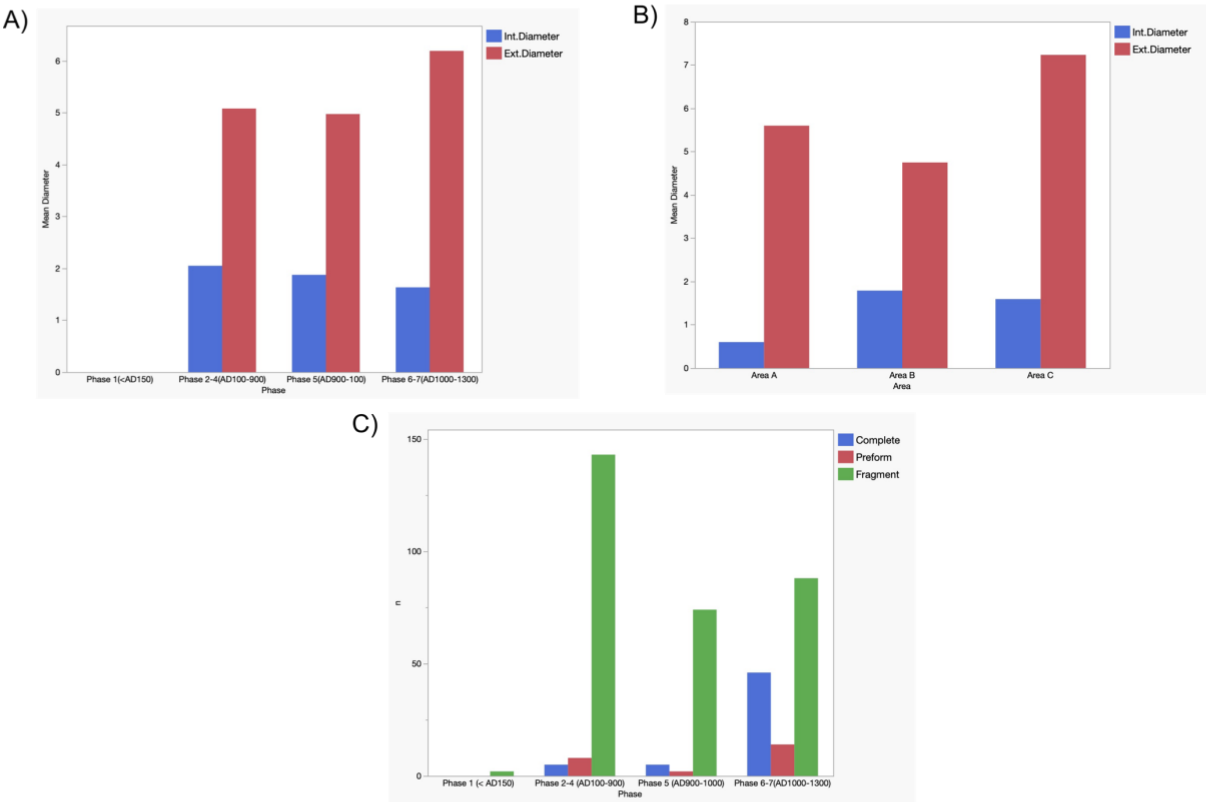

Figure 9. Bead distribution frequencies over different chronological phases (a & c) and different areas (b) of the shelter. Change in internal and external diameter over time (a). Difference in mean internal and external diameter during phases 6-7 across different areas of the shelter (b). Distribution of OES material over different phases (c).

5. Beads and their context from the perspective of Little Muck Shelter

The bead analysis revealed a series of patterns that are worth exploring, but most importantly it exposes the potential beads have in unpacking social relations and economic networks in the middle Limpopo Valley's sequence. We first consider the morphological and technological observations made in this study before considering the broader context of the beads.

Little Muck's foragers preferred beads that were small and round. Their production, however, is more time consuming, tedious, and risky when compared to that of making other bead sizes (Orton 2008), therefore requiring a more careful and skilful approach to the chain of operations (Wei et al. 2017). Made by predominantly drilling from the inside, this technique might have been favoured due to the increased success rate when compared to drilling from the outside, in addition to potentially reducing production times (Martí et al. 2017). However, some beads were drilled from both sides, a method recorded ethnographically (Plug 1982; Orton 2008), and this seems to have broadened their aperture. Despite the various risks associated with producing small beads, the associated challenges with producing them likely enhanced their value (Moffett et al. 2020).

There is also a possibly unusual dynamic between pathway 1 and 2 beads. Pathway 1 was favoured possibly given the lowered breakage risk (Wang et al. 2009). However, an increase in pathway 2 beads in the contact layers (phases 4-7) may indicate a diversification of production strategies, the introduction of new skills that might have been linked to informational exchanges, or the ability to make beads more efficiently using this pathway. Experimentation might aid in resolving this if the risks and rewards (perhaps in terms of production rate, ease of manufacture, etc.) can be assessed. A major limitation though is our inability to distinguish between these pathways for complete beads, so it is possible that many more pathway 2 specimens exist (in stage VII) than pathway 1.

The difference in heat exposure between beads and fragments is interesting. All beads exhibit heat exposure, but only half of the fragments do. The presence of heated fragments might suggest that heating was an important and deliberate part of the bead manufacturing process at Little Muck, and depending on the outcome of this, influenced which were chosen for further processing. However, it is also possible that shell exposed to heating through cooking, for example, represents the heated fragment assemblage (Robbins et al. 1996; Diehl et al. 2022), which subsequently broke into fragments so their heating might not relate to the bead manufacturing process. However, that fragments exhibiting heating were found alongside those without rules out the possibility of post-depositional heating, as in such a case one would expect the entire assemblage to show degrees of heating. Had the heated shell beads and fragments been retrieved from an isolated area or different stratum, such as a hearth, one could suggest that it was unintentional heating, but this is not the case. In addition, the black beads and shell fragments are difficult to explain. Kandel and Conard (2005) have suggested that beads are burnt black for aesthetic purposes. However, experimental studies have failed to replicate this archaeologically observed colour (Craig et al. 2020; but see Diehl et al. 2022), limiting our full understanding. The usage of pigmentation in combination with heat treatment on some of the beads may have been for symbolic, identity, or aesthetic purposes.

Aside from the morphological and technical attributes of the beads, their context indicates an interesting set of outcomes. In the pre-contact phase, before farmers migrated to the region, there is less evidence for bead production. However, shortly after the arrival of farmers, bead frequencies increase and peak during phase 7 (AD 1220-1300). The number of beads and preforms in this phase support the consistent manufacturing of beads. This might lead one to suspect that contact with farmers led to an increasing demand for beads. However, in the preceding phases 5 and 6 (AD 900-1220), during which farmers were present on the landscape, there seems to be less bead production in comparison to phase 7. This could be the result of different sets of craft requirements, such as an emphasis on other goods, bead production primarily taking place at other sites, or of farmers primarily producing their own beads during this time. Using Jacobson's (1987) bead-size analysis, 40.43% (n=19) fall within the 'farmer' size range, whereas slightly more are within the 'forager' range (n=20; 42.55%). However, if the suggested farmer size class is reliable, we should expect to see less of them during the pre-ceramic period. In these strata, only three beads could be measured, and all are less than 6 mm in maximum diameter. The small sample does not allow for a confident interrogation of size variability from pre-contact to ceramic periods, and therefore we cannot assess bead size as a potential stylistic or ethnic marker (Wilmsen 2015; also see Mouton & Antonites 2023).

Despite the second millennium AD increase in complete beads it is not possible to argue, with confidence, for trade or exchange in beads, whether forager or farmer produced. Had higher frequencies of preforms occurred in various stages of production, one could make the argument that the low number of complete beads was the result of them being traded or exchanged, but this does not appear to be the case. Identifying production could also be sought by examining the potential tools used in making beads, other than just the beads themselves. A use-wear analysis of stone scrapers, accompanied by experimentation, showed that shell was being worked in low frequencies during the pre-ceramic period, along with hide, wood and bone, but thereafter bone working predominated (Sherwood & Forssman 2023). This appears to suggest that working shell with stone scrapers was not a regular activity after contact. However, would scrapers be used for making beads? Given that ethnographically recorded production strategies include trimming, boring, and polishing extremities, which are not scraper-associated processes, perhaps not. A recent study on shell beads identified stone drill bits in the Little Muck assemblage that had tip damage consistent with experimentally used drilling pieces (Sherwood & Forssman submitted). Such pieces had not been identified until this experimental study, and further analysis identifying converging tips with comparable damage is necessary to examine the significance of this possible production-associated tool form. However, it serves to show that a variety of tool forms should be consulted to assist with identifying production strategies.

Trade and exchange are also dynamic processes that are present in multiple contexts. As such, consideration of the broader landscape assists in examining such networks. Further support might therefore be found at Leokwe Hill and Schroda, large Zhizo settlements nearby, dating to the end of the first millennium AD. At Leokwe Hill, 1.5 km south-east of Little Muck, Calabrese (2000) notes a difference in OES and *Achatina* beads between a hilltop and low-lying area, which he interpreted as indicating different statuses. He recorded 218 OES and 62 *Achatina* beads in the former area, and 1 and 204, respectively, in the latter. Schroda is further from Little Muck, over 18 km north-east, and the relationship between the two sites has not been considered at all. Here, however, the OES beads number in the thousands (Hall & Smith 2000). Mouton and Antonites (2023) suggest that at this time foragers might have acted as suppliers of shell material while Leokwe or lower-status farmer settlements produced the beads. If foragers were involved in this craft activity, it may be that they oscillated between farmer settlements and their own (e.g., Wadley 1996). From findings made at other sites occupied by foragers during this period, such as Balerno Main (Forssman 2020), foragers continued producing beads throughout this period (van Doornum 2007, 2008; Forssman 2014, 2020; Seiler 2016), although not at Little Muck. During this late first millennium AD period, foragers instead appear focused on activities associated with producing bone items for trade with farmers, and in return received ceramics (possibly with their contents) and glass beads (Sherwood & Forssman 2023).

Ornaments such as beads are powerful tools of communication (Miller 2024). In both eastern and southern Africa, they played an important role in carrying messages in specific contexts and denoting social roles and statuses. This important role they played within society, and specifically among foragers, became enmeshed within a wider socio-political and economic context in the early second millennium AD in the middle Limpopo Valley. From at least AD 900, social, political, and economic transformations began in the region, and they culminated in the appearance of the Mapungubwe state (Huffman 2015). It is noteworthy that the period with the highest frequency of complete beads is phases 6 and 7 at Little Muck. During this period, regional mercantile contexts and forager-farmer relations were notably different to earlier phases of contact. Beads, which were already imbued with meaning, likely took on new roles within society, such as reinforcing identity groups or marking status. Their increase at Little Muck, from this perspective, was possibly the result of wider social patterns emerging across the region. At the time, farmers used OES and *Achatina* beads to distinguish status groups (Calabrese 2000). OES beads marked elevated status. Little Muck's foragers producing beads from OES were possibly part of this larger market economy. These shifts demonstrate consistent forager engagement in the local, social and economic landscapes that led to changes in their own activities at a time when trade wealth was driving reform within local society. At this period, wealth items and social status were crucial facets of society that played an important role in the establishment of elite or royal groups and the local hegemony of the Mapungubwe state. Foragers were part of this milieu and were cognisant of the importance of beads given their increased frequency within this framework.

Despite this being an early attempt at understanding middle Limpopo Valley beads, it is possible to compare the data from Little Muck with other regions where similar bead studies have taken place. Miller and Wang (2022) note that bead sizes in southern Africa fall within a narrow size range of 4.5±0.9 mm, compared to East African beads from the mid- to late Holocene at 6.9±1.2 mm. The southern African dataset was derived from 23 sites, mostly from South Africa (n=13) and Namibia (n=7). Various studies have also shown that bead sizes increase from 5000 BP towards the present. For example, Geelbek's beads from 2500-4000 BP range from ca. 3-5 mm in diameter, but immediately before the turn of the first millennium AD they increase to >5.5 mm. Geduld and Witklip show the same trend, whereas sites with late occupations, such as Kasteelberg (A and B) and Rooiwal, contain larger beads (see Miller 2019: fig. 10 for a summary). Little Muck's average across the sequence is 5.9 mm (from n=47). Unfortunately, when the measured bead assemblage is divided into the eight phases, their numeral values per period is low. Only in phase 7 are there a high number of beads (n=13) and these average 4.8 mm. In one unit thought to date to the historic period, or possibly the Mapungubwe phase, there is an average of 10.8 mm from three specimens. Therefore, it is not possible to assess whether bead size changes over time and in particular after 2500 BP when the average bead diameters begin to increase.

6. Conclusions

Foragers at Little Muck had the skills and technical ability required to produce morphologically similar OES beads. Pathway 1, like at other sites in southern Africa, was the production strategy of choice used to manufacture small, round beads, and drilling was characterised by perforations initiated from the inside of the shell. However, pathway 2 was utilised albeit less commonly, particularly during the contact period. Additionally, manufacturers at Little Muck seem to have applied pigments and altered beads using heat treatment. Further experimentation is needed to confirm this and to better our understanding of these processes. For example, it is worth testing whether heat treating shell fragments assisted with manufacturing stages, perhaps for shaping or drilling or one and not the other, and whether heating impacted the chosen production strategy. Moreover, regional dynamics in the middle Limpopo Valley seem to have had an impact on the manufacture of Little Muck's beads. Before the movement of farmers onto the landscape, bead production was less intense than during the Mapungubwe period, and at this time the production strategies to produce them diversified. This shift was likely the result of unfolding socio-political change in the region that was leading to new hierarchies and needs that distinguished social status and group identity. Foragers were part of this broader social milieu and therefore produced goods with associated meanings. Beads, as an important social item, were likely used as meaning-carrying communication devices.

While the method of analysis is based on a host of previous studies, the sample size is limiting. As such, this research will be followed by studies from other sites in the valley that further investigate the technological variation of OES beads, and their socio-economic significance. It would also be worthwhile comparing bead assemblages from forager and farmer contexts and, specifically, their production strategies and sizes. We suspect that completing these studies will broaden our analytical scope and facilitate the comparative analysis of possible site-specific manufacturing techniques, bead size variability, and the integration of OES data from the middle Limpopo Valley with that of the broader southern African region.

Acknowledgements

We are grateful for the financial support provided by the Palaeontological Scientific Trust to SK and the National Research Foundation's African Origin Platform grant to TF (136506). The South African Heritage Resources Authority (Permit ID 3124) and SANParks (Permit ID FORT1660) issued permits for excavations at Little Muck Shelter. We also thank the members of the Hunter-Gatherer Archaeological Research Project for all of their assistance.

References

Ambrose, S.H. 1998. Chronology of the Later Stone Age and food production in East Africa. Journal of Archaeological Science, 25: 377-392.

Barnard, A. 1992. Hunters and Herders of Southern Africa: A Comparative Ethnography of the Khoisan Peoples. Cambridge: Cambridge University Press.

Calabrese, J. 2000. Interregional interaction in southern Africa: Zhizo and Leopard's Kopje relations in northern South Africa, southwestern Zimbabwe, and eastern Botswana, AD 1000 to 1200. African Archaeological Review, 17: 183-210.

Carden, N., Martínez, G., Mitchell, P., et al. 2024. Spatial and temporal trends in the distribution of engraved eggshell fragments: A comparative view from the Holocene archaeological record of southern Africa and southern South America. Journal of Anthropological Archaeology, 73: 101571.

Collins, B. & Steele, T.E. 2017. An often overlooked resource: Ostrich (*Struthio* spp.) eggshell in the archaeological record. Journal of Archaeological Science: Reports, 13: 121-131.

Collins, B., Wojcieszak, M., Nowell, A., et al. 2020. Beads and bead residues as windows to past behaviours and taphonomy: A case study from Grassridge Rockshelter, Eastern Cape, South Africa. Archaeological and Anthropological Sciences, 12: 192.

Craig, C., Collins, B., Nowell, A., et al. 2020. The effects of heating ostrich eggshell on bead manufacturing: An experimental approach. Journal of Archaeological Science: Reports, 31: 102287.

Craig, C., Collins, B., Nowell, A., et al. 2023. Abrasive wear in heat-treated ostrich eggshell beads: Implications for the archaeological record. Archaeological and Anthropological Sciences, 15: 4.

d'Errico, F., Backwell, L., Villa, P., et al. 2012. Early evidence of San material culture represented by organic artifacts from Border Cave, South Africa. Proceedings of the National Academy of Sciences, 109: 13214-13219.

Dayet, L., Erasmus, R., Val, A., et al. 2017. Beads, pigments and early Holocene ornamental traditions at Bushman Rock Shelter. Journal of Archaeological Science: Reports, 13: 635-651.

Dewar, G. & Stewart, B.A. 2012. Preliminary results of excavations at Spitzkloof rockshelter, Richtersveld, South Africa. Quaternary International, 270: 30-39.

Dewar, G. & Stewart, B.A. 2016. Paleoenvironments, sea levels, and land use in Namaqualand, South Africa, during MIS 6-2. In: Jones, S.C. & Stewart, B.A. (eds) Africa from MIS 6-2, Vertebrate Paleobiology and Paleoanthropology: 195-212. Dordrecht: Springer Netherlands.

Diehl, R.J., Keller, H.M. & Hodgkins, J. 2022. Towards an interpretive framework for heated ostrich eggshell: An actualistic study. Journal of Archaeological Science: Reports, 43: 103465.

Dowson, T.A. 1989. Dots and dashes: Cracking the entopic code in Bushman rock paintings. South African Archaeological Society Goodwin Series, 6: 84-94.

Eastwood, E.B. & Smith, B.W. 2005. Fingerprints of the Khoekhoen: Geometric and handprinted rock art in the Central Limpopo Basin, southern Africa. South African Archaeology Society Goodwin Series, 9: 63-76.

Forssman, T. 2014. The spaces between places: A landscape study of foragers on the Greater Mapungubwe Landscape, southern Africa. Doctoral Thesis. Oxford: University of Oxford.

Forssman, T. 2020. Foragers in the Middle Limpopo Valley: Trade, Place-making, and Social Complexity. Oxford: Archaeopress.

Forssman, T., Kuhlase, S., Barnard, C., et al. 2023. Foragers during a period of social upheaval at Little Muck Shelter, southern Africa. Azania: Archaeological Research in Africa, 58: 114-150.

Hall, S. & Smith, B. 2000. Empowering places: Rock shelters and ritual control in farmer-forager interactions in the Northern Province. South African Archaeological Society Goodwin Series, 8: 30-46.

Hatton, A., Collins, B., Schoville, B.J., et al. 2022. Ostrich eggshell beads from Ga-Mohana Hill North Rockshelter, southern Kalahari, and the implications for understanding social networks during Marine Isotope Stage 2. PLoS ONE, 17: e0268943.

Huffman, T.N. 2000. Mapungubwe and the origins of the Zimbabwe culture. South African Archaeological Society Goodwin Series, 8: 14-29.

Huffman, T.N. 2015. Mapela, Mapungubwe and the origins of states in southern Africa. South African Archaeological Bulletin, 70: 15-27.

Jacobson, L. 1987. The size variability of ostrich eggshell beads from central Namibia and its relevance as a stylistic and temporal marker. South African Archaeological Bulletin, 42: 55-58.

Kandel, A.W. & Conard, N.J. 2005. Production sequences of ostrich eggshell beads and settlement dynamics in the Geelbek Dunes of the Western Cape, South Africa. Journal of Archaeological Science, 32: 1711-1721.

Klehm, C. 2021. Material histories of African beads: The role of personal ornaments in cultural change. In: Mattson, H.V. (ed.) Personal Adornment and the Construction of Identity: A Global Archaeological Perspective: 135-151. Oxford: Oxbow Books.

Lee, R.B. 1979. The !Kung San: Men, Women and Work in a Foraging Society. Cambridge: Cambridge

University Press.
Martí, A.P., Wei, Y., Gao, X., et al. 2017. The earliest evidence of coloured ornaments in China: The ochred ostrich eggshell beads from Shuidonggou Locality 2. Journal of Anthropological Archaeology, 48: 102-113.
McBrearty, S. & Brooks, A.S. 2000. The revolution that wasn't: A new interpretation of the origin of modern human behaviour. Journal of Human Evolution, 39: 453-563.
Miller, J.M. 2012. The ostrich eggshell beads of Mlambalasi Rockshelter. Masters Dissertation. Edmonton: University of Alberta.
Miller, J.M. 2019. Variability in ostrich eggshell beads from the Middle and Later Stone Age of Africa. Doctoral Thesis. Edmonton: University of Alberta.
Miller, J.M. 2024. Perspectives on Stone Age sociality: A new role for ostrich eggshell beads. In: Nowell, A. & Collins, B. (eds) Culturing the Body: Prehistoric Perspectives on Identity and Sociality: 68-86. New York: Berghahn.
Miller, J.M. & Sawchuk, E.A. 2019. Ostrich eggshell bead diameter in the Holocene: Regional variation with the spread of herding in eastern and southern Africa. PLoS One, 14: e0225143.
Miller, J.M. & Wang, Y.V. 2022. Ostrich eggshell beads reveal 50,000-year-old social network in Africa. Nature, 601: 234-239.
Miller, J.M. & Willoughby, P.R. 2014. Radiometrically dated ostrich eggshell beads from the Middle and Later Stone Age of Magubike Rockshelter. Journal of Human Evolution, 74: 118-122.
Mitchell, P.J. 2003. Anyone for *hxaro*? Thoughts on the theory and practice of exchange in southern African Later Stone Age archaeology. Oxford University School of Archaeology Monograph, 57: 35-43.
Mitchell, P.J. & Stewart, B.A. 2024. Enveloping oneself in others: Semiotic, spatial, and temporal dimensions of ostrich eggshell bead use in southern Africa. In: Nowell, A. & Collins, B. (eds) Culturing the Body: Prehistoric Perspectives on Identity and Sociality: 9-40. New York: Berghahn.
Moffett, A.J., Hall, S. & Chirikure, S. 2020. Crafting power: New perspectives on the political economy of southern Africa, AD 900-1300. Journal of Anthropological Archaeology, 59: 101180.
Mouton, M. & Antonites, A. 2023. Shell disc beads and the development of class-based society at the K2-Mapungubwe settlement complex (South Africa). Archaeological and Anthropological Sciences, 15: 34.
Orton, J. 2008. Later Stone Age ostrich eggshell bead manufacture in the northern Cape, South Africa. Journal of Archaeological Science, 35: 1765-1775.
Plug, I. 1982. Bone tools and shell, bone and ostrich eggshell beads from Bushman Rock Shelter (BRS), Eastern Transvaal. South African Archaeological Bulletin, 37: 57-62.
Robbins, L.H., Murphy, M.L., Stevens, N.J., et al. 1996. Paleoenvironment and archaeology of Drotsky's Cave: Western Kalahari Desert, Botswana. Journal of Archaeological Science, 23: 7-22.
Seiler, T.C.S. 2016. An archaeological landscape study of forager and farmer interactions at the Motloutse/Limpopo confluence area, South Africa. Master Dissertation. Tshwane: University of Pretoria.
Sherwood, N.L. & Forssman, T. 2023. Macro use-wear identifiers on lithic scrapers and behavioural shifts at Little Muck Shelter, SLCA. Journal of Archaeological Science: Reports, 49: 104034.
Sherwood, N.L. & Forssman, T. Submitted. Ostrich eggshell beads: Hole drilling technology at Little Muck Shelter, South Africa. Journal of Archaeological Science: Reports.
Silberbauer, G.B. 1981. Hunter and Habitat in the Central Kalahari Desert. Cambridge: Cambridge University Press.
Smith, A.B., Sadr, K., Gribble, J., et al. 1991. Excavations in the south-western Cape, South Africa, and the archaeological identity of prehistoric hunter-gatherers within the last 2000 years. South African Archaeological Bulletin, 46: 71-91.
Stewart, B.A., Zhao, Y., Mitchell, P.J., et al. 2020. Ostrich eggshell bead strontium isotopes reveal persistent macroscale social networking across late Quaternary southern Africa. Proceedings of the National Academy of Sciences, 117: 6453-6462.
Tapela, M.C. 2001. An archaeological examination of ostrich eggshell beads in Botswana. Pula: Botswana Journal of African Studies, 15: 60-74.
Texier, P.J.P., Parkington, G., Rigaud, J., et al. 2010. A Howiesons Poort tradition of engraving ostrich eggshell containers dated to 60,000 years ago at Diepkloof Rock Shelter, South Africa. Proceedings of the National Academy of Sciences, 107: 6180-6185.
van Doornum, B.L. 2005. Changing places, spaces and identity in the Shashe Limpopo region of Limpopo Province, South Africa. Doctoral Thesis. Johannesburg: University of the Witwatersrand.
van Doornum, B.L. 2007. Tshisiku Shelter and the Shashe-Limpopo confluence area hunter-gatherer sequence. Southern African Humanities, 19: 17-67.
van Doornum, B.L. 2008. Sheltered from change: Hunter-gatherer occupation of Balerno Main Shelter, Shashe-Limpopo confluence area, South Africa. Southern African Humanities, 20: 249-84.

Wadley, L. 1996. Changes in the social relations of precolonial hunter-gatherers after agropastoralist contact: An example from the Magaliesberg, South Africa. Journal of Anthropological Archaeology, 15: 205-217.

Wang, C.Z., Gao, Y., Zhang, X., et al. 2009. Archaeological study of ostrich eggshell beads collected from SDG Site. Chinese Science Bulletin, 54: 3887-3895.

Wei, Y., d'Errico, F., Vanhaeren, M., et al. 2017. A technological and morphological study of Late Paleolithic ostrich eggshell beads from Shuidonggou, North China. Journal of Archaeological Science, 85: 83-104.

Werner, J.J. & Miller, J.M. 2018. Distinguishing Stone Age drilling techniques on ostrich eggshell beads: An experimental approach. Journal of Archaeological Science: Reports, 22: 108-114.

Wiessner, P. 1977. *Hxaro*: A regional System of Reciprocity for Reducing Risk Among the !Kung San. Ann Arbor: University of Michigan.

Wiessner, P. 1982. Risk, reciprocity and social influences on !Kung San economics. In: Leacock, E. & Lee, R.B. (eds) Politics and History in Band Societies: 61-84. Cambridge: Cambridge University Press.

Wilmsen, E. 2015. Ostrich eggshells and their beads. South African Archaeological Bulletin, 70: 89-105.

Yates, R. 1995. Appendix B: Report on the analysis of ostrich eggshell beads from Geduld. South African Archaeological Bulletin, 50: 17-20.

Southern African Field Archaeology
2024 Vol. 19: Article 3180
Research report (peer-reviewed): Received May 2024; Revised July 2024; Published September 2024
DOI: https://doi.org/10.36615/safa.19.3180.2024

ISSN 1019-5785
ISSN 2789-1844

STRATHALAN CAVE REVISITED: STONE AGE NETWORKS AND ENVIRONMENTS AT THE FOOT OF THE DRAKENSBERG, SOUTH AFRICA

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ABSTRACT
The broader Drakensberg is an important region for understanding population dynamics and adaptation between the Late Pleistocene and Holocene. Here, we announce our campaign to re-excavate Strathalan Cave in the northeastern Cape of South Africa. Strathalan Cave sits at the foothills of the uKhahlamba-Drakensberg at the edge of the Great Escarpment of southern Africa. Well-known for its organic preservation, the site is important for understanding the archaeology of the region. People have occupied Strathalan Cave intermittently from ca. 29 000 years ago (ka), so exploring occupational patterns at sites such as these is a valuable means of understanding Stone Age behaviour during glacial Marine Isotope Stage 2 (ca. 29-14 ka). In this paper, we provide the first detailed description of the geological, geomorphological, sedimentary and environmental context of Strathalan Cave and review previous studies conducted on the site and region. We also introduce the goals of our re-excavation project and present a detailed map of the three cavities that make up the Strathalan Cave complex as part of a new, comprehensive, spatial control system established on site. Given the remarkable preservation of organic materials, Strathalan Cave may provide an important and rare source of archaeological and palaeoenvironmental data for this period. Future work at Strathalan will likely contribute to our understanding of the links between settlement patterns and environmental change. This is especially important given that Strathalan sits at the juncture between different environmental and geographic regions.

Keywords: Middle and Later Stone Age, Last Glacial Maximum, Marine Isotope Stage 2, Eastern Cape, site survey

1. Introduction

Southern Africa may have been a pivotal region in the development of complex behaviour and innovative technologies during the Late Pleistocene (Marean et al. 2007; Marean 2010; Henshilwood 2012; Wadley 2021; Wilkins et al. 2021). The spread of these techno-traditions through the subcontinent has significant implications for understanding the distribution of technology and populations in the Stone Age (Way et al. 2022). The broader Drakensberg region in southern Africa has an archaeological record extending back to Marine Isotope Stage (MIS) 5 (Carter 1978; Stewart & Mitchell 2018; Loftus et al. 2019). This record includes mountain rock shelters, open-air sites and a rich collection of rock art (Derricourt 1977; Carter et al. 1988). Encompassing the southern African Grassland Biome, the region is a resource-rich landscape with a diverse range of plants and animals which likely made this an attractive area for Late Pleistocene people (Stewart & Mitchell 2018). Given its centrality to the subcontinent and proximity to both the interior escarpment and coastal regions, the Drakensberg and its foothills may have been strategically significant and could hold important clues to understanding socio-ecological and technological dynamics from the cooler, glacial MIS 2 to the warmer Holocene.

Strathalan Cave borders the highlands of the uKhahlamba-Drakensberg and the grasslands of the northeastern Cape (Fig. 1). Its well-preserved organic material and extensive occupations from ca. 29 000 years ago (ka), make this a key site for understanding the archaeology of the region (Opperman

1996a). It has been proposed that Strathalan is located at the juncture of social networks that traversed the broader interior highlands and, possibly, the coastal regions (Fisher et al. 2020; Stewart et al. 2020). Strontium isotope analysis of ostrich eggshell (OES) beads from the Lesotho Highlands suggests the presence of extensive exchange networks across the region (Stewart et al. 2020). Marine shell beads recovered from interior sites such as Grassridge in the northeastern Cape and Sehonghong in Lesotho are good evidence of contact between the interior highlands and coastal regions (Mitchell 1996a; Collins et al. 2020). Population shifts in the interior and the coast may be linked to cooler conditions and environmental change associated with the Last Glacial Maximum (LGM; ca. 26-19 ka), the Younger Dryas (13-11.5 ka), and the Neoglacial (3.5-2 ka) (Clark et al. 2009; Stewart & Mitchell 2018; Thackeray et al. 2019). Moreover, human behavioural adaptations may also be linked to changing environmental conditions, although the extent of this relationship is complex (Pargeter & Faith 2020; Stewart & Challis 2023). Still, key questions arise as to how these periods of environmental stress influenced exchange networks and mobility, and Strathalan Cave may have a role to play in exploring this context. Exploring occupational patterns at sites like Strathalan is thus a valuable means of understanding Stone Age economy, settlement dynamics and ecology in the region.

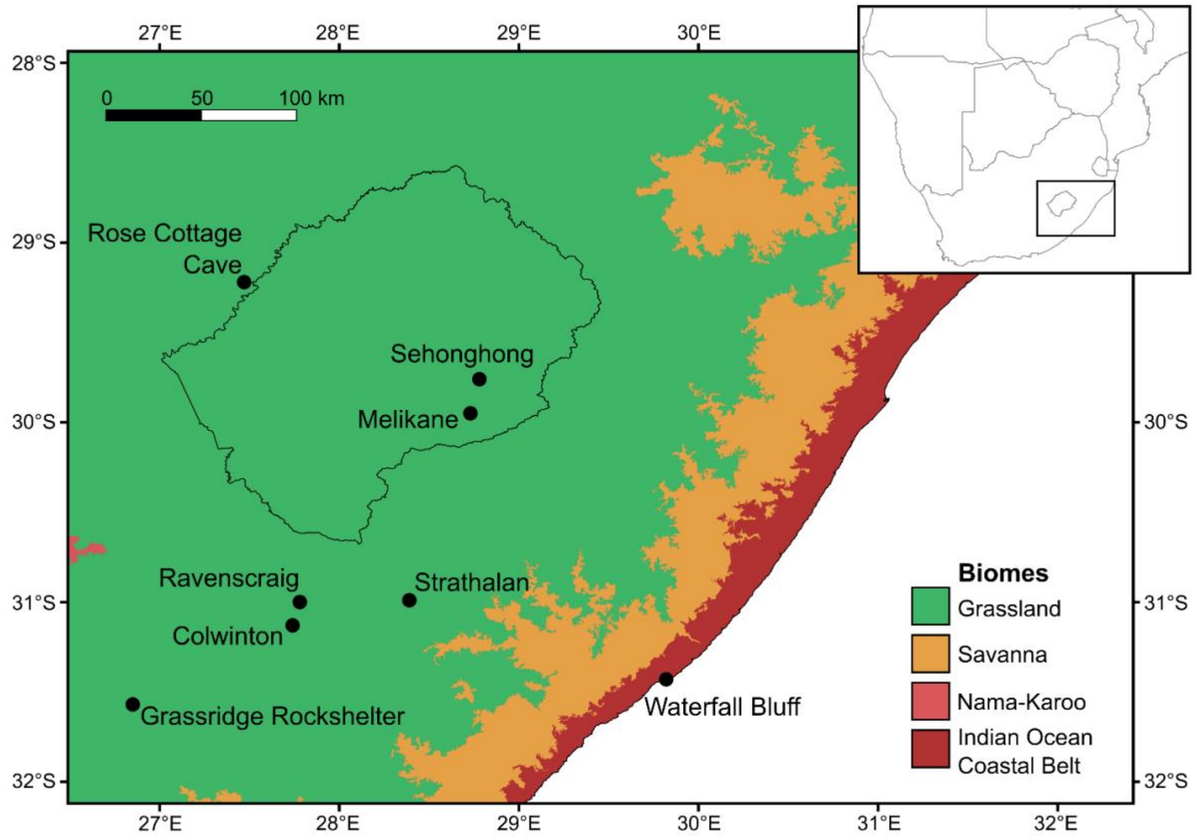

Figure 1. Regional map showing the sites mentioned in this study (vegetation based on Mucina & Rutherford 2011).

We are presently undertaking a new campaign of excavations at Strathalan Cave and a survey of the local region. The goal is to explore occupational patterns in the broader region and gain some insight into the local palaeoecology, augmenting and refining previous research by Opperman (1992, 1996a, b, 1999). The re-excavation of archaeological sites can benefit our understanding of past behaviour in numerous ways. Current advances in specialist *in situ* documentation and laboratory analyses were often not available to earlier excavators. Modern, conventional multi-disciplinary approaches include high-resolution spatial documentation of stratigraphy and artefacts with total stations, *in situ* geoarchaeological documentation and laboratory-based palynological, sedimentological and taphonomic analyses. The aim of this paper is fourfold: (1) to describe Strathalan Cave, its environmental, lithological and sedimentary context, and to review previous studies that have been undertaken on the site and region to provide a contextual foundation for the new research; (2) to introduce the goals and research questions of the Strathalan Cave Excavation Project; (3) to present the recent detailed spatial survey of the site, and; (4) to unpack the broader significance of our hypotheses for future research endeavours and what the implications may be for the site and surrounding region.

2. Site and regional background

Strathalan Cave (30°59’22.81” S, 28°23’18.59” E) sits at the foothills of the uKhahlamba-Drakensberg at the edge of the Great Escarpment of southern Africa (Fig. 2). It is a complex of three moderately sized, deposit-bearing cavities receding into the wall of a large, 100 m-long concave overhang hosted within lithologically variable Molteno Formation sandstones, ca. 1340 metres above sea level. At maximum height, the roof of the overhang is 8-10 m above the floor. Three individual cavities (hereafter, called caves) are named Cave A, Cave B and Cave C (Fig. 3). Cave A is located centrally within the overhang and is, at its entrance, approximately 9.5 m wide and 1.7 m high. The elongated cavity extends 18 m back into the larger shelter wall. Later Stone Age (LSA) material from the cave was dated to between ca. 10 ka to 2.5 ka. The LSA-bearing sediments are unconformably overlain by ephemeral occupations topped by an exceptionally well-preserved living floor dated to ca. 300 years ago (Opperman 1996b, 1999). Cave B, approximately 12 m south of Cave A, extends back into the overhang wall at a higher elevation than Cave A and C. The entrance to Cave B is approximately 4 m above the floor of the overhang. At its entrance, Cave B is approximately 7 m wide and 2 m high. The cave is generally circular in shape, about 13 m deep, and contains evidence of Middle Stone Age (MSA) occupations dated from ca. 29 ka to the onset of the LGM, ca. 22 ka (Opperman 1992). Cave C is 7 m north of Cave A and roughly at the same elevation within the overhang. At its entrance, Cave C is 8 m wide and about 2 m high. The roughly semi-circular cave is about 8 m deep. Our recent survey detected evidence of occupation in Cave C, indicating that it is deposit-bearing, but it is as yet unexcavated.

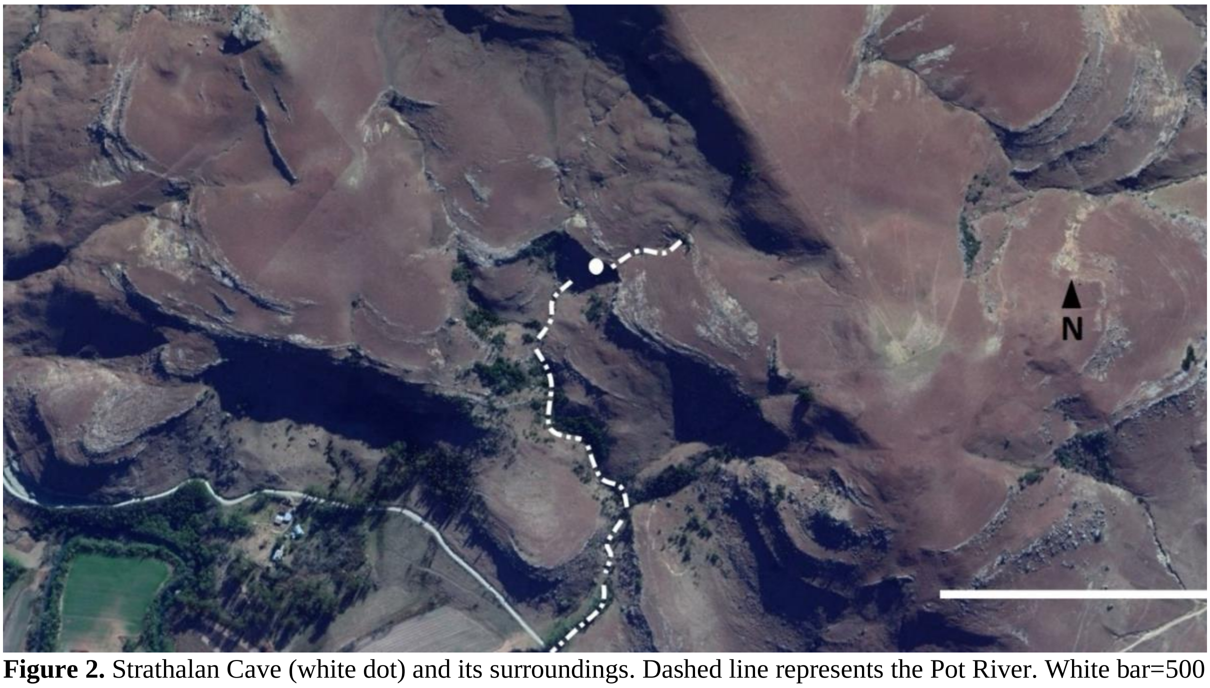

Figure 2. Strathalan Cave (white dot) and its surroundings. Dashed line represents the Pot River. White bar=500 m (map credit: Google Earth).

3. Geomorphology, geology and hydrology

Geomorphology

The Strathalan Cave overhang area has formed at a knickpoint in a short steep valley in an area of well-bedded sandstones of the Molteno Formation. Local vertical variability in the lithology has resulted in the exposure of a thick, generally horizontal, erosion-resistant sandstone bed, which forms a distinct bench and cliff system across the valley. Headward erosion of this bed, in several areas of the valley, has formed knickpoints and associated overhangs at the same general elevation. The roof of the Strathalan overhang represents the underside of this sandstone bed (Fig. 4). A perennial waterfall, fed from a spring that rises about 100 m upstream, cascades over the centre of the overhang onto collapsed sandstone blocks. This stream is one of four tributaries of the Pot River that converge from knickpoints in the same valley system. At Strathalan, the landscape immediately outside the overhang dripline slopes steeply to the southwest and can be described as a vegetated scree slope with massive, detached sandstone boulders remaining close to the outcropping sandstone ledge (Fig. 4). It is unlikely deposits would form or be preserved outside the dripline in this context, although isolated artefacts may be found on the slope. A line of very large, stacked, collapsed sandstone blocks lies just inside the dripline and stretches almost the whole length of the overhang (Fig. 5). Collapsed blocks are only missing from the vicinity around the waterfall, where the ground slopes steeply away to the southwest along the stream course. The collapse zones divide the shelter complex into two areas – Cave C to the north, and Caves A and B in the centre and south of the overhang.

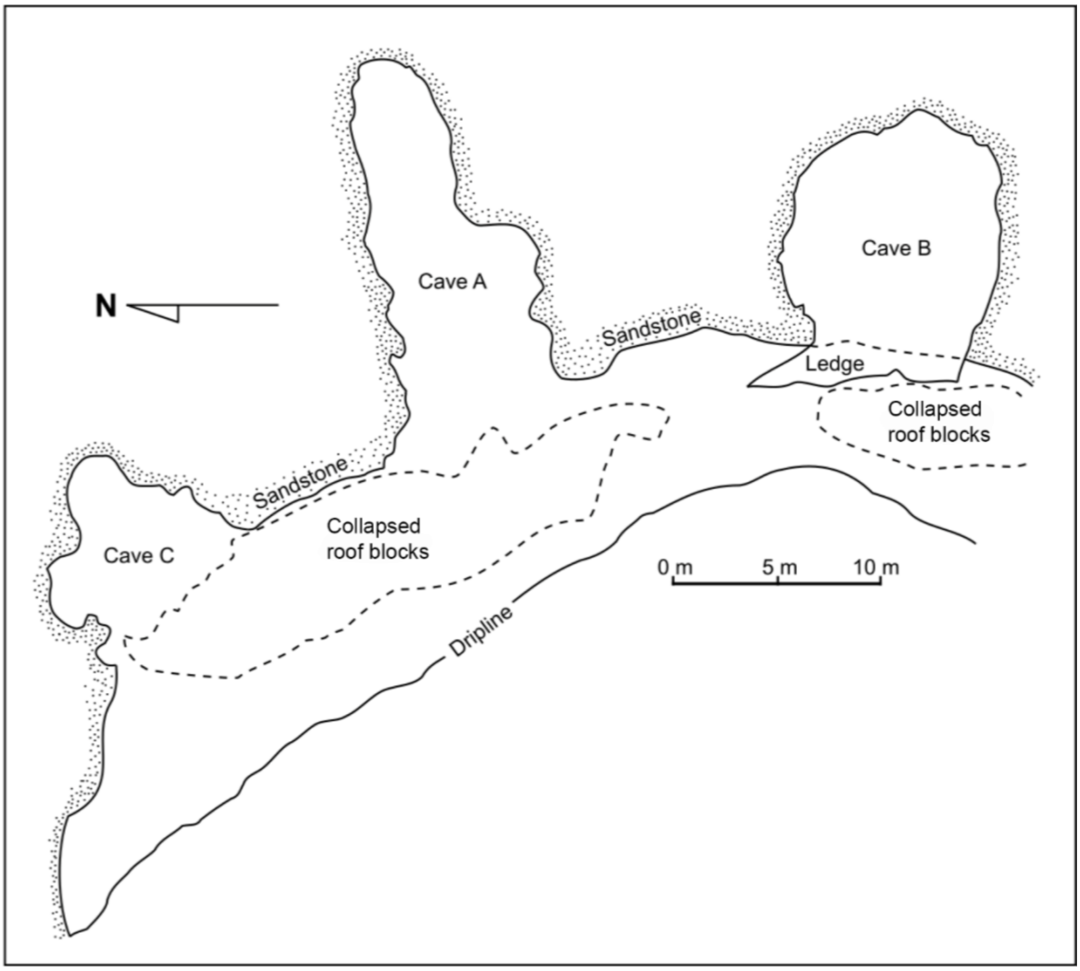

Figure 3. Strathalan Caves A, B and C within the overhang.

Differing geomorphological and geological characteristics across the overhang area, including elevations of sandstone beds and locations/depths of sandstone beds within the larger overhang, all contribute to site formation processes active at each cave. In addition, spatial proximity to fractures in the host rock and variability of the lithology of the host sandstones also play key roles in these processes. Consequently, each cave's sedimentary and archaeological assemblages will have formed under slightly different temporal and environmental conditions. For example, the roof of Cave A is a highly friable and loosely lithified coarse sandstone that breaks down rapidly. Potentially, the cavity formed quickly and was filled relatively quickly, limiting the maximum age of deposits here. To provide an initial perspective on the lithological influences on cavity and deposit formation, we present the first dedicated summary of the geological context of the caves.

Figure 4. Thicketed ravine in front of Strathalan Cave extending steeply downslope from the waterfall. Note the sandstone forming the roof of the overhang and the steep vegetated scree slope descending from the right.

Figure 5. Collapsed sandstone roof blocks inside the dripline of the Strathalan overhang. Cave A is behind the fence and to the right of the total station. Cave C is behind the collapsed roof blocks, to the right of the foliage.

Regional geology

The larger overhang and individual cave development has been guided by the lithology and bed thickness of the host rock. Strathalan is hosted within sandstones of the upper reaches of the Late Triassic Molteno Formation, Stormberg Group, of the Karoo Supergroup. The Molteno Formation has been divided and grouped into informal members by numerous authors (e.g., Turner 1975; Christie 1981; Macdonald 1993; Hancox 1998 – see Bordy et al. 2005 for summary) with only the Indwe Sandstone Member being formally defined and accepted by the South African Committee for Stratigraphy (SACS 1980). Above the Indwe Sandstone Member, up to ten units have been identified (e.g., Christie 1981) with noted lateral and vertical variability (e.g., Turner 1975; Bordy et al. 2005). Hancox (1998) has grouped the units of the upper Molteno into a 'transitional' member, while Bordy et al. (2005) placed them into the informal 'Tsqima' succession. To date, mapping and formal naming of upper Molteno units has not yet been completed. Following Christie (1981) and Bordy et al. (2005), the Molteno Formation sediments comprise a variably thick series of fluvially deposited sandstone units formed in broad, braided perennial rivers. Sediments in the upper Molteno units can generally be described as including massive and upwards fining packages composed of mostly immature matrix- and clast-supported sandstones with structures that include tabular, planar and planar cross-stratified forms. Sandstone sediment grain size is variable in its clay and silt content, and sand particles range from fine to very coarse. Occasionally, units are pebble-supported. Discontinuous massive and laminated planar mudstones and siltstones interstratify the sandstones. Frequent erosional surfaces are associated with well-defined wedge-shaped and tabular beds. At Strathalan, sandstones are often loosely lithified and crumble at a touch into single grains or granules.

Local geology

Locally, four major units (beds from hereout) are visible from the floor of the overhang to the dripline (Fig. 6). These units are tentatively attributed to the informal Tsqima succession based on unit geometry, sedimentology, and structure, but individual bed correlations are not yet possible. The four lithological units exposed at Strathalan are described below to provide context to the cavity formation processes and clastic sediments that contribute to the deposits.

The lower bed (Bed 1) is a horizontal tabular bed of siltstone composed of massive green silts and fine sands that are strongly lithified in fresh exposures and friable when weathered – exfoliating into small concave flakes. The upper contact of Bed 1 is gently undulating, and at the upper contact the unit may be laminated, or the laminations represent a thin interbedded mudrock draped over the undulating surface of Bed 1. Where Bed 1 has been preferentially weathered, receding from the vertical wall of the overhang, the underside of the base of Bed 2 is exposed. Here, negative casts of mud cracks can be seen in the base of Bed 2 suggesting the sands of Bed 2 formed into the mud-cracked surface of Bed 1 or the cracked surface of the interbedding mudrock.

Bed 2 is a 1-1.5 m thick succession of cross-bedded facies in wedge and tabular sub-units. Upwards-fining graded packages of quartz pebbles (sub-angular) line the bases of sequences over erosional truncations. Laterally, this is manifested as significant grain size variability. Bed 2 is friable and decays into detrital particles of coarse to very coarse immature sands. In the south of the overhang area (near Cave B), several additional sub-units are visible in Bed 2 and demonstrate local channel migration during deposition. One of these Bed 2 sub-units is particularly coarse and friable and constitutes the floor of Cave B. Cave B is elevated above the overhang floor and has formed in upper Bed 2 and Bed 3 sandstones.

Bed 3 is generally finer grained than Bed 2 and slightly more strongly lithified but retains the same general succession of cross-bedded, upwards-fining graded sub-units with wedge and tabular geometries. Bed 4 is the most resistant unit and forms the overhang dripline. It is finer grained than Beds 2 or 3, similarly structured at its base but becomes more massive in its upper reaches and is strongly lithified.

Each of the cavities in the Strathalan overhang has formed in and between different combinations of the identified beds exposed in the shelter. Consequently, the shape of each cave and the nature of the autogenically contributed geogenic sediments are different and have intriguing implications for the site formation processes acting across the larger site complex. Caves A and C formed predominantly in Bed

1, the friable siltstone, but differ in that Cave A's roof is defined by the contact between Bed 1 and 2 with the underside of the base of Bed 2 exposed across the roof. As expected, significant granulometric variability is present across the roof of the shelter. Cave C formed in the upper part of Bed 1 with the cavity roof extending upwards into Bed 2 and Bed 3. The autogenic geogenic contributions to the deposits in Caves A and C are defined largely by Bed 2 but also at the walls by decaying Bed 1. Cave C has a potential input from Bed 3. Cave B formed in Beds 2 and 3, with the floor being defined by the contact between Beds 2 and 3 and the roof ascending into the lower parts of Bed 4. Beds 2, 3 and 4 may contribute to the autogenic geogenic sedimentary component of Cave B.

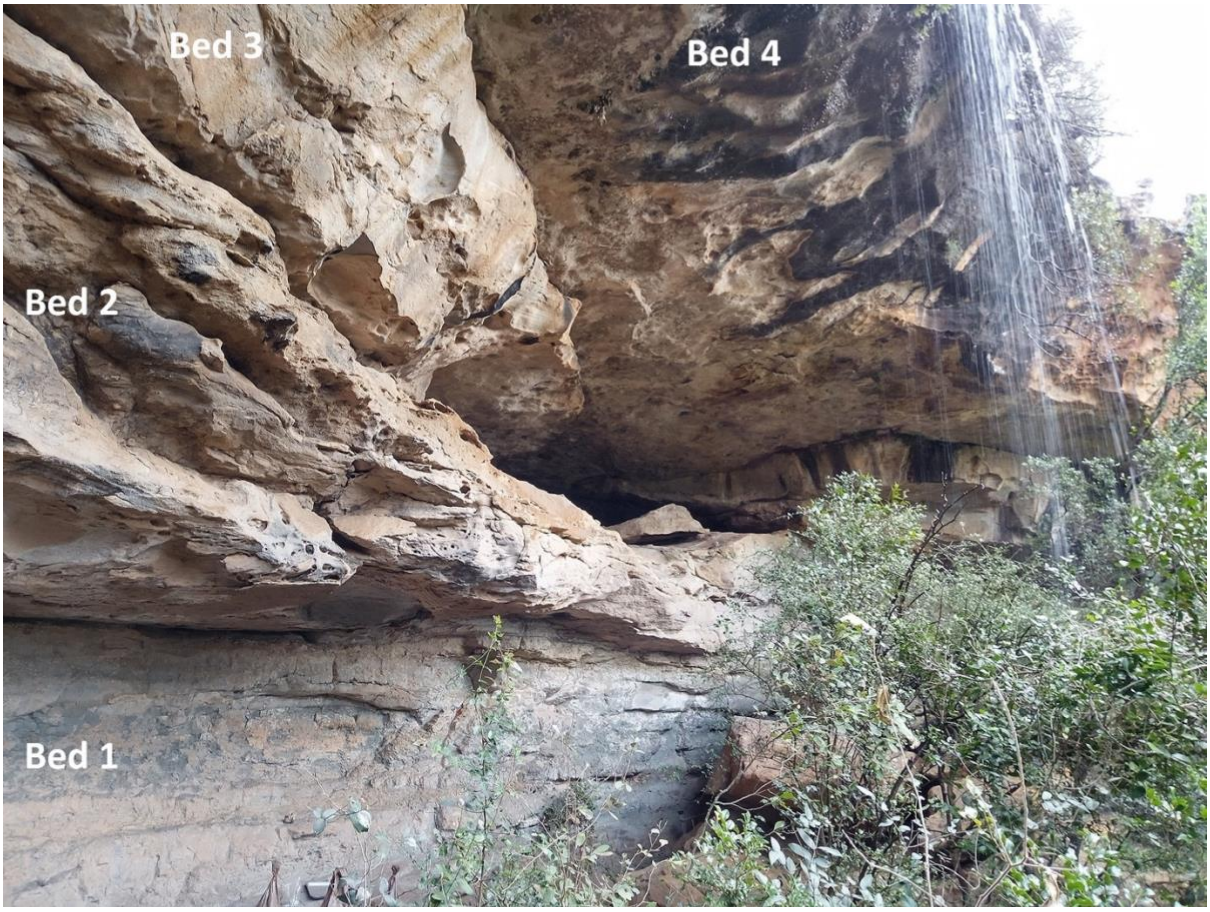

Figure 6. Cave B above the overhang. Note the waterfall descending from the dripline of the overhang. The elevated Cave B can be seen in the centre of the image. Cave A is immediately to the left of the position of the camera. All four local geological beds are labelled in the image. Bed 1 is at the base, Bed 2 and 3 are shown in the upper left corner, and Bed 4 rises to the dripline and waterfall.

Hydrology

Despite the potentially perennial flow of the waterfall (Fig. 6), evidence of water seepage, or penetration through the back of the shelter and into cavities, is limited to some localised flowstone formation on the eastern wall of Cave C and nodules of what is likely to be calcium carbonate on the wall of Cave B. No channels are evident. Some moisture is evident in the sediments in Caves A and C, but these caves are both closer to the overhang dripline and have larger entrances, which are more accessible to animals (entrances are at floor level). It is likely that the front of these caves receive moisture from heavy rains, fog and mist and spray from the dripline when very wet conditions prevail. A thick line of vegetation under the dripline also probably contributes to the conditions and attractiveness to animals of the overhang and Caves A and C. Some seepage is evident along the southern wall of the overhang from rainwater running down the north-facing slope of the valley. To the north, Cave C has a secondary dripline right below the overhang dripline making the cavity more prone to meteoric infiltration, and water can be seen seeping through a 3 m-long north-south running fracture in Bed 1.

4. Regional environment

Strathalan Cave sits in a significant biodiversity hotspot and is part of the Drakensberg Alpine Centre of Plant Endemism (UNESCO 2023). It occurs in the summer rainfall zone with most rain falling between October and March (Mucina & Rutherford 2011). Mean annual precipitation is around 780 mm; generally, in the form of thundershowers but mists are also an important supplier of moisture. Vegetation is dominated by grasses – many of those C4 grasses such as *Themenda triandra* – but with a strong shrub component (e.g., *Buddleja salviifolia*). Small trees (e.g., *Diospyros whyteana*) also occur in thickets in ravines (Mucina & Rutherford 2011). Opperman and Heydenrych (1990) note that dense patches of Protea and Watsonia occurred within two hours walk from the site.

Strathalan is part of the Eastern Lowlands floristic region of the Grassland Biome comprising the *Hyparrhenia hirta* tall grassland (Cowling et al. 2003). The site is at the interface of the Drakensberg and Sub-Escarpment Grassland Bioregions at the ecotone between East Griqualand Grassland and Southern Drakensberg Highland Grassland (Mucina & Rutherford 2011). Most of these grasses fall under Highveld Sourveld and Dohne Sourveld. Southern Drakensberg Highland Grassland occurs in the ridges and valleys of the Stormberg Mountains, dominating the eastern slopes of the uKhahlamba-Drakensberg region. The steep valley below the Strathalan Cave complex is typical of these landscapes with dense tussock grassland on the slopes and dwarf shrubland on exposed rocky outcrops. Grasslands are dominated by *Festuca* sp. with *Erica* sp. the most prevalent types of low shrubs. To the east of the Stormberg-Drakensberg range, Eastern Griqualand Grasslands dominate the terrain. These occur on the hilly slopes near Nqanqarhu and on the landscapes near Strathlalan. Vegetation in this region is dominated by grasses such as *Alloteropsis semialata* but also includes small thicket including *Diospyros lyciodes* and *Vachellia karroo*. Notable endemic plants in this bioregion include cycads (*Encephalartos friderici-guilielmi*) (Hoare & Bredenkamp 2001).

Historically, a diverse range of fauna including suids, antelope, baboons and carnivores occurred in the Nqanqarhu region (Skinner & Chimimba 2005). As expected, grazers are prevalent. Large game associated with open plains – zebra/quagga, blesbok/bontebok, and springbok – occurred in the region and were regularly hunted in the nineteenth century. Interestingly the 'Inxu' River, near Nqanqarhu, is likely to be a corruption of the isiXhosa word 'iNqu' meaning wildebeest (Skead 2007), suggesting that wildebeest were also common in the area. Eland, buffalo and oribi, a favourite target for colonial hunters, were noted in historical records of the region (Harris 1844 in Skead 2007). In the ravines and thicket, browsers such as bushbuck and duiker occurred, with rhebok and klipspringer occurring on mountain slopes and outcrops. Very large herbivores such as elephant and hippo were also recorded near Nqanqarhu. Given the diversity of herbivores, carnivores such as hyena and leopards were relatively common. While lions were rarely mentioned in historical records, place-names bearing the isiXhosa name for lion (inGonyama) suggests these predators were fairly common in the East Griqualand region (Skead 2007).

5. Previous research at Strathalan

The archaeology of the broader Drakensberg is relatively well-studied (Carter 1970, 1978; Mitchell 1994, 1996a, b; Stewart et al. 2016; Stewart & Mitchell 2018). In particular, the highlands of the Drakensberg have been a key area of interest since the nineteenth century (Orpen 1874; Jenkins 2019). Earlier research concentrated on the well-preserved rock art (Van Riet Lowe 1952; Willcox 1956; Vinnicombe 1960, 1976), while later studies generally focused on how people adapted to the harsh environmental conditions of the highlands (Carter 1976; Cable 1982; Mitchell 1990; Stewart et al. 2012; Mitchell & Arthur 2014; Loftus et al. 2015). The foothills of the Drakensberg are often seen as an intermediate region between the cold, harsh highlands of the Drakensberg and the grassland-dominated interior of southern Africa. Opperman (1982, 1987, 1988) excavated multiple sites in this region including Grassridge Rockshelter, Colwinton and Ravenscraig. He argued that hunter-gatherer groups generally focused on mountain resources and only exploited food resources in the foothills of the mountains in times of scarcity.

In a series of excavations, Opperman excavated Cave A and B in the 1980s and 90s (Opperman 1992, 1996a, b, 1999). In Cave B, excavations covering 12 m^2 removed a substantial amount of deposit reaching bedrock in less than 1 m. Radiocarbon dates from Cave B indicate occupations probably occurred during early MIS 2. We calibrated dates from Cave A and B in OxCal (Bronk Ramsey 2009, 2021) using the SH20 curve (Hogg et al. 2020) at two standard deviations. A sample of charcoal from the deepest layer (VBP) was dated to 27 600±420 BP (Pta-4642), providing calibrated ages of between 32 897 to 31 036 years BP. A series of six ages from layer BPL – the youngest anthropogenic layer – dated from 24 200±640 (Pta-4931) (29 850 to 27 313 years cal. BP) to 20 900±350 (Pta-4944) (25 860 to 24 260 years cal. BP) (Opperman & Heydenrych 1990). This puts the occupations at Cave B to just before the LGM (Clark et al. 2009) making it a valuable site to explore human responses to MIS 2. Besides the age of the site, Cave B is significant for several other reasons. Firstly, the spatial patterning indicates the site was used as a sleeping and living area. A relatively large hearth area occurs in the centre of the site, with bedding patches laid out in a semi-circular position around the hearths. Opperman and Heydenrych (1990: 95) argue that these deposits may reflect a series of single occupational events, and that "the patterning at least is consistent with a concordant series of penecontemporaneous and comparable events". The MSA deposits in Cave B are also significant in that they are associated with an MSA technocomplex that persisted to ca. 21 ka. Much of the lithic assemblage consists of whole irregular flakes (n=658; 45%) with 'flake-blades' (blades; n=175; 12%) also common. Hornfels is by far the most common material (~85%) but chalcedony (~12%) also occurs.

Another significant aspect of Cave B is its well-preserved grass bedding and plant remains (Opperman & Heydenrych 1990). The species used in the bedding could not be identified because leaf blades, used for identification, had not survived. Carbon-13 values were more negative than -22‰ indicating that these were C3 grasses. Other preserved botanical remains include twigs, corm scales, seeds and charcoal. Sagewood (*Buddleja salviifolia*) and geophytes such as Watsonia, *Tritonia-Freezia*, and aloe species were identified. Two specimens of unidentified plant stems were recovered tied in knots. Approximately 3 kg of faunal remains were recovered from Opperman's excavations, with most of these from the hearth area (Opperman 1996a). The identified sample reflects what is expected from the historical record including the ubiquitous hyrax and eland, grazers (wildebeest and bontebok/blesbok) and plains game (springbok). Interestingly, a Hippotragine specimen was also recovered. It is possible that this represents roan (*Hippotragus equinus*), a gregarious bovid associated with open habitats near dependable water sources.

Excavations were also undertaken in Cave A, the main rock shelter (Opperman 1996b, 1999). Initially, a 2x1 m test pit was excavated followed by a 5x1 m trench with deposits reaching a depth of 1.2 m. Material from the lowest layers was dated to 9400±900 BP (Pta-4634) (13 183 to 8590 years cal. BP), placing initial occupations here to the onset of the Holocene. A date of 2470±45 BP (Pta-4678) (2706 to 2351 years cal. BP) from the upper layer indicates the cave was regularly occupied for millennia (Opperman 1996b). As in Cave B, hornfels and chalcedony were the most common raw material used for lithics. Scrapers dominated the formal tool assemblage and bone tools were also quite prevalent. The bone tools and artefacts discovered included bone points, pendants, an awl, a bead and a broken fishhook. Wooden artefacts including pegs, a digging stick and a curved piece of worked wood – possibly part of a bow – were also recovered; with most of these from Layer 2 (probably slightly older than ca. 2.5 ka). Other artefacts included cut reeds (likely used for arrows) and fragile items such as string, and a fragment of dressed skin (Opperman 1996b). Fauna and flora are well-preserved, though the site is dominated by plant remains. Protea and Watsonia remains were apparently relatively common. Grass bedding occurs throughout the cave relatively close to the surface. Numerous knotted plant stems similar to those discovered in Cave B were recovered. Most of these were identified as Watsonia with their stems tied in bunches. A small faunal sample was recovered with small bovids such as grey rhebok and klipspringer more common. Grazers such as *Hippotragus* and equid also occurred. Numerous specimens of land snail (*Achatina immaculata*) shells were also recovered, with most of these from Layer 2.

The excavated materials from Cave A and B paint a picture of shifting occupational patterns from the Late Pleistocene to the Holocene. Based on Opperman's excavations, occupations at Strathalan Cave began in Cave B during the MIS 3/2 transition. In that shelter, successive groups probably used the same areas repeatedly as sleeping, hearth and food processing places (Opperman 1996b). Artefact and faunal abundance decline from the earlier to later layers in Cave B, which suggests decreasing frequencies of occupations through MIS 2. At the onset of the LGM, occupations at Strathalan cease, with people only reoccupying the site almost 10 000 years later. Many of the recovered plant remains suggest that plants were exploited for a variety of reasons. The dominance of geophytes indicate that these were important sources of food, and sagewood was likely used for firewood but may have also been used for its medicinal properties (Van Wyk & Van Wyk 1997). The knotted plant stems were probably tied to make them easier to transport and resemble the tied stems recovered at LSA sites such as Melkhoutboom in the southeastern Cape (Deacon 1976).

Environmental changes are also evident in the Cave A and B deposits. The environment of this region was likely wetter and more ameliorable after the Pleistocene-Holocene transition (Lewis 2008; Fitchett et al. 2016; Stewart & Mitchell 2018). This may also have been the case before the onset of MIS 2 and the LGM. Extralimital animal species at Strathalan may indicate increased moisture. *Hippotragus* occurs in both Cave A and B and is reported from rock paintings in the eastern Drakensberg (Carter 1978). Roan occurred in the mid-Holocene deposits of Rose Cottage Cave and Colwinton (Plug 1997), so it is feasible that the *Hippotragus* remains at Strathalan Cave are that species. The possible presence of roan in Layer VBP in Cave B and in Cave A suggests a productive environment with higher quality grass than at present (Arthur et al. 2018). The differences in faunal profiles between Cave A and B may suggest not just environmental change but shifts in subsistence strategies. For example, the prevalence of small fauna such as hyrax and small bovids in Cave A (compared to the larger bovids in Cave B) may also reflect the use of snares and traps. Regarding vegetation, C4 grasses such as *Themenda triandra* currently predominate the non-agricultural environs around Strathalan (Mucina & Rutherford 2011). The apparent prevalence of C3 grasses found in the bedding of Cave B points to a decline in temperature at Strathalan since C3 grasses thrive in cooler conditions. Pollen and isotopic data suggest that the environment around Strathalan Cave corresponded to interstadial conditions with more open grasslands from ca. 34 to 24 000 BP. Thereafter, vegetation resembled the alpine belt of the Drakensberg (Opperman & Heydenrych 1990; Lewis 2008).

6. Current projects and regional studies

Data from newly (re)excavated sites are an important means of documenting occupational movements within the interior, particularly between the interior plains and higher altitude regions. Currently, numerous studies are focusing on the interior of southern Africa, recognising that this area is just as significant to understanding the development of modern human behavioural complexity as coastal regions (e.g., Backwell et al. 2018; de la Peña et al. 2019; Wilkins et al. 2021). Various groups of researchers have established several transdisciplinary projects to explore, in more detail, occupational patterns and mobility in the greater Eastern Cape highlands and Drakensberg interior (e.g., Stewart et al. 2012; Fisher et al. 2013; Collins et al. 2017; de la Peña & Witelson 2020).

Earlier studies of the Eastern Cape and Drakensberg region tended to focus on seasonality and mobility between the coast and the interior (Carter 1970, 1976; Deacon 1976; Cable 1982; Mitchell 1996a). Stewart et al. (2016), however, argue that the Senqu/Orange River Valley was a key route for social networks and seasonal mobility, and OES bead distribution patterns seem to support this. Analyses of strontium isotope ratios of OES beads from sites in the Drakensberg and Lesotho highlands indicate that these beads probably originated from geological formations occurring in the more water-stressed subcontinental interior (Stewart et al. 2020). In combination with ostrich regional distributions, this suggests that Lesotho highland group exchange networks extended hundreds of kilometres throughout the region and may have included Strathalan Cave (Stewart et al. 2020). Occupational patterns across various sites in this region may also point to possible links between these sites. Sedimentary hiatuses are reported at Sehonghong (Lesotho) and Rose Cottage Cave (Free State) between ca. 29 and 25 ka (Pargeter et al. 2017; Loftus et al. 2019) which have been interpreted by the authors as occupational hiatuses. While it must be noted that sedimentary hiatuses and/or unconformities should not necessarily be interpreted as human occupational intervals (Stratford et al. 2021), the fact that these appear to correspond to occupational periods in Cave B (Opperman 1996a) may point to settlement links between Strathalan and these sites. This will be explored in more detail in our new investigations.

Strathalan Cave may also inform on the broader archaeological context of the region. The lithic assemblage from Cave B, dated to between ca. 29-22 ka, is categorised as a final MSA industry and is one of the most recent occurrences of MSA technology in southern Africa (Lombard et al. 2012, 2022). Sites relatively close to Strathalan with final MSA lithics include Melikane (ca. 38 ka cal. BP; Stewart et al. 2012), Sehonghong (ca. 30 ka; Mitchell 1994) and Grassridge rock shelter (ca. 32 ka; Ames et al. 2020) (Fig. 1). Sites in the broader Drakensberg region with final MSA assemblages that persist into MIS 2 – like Strathalan – are rare and include Ha Makotoko in Lesotho (ca. 28 ka; Mitchell & Arthur 2014) and Rose Cottage Cave (ca. 28 ka; Pienaar et al. 2008). Other sites in the eastern region of southern Africa such as Umbeli Belli (ca. 29 ka; Bader et al. 2018), Sibebe in eSwatini (ca. 37-27 ka cal. BP; Bader et al. 2022), and Holley Shelter in KwaZulu-Natal (36-34 ka cal. BP; Bader et al. 2024) also have relatively late MSA industries, with many persisting to MIS 2. The MSA lithics from Strathalan Cave also show apparent similarities to assemblages in this region. For example, the MSA 6 lithic assemblage at Sehonghong resembles Strathalan and Rose Cottage Cave (Bader et al. 2018), and, as at Strathalan, hornfels dominates the MSA 6 and 9 at Sehonghong and Umbeli Belli (Carter et al. 1988; Bader et al. 2018). The persistence of MSA technology in the broader Drakensberg and eastern region raises important questions as to the scope of connections and mobility patterns during later MIS 3/early MIS 2.

While Strathalan was likely part of wider social and exchange networks spanning the broader Drakensberg and Lesotho highlands region, it is also possible that it may have been part of coastal exchange networks. Fisher et al. (2020) argue that the coast was probably a significant part of these regional exchange networks. They note that the presence of vervet monkey and marine shell at Sehonghong, and OES beads at Waterfall Bluff suggests contact between the interior highlands and the Indian Ocean. The current impression of settlement patterns suggests that the Drakensberg highlands was a key centre of occupational intensity during the Late Pleistocene. Radiocarbon dates indicate that the highlands of Lesotho were occupied from ca. 83 ka at Melikane, and regularly from MIS 3 (Stewart & Mitchell 2018). Ephemeral occupations – and possible hiatuses – are noted during the peak of the LGM (ca. 23-19 ka) (Loftus et al. 2019). Along the coast, persistent occupations are recorded at Waterfall Bluff from MIS 3 to the early Holocene (Fisher et al. 2020). Indeed, Fisher and colleagues suggest that Waterfall Bluff may have acted as a refugium during the LGM, especially as deteriorating environmental conditions in the Drakensberg highlands would have driven populations out of the highlands. The question then is how Strathalan Cave would fit into these scenarios, and how could the re-excavation of the site better our understanding of the archaeology of the region.

7. Strathalan Cave research goals

A key goal of the Strathalan Caves Excavation Project is to augment the research of these various projects with data from our new excavations. Our key research questions are the following:

1. Can we link environmental conditions at Strathalan with occupational patterns?

Reorganisation of social, subsistence and mobility patterns may be linked to significant periods of environmental stress such as glacial/interglacial transitions (Brink & Henderson 2001; Pargeter & Faith 2020). A priority for the Cave B excavation is to undertake a new dating programme to confirm whether these deposits occurred during the LGM. It is important to note that LGM deposits are rare in southern Africa, so Strathalan could answer some key questions on environmental conditions during the LGM (for example, see discussion in Fisher et al. 2020 and Faith et al. 2024). Plant and organic remains are well-preserved at the site and may reveal a wealth of information on palaeoenvironmental conditions. Given time limitations, none of the twigs, leaves, seeds and charcoal from Cave B were identified, and neither was the species that make up the grass bedding. The first, and most obvious, question would be what grasses comprised the grass bedding. In our recent survey of the site, twigs, seeds and other plant remains were abundant in the deposit profiles, so it would be crucial to identify these. The Holocene deposits in Cave A could also be critical in exploring environmental change over the last 10 000 years. Previous studies suggest the reoccupation of the Eastern Cape Drakensberg only begins from ca. 10 ka (Stewart & Mitchell 2018; Loftus et al. 2019). This is supported by Opperman's excavation of Cave A where the lowest layer in the rear of the cave was dated to ca. 10 ka (although, it is possible that deposits in the front of Cave A and C date to earlier than that). Because Strathalan Cave may yield a virtually unbroken sequence from at least 10 to 2 ka, it would be interesting to explore how significant environmental changes such as the 8.2 ka event and Neoglacial affected this region. The period from ca. 6 ka to the Neoglacial is also not well-known, with little data available from the Maloti-Drakensberg region. It was likely to have been dryer and warmer (Lewis 2008; Stewart & Mitchell 2018) but more data are needed to explore this period. Palaeoenvironmental data from Cave A could expand our knowledge of this timeframe in the region.

2. Is there any archaeological evidence to link Strathalan Cave with the coast and/or the Lesotho highlands?
We hypothesise that there was contact with the coast. Major rivers such as the Mzimvubu and Mngazi on the eastern coast originate in the eastern Drakensberg. The Pot River – one of the sources of the Mzimvubu – literally runs through Strathalan Cave (Fig. 2), so it is feasible that groups could have moved along these river routes to the coast. One avenue of investigation would be to search for exchange artefacts between Strathalan Cave and coastal sites. Marine shell, bone tools, exotic coastal-linked faunal remains and other artefacts recovered from new excavations could disclose these connections. With regards to the Lesotho highlands, there is good evidence for contact between Strathalan and the broader Drakensberg region during the Pleistocene. Cursory observations of the lithic assemblage in Cave B suggests that they resemble those from Sehonghong and Rose Cottage Cave (Carter et al. 1988; Bader et al. 2018). Detailed technological and typological analyses of the lithics may reveal if these similarities imply a more comprehensive connection between these sites. Evidence for connections between the broader Drakensberg region and Strathalan during the Holocene may be more convincing. Strontium analyses and OES distribution networks suggest strong links between the Strathalan Cave surroundings and the Lesotho highlands (Stewart et al. 2020).

3. What can the faunal and archaeological material reveal about subsistence behaviour?
Zooarchaeological analyses are critical to examining subsistence patterns and could also reveal transport decisions inherent in long-distance exchange networks. Taphonomic analyses of faunal remains (which were not common in the 1990s) would highlight specific subsistence strategies used by the Strathalan occupants and may also be used to explore occupational intensity through the sequence (Reynard 2022). Detailed taphonomic analyses would also be crucial in examining the faunal remains to identify worked bone. Over the last few decades, valuable zooarchaeological studies have been undertaken at sites in the broader regional Drakensberg (Plug & Engela 1992; Plug 1997; Plug & Mitchell 2008; Pargeter & Dusseldorp 2022; Dewar et al. 2024). In combination with these, new data from Strathalan could contribute significantly to our understanding of prey exploitation patterns in the region.

4. What can geoarchaeological analyses at Strathalan Cave tell us about site formation processes and settlement patterns at the site?
The application of archaeological micromorphology may provide additional insight into occupational intensities and durations, and site management behaviours (e.g., Goldberg & Berna 2010; Karkanas et al. 2015; Wadley et al. 2020). Micromorphological analyses may illuminate if site formation processes are linked to environmental conditions and, if so, how populations adapted to changing conditions. To date, microscale studies of MSA anthropogenic deposits in southern Africa have been conducted on significantly older contexts (Goldberg et al. 2009; Miller et al. 2013; Larbey et al. 2019; Wadley et al. 2020; Haaland et al. 2021; Morrissey et al. 2023). The deposits in Cave B provide an important opportunity to reconstruct these behaviours in a terminal MSA context, with the potential to compare them to those recorded at older sites. Analysing these particularly well-preserved deposits could also provide a very useful analogue for the study of older, less-preserved deposits at other sites. Since bedding was first recovered from Cave B in the 1990s, the analysis of bedding has undergone significant advancements with the more recent recovery of bedding at MSA sites such as Sibhudu and Border Cave (Wadley et al. 2011, 2020; Miller & Sievers 2012). Indeed, if the grasses used in the bedding at Cave B can be identified to species, it may inform on not just environmental conditions but also about the domestic habits of the occupants. For example, sagewood, identified in Cave B, may suggest the use of plants for aromatic or medicinal purposes. Sagewood is a fragrant plant that has also historically been used to make herbal tea, as a remedy for coughs and colic, and as an eye lotion (Mutshinyalo 2001).

8. Site survey

The Strathalan complex was surveyed in September 2022 to establish spatial control for future excavations and allow high-resolution spatial documentation in any area of the shelter complex. The survey was conducted with a Trimble C5 total station. A local coordinate system was chosen for the initial control. The main datum is located on the floor within the overhang, between Caves A and B, and was given the coordinates X=100.000; Y=100.000; Z=100.000. Two additional datum points were created outside Cave C. Backsights were marked and plotted on various surfaces around the overhang and inside the three caves to allow the total station to be set up anywhere in the complex by resection (Fig. 7). Points were plotted along the contacts between the deposit and cavity walls to create floorplans for the overhang and each of the caves. Significant features were surveyed, including the overhang's dripline, zones of major collapse, large rocks within the caves, and flowstone and animal burrows in Cave C. Finally, wherever possible, surviving grid markers from the Opperman excavations in Caves A and B were plotted to allow the integration of the existing excavation grids into the new coordinate system and any excavation grid developed. A photogrammetric model of the floor of Cave B was created to enable integration of the old grid and the new coordinate system, and to enable assessment of the condition of the excavation area for monitoring and consistent documentation (Fig. 8). Photogrammetry was used to build a model of the Cave B floor, from low angle oblique photographs that would enable generation of the above perspective and photographic detail. The height of the Cave B roof prohibits the capturing of a single image that includes the whole cave floor.

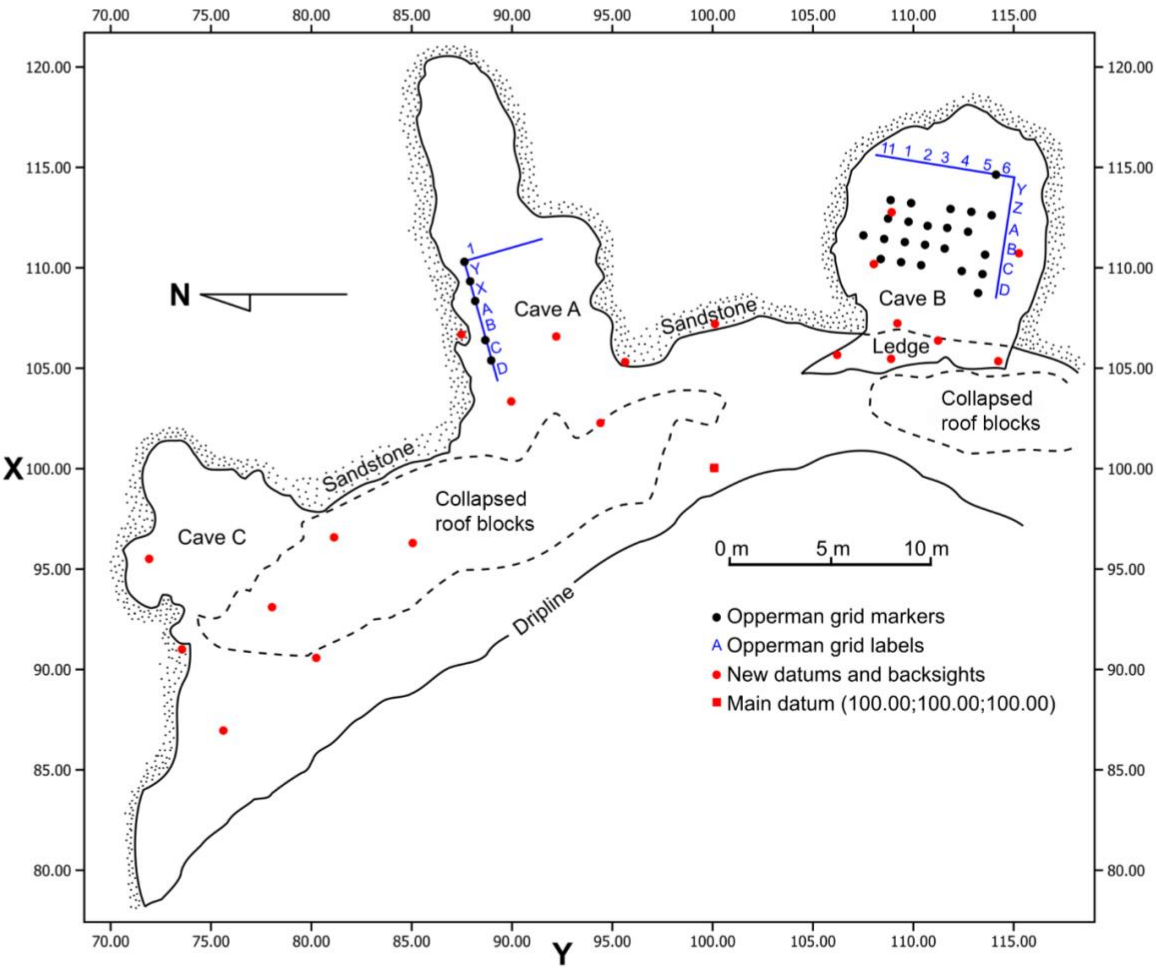

Figure 7. Grid markers and backsites in the Strathalan Caves.

9. Future research

Sitting at the juncture of diverse eco-regions and mid-way between high-altitude landscapes and rolling grasslands, Strathalan may have intersected with multiple social networks. Given this, future work at Strathalan will likely contribute to our understanding of the links between settlement patterns and environmental change. The excavations and surveying of the site and local area will be undertaken in a multi-phased approach. Phase 1 – the survey of the site – has been completed and is reported here. The second phase involves the excavation of Cave A and a survey of the local area. This phase is currently being undertaken, with results from the analyses of materials excavated from Cave A forthcoming. The next phase includes sampling and excavations in Cave B. Much of the bedding in Cave B is still well-preserved, so the focus here is on examining and analysing the bedding exposed from the Opperman cuttings. Finally, we plan to investigate and excavate the newly discovered Cave C. With the wealth of palaeoenvironmental data previously recovered from the site, it is our expectation that future excavations of Strathalan could yield significant information and play a key role in understanding human responses to environmental change in this transitional region.

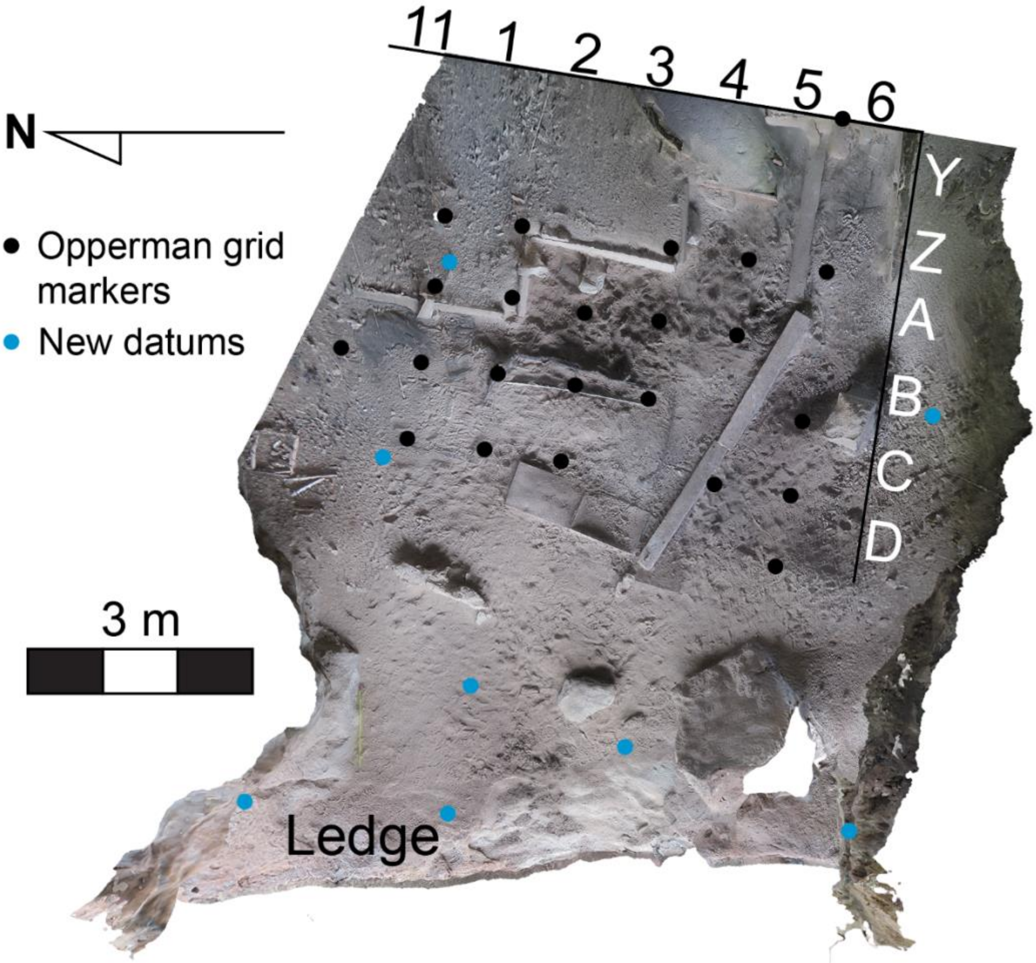

Figure 8. Photogrammetric model of the floor of Cave B.

Acknowledgements
A permit has been granted by the Eastern Cape Provincial Resource Heritage Agency (ECPRHA) to excavate Strathalan Cave (Permit number: APM-BG/22/03/001). We thank Patrick and John O'Mullane and the O'Mullane family for giving us permission to access the site and for their help and assistance during site visits. We also thank Candice Prins for her support and help with accommodation at the Sheeprun Farmstay during our visits. Jerome Reynard is funded by a Genus: DSI-NRF Centre of Excellence in Palaeoscience grant (grant no. 86073), a South African Department of Science and Innovation (DSI)-National Research Foundation (NRF) Thuthuka grant (grant no. 129689) and an Enabling Grant through the Carnegie Diversifying the Academy Programme from the University of the Witwatersrand. JR also gratefully acknowledges funding from the Palaeontological Scientific Trust (PAST) for earlier research. We thank Matt Lotter, Eric Fisher and Gregor Bader for valuable comments and useful suggestions. Their recommendations have significantly improved our manuscript.

References

Ames, C.J.H., Gliganic, L., Cordova, C.E., et al. 2020. Chronostratigraphy, site formation, and palaeoenvironmental context of late Pleistocene and Holocene occupations at Grassridge rock shelter (Eastern Cape, South Africa). Open Quaternary, 6: 1-19.

Arthur, C., Mitchell, P., Dewar, G., et al. 2018. After the silt: Middle and late Holocene hunter-gatherer archaeology of the Metolong Dam, Lesotho. Southern African Humanities, 31: 129-179.

Backwell, L.R., d'Errico, F., Banks, W.E., et al. 2018. New excavations at Border Cave, KwaZulu-Natal, South Africa. Journal of Field Archaeology, 43(6): 417-436.

Bader, G.D., Mabuza, A., Williams, D.P., et al. 2022. Rethinking the Middle to Later Stone Age transition in southern Africa: A perspective from the highveld of Eswatini. Quaternary Science Reviews, 286: 107540.

Bader, G.D., Tribolo, C. & Conard, N.J. 2018. A return to Umbeli Belli: New insights of recent excavations and implications for the final MSA of eastern South Africa. Journal of Archaeological Science: Reports, 21: 733-757.

Bader, G.D., Val, A., Gevers, et al. 2024. Behind the waterfall – interdisciplinary results from Holley Shelter and their implications for understanding human behavioral patterns at the end of the Middle Stone Age in southern Africa. Quaternary Science Reviews, 331: 108633.

Bordy, E.M., Hancox, P.J. & Rubidge, B.S. 2005. The contact of the Molteno and Elliot formations through the main Karoo Basin, South Africa: A second-order sequence boundary. South African Journal of Geology, 108(3): 351-364.

Brink, J.S. & Henderson, Z.L. 2001. A high-resolution last interglacial MSA horizon at Florisbad in the context of other open-air occurrences in the central interior of southern Africa: An interim statement. In: Conard, N.J. (ed.) Middle Palaeolithic and Middle Stone Age Settlement Systems: 1-20. Tubingen: Kerns.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. Radiocarbon, 51: 337-360

Bronk Ramsey, C. 2021. OxCal v4. 4.4. Available from: https://c14.arch.ox.ac.uk/oxcal.html (Accessed: 2024).

Cable, J.H.C. 1982. Aspects of Late Stone Age economic organization in southern Natal. Doctoral Thesis. Cambridge: University of Cambridge.

Carter, P.L. 1970. Late Stone Age exploitation patterns in southern Natal. The South African Archaeological Bulletin, 25(98): 55-58.

Carter, P.L. 1976. The effects of climate change on settlement in eastern Lesotho during the Middle and Later Stone Age. World Archaeology, 8: 197-206.

Carter, P.L. 1978. The prehistory of eastern Lesotho. Doctoral Thesis. Cambridge: University of Cambridge.

Carter, P.L., Mitchell, P.J. & Vinnicombe, P. 1988. Sehonghong: The Middle and Later Stone Age industrial sequence at a Lesotho rock-shelter. Oxford: British Archaeological Reports (BAR) International Series 406.

Christie, A.D.M. 1981. Stratigraphy and sedimentology of the Molteno Formation in the Elliot and Indwe Area, Cape Province. Masters Dissertation. Durban: University of Natal.

Clark, P.U., Dyke, A.S., Shakun, J.D., et al. 2009. The Last Glacial Maximum. Science 325(5941): 710-714.

Collins, B., Wilkins, J. & Ames, C. 2017. Revisiting the Holocene occupations at Grassridge Rockshelter, Eastern Cape, South Africa. The South African Archaeological Bulletin, 72(206): 162-170.

Collins, B., Wojcieszak, M., Nowell, A., et al. 2020. Beads and bead residues as windows to past behaviours and taphonomy: A case study from Grassridge Rockshelter, Eastern Cape, South Africa. Archaeological and Anthropological Sciences, 12(8): 192.

Cowling, R.M., Richardson, D.M. & Pierce, S.M. 2003. Vegetation of South Africa. Cambridge: Cambridge University Press.

de la Peña, P., Val, A., Stratford, D.J., et al. 2019. Revisiting Mwulu's Cave: New insights into the Middle Stone Age in the southern African savanna biome. Archaeological and Anthropological Sciences, 11: 3239-3266.

de la Peña, P. & Witelson, D.M. 2020. 'Project Piedemonte': Between the Maloti-Drakensberg and the Great Escarpment in the Eastern Cape Province, South Africa. Antiquity, 94(376): 1-9.

Deacon, H.J. 1976. Where Hunters Gathered: A Study of Holocene Stone Age People in the Eastern Cape. Cape Town: South African Archaeological Monograph Series 1.

Derricourt, R.M. 1977. Prehistoric Man in the Ciskei and Transkei. Cape Town: Struik.

Dewar, G., Zastrow, J., Arthur, C., et al. 2024. A zooarchaeological perspective on Late Pleistocene/Early Holocene human behaviour in the Maloti-Drakensberg region, southern Africa: The view from Ha Makotoko and Ntloana Tšoana rock-shelters, Lesotho. Quaternary Science Advances, 13: 100170.

Faith, J.T., Chase, B.M. & Pargeter, J. 2024. The Last Glacial Maximum climate at Boomplaas Cave, South Africa. Quaternary Science Reviews, 329: 108557.

Fisher, E.C., Cawthra, H.C., Esteban, I., et al. 2020. Coastal occupation and foraging during the last glacial maximum and early Holocene at Waterfall Bluff, eastern Pondoland, South Africa. Quaternary Research,

97: 1-41.
Fisher, E.C., Poupart, M., Pargeter, J., et al. 2013. Archaeological reconnaissance for Middle Stone Age sites along the Pondoland Coast, South Africa. PaleoAnthropology, 2013: 104-137.
Fitchett, J.M., Grab, S.W., Bamford, M.K., et al. 2016. A multi-proxy analysis of late Quaternary palaeoenvironments, Sekhokong Range, eastern Lesotho. Journal of Quaternary Science, 31(7): 788-798.
Goldberg, P. & Berna, F. 2010. Micromorphology and context. Quaternary International, 214(1-2): 56-62.
Goldberg, P., Miller, C.E., Schiegl, S., et al. 2009. Bedding, hearths, and site maintenance in the Middle Stone Age of Sibudu Cave, KwaZulu-Natal, South Africa. Archaeological and Anthropological Sciences, 1: 95-122.
Haaland, M.M., Miller, C.E., Unhammer, O.F., et al. 2021. Geoarchaeological investigation of occupation deposits in Blombos Cave in South Africa indicate changes in site use and settlement dynamics in the southern Cape during MIS 5b-4. Quaternary Research, 100: 170-223.
Hancox, P.J. 1998. The Beaufort-Molteno contact revised: Ramifications for the development of the Karoo retro-foreland basin during the Triassic. Journal of African Earth Sciences, 27: 103-104.
Harris, W.C. 1844. The Wild Sports of Southern Africa: Being the Narrative of an Expedition from the Cape of Good Hope, Through the Territories of the Chief Moselekatse, to the Tropic of Capricorn. London: Pelham Richardson.
Henshilwood, C.S. 2012. Late Pleistocene techno-traditions in southern Africa: A review of the Still Bay and Howiesons Poort, c. 75–59 ka. Journal of World Prehistory, 25(3-4): 205-237.
Hoare, D.B. & Bredenkamp, G.J. 2001. Syntaxonomy and environmental gradients of the grasslands of the Stormberg/Drakensberg mountain region of the Eastern Cape, South Africa. South African Journal of Botany, 67(4): 595-608.
Hogg, A.G., Heaton, T.J., Hua, Q., et al. 2020. SHCal20 Southern Hemisphere calibration, 0–55,000 years cal BP. Radiocarbon, 62(4): 759-778.
Jenkins, E. 2019. Rock art researchers in the uKhahlamba-Drakensberg. Natalia, 49: 50-64.
Karkanas, P., Brown, K.S., Fisher, E.C., et al. 2015. Interpreting human behavior from depositional rates and combustion features through the study of sedimentary microfacies at site Pinnacle Point 5-6, South Africa. Journal of Human Evolution, 85: 1-21.
Larbey, C., Mentzer, S.M., Ligouis, B., et al. 2019. Cooked starchy food in hearths ca. 120 kya and 65 kya (MIS 5e and MIS 4) from Klasies River Cave, South Africa. Journal of Human Evolution, 131: 210-227.
Lewis, C.A. 2008. Late Quaternary climatic changes, and associated human responses, during the last ~45 000 yr in the Eastern and adjoining Western Cape, South Africa. Earth-Science Reviews, 88(3-4): 167-187.
Loftus, E., Pargeter, J., Mackay, A., et al. 2019. Late Pleistocene human occupation in the Maloti-Drakensberg region of southern Africa: New radiocarbon dates from Rose Cottage Cave and inter-site comparisons. Journal of Anthropological Archaeology, 56: 101117.
Loftus, E., Stewart, B.A., Dewar, G., et al. 2015. Stable isotope evidence of MIS 3 to middle Holocene palaeoenvironments from Sehonghong, eastern Lesotho. Journal of Quaternary Science, 30(8): 805-816.
Lombard, M., Bradfield, J., Caruana, M.V., et al. 2022. The South African Stone Age sequence updated (II). The South African Archaeological Bulletin, 77: 172-212.
Lombard, M., Wadley, L., Deacon, J., et al. 2012. South African and Lesotho stone Age sequence updated (I). The South African Archaeological Bulletin, 67: 123-144.
Macdonald, A.J. 1993. A reassessment of coal resources in the western part of the Molteno coal province. Bulletin Geological Survey South Africa, 116: 1-33.
Marean, C.W. 2010. Pinnacle Point Cave 13B (Western Cape Province, South Africa) in context: The Cape floral kingdom, shellfish, and modern human origins. Journal of Human Evolution, 59(3-4): 425-443.
Marean, C.W., Bar-Matthews, M., Bernatchez, J., et al. 2007. Early human use of marine resources and pigment in South Africa during the Middle Pleistocene. Nature, 449(7164): 905-908.
Miller, C.E., Goldberg, P. & Berna, F. 2013. Geoarchaeological investigations at Diepkloof Rock Shelter, Western Cape, South Africa. Journal of Archaeological Science, 40: 3432-3452.
Miller, C.E. & Sievers, C. 2012. An experimental micromorphological investigation of bedding construction in the Middle Stone Age of Sibudu, South Africa. Journal of Archaeological Science, 39(10): 3039-3051.
Mitchell, P.J. 1990. A palaeoecological model for archaeological site distribution in southern Africa during the Upper Pleniglacial and Late Glacial. In: Gamble, C. & Soffer, O. (eds) The World at 18,000 BP: Low Latitudes: 189-205. London: Unwin Hyman.
Mitchell, P.J. 1994. The archaeology of the Phuthiatsana-ea-Thaba Bosiu basin, Lesotho, southern Africa: Changes in Later Stone Age regional demography. Antiquity, 68: 83-96.
Mitchell, P.J. 1996a. Prehistoric exchange and interaction in south-eastern southern Africa: Marine shells and ostrich eggshell. African Archaeological Review, 13: 35-76.
Mitchell, P.J. 1996b. Filling a gap: The early and middle Holocene assemblages from new excavations at Sehonghong Rock Shelter, Lesotho. Southern African Field Archaeology, 5: 17-27.

Mitchell, P. & Arthur, C. 2014. Ha Makotoko: Later stone age occupation across the Pleistocene/Holocene transition in western Lesotho. Journal of African Archaeology, 12(2): 205-232.

Morrissey, P., Mentzer, S.M. & Wurz, S. 2023. The stratigraphy and formation of Middle Stone Age deposits in Cave 1B, Klasies River Main site, South Africa, with implications for the context, age, and cultural association of the KRM 41815/SAM-AP 6222 human mandible. Journal of Human Evolution, 183: 103414.

Mucina, L. & Rutherford, M.C. (eds) 2011. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. Pretoria: South African National Biodiversity Institute.

Mutshinyalo, T.T. 2001. Buddleja salviifolia. Available at: https://pza.sanbi.org/buddleja-salviifolia (Accessed: 2024).

Opperman, H. 1982. Some research results of excavations in the Colwinton Rock Shelter, north-eastern Cape. The South African Archaeological Bulletin, 37: 51-56.

Opperman, H. 1987. The Later Stone Age of the Drakensberg Range and its Foothills. Oxford: British Archaeological Reports (BAR) International Series 339.

Opperman, H. 1988. An excavation of a Middle Stone Age deposit in Grassridge Rockshelter, Sterkstroom District, Cape Province. Fort Hare Papers, 9: 51-61.

Opperman, H. 1992. A report on the results of a test pit in Strathalan Cave B, Maclear District, north-eastern Cape. Southern African Field Archaeology, 1(2): 98-102.

Opperman, H. 1996a. Strathalan Cave B, north-eastern Cape Province, South Africa: Evidence for human behaviour 29,000-26,000 years ago. Quaternary International, 33: 45-53.

Opperman, H. 1996b. Excavation of a Later Stone Age deposit in Strathalan Cave A, Maclear District, northeastern Cape, South Africa. In: Pwiti, G. & Soper, R. (eds) Aspects of African Archaeology: 335-342. Harare: University of Zimbabwe Press.

Opperman, H. 1999. A 300-year-old living floor in Strathalan Cave A, Maclear District, Eastern Cape. Southern African Field Archaeology, 8: 76-80.

Opperman, H. & Heydenrych, B. 1990. A 22000-year-old Middle Stone Age camp site with plant food remains from the north-eastern Cape. The South African Archaeological Bulletin, 45: 93-99.

Orpen, J.M. 1874. A glimpse into the mythology of the Maluti Bushmen. Cape Monthly Magazine, 9(49): 1-13.

Pargeter, J. & Dusseldorp, G. 2022. The technology and ecology of Lesotho's highland hunter-gatherers: A case study at Sehonghong rock shelter. Quaternary International, 611: 134-145.

Pargeter, J. & Faith, J.T. 2020. Lithic miniaturization as adaptive strategy: A case study from Boomplaas Cave, South Africa. Archaeological and Anthropological Sciences, 12(9): 225.

Pargeter, J., Loftus, E. & Mitchell, P. 2017. New ages from Sehonghong rock shelter: Implications for the late Pleistocene occupation of highland Lesotho. Journal of Archaeological Science: Reports, 12: 307-315.

Pienaar, M., Woodborne, S. & Wadley, L. 2008. Optically stimulated luminescence dating at Rose Cottage Cave. South African Journal of Science, 104(1): 65-70.

Plug, I. 1997. Late Pleistocene and Holocene hunter-gatherers in the eastern highlands of South Africa and Lesotho: A faunal interpretation. Journal of Archaeological Science, 24(8): 715-727.

Plug, I. & Engela, R. 1992. The macrofaunal remains from recent excavations at Rose Cottage Cave, Orange Free State. The South African Archaeological Bulletin, 47: 16-25.

Plug, I. & Mitchel, P. 2008. Sehonghong: Hunter-gatherer utilization of animal resources in the highlands of Lesotho. Annals of the Transvaal Museum, 45(1): 31-53.

Reynard, J.P. 2022. Tracking occupational intensity using archaeo-faunal data: Case studies from the late Pleistocene in the southern Cape of South Africa. Journal of Archaeological Method and Theory, 29(1): 214-250.

Skead, C.J. 2007. Historical Incidence of the Larger Land Mammals in the Broader Eastern Cape, Second Edition. Port Elizabeth: Centre for African Conservation Ecology, Nelson Mandela Metropolitan University.

Skinner, J.D. & Chimimba, C.T. 2005. The Mammals of the Southern African Sub-region. Cambridge: Cambridge University Press.

South African Committee for Stratigraphy (SACS). 1980. Stratigraphy of South Africa. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia, and the Republics of Bophuthatswana, Transkei and Venda (Compiler L.E. Kent). Geological Survey of South Africa Handbook, 8.

Stewart, B.A. & Challis, S. 2023. Becoming elands' people: Neoglacial subsistence and spiritual transformations in the Maloti-Drakensberg Mountains, southern Africa. Transactions of the Royal Society of South Africa, 78(1-2): 123-147.

Stewart, B.A., Dewar, G.I., Morley, M.W., et al. 2012. Afromontane foragers of the late Pleistocene: Site formation, chronology and occupational pulsing at Melikane Rockshelter, Lesotho. Quaternary International, 270: 40-60.

Stewart, B.A. & Mitchell, P.J. 2018. Late Quaternary palaeoclimates and human-environment dynamics of the Maloti-Drakensberg region, southern Africa. Quaternary Science Reviews, 196: 1-20.

Stewart, B.A., Parker, A.G., Dewar, G.I., et al. 2016. Follow the Senqu: Maloti-Drakensberg paleoenvironments and implications for early human dispersals into mountain systems. In: Jones, S.C. & Stewart, B.A. (eds) Africa from MIS 6-2: Population Dynamics and Palaeoenvironments: 247-271. Dordrecht: Springer.

Stewart, B.A., Zhao, Y., Mitchell, P.J., et al. 2020. Ostrich eggshell bead strontium isotopes reveal persistent macroscale social networking across late Quaternary southern Africa. Proceedings of the National Academy of Sciences, 117(12): 6453-6462.

Stratford, D., Braun, K. & Morrissey, P. 2021. Cave and rock shelter sediments of southern Africa: A review of the chronostratigraphic and palaeoenvironmental record from Marine Isotope Stage 6 to 1. South African Journal of Geology, 124(4): 879-914.

Thackeray J.F., Scott, L. & Pieterse, P. 2019. The Younger Dryas interval at Wonderkrater (South Africa) in the context of a platinum anomaly. Palaeontologia Africana, 54: 30-35.

Turner, B.R. 1975. The stratigraphy and sedimentary history of the Molteno Formation in the main Karoo Basin of South Africa and Lesotho. Doctoral Thesis. Johannesburg: University of the Witwatersrand.

UNESCO World Heritage Convention 2023. Maloti-Drakensberg Park. Available from: https://whc.unesco.org/en/list/985/ (Accessed: 2023).

Van Riet Lowe, C. 1952. The Distribution of Prehistoric Rock Engravings and Paintings in South Africa. Pretoria: Union of South Africa, Department of Education, Arts, and Science, Archaeological Survey.

Van Wyk, B. & Van Wyk, P. 1997. Field Guide to the Trees of Southern Africa. Struik: Cape Town.

Vinnicombe, P.J. 1960. The recording of rock paintings in the upper reaches of the Umkomaas, Umzimkulu and Umzimvubu rivers. South African Journal of Science, 56(1): 11-14.

Vinnicombe, P. 1976. People of the Eland: Rock Paintings of the Drakensberg Bushmen as a Reflection of their Life and Thought. Pietermaritzburg: University of Natal Press.

Wadley, L. 2021. What stimulated rapid, cumulative innovation after 100,000 years ago? Journal of Archaeological Method and Theory, 28(1): 120-141.

Wadley, L., Esteban, I., De La Peña, P., et al. 2020. Fire and grass-bedding construction 200 thousand years ago at Border Cave, South Africa. Science, 369(6505): 863-866.

Wadley, L., Sievers, C., Bamford, M., et al. 2011. Middle Stone Age bedding construction and settlement patterns at Sibudu, South Africa. Science, 334(6061): 1388-1391.

Way, A.M., de la Peña, P., de la Peña, E., et al. 2022. Howiesons Poort backed artifacts provide evidence for social connectivity across southern Africa during the Final Pleistocene. Scientific Reports, 12(1): 9227.

Wilkins, J., Schoville, B.J., Pickering, R., et al. 2021. Innovative Homo sapiens behaviours 105,000 years ago in a wetter Kalahari. Nature, 592(7853): 248-252.

Willcox, A.R. 1956. Rock Paintings of the Drakensberg. London: Max Parrish.