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# Revisiting the Acheulean at Namib IV in the Namib Desert, Namibia

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**ABSTRACT**
Namib IV (S23° 44.829′, E14° 19.720′) is frequently cited, as it is one of few Earlier Stone Age sites in the Sand Sea of the Namib Desert. The site was first investigated in 1978 by Myra Shackley, who described 582 artifacts on the surface of a pan as representing an Acheulean butchery site. Descriptions of the artifacts, their number, and area were inconsistently reported. Recently rediscovered, the site of Namib IV is a rare example of a tool-rich and fossil fauna-bearing pan system in the Namib Sand Sea. This project aims to investigate when, how, and under what environmental conditions hominins utilized these landscapes. This article presents the first archaeological research conducted at the site in over 40 years. Typological and technological data was collected from surface-exposed artifacts and large cutting tools (LCTs) and compared to Shackley's assemblage. Data demonstrate that her collection is representative of the Namib IV site and raise many new questions about the original research and the site.

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Earlier Stone Age; Large Cutting Tool; LCT; Namib Sand Sea; Namib IV; landscape archaeology; interdunal pan

## Introduction

The Namib Sand Sea (NSS) is a hyper-arid dunescape occupying a large area in the Namib Desert, which stretches along the western coast of Namibia from northern South Africa to southern Angola. Specifically, the Namib Sand Sea is located between the ephemeral !Khuiseb and Koichab rivers in western Namibia. Frequently referred to as the oldest desert in the world, survival on the hyper-arid landscape is challenging to all mammalian life. Reports of Earlier and Middle Stone Age (ESA and MSA) stone tool assemblages exposed on the landscape surface across the Namib Desert and in the NSS indicate hominin occupation and exploitation of this landscape since potentially the Middle Pleistocene. Exactly when the NSS became as arid as today's landscape is debated and remains a fundamental question influencing interpretations of NSS hominin behavioral adaptation and the formation of the NSS archaeological assemblages. The focus of this article is the site of Namib IV, which lies on an interdune pan surface approximately 8 km south of the !Khuiseb River (Figure 1). The site was first described in 1980 by Myra Shackley (Shackley 1980, 1982, 1985), who designated it as an Acheulean butchery site due to the presence of large cutting tools (LCTs) along with fossil fauna, including *Elephas recki* (Shackley 1980). Mesfin, Pleurdeau, and Forestier (2021) reanalyzed the Shackley lithic assemblage, which is curated at the National Museum of Namibia, and also concluded that the stone tools represent those of a butchery site. The bifaces were originally dated through proposed association with *Elephas recki* fossils (Klein 1983) and later dated with a single U/Th date on a tooth fragment to 300–425 kya (Shackley 1980; Shackley et al. 1985), with biochronological interpretation by Klein (1988) interpreted by Mesfin, Pleurdeau, and Forestier (2021) as indicating an age of > 500 kya. Interpretations of Shackley's stone tool assemblages, and their association with the fossil fauna, are hampered by fundamental inconsistencies in reports of the context and sizes of the assemblages. Exploring the behavioral implications of Acheulean-bearing hominins occupying and exploiting resources in the NSS requires dedicated multiproxy analyses of the site and its assemblages. To this end, a new investigation was initiated with a goal to revisit Namib IV, resample the lithic and faunal assemblages, and contextualize those assemblages within refined depositional, chronological, and paleoenvironmental frameworks.

Namib IV is often cited as one of Namibia's few dated Acheulean archaeological sites (Sandelowsky 1983; Hardaker 2011, 2020; Marks 2015; Kinahan 2020). However, there are numerous inconsistencies between the three primary publications on the site (Shackley 1980, 1982, 1985). In 2013, the site was rediscovered by a joint team from the University of Iowa, the National Museum of Namibia, and Gobabeb Namib Research Institute. Considering the importance of the site and the need to address the questions arising from the inconsistencies in the publications (Shackley 1980, 1982, 1985), a new project was formed to reinvestigate the hominin occupations of Namib IV. A preliminary visit was made in 2021 to assess the site and identify the best methods of approaching it. A second, larger, multidisciplinary team was assembled and began work at the site in 2022. This paper presents the preliminary results from the first new investigation at the site by archaeologists in over 40 years. A new archaeological sample is compared to Shackley's Namib IV lithic collection at the National Museum. Importantly, the bifacial technology is also described, which provides a framework for placing the technology in the regional chronology and for investigating hominin movement across the landscape.

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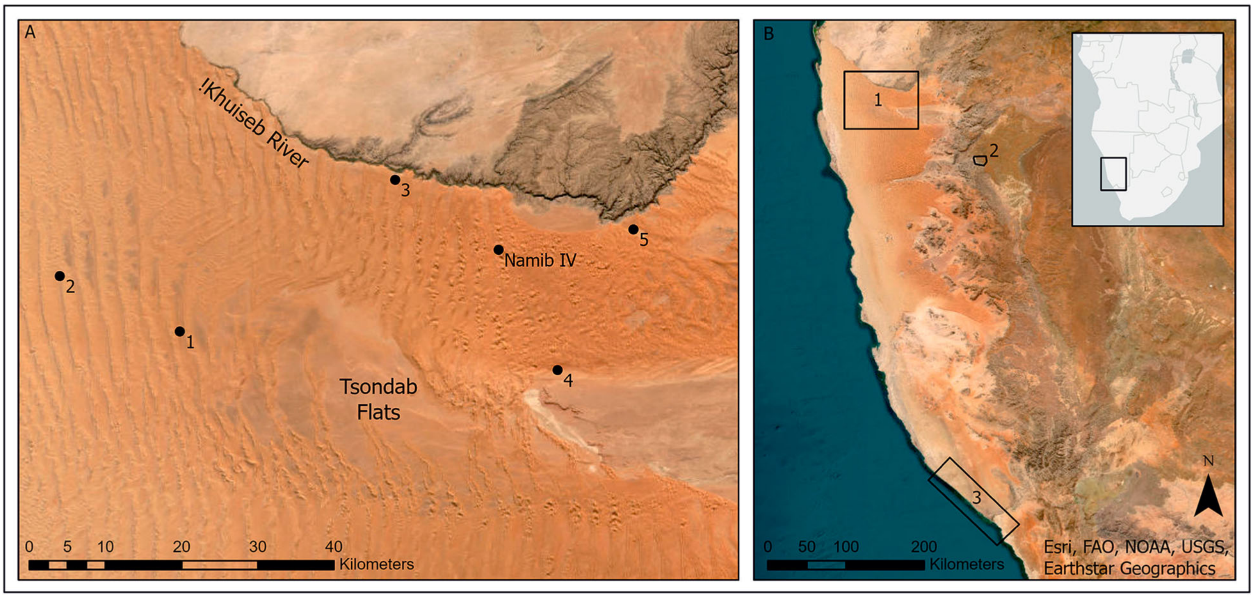


**Figure 1.** Map of the research region showing the site of Namib IV. A) Close up of ESA sites in the survey area from Shackley (1985): 1: Narabeb, 2: Narabeb West, 3: Tsondab Route, 4: Bosworth, 5: Anibtanab, and Namib IV. B) Survey areas: 1: Corvinus (1983), 2: Shackley (1985), and 3: Hardaker (2011).

## *The Earlier Stone Age of the Namibian Sand Sea*

The small amount of published ESA material in the Namib Desert comes from only a few surveys from more than 40 years ago in the Sand Sea's north (Shackley 1980, 1982, 1985), the southwestern coastal region (Corvinus 1983), the eastern region along the Zebra River just outside of the NSS (Hardaker 2011), and from reinvestigation of material curated in the National Museum of Namibia (Mesfin, Pleurdeau, and Forestier 2021).

Large quantities of bifaces, including handaxes, cleavers, and picks, were identified by Hardaker (2011) during a survey along the Zebra River valley on the northeastern edge of the Sand Sea (see Figure 1). The central area of Hardaker's (2011) survey is in the Tsaris Mountains of the Great Escarpment and has a different topographic and geomorphic setting and environmental history than the NSS. Like many of the lithic scatters in the Namib Sand Sea, these are largely without stratified deposits or clearly understood spatial distribution on the landscape. While their documentation is helpful for known distribution, the assemblages remain undated, and the lack of chronology impedes detailed analysis.

Corvinus (1983, 1985) observed similar ESA and MSA scatters within raised beaches of likely early–middle Pleistocene age along the southwestern edge of the Namib Desert. The density of ESA artifacts was highest near the mouth of the Orange River at the western coast. Corvinus (1983) concludes hominin movement into the region from the east along the Orange River. Resources diminished moving away from the riparian environment and resulted in a limited north-to-south distribution once arriving at the western coast. Nonetheless, handaxes, cleavers, and picks are found frequently around the mouth of the river and as far as 45 km north of the Orange River along the coast.

Shackley (1985) identified sites along the southern edge of the !Khuiseb River and north of the Tsondab Flats containing artifacts typical of the ESA (see Figure 1). The interdune flat/pan of Narabeb on the southern edge of the ancient Tsondab Flats (see Figure 1, site 1) was observed to have both ESA and MSA material, including bifaces (Seely and Sandelowsky 1974; Shackley 1985), but again these sites consist of surface scatters with no variation in elevation or lithics found within vertical stratigraphy. Our 2021 and 2022 seasons of fieldwork at Narabeb failed to identify any ESA material and created more questions about the coordinates of the some of the sites provided in Shackley's 1985 publication. The same is true for the site of Narabeb West (see Figure 1, site 2), which was reinvestigated in 2022. The coordinates provided by Shackley (1985) for Narabeb West are 8 km away from the coordinates believed to be the location of the site and fall on a large dune, rather than an interdune pan or flat. Narabeb West was reported to have bifaces (Shackley 1985), but no ESA material was identified by our team at the coordinates associated with the curated artifacts at the National Museum or the surrounding interdunal pans, and it is likely that the actual site is located elsewhere (G. Leader, personal observation). Since these locations were probably deduced from aerial photograph comparisons at the time, we can sympathize with the challenge of deriving accurate map coordinates in a landscape of towering, constantly changing aeolian dunes interspersed with extensive interdune areas covered by water-transported cobbles.

The ESA site of Tsondab Route, situated along the !Khuiseb River (perhaps named after a location along a route from a crossing of the !Khuiseb River to the Tsondab Flats used by earlier researchers at Gobabeb; see Figure 1, site 3), was also observed by Shackley (1985), but the artifacts at this location have not been reinvestigated by our team, as its coordinates do not align with its map placement (Shackley 1985). The site is said to include bifaces and cleavers that are similar to Namib IV (Shackley 1985).

Anibtanab is an interdunal pan site northeast of Namib IV next to the !Khuiseb river ravine (see Figure 1, site 5). The sample assemblage contains 209 MSA artifacts and a single quartzite handaxe, as well as highly fragmented fossil faunal material (Leader et al. 2022). However, because the ESA is limited to only a single artifact, further research must be conducted at the site before making comparisons to denser sites such as Namib IV.

The site of Bosworth (see Figure 1, site 4) is a low-density surface scatter southeast of Namib IV situated near Tsondabvlei, the current endpoint of the ephemeral Tsondab River. The assemblage contains a large flake component likely attributable to the MSA but with some larger flakes which may suggest earlier material. Typologically ESA material includes four handaxes with rounded butts (Shackley 1985).

### *Archaeological investigations of Namib IV*

Shackley's 1980 paper first introduces Namib IV and presents 394 artifacts from a random surface sample of "22,500m$^2$" (Shackley 1980) but provides no detail on the location of that sample within the pan surface. That sample size is equivalent to about a third of the total pan (which is 64,000 m$^2$) and would contain a significantly higher number of artifacts. In the second Namib IV publication (Shackley 1982), Shackley discusses 394 artifacts from a random surface sample of 2500 m$^2$, perhaps suggesting a misprint of the area in the original 1980 paper. The 1982 paper also incorporates into the analysis an additional 107 artifacts but provides no information on the collection area of that sample. With these two samples combined, the 1982 paper discusses a total of 501 artifacts but again provides no location on the pan, and only one of the two samples were from a given spatial area.

The third paper by Shackley (1985) only discussed 82 artifacts from the southern area of the pan. These are said to have been collected from 150 m$^2$. No mention of the previous 501 artifacts is made or why only 82 artifacts are discussed. Adding further confusion to the size of the assemblage from the site is the fact that the National Museum of Namibia curates a total of 300 artifacts (discussed later).

Finally, Shackley discusses the finding of *Elephas recki* fossils at the site, suggesting that the fossils demonstrate the site as a butchering site (1980). In the paper, no mention of the location or deposit in which the fossils occur is given, and therefore it is difficult to ascertain whether or not the fossils are even associated chronologically with the stone technology. No fossils from Shackley's Namib IV discussions have been located at the National Museum. Our investigation at the site has identified two fossil beds which appear to be in different deposits and may be very different in age. Based on a photo from Teller, Rutter, and Lancaster (1990), we believe the *E. recki* fossil may have been discovered just southeast of Fossil Bed 1 (Figure 2).

### *Geological, geomorphological, and chronological context of the Namibian Sand Sea*

The Namib Sand Sea (NSS) is located in the central part of the Namib Desert between the ephemeral !Khuiseb and Koichab rivers in western Namibia. The Namib is frequently described as the oldest desert in the world, with a general pattern of persistent aridity with long-term slow landscape erosion for at least the past 15 mya, interspersed with wetter periods with accelerated denudation (Van Wateren and Dunai 2001). The Namib Sand Sea (NSS) may largely be Plio-Pleistocene aged (e.g., Ward, Seeley, and Lancaster 1983; Ward 1987) or younger, if the Kuiseb Canyon incision timing from cosmogenic isotopic data indicates more-widespread humidity capable of hampering dune accumulation (Van Wateren and Dunai 2001) and not just higher rainfall over the highlands of the Great Escarpment. Overall, the cosmogenic data is equivocal. Whilst the incision of !Khuiseb Canyon is dated to 2.8–1.3 mya (middle reaches) and to 0.4 mya (upper reaches), low denudation rates within interfluves on the gravel plains do not support a wetter Namib Desert coastal margin (Van Wateren and Dunai 2001). Furthermore, NSS dune accumulation may respond more strongly to sediment availability and windiness than to increased moisture balance. The NSS is underlain by an extensive consolidated Palaeogene aeolian deposit, the Tsondab Sandstone Formation (TSF) (Ward 1988; Kocurek et al. 1999; Stone 2013).

## New Research

The SANDS project was developed to investigate the following questions: 1) is Shackley's lithic sample from Namib IV biased by collection practices; 2) are the stone tools and fossil fauna assemblages stratigraphically and temporally associated; 3) is there any spatial patterning in the stone tool and faunal distributions across the site; 4) can a detailed technological analysis of a broader lithic sample from Namib IV clarify technological trends or patterns; and, 5) how was the Namib IV site formed and what were the prevailing environmental conditions in the area when hominins occupied the pan? Here, we present some preliminary results from the first visits to Namib IV.

### *Methods*

#### *Lithic sampling*

In 2021 and 2022, a new sample of artifacts (referred to as "South Sample") was studied at the site of Namib IV. Following a survey of the whole pan, this area was targeted because it was the area that seemed most likely to have yielded the majority of the Shackley assemblage (Shackley 1985; see Figure 2), although the locations of her sample are not reported consistently. Using a map of the site, the sample area was divided into grid squares, and a randomly generated location on the pan was selected for the data collection. The sample includes all surface-exposed artifacts from a 50 × 8 m area at the southern end of the pan (S23° 44.829', E14 ° 19.720', see Figure 2).

In addition to the randomly located South Sample, a sample of bifaces was studied, referred to as the "LCT Sample." Many of the bifaces recorded for the LCT Sample were disturbed by prior research during Shackley's visit to the site in the late 1970s. At that time, a large number of handaxes and cleavers were moved and placed in groups where they could be photographed together. These biface groups are still clustered around other ESA material, such as flakes and cores, which are possibly associated with a specific context. Because of this historic displacement, our biface sample location is not randomly selected but has incorporated these groupings, in addition to randomly scattered LCTs for the LCT Sample.

#### *In situ lithic analysis*

All artifacts were assessed in the following manner: typologies were assigned based on Leakey's (1971) and Kuman's (2001) descriptions and standard variables recorded (maximum length, width, and thickness, raw material, and

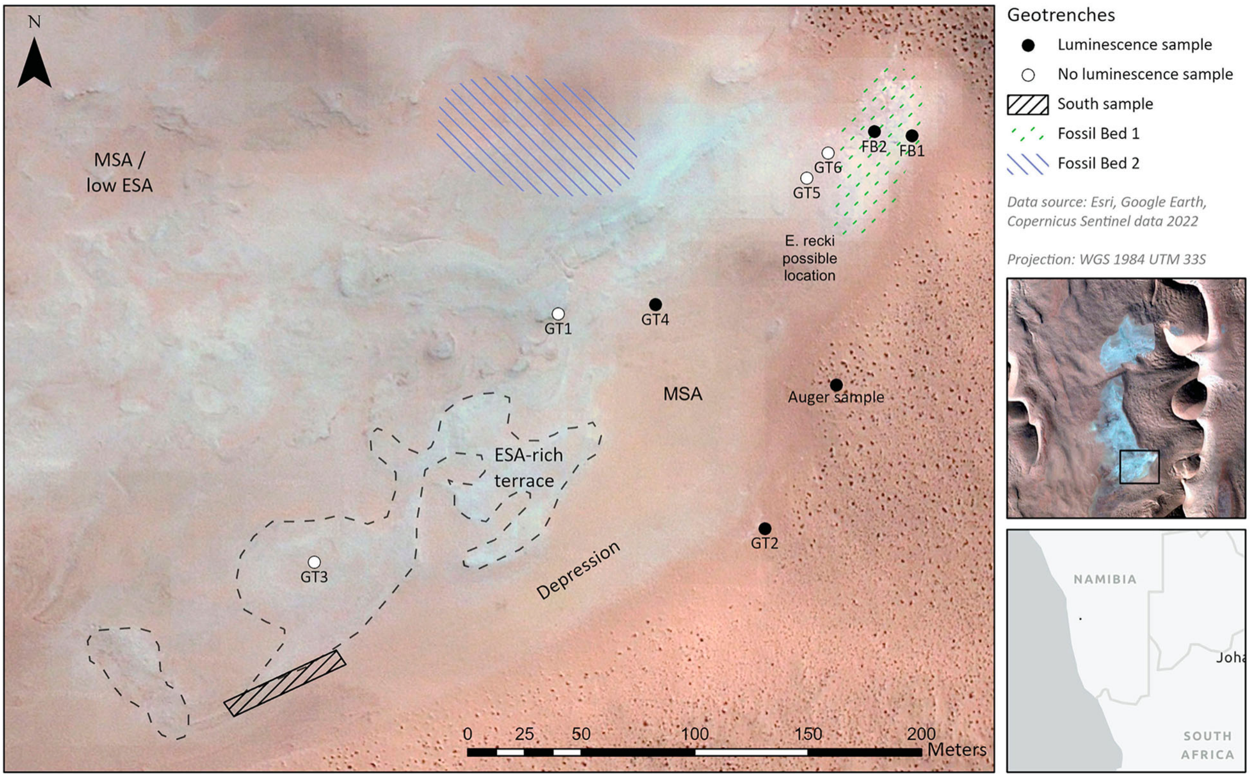


**Figure 2.** The site of Namib IV is located between the !Kuiseb River to the north and the ancient path of the Tsondab River to the south, which flowed northwest.

weight) in situ. On flakes, the number of dorsal scars was counted, and the amount of cortical surface was estimated to the nearest ten percent grouping (i.e., 0–10%, 10–20%). Facets on flake striking platforms were counted. Once data was collected and recorded, each artifact was returned to its position in the 50 × 8 m sample area. The same variables were also recorded on lithic sample curated in the National Museum in Windhoek, Namibia. The same researcher conducted the data collection to avoid interobserver bias and ensure data integrity. This collection was then compared to the South Sample for similarities. Several statistical tests were applied, including Kolmogorov-Smirnov and Chi-square tests, to further assess the similarities of the two collections.

### *Site documentation*

To assess possible associations between fossil fauna and stone tools across the site and provide sedimentological evidence for the formation and evolution of the pan, several geotrenches (see Figure 2) were excavated: at a low-relief ridge south of fossil bed 2 (GT1); on a slightly raised terrace associated with the most ESA lithics (GT3); at fossil bed 1 (FB1 and FB2); on the southwestern edge of the pan where modern dune sand overlies a calcrete outcrop (GT2); and, between GT1 and Fossil Bed 1 (GT4) to explore the nature of the underlying sediment in one of the topographically-lowest areas of the pan. Geotrenches were located to achieve four specific goals: 1) to explore the depth and stratigraphic context of sediments immediately below the stone tool- and fossil-bearing surfaces; 2) to explore sequences of sediments across topographic features to investigate the nature of unit variability and make stratigraphic correlations across space; 3) to attempt to find stone tools or fossil fauna within stratigraphically constrained sediments; and, 4) to provide exposures of sediments documenting the formation of the pan for sampling for sedimentological and microbotanical analysis (e.g., diatoms; Teller, Rutter, and Lancaster 1990) to facilitate site formation and paleoenvironmental assessment. Sediments were described in the field in terms of Munsell color, structure, sorting, texture, and biogenic/pedogenic features. Bulk samples from target units were collected for carbonate, organic matter, particle size, and geochemical and microbotanical analyses. Results from sediment analyses and luminescence dating of target units will be reported elsewhere.

## Results

### *Geomorphological context of Namib IV*

The interdunal pan site of Namib IV sits in the northern portion of the Sand Sea about 8 km south of the !Khuiseb River and 20 km north of the Tsondab River (see Figure 1). The site is represented by an extensive interdune pan surface on which stone tools and fossil fauna are found. The north-south elongated pan extends 1092 m north to south and, at its widest, 508 m east to west and, on average, is 587.5 masl. The dunes to the east and west are long chains of star dunes and rise up to ca. 130 m above the pan surface to elevations of about 680–723 masl. There are also smaller, superimposed dune ridges. The pan surface gently slopes from east to west and from north to south. A narrow east to west orientated sand ridge has separated the pan surface into two areas—a northern, slightly elevated pan and the larger, elongated and lower southern pan. The surfaces of both pans are characterized by a range of cover types: 1) mixed sands deriving from the contemporary dunes and the underlying Tsondab Sandstone Formation; 2) poorly sorted fine to medium sized, rounded to subrounded quartz pebbles; and, 3) eroded, reworked calcrete precipitate clasts, including rhizoliths. Significant variability is seen in the composition of the surface-exposed sediments across the dune surface. Within the pan, surface topography is characterized by low-relief terraces controlled by horizontal calcrete beds and peneplained outcropping TSF with several extensive flat surfaces separated by elongated shallow depressions. A deflated pebble-rich bed dominates the northern pan, while finer-grained sediments characterize the southern pan, with higher densities of finer pebbles concentrated in shallow depressions. Artifacts and fossil fauna are most abundant in the southern pan, and initial detailed survey of stone tool and fossil fauna distribution suggests a correlation between different terrace levels and artifact type—a pattern that is currently the subject of dedicated analysis through total station mapping of the site for high-resolution spatial analyses.

The spatial distribution of lithic and faunal artifacts across the Namib IV pan surface is important when considering the integrity of the assemblages, consistently a significant concern when trying to constrain the age, technology, and environmental context of assemblages or attempting to contextually correlate surface-exposed assemblages across space and time (e.g., Fanning and Holdaway 2001; Zerboni 2011; Borrazzo 2016). Surficial lithic assemblages are common on arid landscapes and are often considered to be deflated or extensively reworked and considerably time-averaged (e.g., Fanning et al. 2009), limiting their interpretative resolution. However, dedicated geoarchaeological research has shown that it is possible to identify multiple processes and their effects on surface assemblages (e.g., Adelsberger et al. 2013), providing opportunities to distinguish aspects of assemblages that may preserve useful behavioral data (Marks 2015). Despite very little documentation by Shackley of intra-pan provenances of ESA artifacts, initial observations in the field suggest the assemblages are not completely homogenized through long-term dispersive mixing and may indicate that spatial patterning reflects differential mobilization and preservation of components of assemblages in certain areas, which may be linked to the complex topography and ultimately the hydrology of the pan (e.g., Nicoll 2010). Ongoing analysis of lithics on the pan surface, the underlying sediments, and topography will provide greater clarity on the formation and taphonomic history of these assemblages and is planned. Particle size analysis, combined with detailed spatial documentation of the clastic component, including the artifacts, will help clarify the susceptibility of mobilization across the landscape (e.g., Bertran et al. 2012). The presence of fossil fauna in the pan provides significant potential for both paleoenvironmental reconstructions (e.g., Shackley 1980) and chronological control (e.g., Klein 1983; but see Todd 2005), but it is not yet clear if the fossil fauna is associated with the ESA or MSA lithic assemblages, limiting the fauna's usefulness until their association is clarified.

**Figure 3.** Geotrench 2 eastern profile exemplifying uncemented sediment sequences exposed in FB1 and FB2 geotrenches.

### *Initial observations of underlying sediment stratigraphy*

From south to north, the following sedimentological observations can be made from the geotrenches. At GT3, a massive, red, cemented sand, interpreted to be the TSF bedrock, underlies a single shallow (0.5 m), rocky, grey-green, consolidated, shale-like, silt-rich (field texture analysis) unit (sensu Besler 1996). In GT1, a massive, cemented, red sand unit (TSF) (just > 1 m) is interbedded and capped by consolidated grey-green silt units that extend to the landscape surface. Both GT3 and GT1 occupy slightly higher elevation areas on the pan. The consolidated silts in the upper reaches of GT1 are heavily fragmented and calcretized and are exposed across this higher elevation area. In contrast to these higher elevation southern and southwestern sites, the sediments beneath the surface calcretes exposed at Fossil Bed 1 at the eastern edge and GT2 at the southern edge are not cemented.

At GT4, a fine-grained consolidate silt occurs below 1 m (interpreted as an upper unit of TSF) and is overlain by a cross-bedded yellow-red to pinkish white sand, dipping north-northwest at an inclination of between 14–24°. Sporadic iron/manganese-rich nodules are found within these beds. The near-horizontal surface covered in modern sand truncates the bedding of the underlying units in a clear disconformity.

At FB1 and FB2, the lowermost sediment encountered is a pale yellow, very dry sand with orange-stained rootlets, overlain by a finely laminated calcrete, followed by a slightly bedded, but heavily mottled, silty, fine sand unit, which at FB1-1 is interstratified with variably thick calcrete units towards the top. In FB1, some sandy organic-rich lenses are intermittently present. Both sequences are covered by a variably thick massive and locally laminated, poorly indurated fossil-bearing calcrete that is exposed on the landscape surface. A similar sequence is observed at GT2 (Figure 3). At the base of the GT2 sequence is a massive red grading into a yellow sand (similar color to modern dunes) that grades into a massive, pale, fine sand. This is overlain by a reddish yellow silty sand with some interstratifying thinner, brown-black and orange-yellow lenses. This unit is overlain by a white, fine, silty sand with occasional isolated small quartz pebbles and intermittent red sand laminations. The white sand unit is overlain by a brown, silty, stratified sand, rich in organic matter. The sequence ends in an indurated, massive and locally stratified calcrete covered by a thin mantle of red dune sand.

## *Lithic assemblages*

Lithic artifacts are present on the surface over an area of > 64,000 m². The highest density scatters of both MSA and ESA artifacts, however, are found at the southern extent of the pan (Shackley 1985; Figure 4), referred to here as the South Sample. Fossil-bearing calcrete deposits are exposed throughout the central and eastern portions of the pan. The calcretes, which preserve abundant root casts, indicate past occurrences of at least intermittent periods of standing water in this part of the pan. A number of *xòrãs*, or shallow waterholes dug by oryx or other game, suggest that water may still accumulate after sufficient rain. It is therefore probably not coincidental that the areas with the highest artifact


**Figure 4.** MSA flake blade produced on quartzite from the South Sample.

**Table 1.** South Sample and Shackley sample totals.

| | South Sample | | | Shackley Sample | | |
|---|---|---|---|---|---|---|
| **Cores** | Total (%) | Quartzite | Quartz | Total (%) | Quartzite | Quartz |
| Bifacial Core | 1 | 1 | 0 | 0 | 0 | 0 |
| Irregular Core | 12 | 2 | 10 | 9 | 3 | 6 |
| Casual Core | 3 | 1 | 2 | 4 | 1 | 3 |
| Chopper Core | 2 | 1 | 1 | 1 | 1 | 0 |
| Pebble Core | 2 | 0 | 2 | 0 | 0 | 0 |
| Centripetal Core | 0 | 0 | 0 | 2 | 0 | 2 |
| Total | 20 (14.3) | 5 | 15 | 16 (5.3) | 5 | 11 |
| **Flakes** | | | | | | |
| Cortical Platform | 13 | 2 | 11 | 25 | 11 | 14 |
| Single Face Platform | 14 | 1 | 13 | 85 | 26 | 59 |
| Multi-Facetted Platform | 6 | 2 | 4 | 7 | 5 | 2 |
| No platform data | 6 | 1 | 5 | 24 | 9 | 15 |
| Total | 39 (27.9) | 6 | 33 | 141 (47) | 51 | 90 |
| **Tools** | | | | | | |
| Handaxe | 0 | 0 | 0 | 4 | 2 | 2 |
| Cleaver | 0 | 0 | 0 | 1 | 1 | 0 |
| Scraper | 10 | 4 | 6 | 3 | 0 | 3 |
| Denticulate | 7 | 0 | 7 | 0 | 0 | 0 |
| Levallois Point | 3 | 2 | 1 | 0 | 0 | 0 |
| Knife | 0 | 0 | 0 | 1 | 1 | 0 |
| Total | 20 (14.3) | 6 | 14 | 9 (3) | 4 | 5 |
| **Debris/Incomplete** | | | | | | |
| Flake Fragment | 21 | 2 | 19 | 74 | 33 | 41 |
| Split Flake | 2 | 0 | 2 | 1 | 0 | 1 |
| Incomplete Flake | 15 | 2 | 13 | 13 | 7 | 6 |
| Shatter | 13 | 0 | 13 | 40 | 19 | 21 |
| Split Pebble | 3 | 1 | 2 | 4 | 0 | 4 |
| Core Fragment | 7 | 0 | 7 | 2 | 1 | 1 |
| Total | 61 (43.6) | 5 | 56 | 134 (44.6) | 60 | 74 |
| Total | 140 | 22 | 118 | 300 | 120 | 180 |

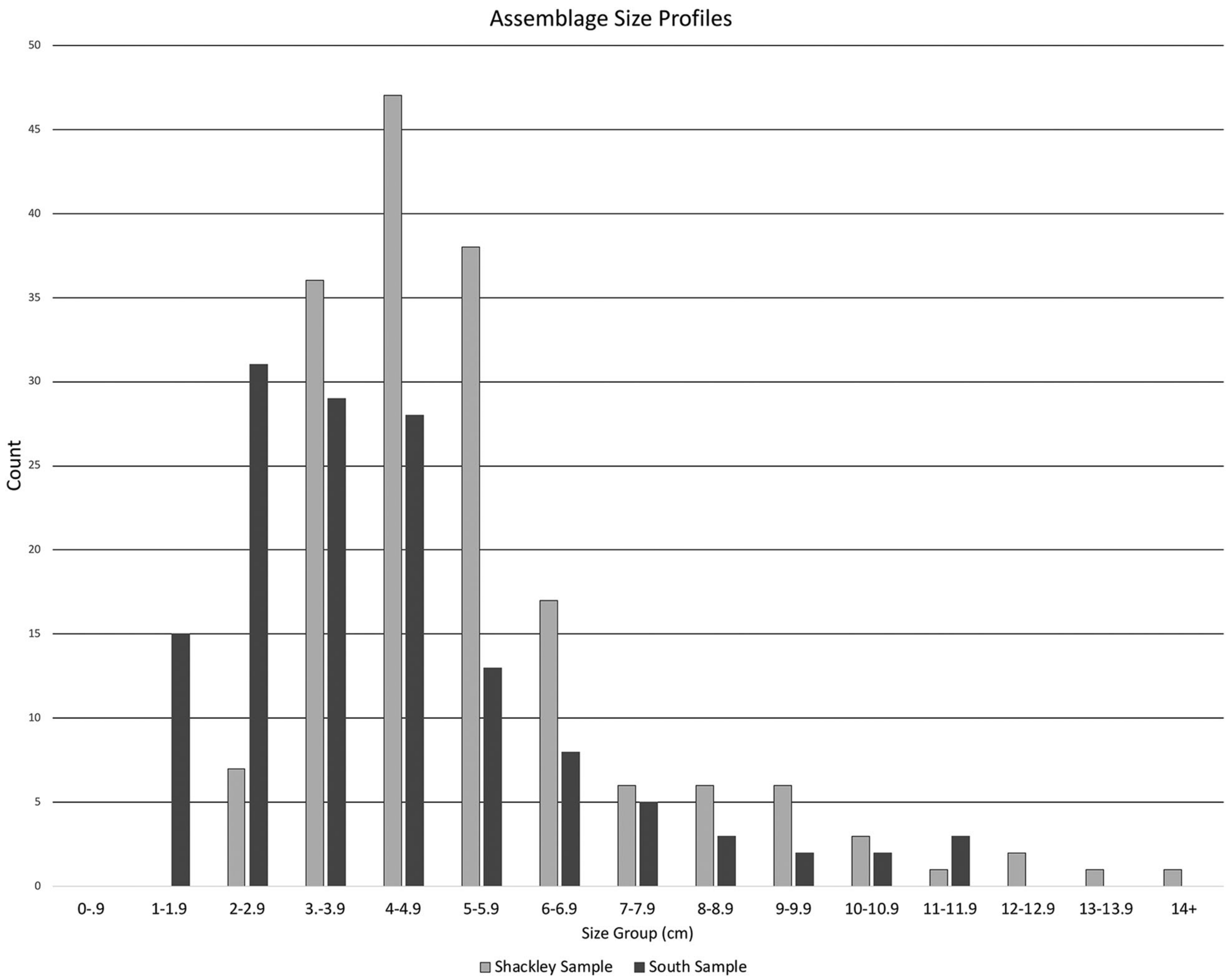


**Figure 5.** Comparison of maximum lengths of Shackley's sample and the South Sample.

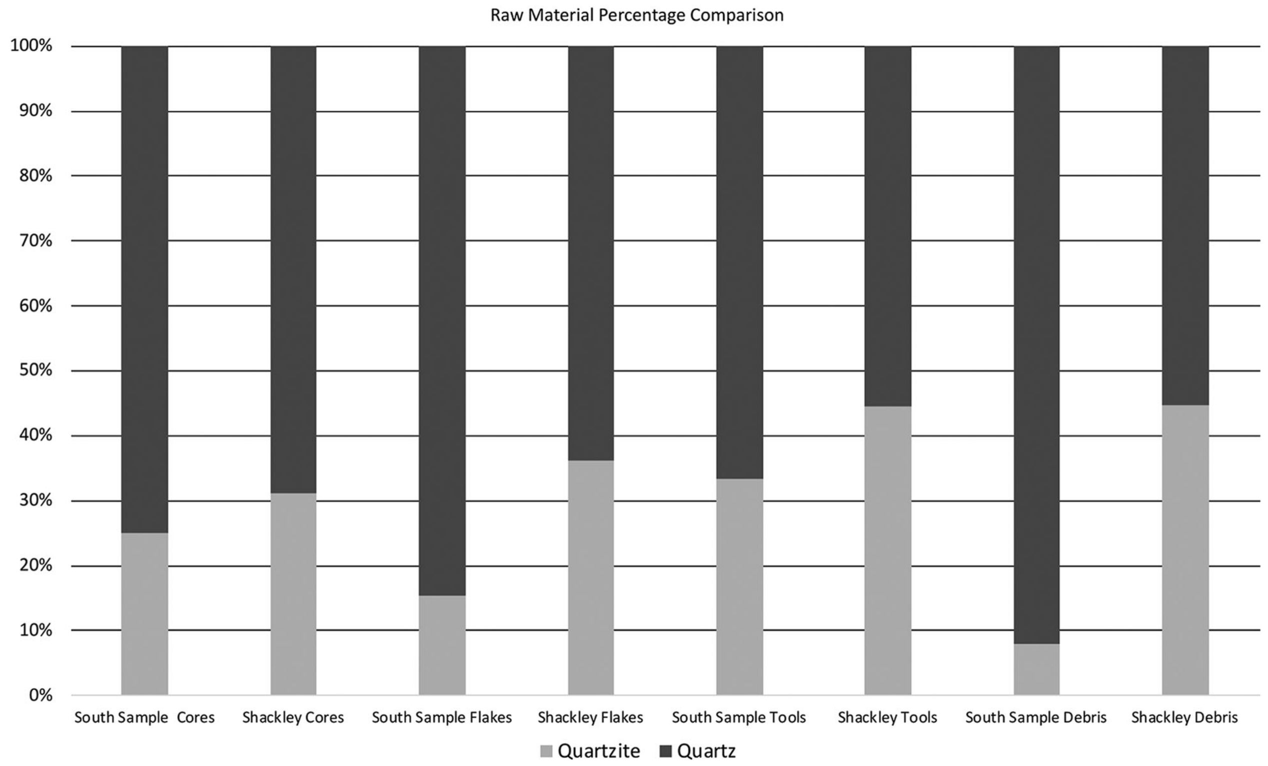


**Figure 6.** Raw material comparison.

density appear to sit adjacent to areas where standing water once collected.

### *South Sample*

The South Sample assemblage includes 140 artifacts (Table 1). There are 20 formal tools, including 10 scrapers, seven denticulates, and three Levallois points. The randomly selected 50 × 8 m sample area did not produce any bifaces. Flakes and flaking debris make up 71.5% of the total sample. The majority of the sample is made up of types of debris (n = 61) such as incomplete flakes (n = 15) which retain their striking platform, flake fragments (n = 21) which are the medial or terminal portions of the flake, split flakes (n = 2), shatter (n = 13), and core fragments (n = 7). The most frequently found core type is an irregular core (n = 12) showing no specific organization in knapping strategy. No Levallois cores were found in the sample area, though three Levallois points were present.

Quartz is the preferred raw material, with 84.3% (n = 118) of the artifacts produced on it, while the remainder are produced on quartzite (n = 22). No other raw materials were identified in the sample area. Flakes with single platforms or fully cortical platforms are the most frequent platform type (69.2%). Multi-facetted platforms are found in smaller numbers (n = 6, 15.4%).

### *Shackley's 1978 sample*

The 1980 sample includes 300 artifacts curated at the National Museum of Namibia.

The assemblage has five bifaces, four handaxes, and one cleaver. Other formal tools include three scrapers and one knife but no denticulates or Levallois points. Flakes and flaking debris account for 47% and 44.6%, respectively. Other debris (n = 134) types include incomplete flakes (n = 13), flake fragments (n = 74), shatter (n = 40), split flakes (n = 1), split pebbles (n = 2), and core fragments (n = 2). The most common core type is irregular core (n = 9), but also found in the assemblage are casual cores (n = 4), two centripetal cores, and one chopper core. The assemblage is produced on quartz 60% (n = 180) of the time with quartzite used for 40% (n = 120) of the artifacts.

### *Assemblage comparison*

The sizes of the artifacts from the South Sample and Shackley's sample are visually similarly distributed (Figure 5). The smallest component of Shackley's sample is 2 cm, while South Sample has 15 pieces in the 1–1.9 cm group. Neither assemblage has artifacts less than 1 cm maximum length. Whilst a Kolmogorov-Smirnov test ($\alpha = 0.05$) shows a statistically different distribution for the recorded lengths of unbroken flakes ($p = 0.0003$), a test on elongation (w/l) shows no statistical difference ($p = 0.1467$), indicating that the overall character of the assemblage is similar.

Raw material is also visually fairly equal between the two assemblages (Figure 6), quartz being the dominant raw material and quartzite fluctuating between 15 and 45% in the various artifact categories. The highest quartzite group is Shackley's sample of formal tools, which may be because the sample includes bifaces. Despite visual appearances, a Chi-square test comparing proportions of quartz to quartzite across broad typological groupings within each sample (defined in Table 1) is moderately significant (Cramers V = 0.390). Removing typology and relying purely on proportions of quartz to quartzite artifacts returns a less significant result (CV = 0.242).

One further discrepancy between Shackley's sample and the South Sample are the bifaces. The random location on the pan for the South Sample collection produced no bifaces. Shackley's sample has four handaxes and one cleaver.

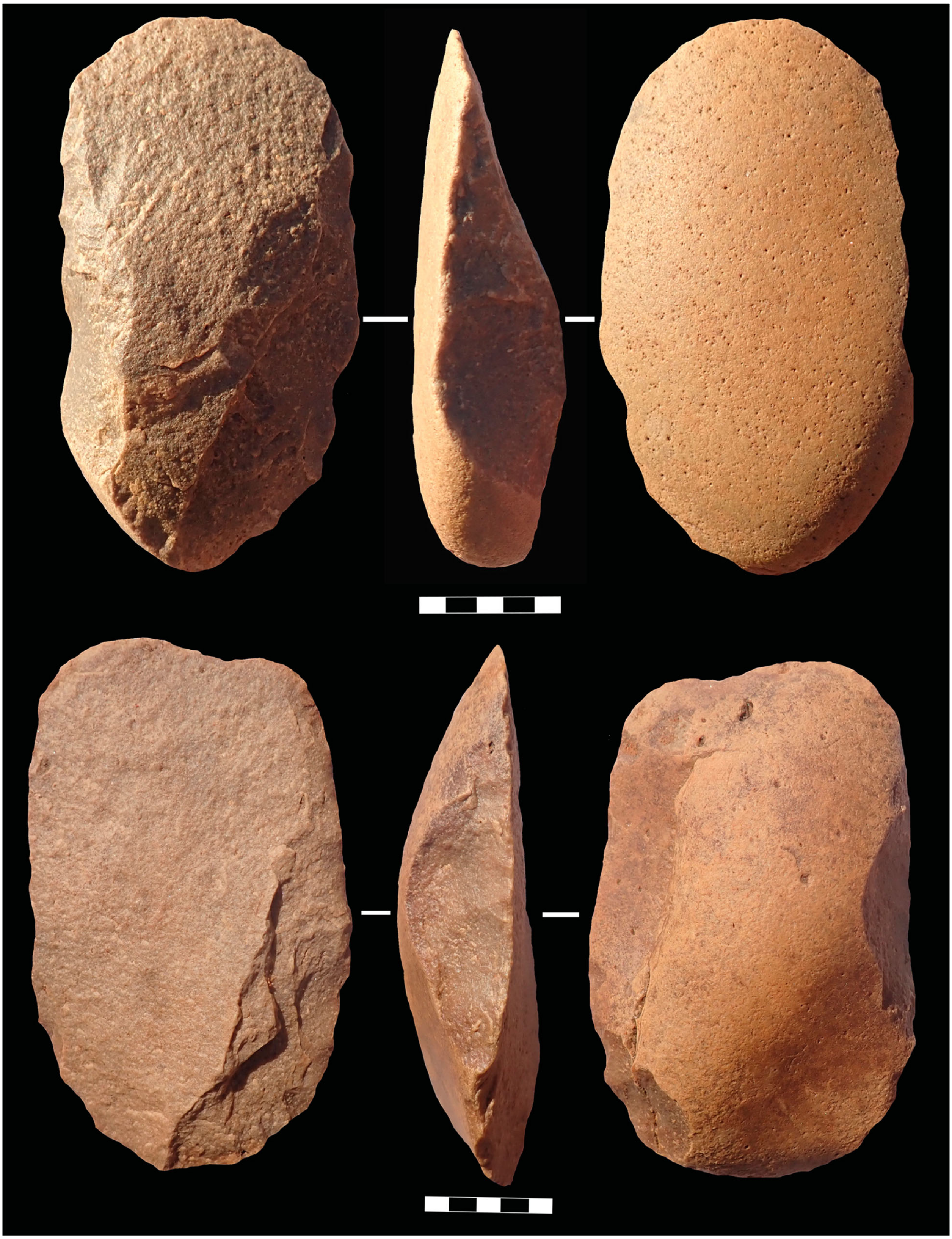

**Figure 7.** Quartzite cleavers on end struck cobble flakes.

## Large Cutting Tool Sample

Bifaces are scattered across the southern area of the pan in low density, but there is a clear high-density area on and next to the deposit with which they are likely associated (see Figure 2). As mentioned previously, many of the bifaces, though not all, were moved and placed in several clusters for photographs in 1978. These clusters are also on and near the deposit associated with the bifaces, but the tools' proveniences have been lost. A new sample, LCT Sample, of bifaces, handaxes, and cleavers, was recorded. This is particularly important because no detailed biface data is available from Shackley's sample beyond our new measurements of the four handaxes and one cleaver in the Namib IV material from Shackley's 1978 collection at the National Museum.

**Figure 8.** Quartzite cleavers on end struck cobble flakes.

The LCT Sample consists of 32 cleavers, along with 22 handaxes. Thirteen LCT flakes show neither a point or a flat "bit" of a cleaver and were classed as neither handaxe nor cleaver because they were less-worked large flakes from a cobble. Cleavers are all produced on flakes from large quartzite cobbles which are split lengthwise from the end or the corner of the flake (Figures 7, 8). Minimal additional shaping is used, averaging only 6.35 additional removals (Table 2). On average, they are $16.96 \times 10.71 \times 4.74$ cm, which is slightly smaller than the handaxes, which are $18.08 \times 9.96 \times 4.07$ cm. This is perhaps due to the shape of the raw material, as cleavers have a tighter size distribution (Figure 9). In comparing the bifaces from the LCT Sample to Shackley's 1985 sample, the handaxes from the LCT Sample are larger (Figures 10, 11). Shackley's sample does have a cleaver (n = 1, Figure 12) included in the curated material, but that is too small a sample to be used for comparison.

## Discussion

The arid landscape of the northern NSS bears evidence of hominin occupation in the form of stone tool artifacts that, in areas, form dense surface scatters typologically

**Table 2.** Biface size profiles.

| Typology/Clast | Descriptive Statistics | Length (cm) | Width (cm) | Thickness (cm) | Scar Count | Mass (g) |
|---|---|---|---|---|---|---|
| Cleaver | Max. | 22.5 | 13 | 6.6 | 15 | 1531 |
| Quartzite Cobble Flake | Avg. | 16.95 | 10.71 | 4.74 | 6.35 | 918.67 |
| (n = 34) | Min. | 11.1 | 6.4 | 3.4 | 1 | 511 |
| | Std. Dev. | 2.599 | 1.51 | 0.72 | 3.47 | 282.73 |
| Handaxe | Max. | 21.4 | 12 | 6.6 | 14 | 1430 |
| Quartzite Cobble Flake | Avg. | 18.08 | 9.96 | 4.87 | 8.47 | 827.28 |
| (n = 22) | Min. | 12.8 | 8.1 | 3.7 | 5 | 476 |
| | Std. Dev. | 2.35 | 1.06 | 0.69 | 2.71 | 200.5 |
| LCT | Max | 22.2 | 12.5 | 5.8 | 12 | 1514 |
| Quartzite Cobble Flake | Avg. | 17.48 | 10.31 | 4.45 | 5.18 | 885.53 |
| (n = 13) | Min. | 14.1 | 8.9 | 3 | 0 | 385 |
| | Std. Dev. | 2.31 | 1.27 | 0.96 | 3.54 | 299.65 |

representative of at least intermittent occupation from the ESA. Shackley's initial documentation of LCTs and fossil fauna from Namib IV proposed some intriguing hypotheses regarding Pleistocene hominin exploitation of this landscape, but fundamental inconsistencies in the reports limit contemporary assessments of these assemblages within the technocultural and paleoenvironmental context of the Namibian Stone Age and within the context of the Namib IV pan.

It is often assumed that surface sites such as these lack stratigraphic context, and as such the scatters have been largely overlooked, leading to a biased picture of early hominin distribution in arid environments the world over (Knight and Zerboni 2018). Despite the challenges posed by desert surface assemblages, their ubiquity offers insights into hominin behavior over longer time scales within these marginal environments: migrations; resource distribution and exploitation; and, raw material use and discard (for example, Blumenschine, Stanistreet, and Masao 2012). Whilst fluvial runoff features such as the !Khuiseb and former Tsondab River have cut into and eroded the Palaeogene TSF, the sands of the NSS represent a depositional phase. There is widespread evidence for conditions wet enough to develop reticulated drainage networks (Paillou et al. 2020) and for rivers to flow intermittently deep into the NSS until the Late Pleistocene (Stone and Thomas 2013). These clues for open surface water are obscured, literally and figuratively, by the massive dunes of the NSS, which Lancaster (1989) estimated to have accumulated over 2–3 mya by volume. The dune sand originates from the Orange River that migrates from south to north along the coast and eastwards from the coast to the interior. Minimum age estimates for the formation of the NSS are well in excess of 1 mya, based on a north-south transect of cosmogenic burial ages (Vermeesch et al. 2010), suggesting that it takes near-surface sand at least that time to be transported across the area. Whilst smaller dune forms may migrate very fast, the star dunes and linear dunes to the east of the sand sea are the least migratory features (Stone 2013), even though they may accumulate/migrate quite rapidly (Bristow, Duller, and Lancaster 2007; Chandler et al. 2022). This means that interdune pans may be exposed for significant periods, providing an opportunity to explore questions about hominin

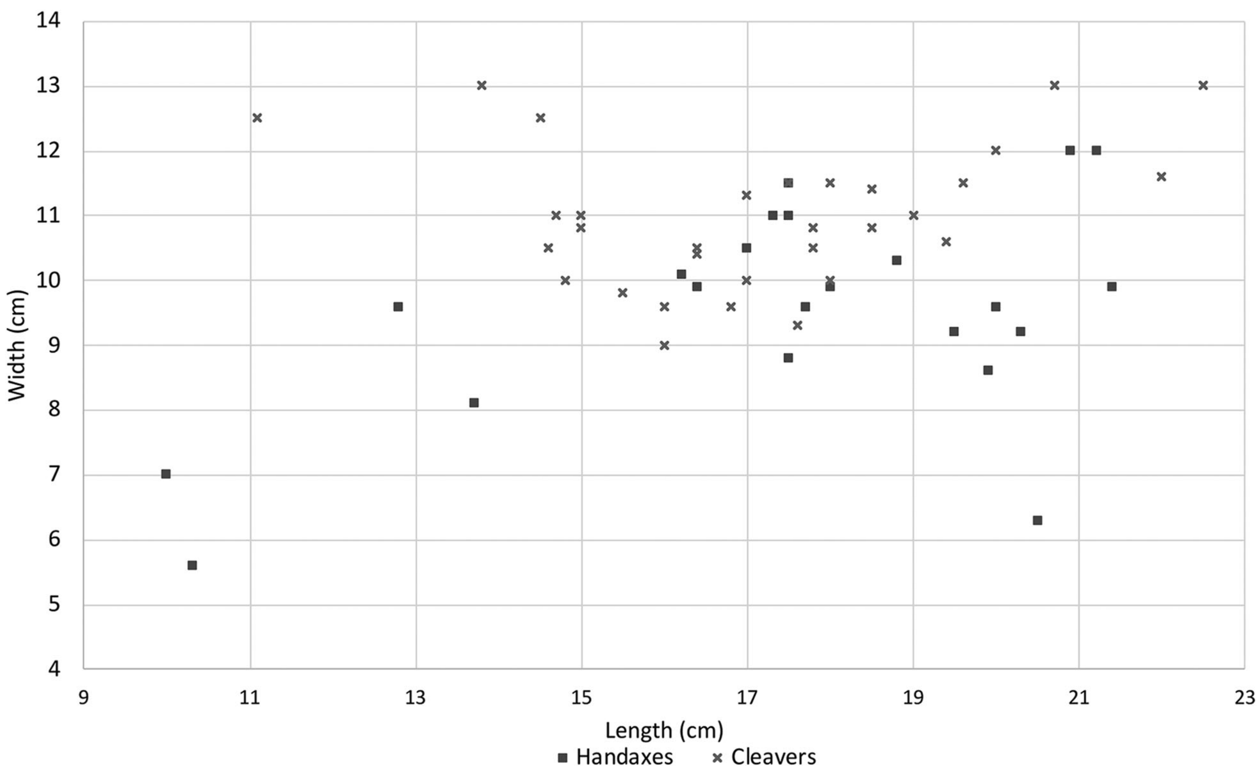


**Figure 9.** LCT Sample handaxe and cleaver size distribution.

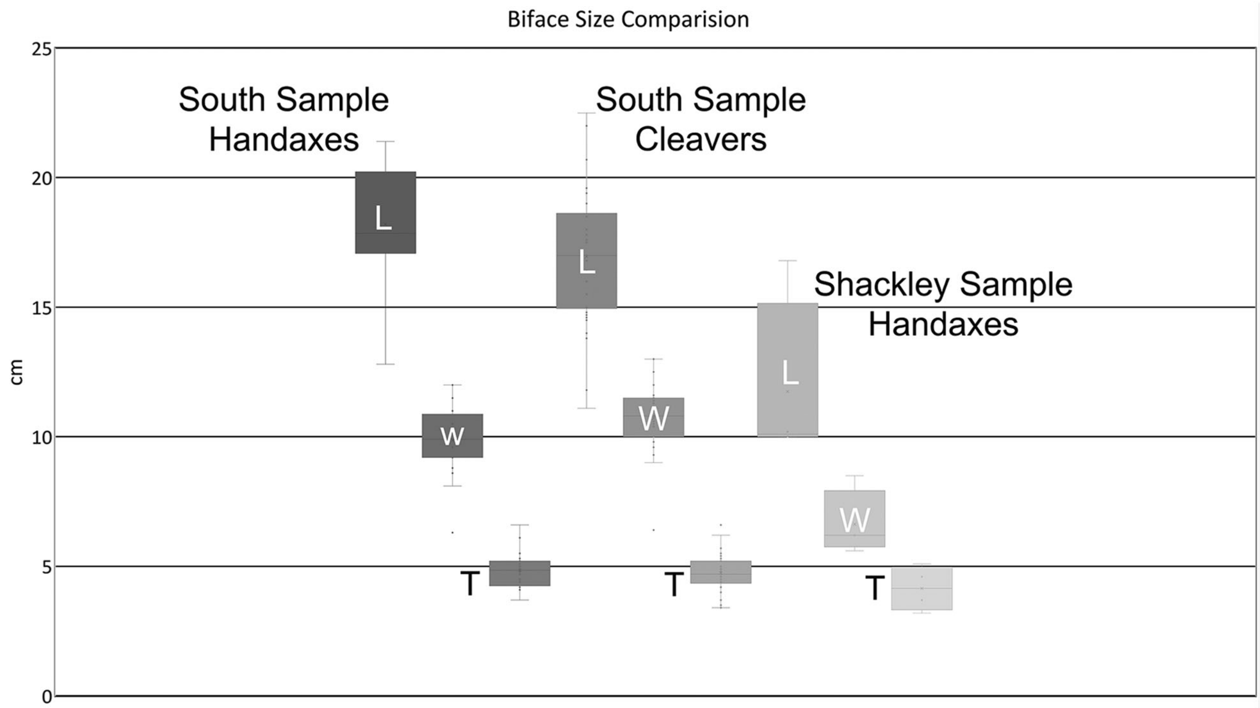


**Figure 10.** LCT Sample handaxes and cleavers compared to Shackley's (1985) handaxes (cleaver n is too low in Shackley's 1985 sample for comparison).

occupation and migration within a relatively stable landscape, and Namib IV is a site with multiple forms of evidence to combine for a complete picture of the environment and hominin technology. From a site formation perspective, the following preliminary interpretations can be proposed. Though further high-resolution spatial mapping is planned, the MSA deposits and LCTs (ESA deposits) are observed to be separated both spatially

**Figure 11.** Handaxe on quartz from the South Sample.

**Figure 12.** Cleaver from Myra Shackley's 1980 assemblage curated at the National Museum of Namibia in Windhoek.

and by elevation, suggestive of association with different deposits. The fine sediments exposed in the geotrenches allude to complex, low energy, alluvial sequences depositing sediment over weathered and eroded TSF rocks with intermittent periods of standing water or saturated sediments in the lower soil profile forming sequences of pedogenic calcretes that seal root-penetrated sands, indicative of soil formation. Interstratifying pale and red horizontally-bedded sands suggest a punctuated deposition of more distal sediment sources and locally reworked dune sands into the pan, while darker sands are visibly rich in organic matter. Deflated pebble-rich pavements in the northern pan suggest the prolonged presence of fluvial networks. Lighter color sands are indicative of the presence in water in two ways: 1) mechanical transportation of sand from a different source, or washing off the coatings on the sand, or 2) precipitation of calcium carbonate during periods of sediment wetting and evaporation. Near-horizontal bedded silty sands are indicative of shallow, low energy alluvial deposition, while cross bedded sands (e.g., GT4) are indicative of a migrating sand dune (slip face), and in this case the near-horizontal surface indicates this was then partly eroded, most likely by water that then filled the basin. Evidence of water on the Namib IV landscape is clear: when that water was present in relation to the stone tool and fauna assemblage formation is the next question. Although the eastern geotrenches did not reach the TSF contact, understanding the morphology of the bedrock is important for modeling the paleohydrology of the area. The geomorphological evolution of the pan is a crucial process to further clarify, given its influence on the possible transport of different elements of the stone tool and fossil faunal assemblages. Taphonomic analyses of both materials will help decipher their history within this complex environment. The freshness of the stone tools, nature of the sediments, and localized distributions of the assemblages suggest a spatial distribution of geogenic processes that may have enabled the preservation of older landforms in the pan.

Namib IV is often cited as an example of an ESA site in Namibia, but scrutiny of the published assemblages has raised questions that need to be addressed. The first archaeological work conducted in the late 1970s offers only hints at methods, sample locations, and sample sizes. Rather than continue to accept that the curated material is an accurate representation of the site, a new random sample with a known location and area was studied. Ultimately, the artifacts collected from the South Sample demonstrated that Shackey's sample (1985) was probably obtained from an area similar to the 50 × 8 m area used in the South Sample. The sample is consistent with a MSA sample and produced mostly on quartz. However, bifaces are numerous on the large pan surface, though none fell in the South Sample collection area.

The bifaces are evidence of hominins collecting large ovular clasts in the !Khuiseb River valley as a source of raw material. Quartzite raw materials derived from the vicinity of the !Khuiseb have been linked with Namib IV and other sites in the Sand Sea through x-ray fluorescence, indicating hominin movement from the river valley into the dune environment (Leader et al. 2022). Further work is needed to determine if bifaces were knapped on-site or knapped elsewhere and brought to the site. The cleavers were produced by removing a large end or corner struck flake from an ovular river cobble and finished with only a few additional removals. The cleavers are unique in their final form, which often includes a long but curved cleaver "bit." Compared to other cleavers in the Acheulean, the cleavers at Namib IV are minimally worked but have a highly functional working edge.

## Conclusions

Namib IV is an ESA and MSA pan site between the Tsondab Flats and the !Khuiseb River between high dunes of the Namib Sand Sea. MSA artifacts are found in moderate density across the entire surface of the pan site but in higher numbers towards the southern end of the pan. ESA artifacts are also scattered across the southern end of the pan and appear in high densities near calcrete deposits, possibly indicative of their association with those deposits and with surface water resources.

The bifaces were originally dated through proposed association with *Elephas recki* fossils (Klein 1983), later dated with a single U/Th date to 300–425 kya (Shackley 1980; Shackley et al. 1985; Mesfin, Pleurdeau, and Forestier 2021). However, the known date range of *Elephas recki* and its presence in this part of southern Africa has been called into question, raising the possibility of a misidentification (Todd 2005). No distinctive fossil material could be located in the material from Namib IV curated by the National Museum to allow re-identification. Further, the association between two different fossil deposits at the site and the artifact deposits remains, for the time, unknown. As such, the previous date range provided by Shackley (1980) of 400–700 kya cannot yet be confirmed.

Bifaces are dominated by large cleavers produced on river cobbles. They are consistent with Acheulean technology but remain undated. Cleavers are more frequent than handaxes, which occur in other Early Acheulean sites in southern Africa (Leader 2014), though this is not always the case (Lotter and Kuman 2018; Lotter, Caruana, and Lombard 2022).

The site was originally interpreted as an ESA butchering site based on the bifaces and faunal remains (Shackley 1980). However, the paleoenvironmental and depositional record and chronology is not yet understood. Ancient ephemeral fluvial channels (Stone and Thomas 2013; Paillou et al. 2020) and persistent alluvial pans supporting peripheral soil formation, vegetation, and support for grazing animals may have played a role in attracting hominins to this now hyper-arid environment.

## Future Work

High resolution spatial and taphonomic survey of the entirety of the surface material is planned for the next field season, which may link ESA artifacts with specific deposits. Additional geotrenches will refine pan-wide stratigraphic correlations and attempt to expose the morphology of the underlying TSF. In addition, additional and expanded geotrenches will hopefully yield in situ artifacts. Depositional and paleoenvironmental features will be examined through microscopic studies, and local sedimentary and geomorphological features will be linked with broader, regional hydroclimatic conditions through remote sensing. In addition, chronological control of sediments in geotrenches will be attempted by luminescence dating, utilizing protocols that extend the age-range of the dating technique.

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