Erb Tanks: a Middle and Later Stone Age Rockshelter in the Central Namib Desert, Western Namibia

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ABSTRACT

This report describes the results of the 2009 excavations at the Erb Tanks Rockshelter on the central Namib gravel plain in western Namibia. These excavations revealed Middle Stone Age (MSA) archaeological remains dated between 130–45 ka through ostrich eggshell amino acid racemization and Later Stone Age (LSA) archaeological remains dating from around 5 ka through AMS ^{14}C through the period of colonial contact. This paper describes our field methods and offers information concerning site formation and post-depositional processes. In describing the lithic assemblage, this paper proposes two distinct phases of the MSA and subtle change over time in the LSA lithic technology. The earlier MSA phase is characterized by more expedient knapping strategies, the use of local vein quartz, and very low frequencies of end-products. The later MSA phase is characterized by more elaborate core reduction strategies, the exploitation of more distant dolerite, and higher frequencies of technical end-products. This report also discusses the characteristics of LSA ostrich eggshell beads, ceramics, and historic objects.

INTRODUCTION

This paper reports preliminary results from the 2009 test excavations at the Erb Tanks Rockshelter in the central Namib Desert, western Namibia. The uncovered archaeological remains range from the Middle Stone Age (MSA), dating to at least Marine Isotope Stage (MIS) 4 through racemization (AAR), through the period of European contact. Our excavations, in combination with other regional studies (Kinahan and Kinahan 2010), suggest a hiatus in the occupation of the central Namib from the later MSA through the Middle Holocene Later Stone Age (LSA), with this gap ranging between approximately 45 ka to 8 ka. The results of our excavations also suggest a long-lasting and sustained MSA human presence in this hyper-arid region.

The presence of early modern humans in such an extreme periphery of the African landscape during the Upper Pleistocene has important implications for prehistoric demographics and human adaptive capabilities. Among other things, this demonstrates that MSA early human groups had the capability of living in extremely arid environments.

SETTING AND DISCOVERY

The Erb Tanks Rockshelter is located on the central Namib gravel plains about 10km east of the town of Arandis and about 15km north of the Khan River (Figures 1–6). It is located on the south-facing edge of a Damara sequence gran-

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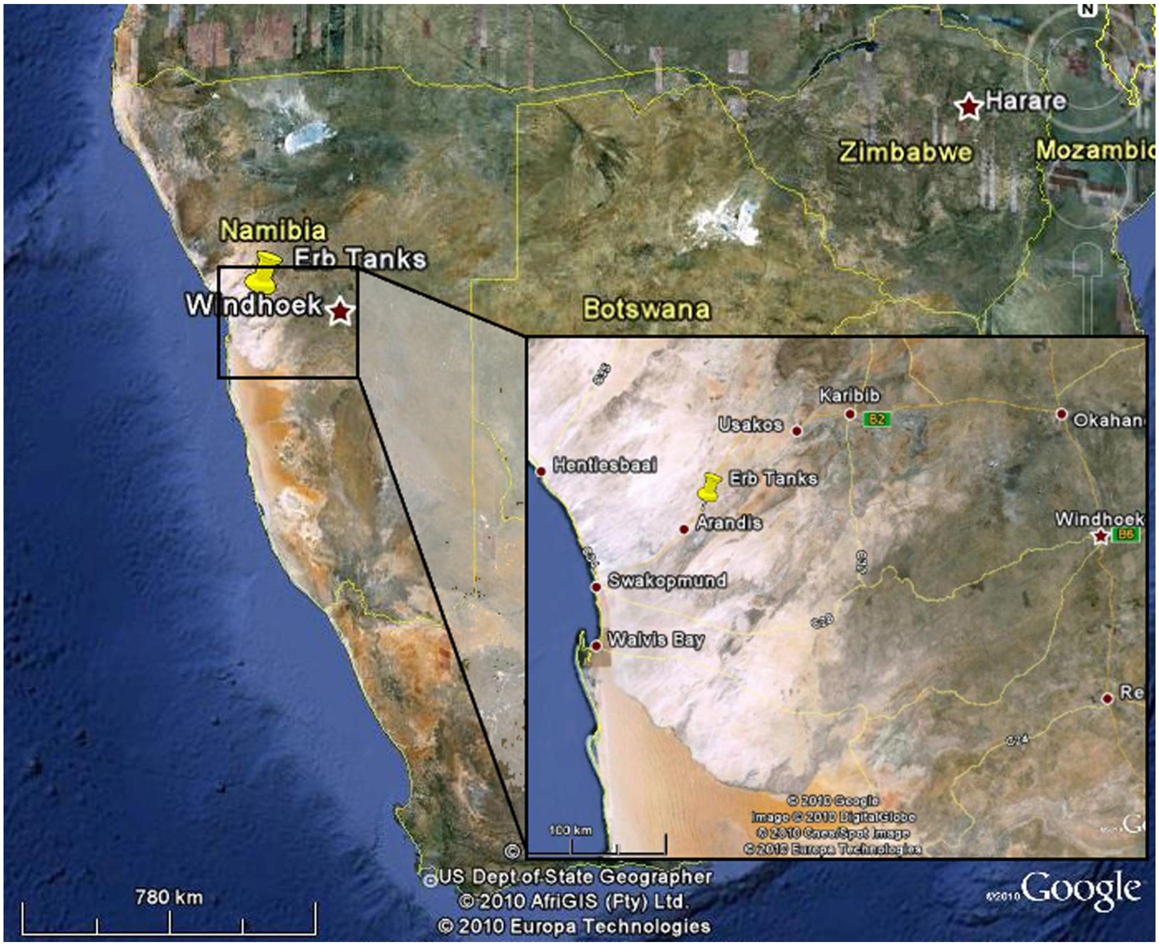

Figure 1. Location of Erb Tanks on the central Namib gravel plains, western Namibia.

ite outcrop, or *koppie*, adjacent to an erosional basin that collects runoff. Such pools are one of five types of springs and wells recognized by local Topnaar and Damara pastoralists, in the Khoekhoegowab language referred to as a //*gurab* (Hoernle 1925; see Figure 6). There is another such formation on the northwestern edge of the *koppie* that has been enhanced through the construction of a concrete dam, known locally as Arandis Dams. Both wells are still used by the current landowner as a key water source, though the water is now pumped and transported to the main farm using a water truck. There are also 5 stone structures adjacent to Arandis Dams (see Figure 2). These structures seem to be relatively recent by virtue of their association with 19th and early 20th century glass (especially wine and gin bottles), other historical remains, and the scarcity of lithic artifacts.

The Erb Tanks Rockshelter was brought to our attention in 2008 during a fieldtrip led by the director of the Swakopmund Municipal Museum, Elke Erb (for whom the site is named). During our inspection of the site, we found high frequencies of surface artifacts, some of which appeared to be typologically MSA. In addition, while the sediments adjacent to the well seemed quite disturbed by modern farming-related activities, there appeared to be relatively deep and intact sediments at the mouth of the shelter. Given this evidence, we considered Erb Tanks a good candidate to contain buried MSA archaeological remains—something thus far unknown elsewhere in the central Namib and very rare in Namibia more generally (Vogelsang 1998).

The gravel plains surrounding Erb Tanks are sparsely vegetated with various grasses (*Stipagrostis* spp.) and shrubs (mainly *Acacia* spp. and *Aloe asperifolia*). Local mammalian fauna consists of springbok (*Antidorcas marsupialis*), gemsbok (*Oryx gazella*), mountain zebra (*Equus zebra*), brown hyena (*Hyaena brunnea*), black-backed jackal (*Canis mesomelas*), cape fox (*Vulpes chamas*), springhare (*Pedetes cafer*), scrub hare (*Lepus saxatilis*), and numerous small rodent species. The nearby Khan River valley, on the other hand, is a relatively productive corridor of riparian woodland. Erb Tanks receives on average around 50mm of rain annually, which often occurs during large storm events. Located at an elevation of around 600m, Erb Tanks is at the edge of the Namib Desert fog zone, in which Atlantic Ocean moisture is transported inland by westerly onshore flows. The site also is frequently blasted with hot and dry east winds from the interior, known as "*bergwinds*." The environmental context of Erb Tanks may be considered one of extreme aridity relative to the interior of north-central Namibia, while not quite as extreme as portions of the gravel plains nearer to the coast.

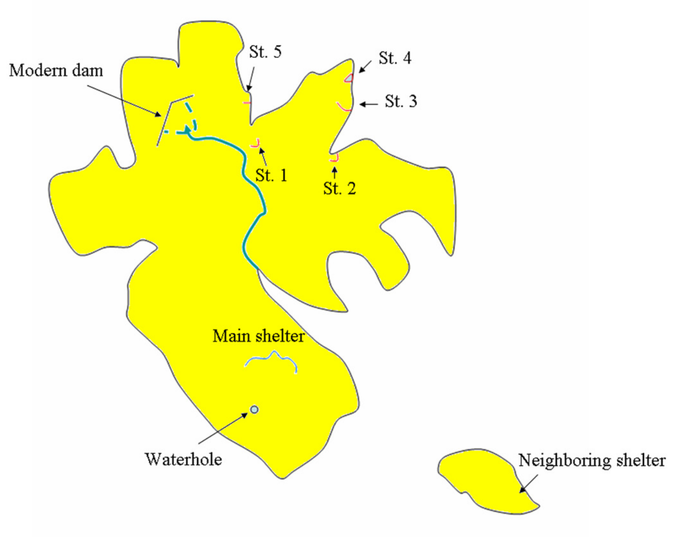

Figure 2. Map of the koppie on which the Erb Tanks Rockshelter is situated showing the location of the pastoralist structures and the modern dam.

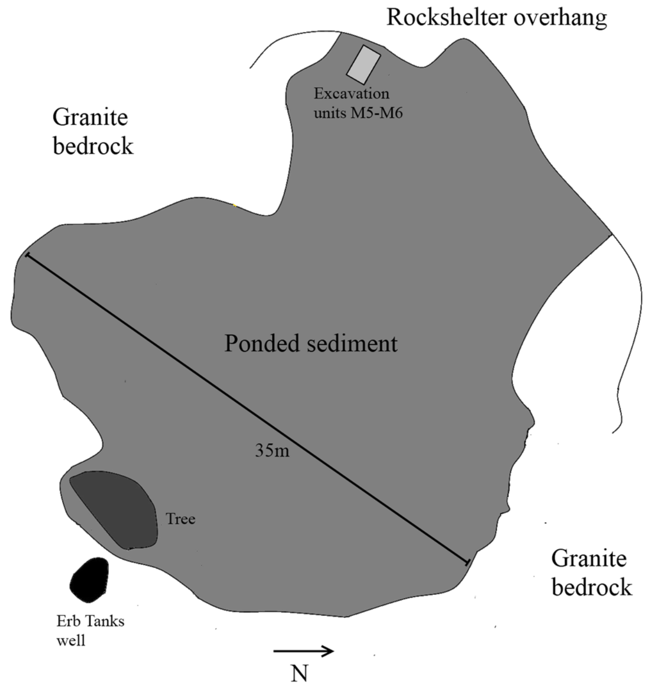

Figure 3. Map of fieldwork activities in the Erb Tanks Rockshelter.

EXCAVATION AND SURFACE COLLECTION METHODS AND RESULTS

In June of 2009, we began our initial fieldwork at Erb Tanks. Our most immediate goals were: 1) the establishment of the presence of intact sediments and buried MSA archaeological remains within the shelter; 2) the documentation of any natural or cultural stratigraphy that might be present; and, 3) the collection of relevant dating samples with which to build a preliminary chronology. Given these goals, we decided to put in a limited 2x2m test excavation unit using arbitrary 5cm levels, except when features or stratigraphic changes were encountered. All artifacts larger than 2cm were piece-plotted and all sediment was screened using a 1/8th inch nylon mesh.

The stratigraphic distinctions represented in our profile were based mainly on sediment color, as there were relatively minor changes in its other properties (such as grain size). In addition, sediment colors changed rapidly during the excavation due to oxidation resulting from contact with the air. The result was that we failed to recognize many of the subtle stratigraphic changes while excavating and we were only able to recognize them in the profile through a process of wetting the wall and observing color changes as

Figure 4. The Erb Tanks Rockshelter view from the south.

Figure 5. The Erb Tanks Rockshelter viewed from the northeast.

it dried. The stratigraphy at Erb Tanks is certainly not a horizontal "layer cake" and this implies that our arbitrary 5cm levels likely mixed the natural strata in places. This phenomenon was most prevalent in Levels 12–13, where there was an apparent mix of MSA and LSA lithics. This problem was not, however, as extreme as the profile drawing suggests, as the levels which mostly likely mixed natural strata had very few artifacts in them. The major concentrations of MSA and LSA artifacts were separated by several levels with very few artifacts (Levels 7–11) and nearly all of our MSA artifacts were piece-plotted.

The Erb Tanks rockshelter has been used frequently as a campsite in recent times by local vacationers and we were concerned about the potential for this activity to contaminate our carbon samples. Therefore, before beginning the excavation, we swept the surrounding area extensively and screened the loose dust that was removed. We also conducted a surface collection of artifacts along the western edge of the rockshelter, which was between our campsite and the excavation unit and was getting trampled by our traffic. While relatively few artifacts were collected, we did make some interesting discoveries through this process, including two Howiesons Poort-like milky quartz backed blades.

Our excavation resulted in the documentation of 16 levels and concluded at a depth 192cm (Figure 7). These excavation units had the following properties:

- Levels 1–2 were composed of loose sandy silt (2.5Y 4/3) and contained LSA lithics (including some made on historic glass), several glass beads, various small animal bones, ostrich eggshell, charcoal, white ash, and a few ceramic pieces. These levels mostly correspond with the layer of loose dust and silt represented on the excavation profile.
- Levels 3–6 were composed of sandy silt (2.5Y 4/2) mixed with more white ash and charcoal. There were also three pit features interspersed within these levels (Features 1–3), which contained more ash and charcoal, the burned bones of mammals of various sizes, and large articulated pieces of burned ostrich eggshell. These levels and features were characterized by the presence of LSA lithics without ceramics or other historical remains, and roughly correspond with the layer of conflated hearth fill and features represented on the excavation profile.
- Levels 7–9 were composed of a reddish silty sand (and white ash with lower frequencies of LSA lithics. The frequencies of white ash and charcoal in these levels were significantly lower than in Levels 3–6, and animal bones were nearly absent. In addition, there was a relatively low frequency of ostrich eggshell. These levels correspond mostly with the layers of ashy sediment represented on the excavation profile.
- Levels 10–11 were composed of reddish silty sand (10YR 4/3) and marked by an increase in the frequency of LSA lithics. Animal bones were absent and ostrich eggshell remained relatively rare. These levels also contained several large flakes, some of which were considerably weathered and/or coated with calcrete deposition. For these reasons, we consider these large flakes to be the uppermost occurrence of MSA artifacts. These levels correspond with the upper portions of the layer of reddish sandy sediment represented on the excavation profile.
- Levels 12–13 were composed of reddish silty sand

Figure 6. The Erb Tanks well view from the east with the rockshelter in the background.

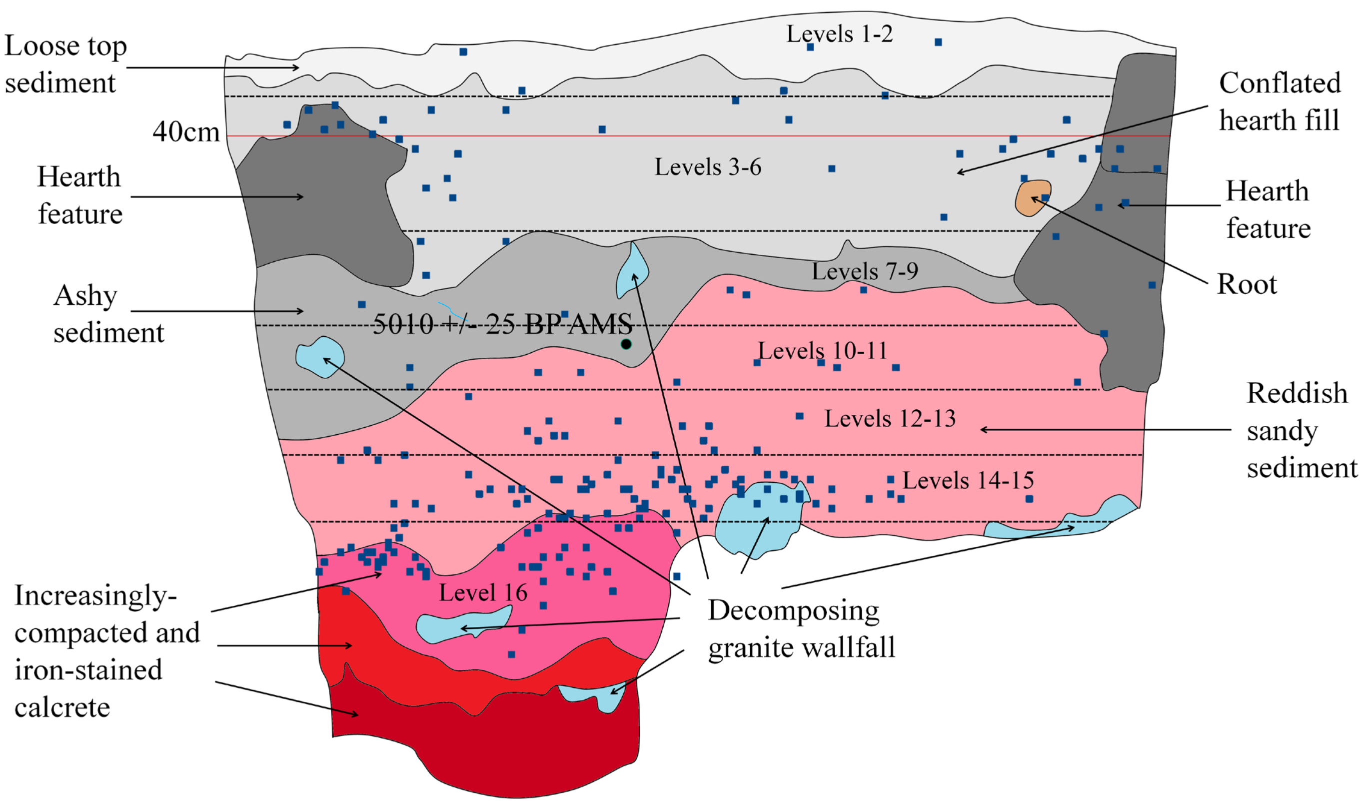

Figure 7. Profile of sediment stratigraphy from the south wall of the M5 excavation unit. Blue squares represent the positions of piece-plotted lithic artifacts.

(10YR 4/3). They contained ostrich eggshell but no animal bones, and were characterized by a mix of LSA lithics and larger flakes, some of which were weathered. On this basis, we conclude that there was mixing of MSA and LSA components between Levels 10–13. These levels contain the middle portion of the layer of reddish sandy sediment represented on the excavation profile.

- Levels 14–15 were composed of reddish sand (10YR 4/3) interspersed with loose calcrete nodules and gravel. The lithics were uniformly large, with some distinctive type specimens of the MSA, including two Levallois points. Levels 14–15 contained ostrich eggshell (including some pieces encrusted with calcrete) but no animal bones. Near the bottom of Level 15, we encountered a more pervasive layer of consolidated calcrete, which made excavation with small tools difficult. With our time in the field running short and determined to excavate the test unit down to bedrock, we reduced our excavations to a 1x0.8m section in the southwest corner of the unit, where the calcrete was loosest. The levels correspond with the lower portion of the layer of reddish sandy sediment and upper portion of the layer of oxidized consolidated calcrete.
- Level 16 was composed of reddish sandy gravel (10YR 4/3) consolidated with calcrete. It contained large MSA flakes and cores, some of which were weathered. It also contained ostrich eggshell but no animal bones. The lithics and ostrich eggshell fragments were frequently encrusted with calcrete. This level corresponds with the lowest two stratigraphic levels represented on the excavation profile.

SITE CHRONOLOGY

The most recent occupations of the Erb Tanks Rockshelter can be dated using the presence of historic remains. In particular, the bottle glass has European origins, dating to the early 19th through early 20th centuries (Kinahan 2000). The presence of cattle bones in Levels 3–6 (and associated features) suggests a date of sometime after 2 ka, since this is the time range in which cattle pastoralism is known to have been practiced in the central Namib (Kinahan 1991; Sandelowsky 1977; Smith and Jacobson 1995). In addition, the earliest LSA occupations elsewhere in the central Namib date to around 8.5 ka (Kinahan and Kinahan 2010) and we take this to be a reasonable *terminus post quem* for the LSA occupation of Erb Tanks.

We collected numerous charcoal and ostrich eggshell samples from Levels 1–11 (including Features 1–3) for the purposes of AMS dating. Keeping in mind our main goal of dating the MSA levels, we decided upon the AMS analysis of a carbon sample from Level 11 (our deepest carbon sample) and an ostrich eggshell fragment from Level 15. The Level 11 charcoal sample returned a date of 5010 BP±25. The Level 15 ostrich eggshell sample returned a date of 2590 BP±25. This problematic date from a putative MSA level represents either some form of contamination or stratigraphic mixing—a topic we return to below. The AMS date for the Level 11 charcoal sample should perhaps be taken with a grain of salt given the other evidence for stratigraphic mixing. If valid, however, it generally corroborates an initial LSA forager occupation of Erb Tanks during the Middle Holocene based on the chronology of other sites in the region (Kinahan and Kinahan 2010). The roughly 20cm of LSA deposits below our Level 11 AMS sample also are consistent with the somewhat earlier LSA occupation of the region known from neighboring sites.

In examining the MSA chronology of Erb Tanks, we also conducted amino acid racemization analyses (AAR) of 15 ostrich eggshell fragments from Levels 11, 14, and 16. These analyses were somewhat more productive but produced a wide range of aIle/Ile values (Table 1). We used the regression curve presented for AAR at Apollo 11, south-central Namibia, as our basis for assigning dates to our aIle/Ile values (Miller et al. 1999)[1]. The first thing that is apparent is the probability of stratigraphic mixing evident between Levels 11–16. There are MSA dates associated with Level 11—a putative LSA level—and there are LSA dates associated with Level 16—a putative MSA level. This perhaps puts the ostrich eggshell AMS date from Level 15 in a clearer light and points to the vertical movement of ostrich eggshell pieces within the sediment matrix.

This is a well-known phenomenon at southern African MSA and LSA sites, and has been discussed elsewhere by Miller and colleagues (1999). In addition, we think it likely that the early LSA dates (10–25 ka) were influenced by *in situ* burning (for which there is abundant evidence) and actually belong to a Middle Holocene chronological context. With that said, it may be worth keeping an open mind to the possibility of earlier LSA occupations at Erb Tanks.

In addition to the dating attempts described above, we are continuing with our efforts at refining the chronology of the MSA and LSA periods at Erb Tanks. Further AMS samples from the LSA levels are currently being analyzed, with the primary goal of isolating the transition from foraging to pastoralism. In addition, we collected samples for optically stimulated luminescence (OSL) dating from both the MSA and LSA levels, which are also in the process of analysis. In the long run, our goal is to combine these separate lines of chronological evidence, to use them to calibrate the dating of our AAR values, and to make sense of their results collectively.

Ignoring these problems and the issue of stratigraphic mixing for the moment, these dating results have important implications for the MSA chronology of the central Namib. Three of the dates cluster between 60–65 ka, a fourth is around 85 ka, and there are two outliers at around 45 ka and 130 ka. This clearly indicates a significant MSA occupation of the central Namib during the Upper Pleistocene. The range of AAR dates also is supported by the typological comparison of the Erb Tanks artifacts with those from Apollo 11. The MSA levels at Erb Tanks have the same basic type fossils in comparable frequencies with the pre-Howiesons Poort levels at Apollo 11, for which Vogelsang (2008)

TABLE 1. OSTRICH EGGSHELL AMINO ACID RACEMIZATION RESULTS FROM LEVELS 11, 14, AND 16*.

Field ID	AAL#	aIle/Ile (Run 1)	aIle/Ile (Run 2)	Date
M5-Level 11-Lot 100	13390	0.068	0.068	<5 ka
M5-Level 11-Lot 100	13390	0.073	0.072	<5 ka
M5-Level 11-Lot 100	13390	0.176	0.178	12 ka
M5-Level 11-Lot 100	13390	0.368	0.367	45 ka
M5-Level 11-Lot 100	13390	0.49	0.481	60 ka
M5-Level 14 - Lot 113	13399	0.049	0.05	<5 ka
M5-Level 14 - Lot 113	13399	0.102	0.102	6 ka
M5-Level 14 - Lot 113	13399	0.198	0.198	15 ka
M5-Level 14 - Lot 113	13399	0.253	0.254	25 ka
M5-Level 14 - Lot 113	13399	0.575	0.579	65 ka
M5-Level 16-Lot 179	13400	0.158	0.159	10 ka
M5-Level 16-Lot 179	13400	0.219	0.215	20 ka
M5-Level 16-Lot 179	13400	0.569	0.555	65 ka
M5-Level 16-Lot 179	13400	0.663	0.654	85 ka
M5-Level 16-Lot 179	13400	1.013	1.013	130 ka

*Age estimates were derived using the Apollo 11 regression curve proposed by Miller et al. (1999).

proposes dates between 80–120 ka (see also Jacobs et al. 2008 and Miller et al. 1999). This fact, in combination with the absence of diagnostic Still Bay and Howiesons Poort material, perhaps suggests a pre-Still Bay age range for the bulk of MSA material at Erb Tanks, though we also recognize the likely presence of a post-Howiesons Poort component. This would make most of the MSA lithics from Erb Tanks equivalent with the MSA I–II periods in the South African sequence (Singer and Wymer 1982). It would also imply that the chronology of the MSA materials at Erb Tanks has considerable similarity with those known from ≠Gi and White Paintings Shelter in Botswana (Brooks et al. 1990; Kuman 1989; Murphy 1999).

SITE GEOLOGY AND FORMATION PROCESSES

As an unusual combination of pond and rockshelter depositional contexts, the geology of Erb Tanks is quite complex. The coarser-grained sediments, matrix oxidation, and calcrete formation associated with the MSA levels (especially Level 16) likely indicate association with ponded water. In fact, we suspect that the lowest portion of the excavation in the southeast corner of the pit may, in fact, be a depression in the granite bedrock like the modern well, which filled with sediment during the Upper Pleistocene. In this scenario, we suspect that the pedogenic calcrete endemic to the MSA levels formed as the result of the leaching of carbonate ions from the strata above in combination with contact with groundwater (Dixon and McClaren 2009). We also suspect that this process is responsible for the oxidation of the lower LSA and MSA sediments, with the upper strata representing a zone of oxide ion loss and the lower strata representing a zone of gain. No doubt the rise and fall of groundwater levels was erratic and complex, and we implicate this phenomenon in the pedogenic dynamics of the lower levels.

The sediment deposition of Levels 3–6 and the features would seem to have a substantial anthropogenic component. For one thing, these levels encompass about 0.7m vertically—more than a third of the total depth of the sediment at Erb Tanks—and they accumulated in less than 5 ky, compared with more than 125 ky for lower 1.2m of sediment. This substantially higher rate of sedimentation points to more intense (or at least different) human activities during the LSA occupation of the site. Since Levels 3–6 represent a series of conflated hearths, roasting pits, and other pyrogenic features, we suspect that the human contribution of ash was a primary factor responsible for the evident higher rate of sedimentation. Specifically, we suspect that the LSA saw the use of the Erb Tanks site as a residential base and this phenomenon was likely particularly intense and continuous during the pastoralist period by virtue of the proximity of the wells.

The higher rate of sedimentation and greater amounts of ash during the LSA period also was apparently responsible for the relatively good preservation of animal bone, which is absent from the MSA levels. In addition, the identification of recognizable hearth/pit features also gives the

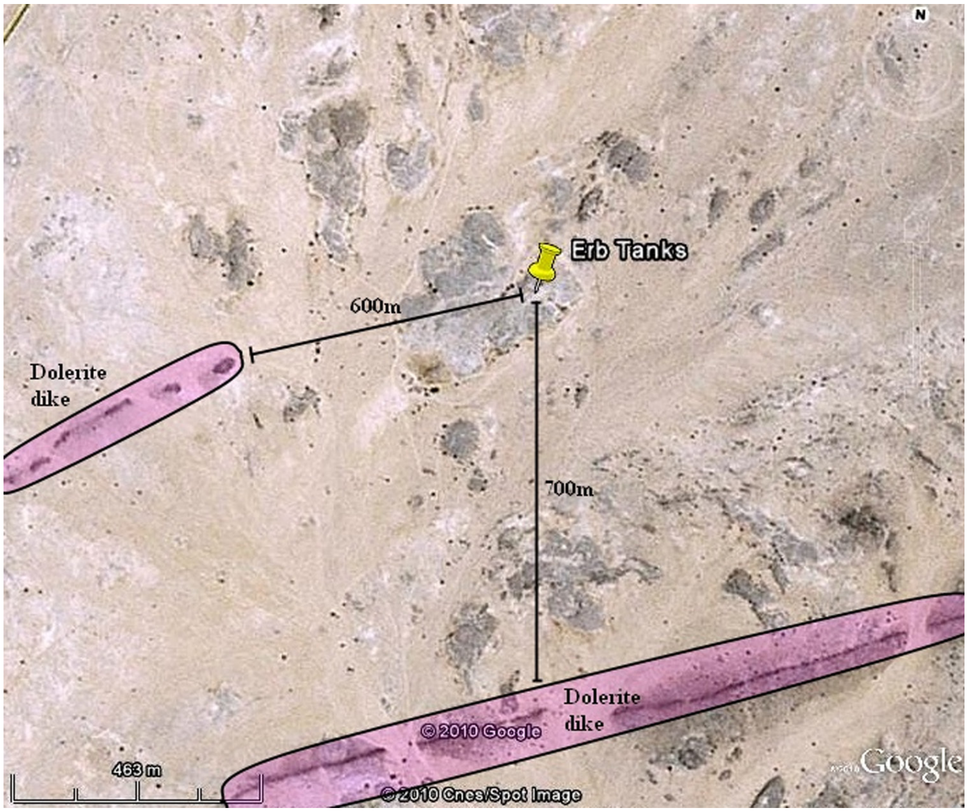

Figure 8. Locations of dolerite sources relative to the Erb Tanks Rockshelter.

impression of less disturbance, though no fine-grained strata were recognizable either during the excavation or in the profile of the excavation unit. It also was apparent that recent human activities at Erb Tanks were responsible for the disturbance of the uppermost two levels, which contained a few recent objects (including a $5 Namibian coin dated to1998).

The apparent disturbance within the MSA levels is an important issue that warrants its own discussion. Several lines of evidence point to significant mixing and intrusiveness within Levels 11–16 and especially Levels 12–13. These include: 1) the range of AAR dates on ostrich eggshell samples, spanning the Holocene and Upper Pleistocene; 2) the mixture of typologically LSA and MSA lithics in Levels 10–13[2]; 3) the mixture of weathered, calcrete-encrusted, and fresh lithics throughout the MSA and lower LSA levels; and, (4) the presence of calcrete-encrusted lithics as high as Level 10. While there was some evidence for small-scale bioturbation resulting from burrowing insects, rodents, and tree roots, we suspect that these were not the most important sources of stratigraphic disturbance. We feel that the position of the unit at the edge of a fluctuating pond was a major factor contributing to the apparent mixing. Such locations are known to be affected by a wide range of both geological and animal activities (Rapp and Hill 2006). Elsewhere around Erb Tanks, the peripheries of the modern well have surface assemblages which combine artifacts from wide ranges of time periods (e.g., a handaxe, MSA cores and flakes in combination with beer bottle fragments). Thus, we find it likely that pond-edge geological and biological processes account for the significant mixing of the lower LSA and MSA levels.

DESCRIPTION OF THE LITHIC ARTIFACTS

The vast majority of the archaeological material recovered from Erb Tanks was lithic debris and this section reports our initial observations on the MSA and LSA industries. Given the preliminary nature of this report, these data are presented without much commentary.

AVAILABLE LITHIC RAW MATERIALS

Both the MSA and LSA industries relied primarily on a number of locally available raw material types. Clear crystal quartz is available in the form of very small derived pebbles, which are fairly ubiquitous in local gravels. Hydrothermal vein quartz (hereafter called "milky quartz") is available both in veins present within the Damara sequence granite koppies around the Erb Tanks Rockshelter (though not on the Erb Tanks koppie itself) and in derived contexts on the adjacent gravel plain. Dolerite is available in dike formations exposed through a combination of tectonic uplift and erosion at several locations within 700m of the rockshelter. Figure 8 shows the location of dolerite dikes relative to the Erb Tanks rockshelter. While all three raw materials are available in the vicinity of the rockshelter, the dolerite is only available at primary sources at slightly more distant locations. In addition, the milky quartz is sporadically available around the surrounding landscape but

TABLE 2. FREQUENCIES OF MAJOR RAW MATERIAL TYPES.

Level	Milky Quartz	Dolerite	Crystal Quartz	Brown Chert	Grey Chert	Chalcedony	Hornfels	Other	Total
1 and 2	71 (19.94%)	15 (4.21%)	153 (42.98%)	30 (8.43%)	6 (1.69%)	45 (12.64%)	14 (3.93%)	22 (6.18%)	356
3–6 and features	424 (18.81%)	62 (2.75%)	996 (44.21%)	221 (9.80%)	36 (1.60%)	397 (17.62%)	70 (3.11%)	47 (2.09%)	2253
7–9	57 (28.79%)	4 (2.02%)	77 (38.89%)	18 (9.09%)	5 (2.53%)	19 (9.60%)	8 (4.04%)	10 (5.05%)	198
10 and 11	74 (36.45%)	17 (8.37%)	39 (19.21%)	33 (16.26%)	5 (2.46%)	24 (11.82%)	10 (4.93%)	1 (0.49%)	203
12 and 13	90 (36.89%)	50 (20.49%)	41 (16.80%)	44 (18.03%)	1 (0.41%)	13 (5.33%)	2 (0.82%)	3 (1.23%)	244
14 and 15	75 (51.37%)	46 (31.51%)	0 -	18 (12.33%)	0 -	1 (0.69%)	1 (0.69%)	5 (3.43%)	146
16	789 (62.27%)	209 (19.50%)	40 (3.16%)	128 (10.10%)	19 (1.50%)	12 (0.95%)	9 (0.71%)	23 (1.82%)	1267

it is difficult to find in large blocks in the immediate vicinity of the site.

Both the MSA and LSA industries also show low frequencies of exotic lithic raw materials, including grey and brown cherts, chalcedony, and hornfels. Grey chert is available at a large primary source about 35km southwest from Erb Tanks at the Rössing Mountain (Kinahan, personal communication 2009) and as derived cobbles available on a large portion of the central Namib gravel plain downstream from the confluence of Khan and Swakop rivers. Brown chert is available at a primary source about 20km southwest from Erb Tanks near the Khan mine, and in both primary and secondary contexts on the central Namib gravel plains in the vicinity of the Goanikontes formation, around 45km distant. Hornfels and chalcedony are both available as derived pebbles in the gravels of the Khan River, around 15km distant, and elsewhere on the central Namib gravel plain.

MSA KNAPPING STRATEGIES AND ASSEMBLAGE CHARACTERISTICS

The MSA assemblage from Erb Tanks comes predominately from Level 16, which contained 1,267 pieces of lithic debris. Levels 14–15 also were characterized exclusively by typologically MSA artifacts, but only contained 146 pieces. Levels 12–13 contained only 244 lithic pieces and showed a mix of MSA and LSA characteristics. Isolated MSA-like flakes continued as high as Level 10. Given the possibility of mixing in Levels 10–13, this discussion will focus on the MSA lithic artifacts from Levels 14–16.

The MSA levels are dominated by milky quartz and dolerite (Table 2 and Figure 9). There is also a moderate amount of brown chert, which is high-quality, fine-grained, and by far the most common exotic raw material within the MSA levels. The frequency of brown chert in Levels 14–15 and level 16 is relatively high in comparison with the frequency of exotic fine-grained raw materials at other MSA

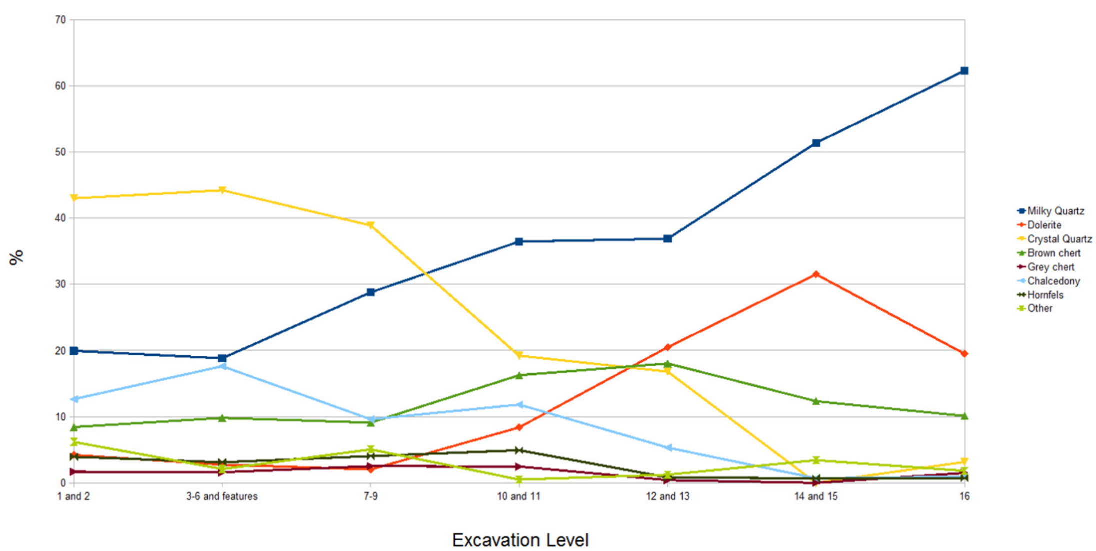

Figure 9. Frequencies of major raw material types.

TABLE 3. FREQUENCIES OF CORES WITH VARIOUS STRATEGIES OF REDUCTION.

Level	Levallois cores	Centripetal cores	Multidirectional cores	Indeterminate fragments	Total
10 and 11	0 -	0 -	3 (100%)	0 -	3
12 and 13	0 -	0 -	1 (50%)	1 (50%)	2
14 and 15	1 (12.5%)	0 -	7 (87.5%)	0 -	8
16	3 (6.82%)	9 (18.18%)	7 (15.91%)	25 (39.09%)	44

sites in South Africa, excluding the Still Bay and Howiesons Poort industries (Ambrose 2006; Ambrose and Lorenz 1990; Lombard 2005; McCall 2007; Minichillo 2006; Villa et al. 2005). However, it is similar to the broadly contemporaneous patterns of MSA raw material use described at White Paintings Shelter (Murphy 1999; Robbins et al. 2000) and ≠Gi (Kuman 1989).

The core reduction strategies evident in the MSA levels were dominated by multidirectional / irregular and centripetal techniques (Table 3). The irregular cores are characterized by a polyhedral pattern of negative flake scarring and the absence of any systematic orientation of flake removals. The centripetal cores are characterized by flake removals from the perimeter of raw material blocks toward the center and the systematic rotation of the core. For the purposes of this study, we consider the Levallois technique to be a specialized variant of centripetal core reduction. Of course, it is problematic to infer the use of the Levallois technique purely on the basis of cores and flakes with diagnostic technical characteristics (Chazan 1997). However, we feel the Levallois technique is manifested at Erb Tanks in the presence of points with characteristic patterns of platform morphology. In addition, we have placed several cores into the Levallois category on the basis of the exploitation of distal and lateral convexities in the production of "atypical" debitage (Boëda 1995).

Most of the cores present in the MSA levels were made on either milky quartz or dolerite, both of which tend to occur in rectangular blocks. It appears that these blocks were initially shaped into centripetal roughouts through a process of edge-turning and the removal of core shaping thinning flakes (though no true bifaces were present in the MSA assemblage). One large core was abandoned at this stage of reduction, after a number of flakes were removed unidirectionally from its margins (Figure 10, a). The centripetal cores often show evidence for the removal of elongated debitage. For example, one core had several flake scars resulting from the removal of blades, though none of the blades in the assemblage refit with this core (Figure 10, b). The Levallois cores were mostly quite small and exhausted. Two such cores had flake scars resulting from the removal of overshot flakes on their transverse surfaces, which effectively ended their utility (Figure 11, a-b). A third was disrupted by a step fracture on its transverse surface, which also seems to have ended its use-life.

There were also numerous multidirectional cores that showed no systemic organization and these were predominately made on milky quartz. The quality of the milky quartz raw material may account for some of this phenomenon, as it tends to contain numerous internal flaws and break along linear crystal lattice plains rather than forming true Hertzian conchoidal fractures. On the other hand, we did find several Levallois points made on milky quartz (Figure 12), suggesting that knappable pieces of this raw

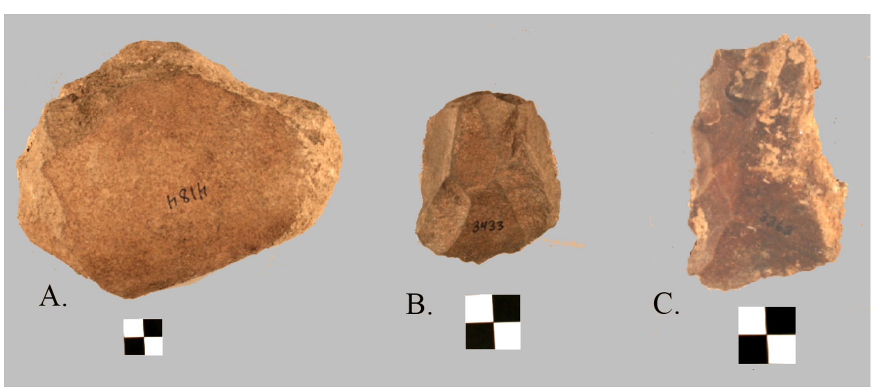

Figure 10. Centripetal cores from the MSA levels at Erb Tanks.

Figure 11. Levallois cores.

material were locally available. In general, we found relatively few cores in the MSA levels that showed evidence of strategic and systematic reduction, and the bulk of the core assemblage was comprised of blocky and irregular cores and core fragments.

The MSA flake assemblage was dominated by unretouched flakes, comprising 98.4% of the total. Within the population of unretouched flakes, there were 7 Levallois points (see Figures 11 and 12), 5 Levallois flakes, 12 blades, 6 convergent blades, and 22 core preparation / thinning flakes (Table 4). Combined, these special debitage categories comprised around 3.8% of the total unretouched flake total. The high frequency of expedient debitage largely agrees with the high frequencies of multidirectional and centripetal cores relative to other more elaborate core reduction strategies. The retouched tool forms in the MSA levels included scrapers, denticulates, and one unifacial retouched point (Table 5; Figure 13). The scrapers were mainly made on milky quartz and were primarily unifacial (Figure 14). Denticulates were the most common retouched tool and were made on a wide range of flake forms, including one on an apparent thinning flake and one on a point (Figure 15). Levels 14–16 contained only one true retouched point, which was produced using unifacial marginal trimming. A second specimen also appeared to show very light retouch at its tip, although we did not deem this sufficient to warrant its classification as a retouched point rather than a Levallois point. There also was another unifacial retouched point found in Level 14. Figure 16 shows a flow chart of reconstructed lithic reduction sequences for the MSA from Levels 14–16.

The whole and broken flakes from Levels 14–16 show high frequencies of multifaceted striking platforms, with 16.7% having more than one facet (Table 6). This is especially true of Levels 14–15, where 28.1% of platforms have multiple facets. High frequencies of multifaceted platforms are characteristic of MSA archaeological sites (Ambrose 1998), and this phenomenon may also relate to the various complex strategies of core reduction that typify this time period. It may also implicate later-stage core reduction as a primary activity—an inference that is consistent with high frequencies of small cores and polyhedral cores, as

TABLE 4. FREQUENCIES OF SPECIAL DEBITAGE TYPES FOR THE MSA LEVELS.

Level	Levallois points	Levallois flakes	Blades	Convergent blades	Core prep. / Thinning flakes	Total
10 and 11	1 (0.54%)	0 -	1 (0.54%)	0 -	1 (0.54%)	186
12 and 13	2 (0.90%)	0 -	3 (1.36%)	7 (3.17%)	9 (4.07%)	221
14 and 15	2 (1.48%)	3 (2.22%)	4 (2.96%)	5 (3.70%)	11 (8.15%)	135
16	5 (0.41%)	2 (0.16%)	8 (0.66%)	1 (0.08%)	11 (0.90%)	1219

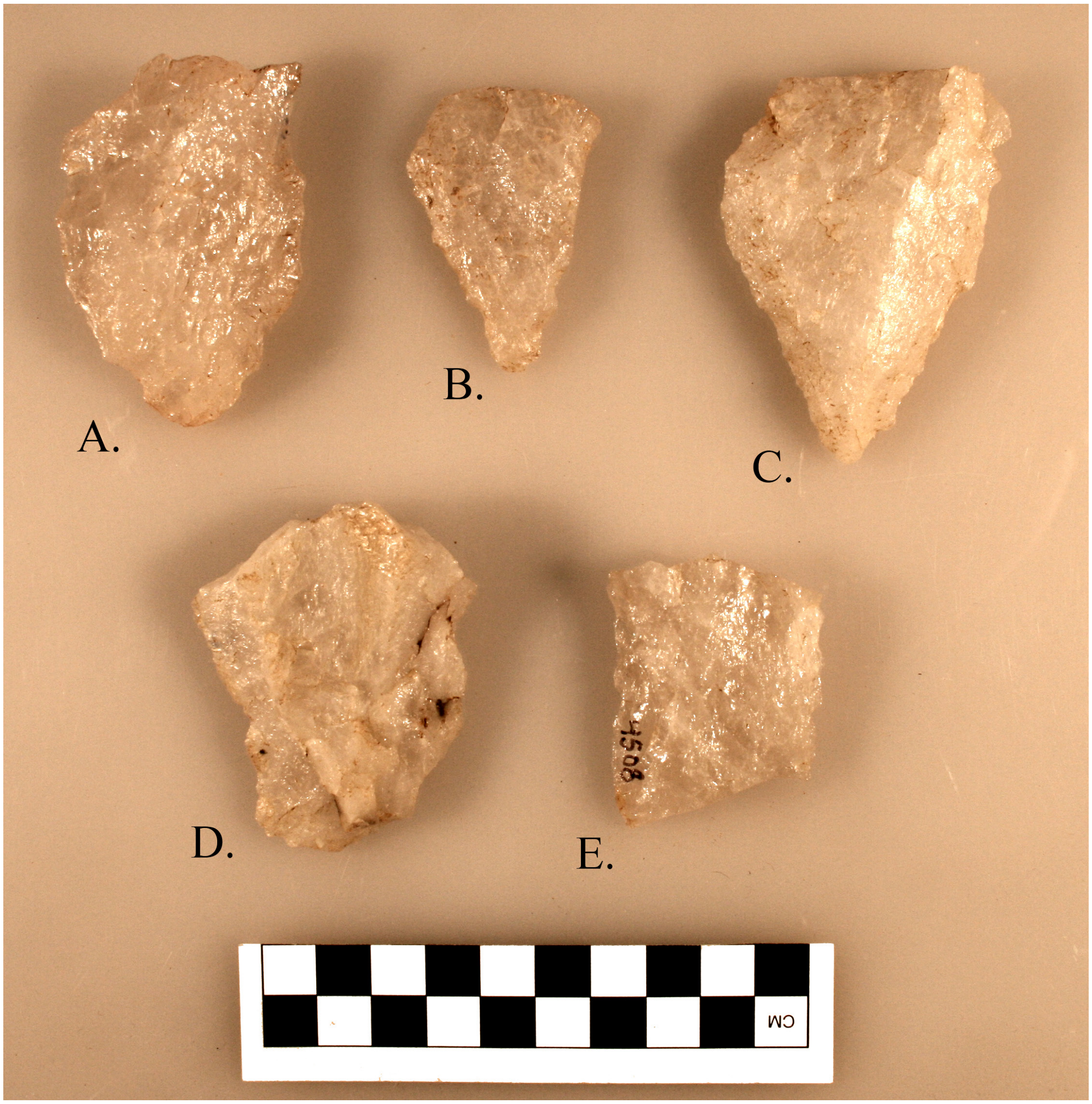

Figure 12. Various kinds of points made on quartz.

TABLE 5. FREQUENCIES OF RETOUCHED TOOL TYPES FOR THE MSA LEVELS.

Level	Retouched points	Scrapers	Denticulates	Other Retouched	Total
10 and 11	0 -	0 -	1 (0.54%)	0 -	186
12 and 13	1 (0.45%)	0 -	1 (0.45%)	2 (0.90%)	221
14 and 15	0 -	3 (2.22%)	3 (2.22%)	0 -	135
16	1 (0.08%)	6 (0.49%)	9 (0.74%)	0 -	1219

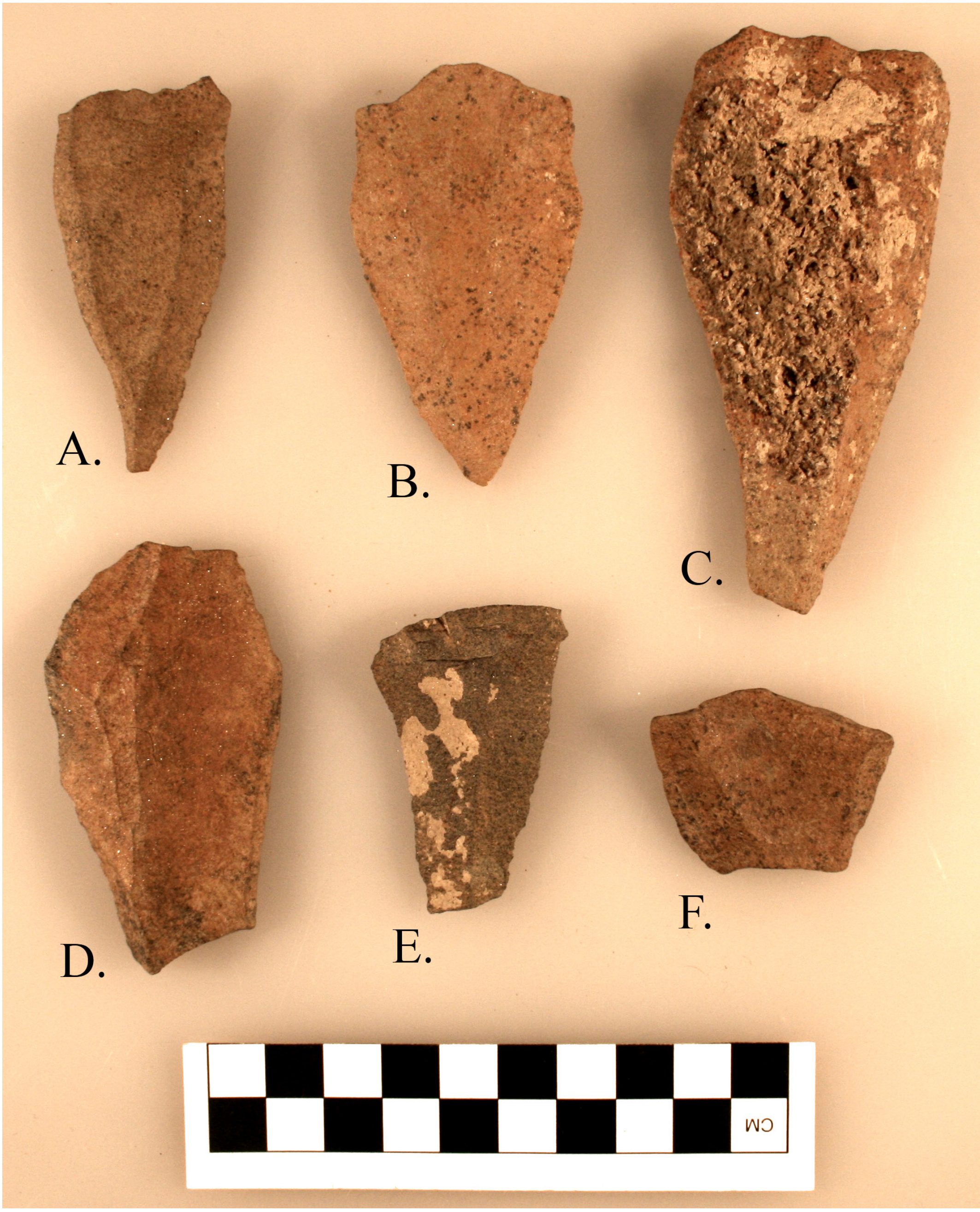

Figure 13. Dolerite points from the MSA levels.

well as the low frequency of core preparation flakes. At Erb Tanks, cortex data is unavailable, as the local milky quartz and dolerite do not form weathering rinds that would be recognizable as cortex. In addition, the exotic cherts and chalcedonies, which presumably had cortical rinds at their derived sources, lack them in their archaeological context at Erb Tanks.

The size of whole flakes in Levels 14–16 was small, with a mean length of 2.94cm (Table 7; Figures 17 and 18). In addition, whole flakes were rare, comprising only 26.7% of the flake assemblage from these levels. Once again, dynamics of raw material quality may have played a major role in causing these patterns, especially in terms of the prevalence of milky quartz. There is also an obvious difference between Levels 14–15 and 16 in terms of flake size. Mean flake length in Levels 14–15 is 4.52cm, compared with only 2.74cm (two-sample T test, $p < 0.001$) in Level 16. Once again, this may be at least partially attributable to the higher frequency of dolerite and lower frequency of milky quartz in Levels 14–15 compared with Level 16.

While the disparities in the sample sizes between putatively MSA levels makes statistical comparison problematic, we feel that there are some diachronic trends that warrant brief discussion. Specifically, our instinct here is that there are noteworthy technological and organizational differences between the lithics from Level 16 and the MSA

Figure 14. Scrapers from the MSA levels.

artifacts from higher excavation units. In terms of lithic raw materials, there is an increase in the frequency of dolerite pieces and a decrease in milky quartz between Level 16 and Levels 14–15. While both raw materials should be considered low-quality, the dolerite has the advantage of being available in larger blocks and having fewer internal flaws. Thus, the higher frequency of dolerite in Levels 14–15 may have a relationship with the increased flake size and patterns of platform faceting described above. The dolerite is more amenable to complex core reduction, such as the Levallois technique and blade production from centripetal cores. These features occur in somewhat higher frequencies in Levels 14–15 and there is also a higher frequency of retouched tools. It seems possible that these patterns may

TABLE 6. FREQUENCIES OF PLATFORM FACET TYPES FOR THE MSA AND LSA LEVELS.

Level	One Facet	Two Facets	Three+ Facets	Total
1 and 2	50 (98.04%)	1 (1.96%)	0 -	51
3-6 and features	501 (94.89)	18 (3.41%)	9 (1.70%)	528
7-9	30 (90.91%)	3 (9.09%)	0 -	33
10 and 11	36 (66.67%)	14 (25.92%)	4 (7.41%)	54
12 and 13	51 (75%)	11 (16.18%)	6 (8.82%)	68
14 and 15	41 (71.93%)	13 (22.81%)	3 (5.26%)	57
16	357 (84.80%)	42 (9.98%)	22 (5.23%)	421

TABLE 7. MEAN SIZES OF WHOLE FLAKES FOR THE MSA AND LSA LEVELS.

Level	Avg. Mass (g)	Avg. Length (cm)	Avg. Width (cm)	N
1 and 2	2.02	1.68	1.36	160
3-6 and features	1.27	1.5	1.21	1016
7-9	2.34	1.91	1.43	84
10 and 11	3.09	2.02	1.62	50
12 and 13	9.37	2.92	2.31	50
14 and 15	20.4	4.52	3.26	41
16	7.52	2.74	2.2	320

point to shifts in the organizational dynamics of the accumulation of lithic artifacts at Erb Tanks, and perhaps point to distinctions between early and later phases of the MSA. Larger artifact sample sizes and more refined chronological information are both necessary to critically assess our current speculation.

LSA KNAPPING STRATEGIES AND ASSEMBLAGE CHARACTERISTICS

The LSA levels are dominated by crystal quartz, milky quartz, and chalcedony (see Table 2 and Figure 9). The early LSA levels have amounts of milky quartz intermediate between the MSA and later LSA levels. Some of this may be the result of mixing, but we view the declining amount of milky quartz over time as a real trend. There is also a corresponding increase in the amount of crystal quartz across the LSA levels. In addition, there is a moderate increase in the amount of chalcedony in Levels 3–6 and in the features. The increase in the amount of crystal quartz represents a shift to the exploitation of small pebbles of derived raw material immediately available at the Erb Tanks rockshelter. The relatively high frequency of chalcedony in the later

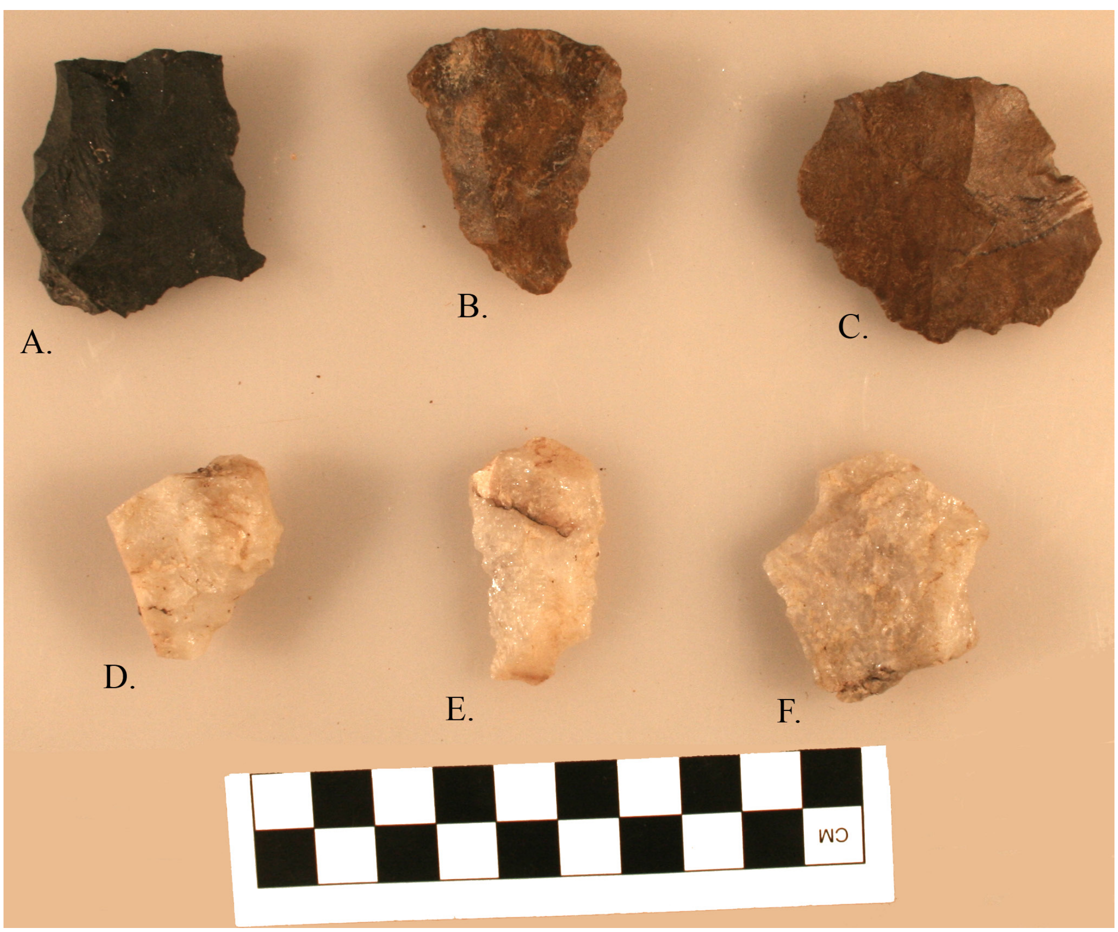

Figure 15. Denticulates from the MSA levels.

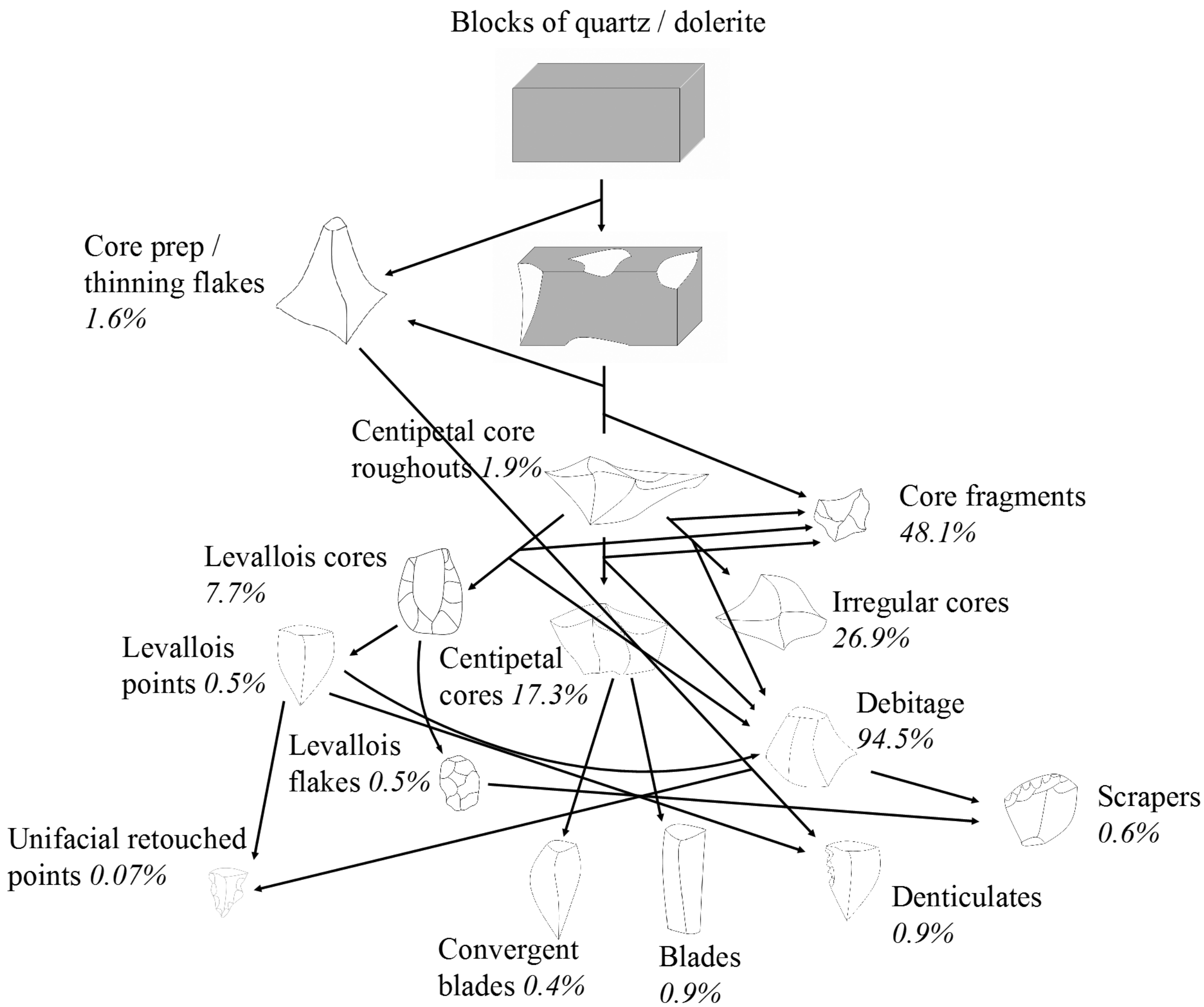

Figure 16. Flow chart of lithic reduction sequences from the MSA levels. Percentage of core categories are taken from the total of cores. Percentage of debitage and retouched tool categories are taken from the total of flakes.

LSA levels is also noteworthy. Taken together, these trends point to subtle but significant changes in raw material collection practices and perhaps mobility patterns across the LSA.

The LSA lithics are typical of the Wilton industry endemic to southern Africa, dating from the Middle Holocene through the period of historic contact (Clark 1959; Deacon and Deacon 1999; Sampson 1974). This industry is characterized by bladelet production and the manufacture of backed bladelets (Figure 19). While cores are quite rare in the LSA levels, there is evidence for lithic production using both direct percussion and the bipolar technique, which also is consistent with Wilton industry assemblages known from elsewhere in southern Africa (Barham 1987). We suspect that the rarity of cores in the LSA assemblage (especially in the later LSA levels) may relate to the use of the

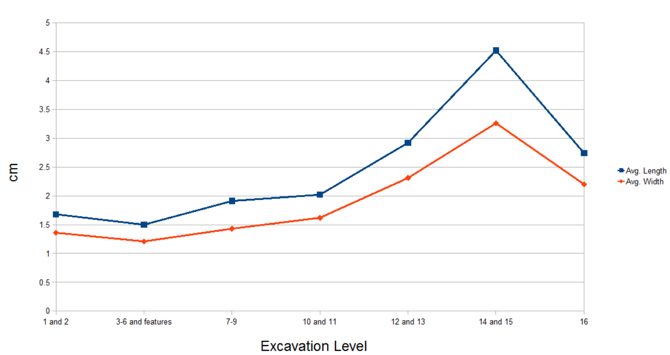

Figure 17. Mean length and widths of whole flakes for the MSA and LSA levels.

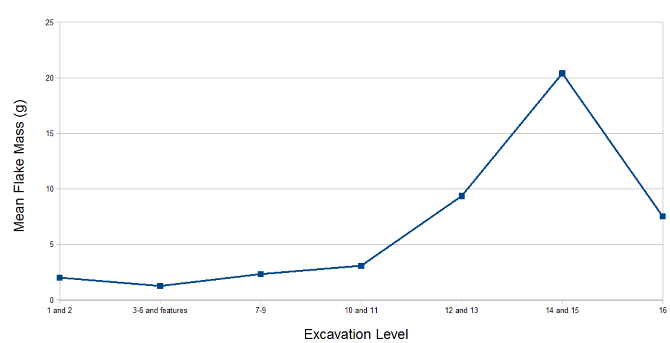

Figure 18. Mean mass of whole flakes in the MSA and LSA levels.

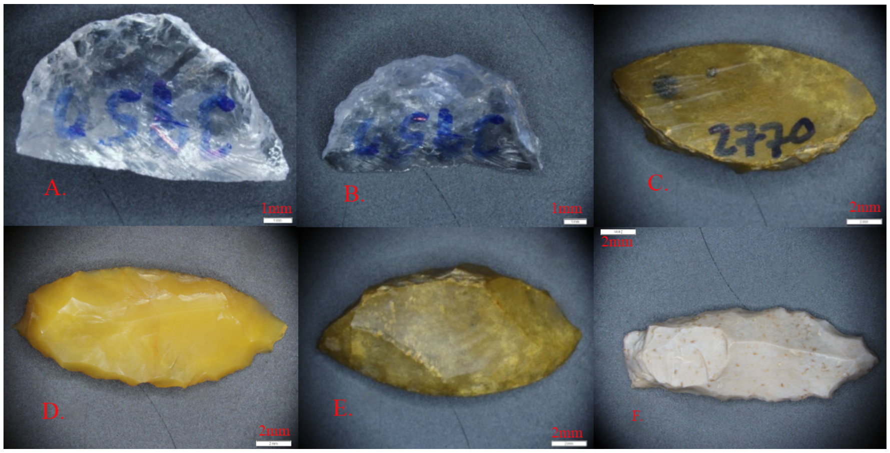

Figure 19. Backed bladelets from the LSA levels.

bipolar technique at the end of the use-lives of small direct percussion platform cores, generally resulting in their destruction.

The LSA levels have low frequencies of backed bladelets and other retouched tool forms (Table 8). Within these levels, there is no significant change in the frequencies of retouched tool types. This finding is interesting, given that the LSA materials span the transition from foraging to pastoralism and there is no apparent technological change that accompanies this major economic transition in terms of either the types of tools present or their relative frequencies (for similar findings elsewhere in Namibia, see the work of Kinahan 1991 in the Brandberg and Smith and Jacobson 1995 at Geduld). There is, however, a shift from a relatively high frequency of multifaceted platforms within the earlier LSA levels (10–13) to almost no multifaceted platforms within the later LSA levels (1–8). Some of the relatively high frequency of multifaceted platforms in Levels 10–13 may have been caused by stratigraphic mixing, but we strongly doubt that mixing is the only cause of this pattern. There is also a small but consistent decrease in flake size from the lower to upper LSA levels. During the LSA, flakes reach their minimum mean size in Levels 3–6 and the features.

While there are no changes during the LSA in the types of retouched tools present or their frequencies, the shifts in raw material use, flake size, and platform faceting may point to organizational changes in strategies of core reduction and raw material management. We suspect that these collectively reflect an increasing focus on local lithic raw material resources (especially crystal quartz) brought about by a pastoralist settlement system tethered to the Erb Tanks well, in addition to a decline in the frequency of foraging trips where embedded raw material procurement may have occurred.

DESCRIPTION OF OSTRICH EGG SHELL AND GLASS BEADS

In our excavations, we encountered a large number of ostrich egg shell (OES) beads, as well as a few glass beads. All of the beads were found in LSA or mixed levels, with the exception of two fragments of broken bead manufacture debris in Level 14. Given the significant movement of OES

TABLE 8. FREQUENCIES OF RETOUCHED TOOL TYPES AND BIPOLAR PIECES FOR THE LSA LEVELS.

Level	Backed bladelets	Scrapers	Other retouched	Bipolar fragments	Total
1 and 2	4 (1.11%)	1 (0.27%)	4 (2.22%)	12 (6.67%)	360
3-6 and features	51 (2.30%)	5 (0.22%)	23 (1.04%)	82 (3.70%)	2219
7-9	1 (0.50%)	2 (1.00%)	2 (1.00%)	4 (1.99%)	201
10 and 11	5 (2.54%)	0 -	1 (0.51%)	13 (6.60%)	197
12 and 13	1 (0.42%)	0 -	3 (1.27%)	12 (5.06%)	237

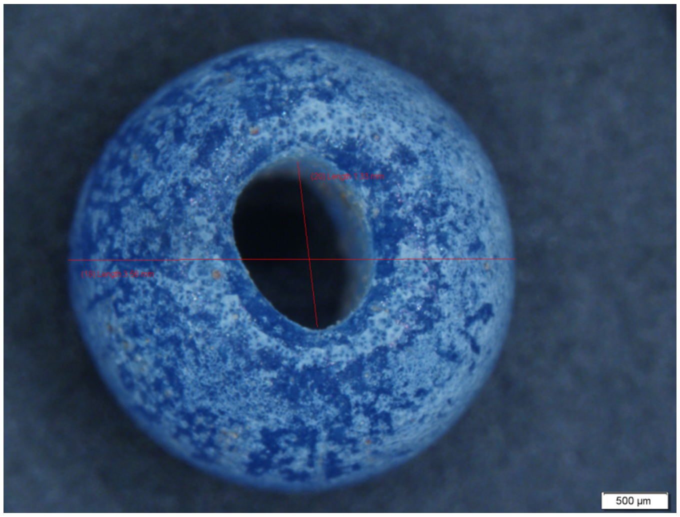

Figure 20. Late pre-contact blue glass bead from Level 3.

fragments through the stratigraphy at Erb Tanks, we doubt that these fragments have MSA origins but we cannot rule out that possibility. The glass beads have late pre-contact origins (Kinahan 2000) and were found in Levels 1–2 in association with metal fragments and knapped bottle glass. Figure 20 shows an example of the glass beads and Figure 21 has a sample of the OES beads.

In our analysis of the OES beads, we used Orton's (2008) manufacture stages, which include the following categories: 1) non-perforated blanks, 2) drilled blanks, 3) perforated blanks, 4) partially rounded, 5) rounded, 6) partially polished, and 7) complete. Figure 22 and Table 9 show the number of beads at each manufacture stage. These data demonstrate that all stages of manufacture are present within the LSA levels, suggesting that bead manufacture was occurring at Erb Tanks.

It is also apparent that Levels 3–6 and the features have both the largest number of beads and the highest frequency standardized to the volume of excavated sediment. It has been suggested that bead manufacture and accumulation was an important element of the introduction of the pastoral economy in the central Namib (and elsewhere), as beads acted as a mechanism with which livestock owners

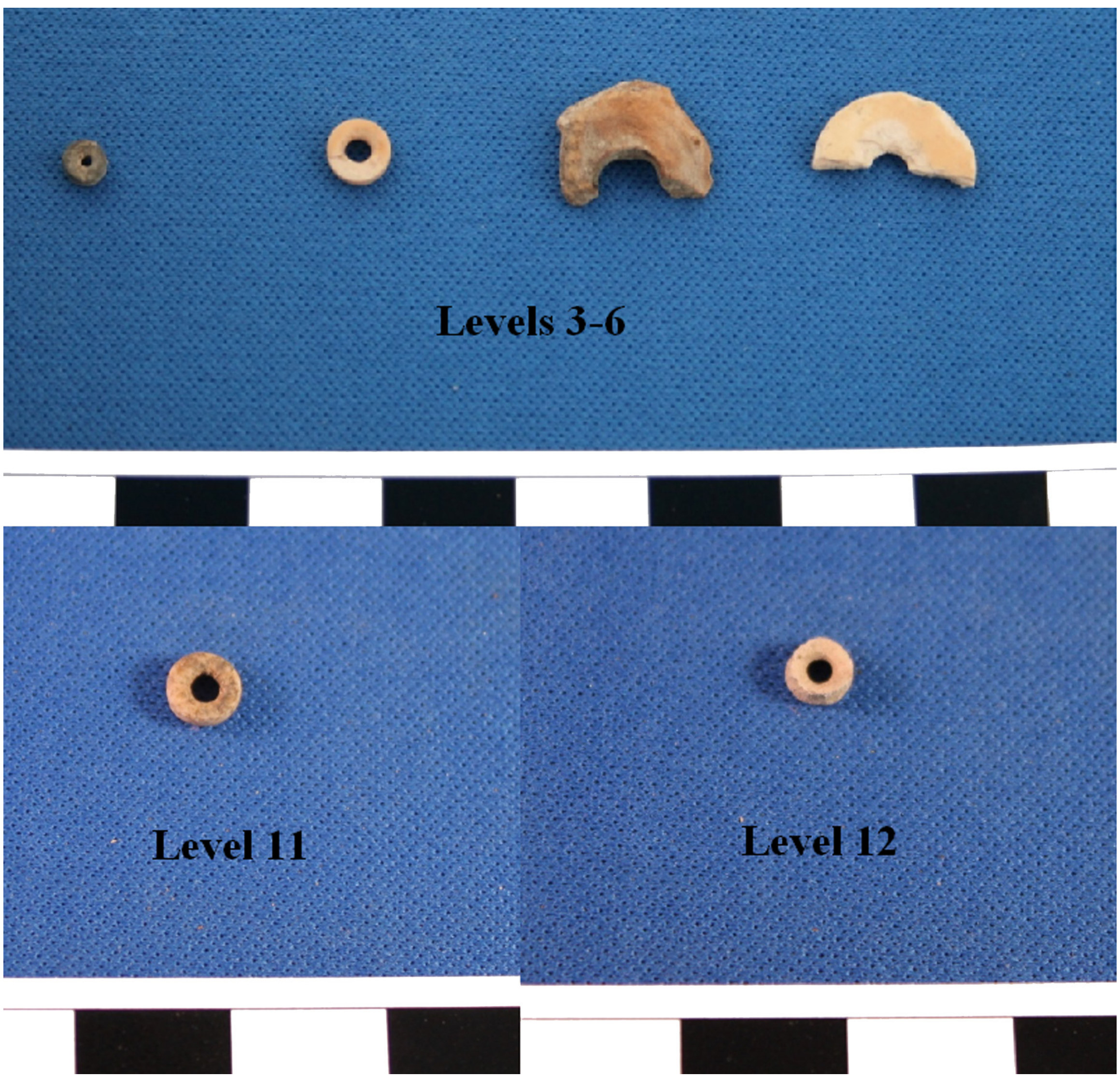

Figure 21. Montage of beads from the LSA and mixed levels. The bead on the upper left is the glass bead pictured in Figure 20.

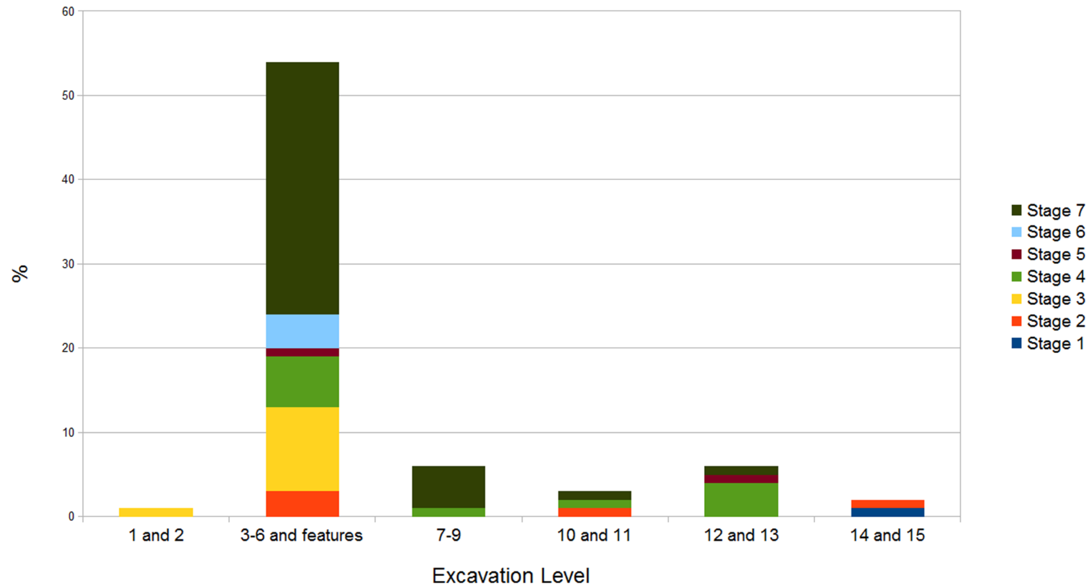

Figure 22. Frequencies of ostrich eggshell beads at various stages of production (after Orton 2008).

could manifest their wealth in terms of existing material culture (Kinahan 2000; Kinahan 1991; Smith and Jacobson 1995). On the one hand, the number of beads associated with the pastoralist levels would seem to support this idea. However, when the number of beads is standardized to the amount of lithic debris rather than sediment volume, this pattern disappears (see Table 9). This perhaps suggests that the number of beads relates mostly to the intensity of occupation and not to the adoption of a pastoralist economy. We also suggest that the decline in the frequency of beads in Levels 1–2 relates to the adoption of glass trade beads during the time range spanning the period of historic contact.

DESCRIPTION OF THE GROUND STONE ARTIFACTS

The Erb Tanks Rockshelter also contained a moderate number of ground stone artifacts. Table 10 reports the number of upper and lower grinding stone fragments and the total mass of ground stone artifacts per level. Based on a preliminary refitting of the ground stone assemblage, we estimate that there were perhaps seven upper grinding stones and one to two lower grinding stone pieces deposited in the LSA levels. Compared with other contemporaneous LSA assemblages in the Namib, this is a fairly large number relative to the small size of the excavation (Kinahan 1991; Sandelowsky 1977; Smith and Jacobson 1995). It has been argued that LSA grinding technology was used for the processing of various grass seeds collected from the nests of harvester ants (*Messor* sp.; Kinahan 1991; Kinahan, personal communication 2009; see also Sullivan 1999 for an ethnographic account). This species of ant accumulates silk grass seeds in larders often reaching sizes of 1–2kg, making an appealing target for foragers. There is also archaeological evidence for the exploitation of these nests and the construction of granary features using granite spalls (including

TABLE 9. FREQUENCIES OF OSTRICH EGGSHELL BEADS AT VARIOUS STAGES OF PRODUCTION (after Orton 2008).

Level	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Total	Beads / m³	Beads / Lithic Piece
1 and 2	0	0	1	0	0	0	0	1	1.39	0.003
3-6 and features	0	3	10	6	1	4	30	54	37.5	0.024
7-9	0	0	0	1	0	0	5	6	5.56	0.030
10 and 11	0	1	0	1	0	0	1	3	4.17	0.015
12 and 13	0	0	0	4	1	0	1	6	8.33	0.025
14 and 15	1	1	0	0	0	0	0	2	1.78	0.017

TABLE 10. FREQUENCIES AND MASSES OF GROUND STONE PIECES.

Level	Lower Grinding Stone Fragments	Upper Grinding Stone Fragments	Complete Upper Grinding Stones	Total Ground Stone Mass (g)	Ground Stone Mass (g) / m³	Ground Stone Mass (g) / Lithic Pieces
1 and 2	0	1	0	104	144.4	0.34
3-6 and features	4	24	2	1540	1069.4	0.68
7-9	0	1	0	31	28.7	0.15
10 and 11	0	2	1	202	280.6	1.38

one at Arandis Dams). The subsistence strategy of robbing harvester ant nests represents an extreme form of subsistence intensification, as it requires a great deal of digging and the processing of seeds through grinding and cooking. In addition, harvester ants have extremely powerful jaws and can deliver a nasty bite.

The vast majority of ground stone material belongs to Levels 3–6 and the features. It is possible that this indicates an increase in grinding activity correlated with the adoption of pastoralism, which would make sense in terms of the longer occupation of residential sites and the exploitation of lower-ranked food resources. When the amount of ground stone is standardized to the number of lithic pieces, however, the evidence for an increase in grinding seems slighter. Again, the fluctuations in the amount of ground stone in the assemblage seem to scale more to the intensity of occupation rather than any major shift in subsistence practices. In addition, the practice of seed grinding (and perhaps harvester ant nest exploitation) clearly dates to relatively early periods of the LSA.

Our refitting analysis also suggests a great deal of reuse of grinding stones. Rather than being transported, these items were more likely elements of site furniture that were consistently reused over long periods of time. Given the functional and organizational properties of ground stone artifacts and their discard patterns, it is difficult to argue for substantial changes in grinding activity over time during the LSA.

Figure 23. Late prehistoric ceramic vessel refitted from surface finds.

DESCRIPTION OF CERAMICS

We found very few ceramic fragments in our excavation unit. This was somewhat surprising, as ceramic technology formed an important element of food processing technology in the central Namib after around 2 ka, and ceramic debris is fairly common at other central Namib sites (Kinahan 1991, 2000; Sandelowsky 1977; Smith and Jacobson 1995). The discoverer of the site, however, did find a number of large ceramic fragments on the surface and was able to refit these into a nearly complete pointed-base cooking pot typical of Khoe pastoralists along the Atlantic coast (Figure 23). While this surface find lacks any useful archaeological context, we suspect that it is relatively recent. In addition, the stone structures on the northwestern side of the *koppie* have a larger number of ceramic fragments, although we did not collect these.

We suspect that the dearth of ceramics at Erb Tanks in part relates to its location on the landscape. While central Namib ceramics are generally low-fired and expediently manufactured, they still require clay availability for manufacture and represent a significant cost in terms of transport. The nearest clay source is likely in the sediments of the Khan River and it seems that few ceramic vessels were transported from the location of their manufacture to Erb Tanks.

DISCUSSION

The results of our excavations at Erb Tanks have implications both for our knowledge of the regional prehistory of the central Namib and for our understanding of broader archaeological phenomena across southern Africa. Erb Tanks is one of only a handful of known sites in Namibia with

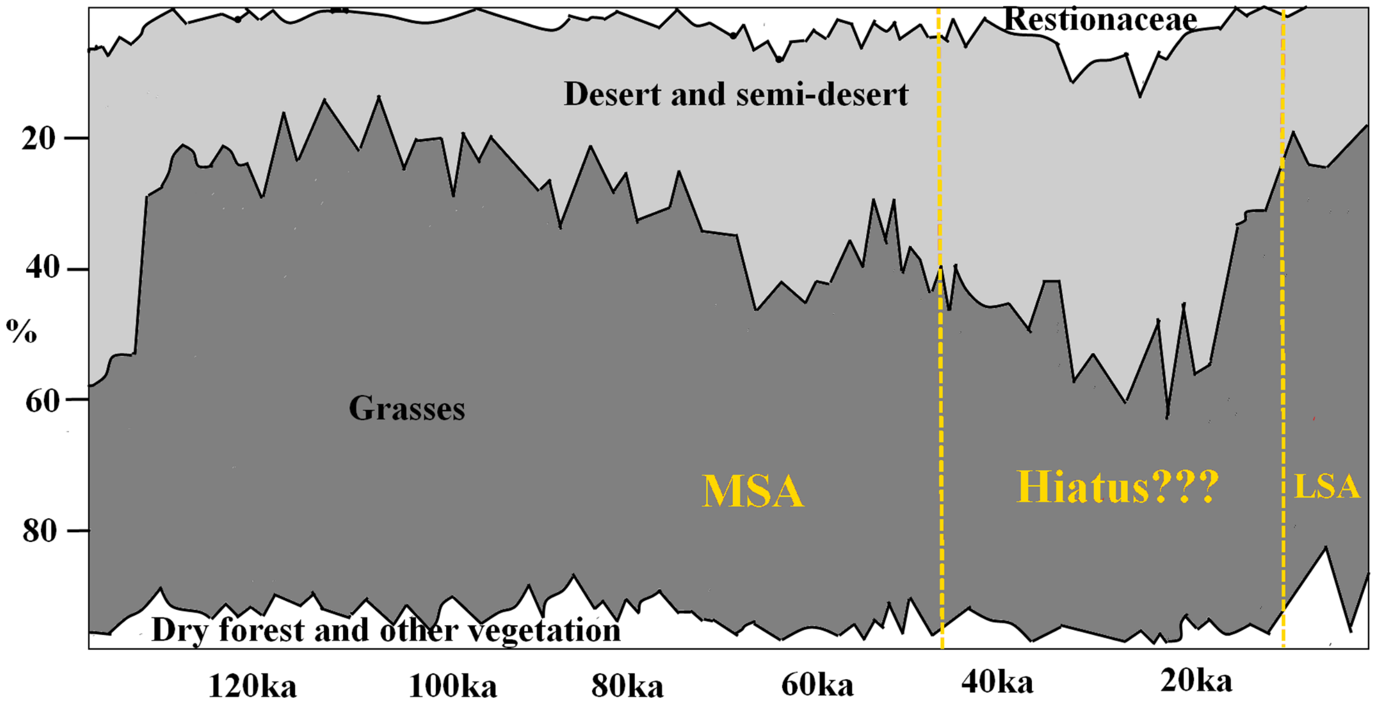

Figure 24. Frequencies of pollen types for the Upper Pleistocene through the Holocene taken from the GeoB1711 marine sediment site off of western Namib Desert (after Shi et al. 2001).

buried MSA archaeological remains. Its location is consistent with previously documented patterns of MSA occupation in Namibia. In his comprehensive review, Vogelsang (1998) points out both the scarcity of MSA sites on Namibia's interior plateau and the more frequent occupation of the Namib fringe of this plateau. In addition, Kinahan and Kinahan (2010) report a high frequency of MSA surface assemblages on the central Namib gravel plains west of the confluence of the Khan and Swakop rivers. Thus, MSA assemblages occur in large numbers in the central Namib and represent an important piece of that region's prehistory.

To our knowledge, Erb Tanks is the first MSA assemblage on the central Namib gravel plains to be successfully chronometrically dated. While the absolute accuracy of our AAR dates is debatable, they demonstrate that MSA occupations of the central Namib were not particularly sporadic nor were they linked with any short-lived period of improved environmental productivity.

Shi et al. (2001) provides the most pertinent regional paleoenvironmental data for the Namib on the basis of pollen present in marine sediment cores taken off the Namib coast. Figure 24 reports the results of this analysis, showing a period of increased grass pollen beginning after 130 ka and gradually declining toward the Last Glacial Maximum (LGM; see also Yamagata and Mizuno's 2005 for evidence of LGM aridity in the Namib). This period of increased grass pollen corresponds fairly well with the Upper Pleistocene MSA occupation of Erb Tanks. It also demonstrates that environmental conditions were moderate relative to peak periods of aridity and were likely similar to the environments of the Central Namib during the Holocene. At White Paintings Shelter, there is a similar relationship between the intensity of MSA occupations and regional environmental change. Robbins et al. (2000) note evidence for the correspondence of peaks in MSA artifact frequencies with periods of wetter conditions in the western Kalahari prior to 70 ka. They also note declines in MSA artifacts associated with the increasingly frequent and intense dry periods at the close of the Upper Pleistocene.

The Erb Tanks sequence would seem to have the most in common with that of Apollo 11 (Vogelsang 1998, 2008; Wendt 1972). The MSA materials and sequences at both sites are broadly similar, with the major difference being the absence of any diagnostic Still Bay or Howiesons Poort material at Erb Tanks. These similarities between Erb Tanks and Apollo 11 tend to suggest an affinity with the sequences documented at South African MSA sites (Vogelsang 1998, 2008). Thus, the early MSA levels at Erb Tanks are comparable with the MSA I–II periods in the South African sequence and we feel that the later MSA levels are consistent the MSA III–IV periods (Singer and Wymer 1982; Thackeray 1989, 1992; Volman 1984).

Elsewhere in Namibia, the expedient core reduction strategies and low frequencies of retouched tools in the lower MSA levels at Erb Tanks are quite similar to the patterns documented at Tsoana, an early MSA site in Kaudom National Park (McCall 2009). In addition, the Erb Tanks sequence has much in common with that documented at White Paintings Shelter (Murphy 1999; Robbins et al. 2000). This is especially true in terms of the high frequencies of exotic lithic raw materials and the presence of elongated debitage in the later MSA levels. Erb Tanks, however, lacks backed blades and several other tool types found in the terminal MSA levels at White Paintings Shelter.

Finally, the lithics from ≠Gi are likely pene-contemporaneous with the MSA levels at Erb Tanks, though the two sites are quite different in terms of their assemblage composition (Brooks and Yellen 1977, 1987; Brooks et al. 1980; Kuman 1989). ≠Gi has high frequencies of unifacial and bifacial retouched points and other retouched tools, and it has been aligned with the Bambatan industry endemic to sites such as Redcliffe Cave in Zimbabwe (Brooks and Yellen 1977; Brooks et al. 1980; Brooks et al. 1990; Brooks et al. 2006; Kuman 1989). The absence of such diagnostic tool types at Erb Tanks perhaps suggests a closer culture-historical relationship with known MSA sites in South Africa. On the other hand, it is also possible that these differences in assemblage composition stem from divergent organizational dynamics and site functions.

By itself, the presence of substantial human populations in the central Namib during these periods of the Upper Pleistocene has implications for regional populational dynamics. Today, the central Namib is a hyper-arid environment, which severely limits its productivity in terms of food production and occupation by human groups. The fact that this region was occupied for so long by MSA humans is remarkable. Furthermore, available paleoenvironmental data (e.g., Shi et al. 2001) suggest that large portions of this time range were actually more arid than at present. Thus, we can firmly characterize the central Namib gravel plains as a "fringe" environment and its occupation by MSA humans would seem to point to relatively large populations at the continental scale. The population pressure that induced humans to move into the central Namib may be an aspect of the phenomena leading up to the appearance of certain aspects of behavioral modernity during the Still Bay and Howiesons Poort periods and the movement of modern humans out of Africa.

The LSA remains from Erb Tanks are consistent with the patterns recognized at other contemporaneous sites in the central Namib. Our excavations support a Middle Holocene reoccupation of the Namib by LSA foragers, followed by the adoption of pastoralism. Excavations in the Hungorob Ravine of the Brandberg (Kinahan 1991), at Geduld (northeast of the Brandberg; Smith and Jacobson 1995), and at the Mirabib rockshelter (Sandelowsky 1977) have dated the origins of pastoralism in the central Namib to around 2 ka. Our excavations offer no reason to doubt this date for the earliest pastoralist activity in the area and they perhaps suggest that the early pastoralist period saw the most intensive occupation of the Central Namib.

This Middle Holocene reoccupation of the central Namib corresponds with the improvement of regional climatic conditions from their LGM low-point (see Figure 24). Subsequent Holocene environments continued to be extremely arid and fluctuated at short time scales (see also Wilkinson 1990; Yamagata and Mizuno 2005). Thus, the central Namib's LSA occupants adapted to these conditions through both the adoption of increasingly specialized patterns of foraging intensification (e.g., the exploitation of harvester ant nests) and eventually a pastoralist economic system capable of dealing with such harsh conditions.

CONCLUSION

This paper has reported on the 2009 archaeological fieldwork at the Erb Tanks Rockshelter. These investigations established the long-term presence of human populations in the central Namib Desert, with MSA occupations ranging conservatively between 130–45 ka and LSA occupations after 8 ka. The MSA lithic assemblage is comprised of two phases. The earlier component is based on relatively expedient core reduction strategies, low frequencies of formal end-products, and a high frequency of local vein quartz. The later component is characterized by more elaborate core reduction strategies, high frequencies of formal end-products, and a more prevalent exploitation of dolerite from slightly more distant sources. The LSA lithic assemblage is characterized by subtle organizational changes from the Middle Holocene onward. The later LSA levels also include ground stone technology, ceramics, and ostrich eggshell beads typical of the Wilton industry elsewhere in southern Africa after 2 ka.

The setting of the Erb Tanks Rockshelter on the hyper-arid central Namib gravel plains constitutes a major aspect of its archaeological importance. The substantial presence of MSA humans in the central Namib spanning a large segment of the Upper Pleistocene bespeaks the adaptability of early modern human populations and also likely points to increasing population densities in the more productive environment regions of sub-Saharan Africa. The appearance of MSA humans in the central Namib may also implicate the demographic expansions responsible for the dispersal of modern humans into the rest of the Old World. In addition, the LSA archaeological record in the Namib points to various aspects of subsistence intensification and post-Pleistocene adaptation typical of the Wilton Industry elsewhere in southern Africa, including the early adoption of pastoralism.

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ENDNOTES

[1]Average temperature is the primary variable conditioning amino acid racemization. The average annual temperature for the weather station nearest to Erb Tanks, at the Arandis airport, is 19.0° C, compared to the value of 21.6° C reported for Apollo 11 by Miller et al. (1999). If anything, this would imply that our AAR dates are slightly young. Additionally, difference in sediment pH, humidity, and other environmental conditions may complicate these dates. In the future, we plan on calibrating our own AAR regression curve based on AMS dates of OES pieces.

[2] Though, it is interesting to note the substantial presence of LSA-like microlithic stone tools in the later MSA levels at White Paintings Shelter (Murphy 1999; Robbins et al. 2000). These suggest the possibility that the microliths in Levels 12–13 may not be intrusive.

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