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LARGE GEOMETRIC PATTERNS FROM THE MIDDLE STONE AGE IN AEOLIANITES ON THE CAPE SOUTH COAST, SOUTH AFRICA

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Abstract. The making of abstract images is one means through which cognitive modernity can be inferred. Archaeological research has demonstrated that palaeoart was created during the Middle Stone Age on South Africa's Cape south coast. We have identified two large geometric features on loose Pleistocene aeolianite slabs on this coastline. Field relations suggest that the surfaces date from Marine Isotope Stage 5. Our interpretation is that early modern humans may have drawn these features on dune surfaces of unconsolidated sand. The potential for images drawn in sand to be preserved creates an opportunity for the appreciation of palaeoart.

Introduction

One of the means through which cognitive modernity can be inferred is the making of abstract images, and artistic expression can be regarded as a proxy for complex cognition (Brown et al. 2012) or symbolic thought (Anderson 2012). While such images are well documented in the Upper Palaeolithic of Eurasia, reports over the past couple of decades have established the Cape south coast of South Africa as an area in which examples of engravings in ochre (Henshilwood et al. 2002, 2009, 2011; Watts 2010) and an abstract drawing on a silcrete flake (Henshilwood et al. 2018) were created during the Middle Stone Age (MSA), before the appearance of such images in the Northern Hemisphere. Such discoveries have contributed to the corpus of evidence that suggests the emergence of modern human behaviour in Africa, and the importance of southern Africa in this regard (Brown et al. 2009, 2012; d'Errico et al. 2005; Henshilwood et al. 2001; Marean 2010; Marean et al. 2007; McBrearty and Brooks 2000).

Examples of palaeoart become less common with increasing time intervals between their creation and the present. While this could reflect a real phenomenon, it may be related to taphonomic effects, whereby certain art forms deteriorate faster than others, or to the challenges inherent in identifying more ancient examples (Bednarik 1994). There is thus a real possibility that palaeoart was far more common than is suggested in the archaeological record of the MSA. The identification of another medium that might record the expression of our hominin ancestors would therefore be significant. We have identified unconsolidated sand, now preserved as rock surfaces, as potentially being such a medium (Helm et al. 2019a, 2020a). We report here on two aeolianite surfaces on the Cape south coast that exhibit large geometric patterns from the MSA and anticipate that they may contribute to the understanding of palaeoart and the complex cognition of early modern humans.

We have identified more than 250 Pleistocene vertebrate tracksites since 2007 on the Cape south coast of South Africa, along a 350 km stretch of coastline (Fig. 1) between the town of Arniston and the Robberg peninsula (Helm et al. 2020b). Most of the tracksites occur in cemented aeolianites and cemented foreshore deposits. The number and variety of these sites demonstrate the capacity for evidence of events that transpired on these Pleistocene dune and beach surfaces to be preserved in the trace fossil record, sometimes in exquisite detail.

A hominin presence on these Pleistocene palaeosurfaces was demonstrated through documentation of 40 tracks (estimated at 90 ka) made by humans moving down a dune-face (Helm et al. 2018a). Subsequently, we recognised patterns that suggested a 'hominin signature'. We reported on this (Helm et al. 2019a, 2020a) and coined the term 'ammoglyph' to describe a pattern made by humans in sand, which is now evident in rock ('ammos' being Greek for 'sand'), thus complementing terms such as pictogram, petroglyph, dendroglyph and geoglyph. Examples included a circle with a central depression, possible evidence of foraging, sub-parallel grooves, fan-shaped and chevron patterns, and

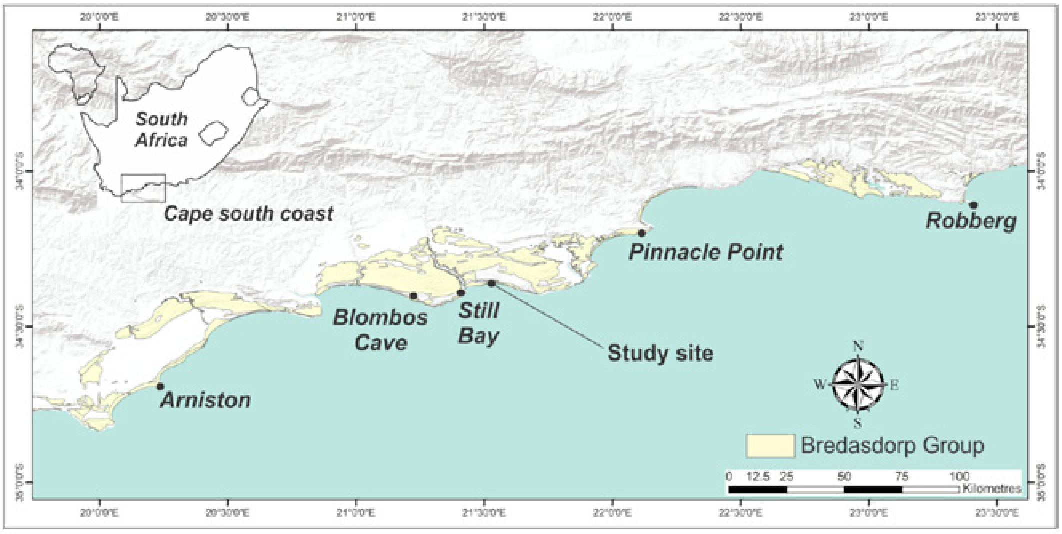

Figure 1. *Map of South Africa and the Cape south coast, showing the study site and places mentioned, and the extent of outcrops of the Bredasdorp Group.*

multiple levels of symmetry in what may have been a three-dimensional representational sand-sculpture. In making these assertions, we provided a detailed analysis of other potential agents, both biogenic and non-biogenic, that might conceivably have caused similar patterns (Helm et al. 2019a).

Our rationale in interpreting these sites was as follows:

- we knew, through our ichnological studies, that these rock surfaces could record events that occurred when they were unconsolidated dunes and beaches;
- we knew that humans trod these palaeo-surfaces (Helm et al. 2018a, 2019b);
- we knew that southern Africa has an extensive record of palaeoart (Bednarik 2013);
- we knew that humans were creating engravings or drawings in Cape south coast caves on portable objects during the MSA at sites like Blombos Cave (Henshilwood et al. 2002, 2009, 2011, 2018) and Pinnacle Point (Watts 2010); Henshilwood et al. (2002) documented an engraving in ochre from Blombos Cave to ~77 ka, and Henshilwood et al. (2018) documented a drawing from Blombos Cave to ~73 ka.
- We knew that the age of the palaeosurfaces that we were examining approximately correlated with the time period in which this palaeoart was created.

While acknowledging that the motivations behind the creation of patterns in sand and engravings on portable items in caves might not be the same, we considered that it might have been easier in the MSA to use a finger or stick to create images in sand, rather than to create art-like markings on stone (which might involve transportation of ochre manuports, and expenditure of time and effort to inscribe images). We thought it plausible that humans did not just leave their footprints on these dunes, but left other evidence of their presence, such as symbols, patterns, sculptures or foraging signs. We reflected on the delight that humans take in creating patterns and sculptures on sand surfaces today. We appreciated that if we could substantiate this evidence, it might contribute to a previously undocumented form of MSA human expression.

Further hominin tracksites have been identified, along with corroborating evidence at one of the ammoglyph sites (Helm et al. 2020c). Also, what we interpret as another probable ammoglyph site comprising two adjacent surfaces, containing linear grooves in large geometric patterns, was identified on a remote coastal stretch east of Still Bay in 2019. The purpose of this article is to describe the findings from this site, consider other possible causes for these geometric patterns, provide our interpretations and discuss implications.

Geological context

Aeolianites, cemented dune deposits, are best distributed globally in mid-latitude regions between 20° and 40° (Fairbridge and Johnson 1978; Brooke 2001). They occur commonly on the Cape south coast, forming the Waenhuiskrans Formation, part of the Bredasdorp Group (Malan 1989). Cemented foreshore deposits form part of the Kleinbrak Formation, also part of the Bredasdorp Group (Malan 1991).

In this region, their age is best determined through optically stimulated luminescence (OSL). While dates of outcrops on this coastline corresponding to Marine Isotope Stage (MIS) 11 (Roberts et al. 2012), MIS 6 (Bateman et al. 2011), and MIS 3 (Carr et al. 2019), have been documented, the majority of dated aeolianites are from MIS 5 (Bateman et al. 2011; Carr et al. 2010, Cawthra et al. 2018; Roberts et al. 2008). The plentiful occurrence of tracksites has been explained (Roberts and Cole 2003): moist sand provided a cohesive moulding agent; high sedimentation rates promoted swift track burial; rapid lithification followed via partial solution and re-precipitation of bioclasts, and shoreline erosion re-exposes the fossil-bearing surfaces.

East of Still Bay, Roberts et al. (2008) conducted a

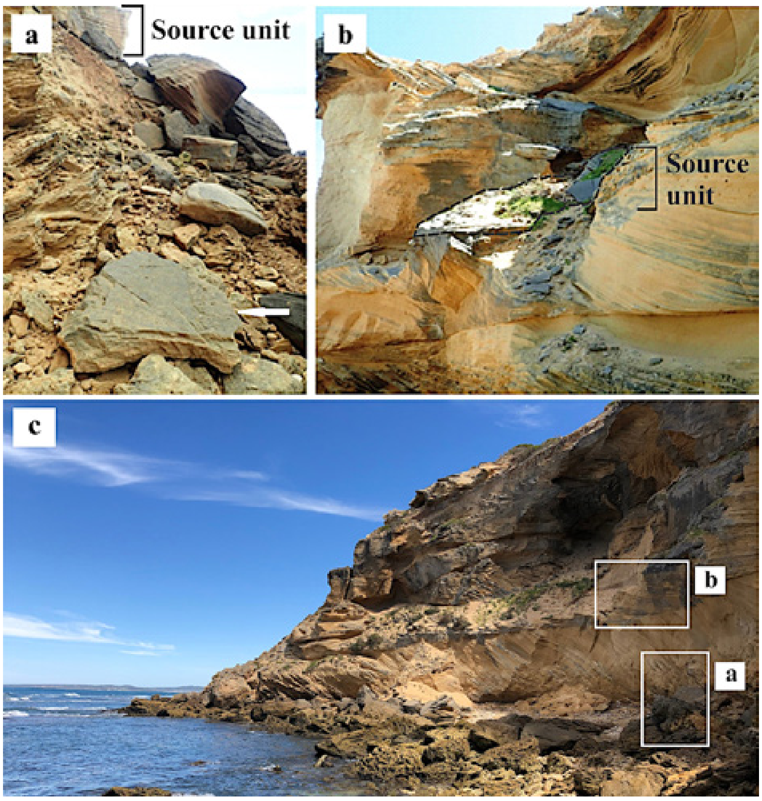

Figure 2. *(a) Loose slab containing Surface 1 (indicated by white arrow), at the foot of coastal cliffs; (b) view of the cliffs, gully and erosion bowl, facing northwest; (c) view of the coastal cliffs, looking west, and indicating the areas featured in (a) and (b).*

detailed sedimentological and ichnological study of the Pleistocene dune cordon, of which the internal architectural elements are exposed along the shore by recent wave erosion. Planar cross-bedded units ranging in thickness from 0.4 to 18 m are the dominant primary sedimentary structure in the succession. The large-scale units (more than 2 m in thickness) are laterally persistent for tens of metres, with foreset dips of up to 37°. The large-scale, steeply dipping planar cross-bedded facies display all three of the main aeolian sedimentation processes (grainfall, ripple migration and grainflow) proposed by Hunter (1977). Sedimentary facies are dominated by large-scale planar cross-stratification formed by foreset progradation of large-scale dunes (Roberts et al. 2008). Convex-up foresets are considered to have formed in the nose and trailing arms of parabolic dunes; the foreset orientation showed a dominance of westerly winds, and it appears that Late Pleistocene palaeowind patterns and their influence on dune genesis and morphology were similar to those of the present (Roberts et al. 2008). Vertebrate trace fossils are relatively abundant in low-angle to horizontal lamination facies, which are interpreted to reflect interdune sedimentation (after Hunter 1977). We have identified 80 vertebrate tracksites along this 6 km stretch of coast (Helm et al. 2020b).

The OSL and amino acid racemisation (AAR) dating at Still Bay (Roberts et al. 2008) demonstrates ages ranging from MIS 6 (140 ka ± 8.3 ka) to MIS 5b, and termination of Late Pleistocene aeolian sedimentation at ~90 ka. The Pleistocene aeolianite is separated from the overlying unconsolidated Holocene dunes (dated to ~8 ka) by a significant hiatus recorded by a zone of intense pedogenesis (rubification and secondary calcification). Because of the present interglacial highstand (MIS 1), MIS 5 aeolianites are being actively and rapidly eroded by storm wave activity, and fresh blocks of material are frequently dislodged. We have used stratigraphic correlation to this dated sequence in analysing a nearby tracksite (Helm et al. 2018b). The area dated by Roberts lies less than 2 km from the site with geometric patterns that we describe here.

Once exposed, tracksites are typically ephemeral: they may slump into the sea, fragment, become reburied in landslides, or deteriorate in quality through wind and water erosion. For example, the main elephant tracksite in this section of cliffs, dated by Roberts et al. (2008), split in two and slumped into the ocean (Helm et al. 2019c). Further east a surface containing crocodylian tracks and MSA lithics was buried soon after it was identified, before the research describing it was published and before it could be examined by other researchers (Helm et al. 2020d), and a site containing globally unique flamingo tracks and feeding traces was destroyed in a storm surge event (Helm et al. 2020e).

Methods

Global Positioning System readings were taken, using a handheld device. Measurements included the dimensions of the slabs and the length, width and depth of the groove features (in centimetres), and angles of intersection of the groove features in degrees. A tracing was made, using a transparent acetate film. Photographs were taken under a range of lighting conditions.

Photographs were taken for photogrammetry (Matthews et al. 2016). 3D models were generated with Agisoft MetaShape Professional (v. 1.0.4) using an Olympus TG-5 camera (focal length 4.5 mm; resolution 4000 × 3000; pixel size 1.56 × 1.56 um). The final images were rendered using CloudCompare software (v.2.10-beta). The surrounding stratigraphy was examined to determine the site of origin of the slabs bearing the geometric features.

A sample for OSL dating was taken from the larger slab (Surface 1, as described below), and has been sent to the University of Leicester for analysis. Locality data were reposited with the African Centre for Palaeoscience at Nelson Mandela University, to be made available to *bona fide* researchers upon request.

Results

Geometric features were noted on the upper surfaces of two loose slabs, two metres apart. The eastern surface was larger; we refer to it as Surface 1, and to the smaller western surface as Surface 2. The slabs lay above the high tide mark at the foot of cliffs that rise 30 m above sea level (Fig. 2a). They were rarely exposed to direct sunlight, and never to low-angled sunlight, which would have provided optimal viewing. During our first two visits, only Surface 1 was evident. On our third visit, following exceptionally high tides, Surface 2 was also apparent. Above the slabs was a vertical cliff, and above this cliff was a sizeable concave erosion bowl, or recess in the cliffs (Fig. 2b). The potentially unstable cliffs are subject to erosion by storm surges and spring high tides. Based on the thickness and primary sedimentary characteristics of bedding planes, we ascertained the possible source and original position of the slabs, being a competent layer within the concave erosion bowl (Fig. 2).

The maximum length of Surface 1 was 131 cm, maximum width 110 cm, and a maximum thickness of 16 cm. Parallel bedding was evident. The layer containing the geometric feature was 2–3 cm thick. Low-relief surface ripple marks were present.

Three straight lines in the form of grooves appeared to form a triangle (Figs 3 and 4), although the grooves were truncated by the edges of the slab near their points of probable intersection. Hence, the points of probable intersection of these lines were not visible. Displacement rims were not evident. Acknowledging that this was an *ex-situ* fallen slab, we describe the block as it was discovered.

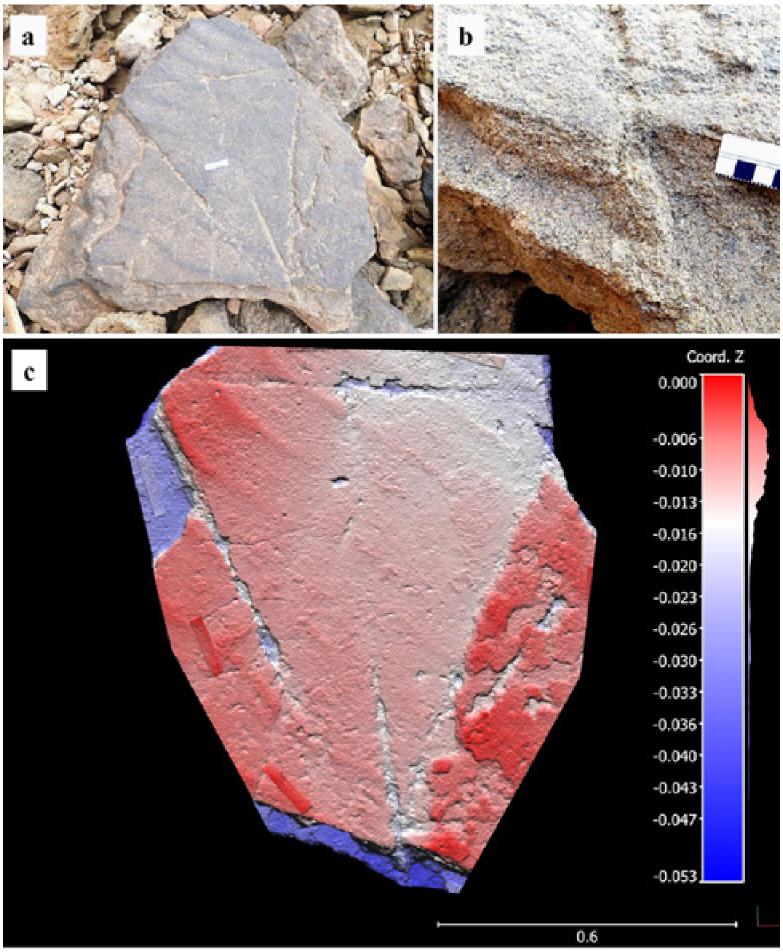

Figure 3. *Surface 1. (a) Facing east; scale bar = 10 cm; (b) the raised feature that forms an extension of the bisector groove is indicated by a white arrow; scale bar is in cm and mm; (c) photogrammetry grey-scale mesh of Surface 1, using 187 images. Photos were taken average 0.68 m from the surface. The re-projection error is 0.386 pix. Vertical and horizontal scales are in metres.*

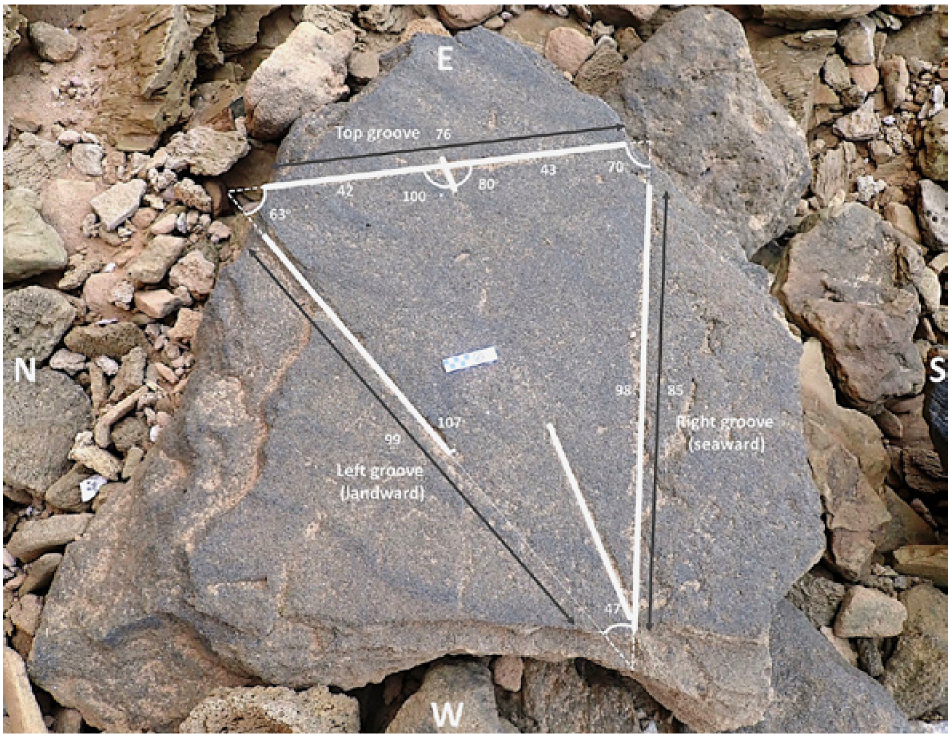

Figure 4. *Surface 1, viewed from the west. Bold white lines indicate deep grooves. Dark grey lines indicate the lengths of the grooves that are evident on the surface. Dotted lines indicate extensions of the lines of the grooves to where they would meet. Lengths are in cm, and angles are in degrees. Scale bar = 10 cm.*

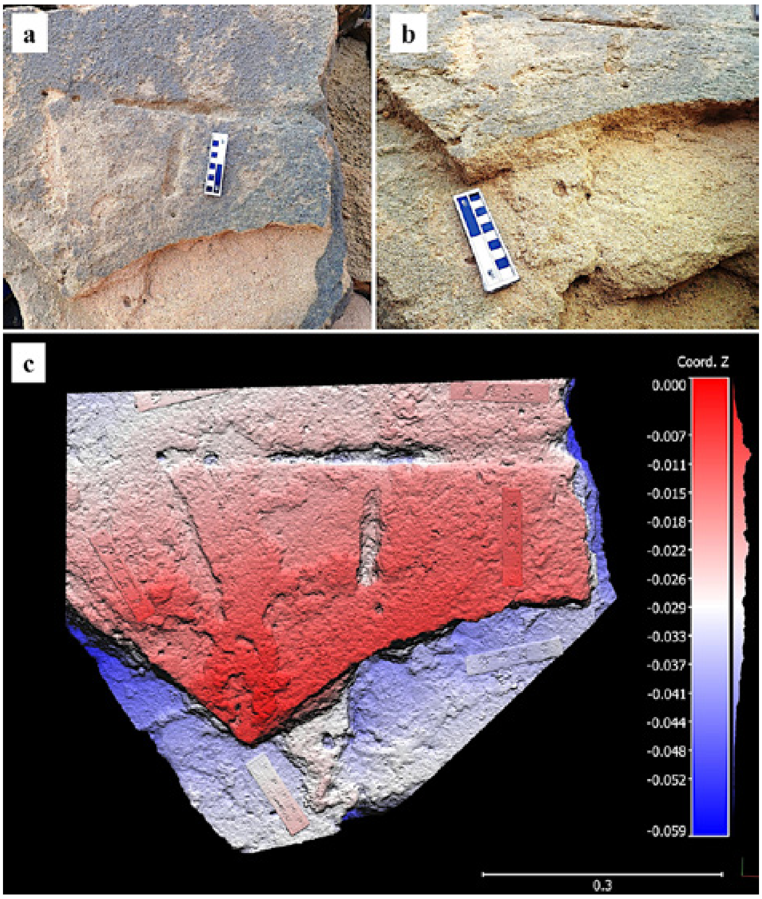

Figure 5. *Surface 2. (a) The view facing south; scale bar = 10 cm; (b) detail view of the raised wedge feature; scale bar = 10 cm; (c) photogrammetry colour mesh of Surface 2, using 72 images. Photos were taken average 0.54 m from the surface. The re-projection error is 0.456 pix. Vertical and horizontal scales are in metres.*

We describe this triangular feature from the west; hence we refer to the three grooves as the 'left groove' (landward), the 'right groove' (seaward) and the 'top groove' (at the east end); we refer to the angle at the western end as the 'bottom angle'. We use the terms 'proximal' for the westward portion of the surface, and 'distal' for the eastern portion.

A surface length of 99 cm was measured for the left groove, 85 cm for the right groove, and 76 cm for the top groove. When we projected the groove axes beyond the ends of the surface to where they would form angles of a triangle, the lengths of the triangle sides would be ~107 cm (incorporating the left groove), ~98 cm (incorporating the right groove), and 85 cm (incorporating the top groove). The three angles of the triangle would be 63° (top left), 70° (top right), and 47° (bottom).

A groove that almost bisected the bottom angle ran from close to this angle towards the midpoint of the top groove. Its proximal portion, 45 cm in length, was up to 2 cm wide and 0.5 cm deep. Distally this groove disappeared abruptly, then reappeared faintly near where it met the top groove and extended marginally beyond the top groove. This groove was truncated by the edge of the surface near the bottom angle.

Whereas it cut the top groove into almost equal halves (42 cm on the left, 43 cm on the right), it did not perfectly bisect the bottom angle. The angles where the bisecting groove met the top groove were 100° on the left and 80° on the right. Although the most proximal portion of the bisecting groove was truncated, the underlying bedding plane was preserved in this area, and the axis of the groove could be followed as a raised feature for a further 7 cm. We estimated its length from near the bottom angle to its intersection with the top groove as ~103 cm. A fourth groove was aligned to the right of the right groove, extending intermittently for 32 cm.

The left groove was more deeply inscribed distally. The portion of the surface to the right of the right groove was up to 1 cm higher than the remainder of the surface. Portions of the right groove were narrower, having been almost occluded by this higher surface. Photogrammetry was performed on Surface 1.

Surface 2 (Figs 5 and 6) exhibited maximum dimensions of 80 cm × 50 cm; slab thickness was 16 cm. The layer on which the geometric feature occurred was 2–3 cm thick. Sedimentary structures seen in section appeared similar to those on the slab containing Surface 1. Three straight grooves were evident, without evidence of displacement rims. Maximum groove width was 2 cm; maximum depth ~1.5 cm.

We chose to view Surface 2 facing south, towards the ocean. From this perspective, the top (seaward) groove was 50 cm long, deep in places, and occluded in places. It was truncated at its right (western) end by the edge of the rock. A second groove extended landward (northwards), almost perpendicular to the top groove, from near a point 26 cm from its eastern end. The angles of intersection were 86° on the left and 94° on the right. The deep portion of this perpendicular groove was 11 cm long. While it appeared to terminate at the proximal (northern) end of this deep section, its axis formed the right margin of a raised wedge feature on the bedding plane 3 cm below, where this was exposed at the landward end. The third groove (left, eastern) was shallower, and extended landwards from the left end of the top groove, making an angle of 70° with it. The edge of the surface truncated this groove at its landward end; hence the third angle of the triangle made by the three grooves was not visible on the surface. However, the axis of the left groove was also evident as the left margin of the raised wedge feature 3 cm below. The margins of this feature were thus formed in the axes of the perpendicular groove and the left groove, meeting at an angle of 24° to form the third angle of the triangle. Photogrammetry was performed on this surface.

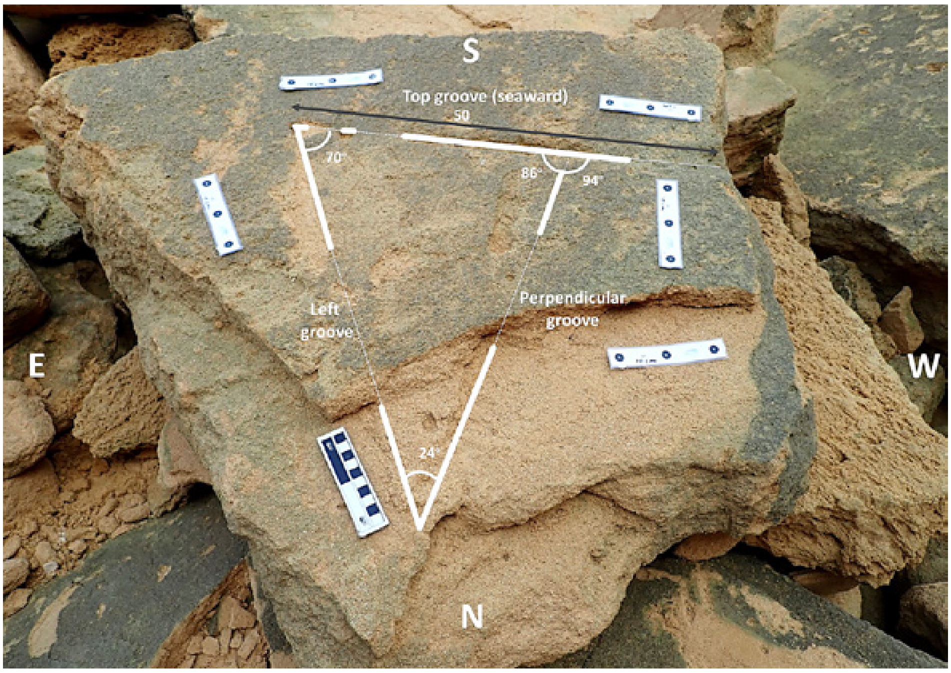

Figure 6. Surface 2, viewed facing south. Bold white lines indicate deep grooves or the edges of the underlying raised wedge feature. The dark-grey line indicates the length measurement of the top groove that is evident on the surface. Lengths are in cm, and angles are in degrees. Scale bars = 10 cm.

Our stratigraphic analysis suggested that the slabs originated from the strata exposed within the large bowl-like erosion feature in the cliffs above. We suggest that, as part of a rockfall event, they slid down the gully in the floor of this bowl, and toppled off the edge to land near their present positions. Either they survived the fall intact, or they were part of larger blocks that cleaved to expose the currently visible surfaces. Loose slabs of similar size and colouration were evident in the gully near its bottom end. If they tumble down to the cliff bottom, further geometric features may become apparent.

Discussion

Surface 1 and Surface 2 exhibit similar stratigraphy, and were found beside each other; they, therefore, may have been part of the same palaeo-surface. Furthermore, the available geological evidence indicates to us that:

- linear, deep grooves a metre and more long were made when this surface was composed of unconsolidated sand;
- to varying degrees, parts of these grooves filled with sand before the surface was covered (by another sand layer);
- the grooves were deeply enough inscribed to cause disturbances in the underlying sand, sufficient to allow those effects to be observed today where an underlying layer is exposed.

We note that although grooves of varying shapes are a common feature on Cape south coast aeolianite surfaces, we have not noted examples of such disturbance in underlying layers, other than in the circle ammoglyph described in Helm et al. (2019a). In contrast, extensive disturbance of underlying layers is a frequently encountered ichnological phenomenon, especially when tracks of the larger, heavier track-makers (e.g. elephants) are viewed in cross-section: these are referred to as undertracks or transmitted tracks.

In substantiating these interpretations, we consider the challenges inherent in the identification of possible ammoglyphs, which include questions of whether other agents may have caused such patterns. Many aeolianite surfaces contain lines and grooves, caused by a variety of agents, including wind, water, and traces left by plants, invertebrates and vertebrates. Distinguishing a possible hominin signature from this plethora of patterns is not straightforward. Furthermore, modern graffiti are sometimes encountered, which may be easily identifiable when taking the form of letters and modern symbols, but perhaps not for older or abstract markings. As noted above, we explored these questions extensively in Helm et al. (2019a), and address them further here in the context of the described geometric patterns.

First, we ask if modern graffiti may be responsible. We then consider whether other agents may have caused these patterns in unconsolidated sand. Thirdly, we consider diagenetic factors. Finally, we consider whether patterns that are now evident may be a random agglomeration of unexplained features.

In our observations, fresh graffiti carved into aeolianites are usually lighter in colour than the surrounding surface and have sharp edges. These features may be absent in older graffiti. Rims, if present, would exclude graffiti, but their absence does not confirm or refute the possibility of graffiti. For Surface 1 and Surface 2, graffiti are excluded on two counts. Firstly, the partial or complete occlusion of the grooves in places is inconsistent with graffiti. With the right groove on Surface 1, gravity may have contributed to sand trickling in from the higher surface to the right. In all cases, windblown sand may have partially filled in the grooves, or the sidewalls of the grooves may have partially collapsed. Secondly, the disturbance in the underlying layer below both surfaces is incompatible with graffiti. It indicates a compressive force from above when the groove was formed, and the surface sand was unconsolidated, akin to the ichnological formation of transmitted tracks. Finally, graffiti are predominantly encountered on rock surfaces situated in areas that are accessible to humans. As a result of the remote nature of the site described herein and the physically challenging terrain, the amount of graffiti that has been detected on aeolianite surfaces along this stretch of coastline is minimal.

Could other agents have caused such patterns in unconsolidated sand? Any such agent must have been capable of forming straight lines in a variety of orientations, sometimes terminating at meeting points. We considered the possibility of roots, which in sand are often straighter than their counterparts in rocky terrain. Although roots are mostly more vertically orientated, they can follow bedding plane surfaces. We have noted fossil roots or rhizoliths extending for metres, and their branching appearance in some cases is not inconsistent with some angles of the geometric features.

However, rhizoliths, which include root moulds, root casts, root tubules, rhizocretions and root petrifications (Klappa 1980; Durand et al. 2018), have features that are inconsistent with our observations. Firstly, they tend to taper if exposed for a sufficiently long distance. Secondly, they often alter the appearance of the surrounding rock in all directions, not just in the underlying layer. Thirdly, the possibility of the grooves representing root moulds is incompatible with areas of occlusion or near-occlusion and does not appear consistent with the evidence in the underlying layers of a substantial compressive force.

Next, we consider whether diagenetic forces may have been responsible for the described groove features. Soft-sediment deformation resulting from slope processes, stacked dune sequences and loading on a narrow coastal plain, and variable cementation as a result of diagenesis, produces recognisable structures in Pleistocene dune sequences (Mills 1983; de Beer 2012). The commonly associated structures of soft-sediment deformation in a South African aeolianite context include those associated with vertical deformation rather than horizontal shear stress and exhibit evidence of brittle failure, including joints, fractures and neotectonic faults (de Beer 2012). These are generally contemporaneous with deposition and most prolific in fine- to medium-grained sand (Roberts et al. 2013). The high depositional rate, low permeability and well-sorted nature of these dune deposits have most likely responded to slumping or slope failure and result in vertical structures visible in Pleistocene coastal cliffs.

Undeformed master bedding is remnant of soft-sediment deformation and structures that cross-cut laminae and beds without generating significant offset. Because the grooves described in this study are in the same orientation with respect to bedding surfaces, and because the incisions are more rounded than angular in form, we suggest that processes of soft-sediment deformation, in this case, can be eliminated as agents of origin of the structures.

Could the patterns result from a random agglomeration of unexplained grooves? Could there be so many pattern-containing aeolianites on this coastline that eventually forms appear that uncannily seem anthropogenic? Recognition of this possibility mandates caution when, for example, features that appear to exhibit symmetry or parallel or nested lines are noted, and requires an acknowledgement that a collection of intersecting grooves on its own is not diagnostic of a hominin signature. A disciplined approach requires that a non-anthropic cause be considered and that further indicators of an anthropic origin are sought. While absolute proof is an elusive notion, we contend that the lines of evidence presented above, including the implication of considerable downward force during groove creation, argue against the geometric patterns being a random collection of lines. Therefore, we are comfortable in interpreting the geometric features on Surface 1 and Surface 2 as probable ammoglyphs, and adding them to the suite of probable ammoglyphs previously reported (Helm et al. 2019a).

One deep groove on Surface 1 resembles a bisector. If the triangle were isosceles, then a means of creating a bisector would be to first determine the midpoint of the line opposite to the angle to be bisected. In the case of Surface 1, the top groove is almost perfectly bisected, but the triangle is not perfectly isosceles in shape, and the groove does not perfectly bisect the bottom angle. One groove on Surface 2 lies almost perpendicular to another, resulting in what is close to a right-angled triangle. We note that near-isosceles triangles, right-angled triangles, bisectors and perpendiculars are rarely encountered natural phenomena on Pleistocene palaeosurfaces.

Given that Surface 1 and Surface 2 contain geometric features that include triangles, we note that the cross-hatched or 'chevron' pattern, epitomised at Blombos Cave by a pattern on engraved ochre dated to ~77 ka (Henshilwood et al. 2002), can be viewed as a series of adjoining triangles. Surface 2 appears to have at least one angle at which two lines meet and do not continue. However, this cannot be said for Surface 1, as the probable meeting points of the triangle sides are not evident, because the edges of the surface truncate the sides. While we cannot assume that the lines met (although this appears highly likely), we also cannot assume that they would have ended where they probably intersected. They may have continued, and formed part of a larger geometric figure, similar, conceivably, to the Blombos Cave engraving writ large. The fourth groove hints that the geometric figure might have comprised more than a single triangle. The size of the triangles, particularly on Surface 1, serves to distinguish them from known MSA engravings (Henshilwood et al. 2002, 2009, 2011; Watts 2010) and a drawing (Henshilwood et al. 2018) from the region. Even if the feature on Surface 1 was just a single triangle, it is a reminder that a canvas of sand is potentially enormous.

The notion of early modern humans creating patterns in sand is not new. Hodgson and Helvenston

(2007) speculated that early art would have been: 'likely in sand originally', and that '… scratches in the sand … are seldom preserved from those distant times … Morriss Kay (2009) lamented how much palaeoart must have been 'created in perishable materials and has therefore been lost to the archaeological record'. Sand, by implication, fell into this category.

Two archaeological sites on the Cape south coast that have contributed to the global palaeoanthropological record are Blombos Cave and Pinnacle Point. Blombos Cave lies ~30 km west of the site we describe here; Pinnacle Point lies ~50 km to the east. We consider it remarkably fortuitous that preservation of Pleistocene dune and beach surfaces, during the approximate time and in the same region that engravings in ochre and a drawing with an ochre crayon on a silcrete flake were being created, allows us to potentially complement that record through documentation of ammoglyphs. Consequently, we consider ancient dunes not as inert surfaces, but as potential canvases on which early humans could express themselves. The palaeoart record is biased towards materials that endure over time (Bednarik 1994). The realisation that there is another medium through which it can potentially be interpreted is therefore opportune.

Establishing the age of these rocks is essential. Until precise results are known from the sample that we have submitted for OSL dating, stratigraphic correlation to the dated sequence 2 km to the east (Roberts et al. 2008) is used to provide depositional context. Based on correlations to this sequence, we suggest that these deposits may date to between MIS 5e and MIS 5b, as the published ages for units at the same elevation obtained 2 km to the east date to between 136 ± 8 ka and 91 ± 4.6 ka. The blocks containing geometric patterns were found *ex-situ*, but share sedimentary characteristics of low-angle dipping beds, bed thicknesses of up to 25 cm and well-cemented consolidation with an overhanging bed ~10 m above Mean Sea Level in the cliffs.

This unit was not specifically dated by Roberts et al. (2008); hence we provide a range. The e*x-situ* blocks dislodged from the cliffs comprised a single bedding plane of ~20 cm thickness, which was well cemented. Compared to the basal unit in the sequence, which is poorly cemented and characterised by steeply dipping laminae of less than 5 cm in thickness, we interpret the outcrop of origin to be a positive feature (i.e. a less eroded unit), which is horizontally exposed, protruding from the cliff sequence above the basal deposits (Fig. 2).

The history of geometric patterns in palaeoart has been documented by Bednarik (2003, 2013). Obtaining consensus as to their meaning has proven elusive. For example, Hodgson (2006a, 2006b, 2019a), has advocated the neurovisual resonance theory, describing a proto-aesthetic response based on how the early visual cortex responds to simple geometric images; this followed earlier work (Hodgson 2000a, 2000b) describing the importance of the early visual cortex and its relationship with environmental factors. Lewis-Williams (2002, 2003) and Lewis-Williams and Dowson (1988) focused on altered states of consciousness, entoptic phenomena and the role of shamans. Mellet et al. (2018), using neuro-imaging studies, concluded that the engravings are representational, or symbolic. Subsequent debate (Hodgson 2019b; Mellet et al. 2019) has drawn attention to these perspectives.

Tylén et al. (2020) noted similarities in the nature of engravings in ochre at Blombos Cave and engravings in ostrich eggshells at Diepkloof Rock Shelter (Texier et al. 2010, 2013), on the west coast of South Africa. They observed in both cases that the engraving composition evolved over a time interval of 30 ka or more. Using the engravings as stimuli, they performed experiments which suggested that over time the images became more 'salient, memorable, reproducible, and expressive of style and human intent'. Determining the age of the geometric patterns on Surface 1 and Surface 2, and that of the other probable ammoglyphs, will allow a more accurate temporal comparison with these well-documented engravings.

While we choose not to involve ourselves in the detail of such debate, when we encounter patterns or motifs that resemble those documented elsewhere in Middle Stone Age art, we are intrigued. For example, our summary of probable ammoglyph sites (Helm et al. 2019a) included a circle, chevron and fan-shaped patterns, and examples of symmetry. In this context, Von Petzinger (2009) described an array of Upper Palaeolithic geometric signs in parietal art in France, noting that triangular shapes were present at numerous sites and occurred in all periods.

Anderson (2012) considered possible patterns that would have been evident to MSA hominins and that might have led to the creation of the prevalent cross-hatched pattern images, noting that 'pattern and design may be representative of more immediate, perceptible concerns that are demonstrably intelligible. The capacity to emulate, draw inspiration from, and make associations regarding the natural and cultural environment in visual terms may be seen as a particularly human trait …'. Furthermore, it was noted that natural weathering processes could create apparent cross-hatched patterns in rocks, and that 'southern Africa has a distinctive geological propensity for rock formations that exhibit horizontal, vertical and diagonal folds, cracks or striations in the rock'. A photograph of Table Mountain Group quartzite rocks (part of the Cape Supergroup) on the approach to Blombos Cave, containing cracks in a pattern that included triangles (Anderson 2012: 201), was used to substantiate the assertion that awareness of such patterns may have been a precursor to the making of images that incorporated them. We note that aeolianites and cemented foreshore deposits do not form joints or fracture lines in these patterns and that the dominant structural deformation in the Cape Supergroup successions is remnant of the Permo-Triassic fragmentation of the supercontinent Gondwana. However, the fact that triangular patterns in Palaeozoic Cape Supergroup rocks on the Cape south coast would, in all likelihood, have been apparent to MSA inhabitants of the region, and may have inspired them, is an avenue for intriguing speculation.

Another angle of speculation is based on the notion that the making of stone tools required an understanding of geometric fundamentals, as enunciated by Hodgson (2003): 'a likely explanation for the appearance of geometrics is to be found in the fact that, in the de-fleshing of bone and making of tools, scratch marks of various kinds will have been produced. Some will have accidentally assumed the configuration of a regular pattern and therefore became significant …'. Hominin appreciation of pattern and symmetry is evidenced through the recognition of fossils and crystals (Bednarik 2003); this concept has been explored in the southern African setting by Helm et al. (2019d). Furthermore, appreciation of proportion concerning stone tools has been claimed (Feliks 2008).

In this context, and while our intent is not to attempt to ascribe meaning to the geometric patterns that we have described, we cannot help but note that the triangle on Surface 1, with its 'bisector' that appears to terminate abruptly after 45 cm, resembles a purported female fertility symbol that becomes manifest in palaeoart in Europe in the Aurignacian, particularly in southern France (Gimbutas 1989; Leroi-Gourhan 1982). This type of triangle, known as the 'female pubic triangle', has been attributed to the celebration of the 'Mother Goddess', or 'birth-giving Goddess' and her 'regenerative vulva' (Gimbutas 1989; Clottes and Lewis-Williams 1998). Such images have been viewed as a *pars pro toto*, in which they represent the entirety of the female body and the concept of fertility. These inverted-triangle images often include a shorter line that approximately bisects the bottom angle and ends somewhere near the middle of the triangle; this has been attributed to the vulva. Such Aurignacian 'triangular vulva' images from La Ferrassie have been thus described by Von Petzinger and Nowell (2014). Some such interpretations have not been uniformly accepted or have been viewed as 'androcentric' (Hosking 2013). Nowell and Chang (2014) argued that 'interpreting the figurines in a purely sexual context obstructs their objective, scientific study', and drew attention to the role of the media in sensationalising the topic. Our intention is not to be engaged in such debate, but merely to draw attention to the resemblance of what is apparent on Surface 1 to this motif.

Subsequent discoveries at Chauvet Cave and Abri Castanet of rock art interpreted as vulvas have pushed the dates of these motifs back to 37–36 ka (White et al. 2012). Whatever their meaning may be, their appearance relatively soon after modern humans are purported to have entered Europe from Africa lends credence to the possibility that such motifs had an older, African origin. From their appearance in Europe in the Aurignacian, they occur in the Solutrean and into the Magdalenian, persisting through the Upper Palaeolithic of Europe (Clottes and Lewis-Williams 1998).

In our ichnology studies, we hesitate to identify a fossil track unless multiple tracks are present; otherwise, we might mistakenly identify erosional features as vertebrate tracks. Likewise, on Surface 1, there is only one possible-motif to consider. The grooves and the 'bisector' could be arranged in a fashion that suggests this pattern but might have had no such significance to their creator. The abrupt termination of the 'bisector' after 45 cm could be due to the rest of this groove having been filled in with sand, as occurs with the left groove of Surface 1 and with two grooves on Surface 2. If further geometric features with similar form are identified, the case for this motif will be strengthened.

In the meantime, we note simply that if speculation is valid that the triangle and bisector on Surface 1 represent the same motif that has been observed later in Europe, then this may double or triple the earliest age from which it has been reported. This would not be the first time that southern African discoveries have pushed back in time what has been viewed as an Upper Palaeolithic Eurasian phenomenon (McBrearty and Brooks 2000).

While contentious, the notion of early hominin species creating images is not new. Joordens et al. (2014) attributed a zigzag pattern on a shell from Indonesia, dated to 500 ka, to *Homo erectus*. Rodríguez-Vidal et al. (2014) attributed a cross-hatched pattern from a Gibraltar cave, dated to >39 ka, to *Homo neanderthalensis*. Bednarik and Beaumont (2012) described seven sub-parallel engraved lines, dated to >276 ka, on a stone plaque from Wonderwerk Cave, South Africa. Jacobson et al. (2011) used tomography to demonstrate that grooved surfaces found within this cave could be surface manifestations of natural fissures in the rock, but did not analyse the surface that was assessed and described in detail by Bednarik and Beaumont (2012). Chazan and Horwitz (2015) subsequently reported 'unequivocal evidence' for the intentional marking of rocks at this site, understood to predate the engraved ochre at Blombos Cave by at least 100 ka.

What is indeed new is the appreciation that aeolianites can preserve features registered in unconsolidated sand on the Cape south coast and that these features could include anthropogenic images. It was likely apparent to those who may have made or viewed such patterns that they were of short duration, destined to be obliterated by the next wind-storm or covered by encroaching sand layers. However, an example from Australia counters any assumption that patterns of short duration are insignificant: Morphy (2007) noted how, for the Yolngu, the temporary nature of patterns and sculptures in sand was somehow essential to their meaning.

As patterns drawn in sand may have seemed ephemeral to their creators, it is perhaps ironic that those sand surfaces have been preserved as aeolianites and cemented foreshore deposits. Nonetheless, after being buried for thousands of years and cemented, once these patterns are re-exposed, they are indeed ephemeral. If they cannot be recovered, they may slide into the ocean, become reburied, fragment or their surface features become tarnished. We, therefore, enjoy a brief time-window in which to identify possible ammoglyphs soon after being exposed.

Our approach is, therefore, to report on our findings as rapidly as possible, even though the most accurate dating results are not yet available (and in consideration of the substantial period that it takes to obtain these results) in the hope that other researchers may be able to examine these patterns before their disappearance or destruction. This is particularly pertinent to the sites we describe herein, which are likely not recoverable. In other cases, such as some of the probable ammoglyphs described in Helm et al. (2019a), recovery has been carried out, leading to the specimens being reposited in the Blombos Museum of Archaeology in Still Bay.

Conclusions

Humans travelled on dune surfaces along the Cape south coast in the Middle Stone Age, during approximately the same time interval in which they created geometric figures in caves in this region. Aeolianites and cemented foreshore deposits can preserve a record of their activities. The large geometric features which we have described suggest that humans may have created these patterns on these surfaces when they were composed of unconsolidated sand. They may therefore be ammoglyphs, a recently identified potential record of MSA human expression, and they strengthen the notion of Pleistocene dune and beach surfaces being potential canvases of sand. Their size distinguishes them from documented regional examples of palaeoart. Thus they may not only add to the regional record of examples of abstract images, but may enhance the global record of palaeoart, and may contribute to the global archaeological record concerning the emergence of early modern human behaviour and complex cognition.

Data availability

Locality data is reposited with the African Centre for Palaeoscience at Nelson Mandela University, Port Elizabeth, South Africa, to be made available to *bona fide* researchers upon request to the corresponding author.

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