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A PURPORTED PLEISTOCENE SAND SCULPTURE FROM SOUTH AFRICA

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Abstract. A purported cemented sand sculpture found in Pleistocene aeolianite deposits on the Cape south coast of South Africa resembles a stingray (minus a tail) in outline. Symmetry is evident in the rock's shape and the pattern of grooves on its surface. It is postulated that it may be a three-dimensional example of representational art of another species. Optically stimulated luminescence studies of rocks in the vicinity indicate that it dates to the Middle Stone Age, most probably during Marine Isotope Stage 5 (when high sea levels imply a nearby coastline). The correspondence in shape between the purported sand sculpture and the blue stingray (*Dasyatis chrysonota*) suggests that it may have been traced from a fresh specimen. Tracings on sand are postulated as a possible 'stepping stone' between abstract early palaeoart and representational rock art. Features of the rock suggest that the creation of a stingray sand sculpture may conceivably have been followed by symbolically wounding it and amputating its lethal end. Identification of further ammoglyphs will be important in refining the analysis of this newly identified form of early palaeoart.

Introduction

Aeolianites (cemented dune sands, sometimes also referred to as calcarenites) and cemented foreshore deposits on the Cape south coast of South Africa preserve not only the tracks that our hominin ancestors made on Pleistocene dunes and beaches but also other evidence of their activities (Helm et al. 2019a, 2021). Consequently, the term 'ammoglyph' was coined to represent an anthropogenic pattern registered in unconsolidated sand, which is now evident on a palaeosurface of rock. These reports complement the identification of several Pleistocene hominin tracksites on this coastline (Helm et al. 2018a, 2020a, 2023a). To date, ammoglyphs have not been reported from any other region.

More than 350 vertebrate ichno-sites have been identified on a 350-km stretch of the Cape south coast between the town of Arniston in the west and the Robberg Peninsula in the east. It is serendipitous that such palaeosurfaces occur in an area known to be important in the understanding of hominin origins and innovations, and the emergence of cognitive complexity. Furthermore, the ability of ichnology (the study of tracks and traces) to complement the region's extensive Pleistocene body fossil record has been repeatedly demonstrated (e.g. Helm et al. 2018b, 2020b, 2020c, 2023b; Lockley et al. 2019; Helm and Lockley 2021).

The majority of the reported ammoglyphs described to date are recorded on two-dimensional palaeosurfaces (Helm et al. 2019a, 2021) and include:

- large geometric triangular patterns,
- a circle with a small central depression,
- a chevron pattern,
- a radial pattern,
- a fan-shaped pattern,
- sub-parallel lines associated with smaller round depressions,
- more complex patterns.

Some patterns might represent utilitarian activity, such as foraging. Others resemble motifs described from Middle Stone Age (MSA) mobiliary and parietal art (e.g. engravings on ochre or shells, or drawings in caves): the Cape south coast harbours examples of such works from the MSA at Blombos Cave (Henshilwood et al. 2002, 2018), Pinnacle Point (Watts 2010), and Klipdrift Shelter (Henshilwood et al. 2014). The presence of adjacent human tracks (Helm et al. 2019a, 2020a) or putative knee impressions (Helm et al. 2019a) close to purported ammoglyphs further supports an anthropogenic origin. The value of such findings is significant, given the established principles of taphonomic bias, whereby certain substrates on which palaeoart might have been recorded decay at a faster rate than others: stone tends to decay slower than bone or ostrich eggshell, which decays slower than wood, leather, or other organic materials (Bednarik 1994).

Humans of all ages appear to enjoy creating sculptures in sand, but it is not known how deep such a proclivity might extend into antiquity. It can be asked if evidence for such atavistic activity might be preserved in the form of ammoglyphs. A potentially remarkable exception to the occurrence of ammoglyphs on two-dimensional surfaces was provided by a specimen found on a remote section of coastline east of Still Bay. It was identified in 2018, close to the high-tide mark, at the base of coastal cliffs from which it had presumably been dislodged. It exhibited multiple examples of symmetry, which have been briefly described (Helm et al. 2019a, 2019b). It was noted that its shape resembled that of a stingray, and it was suggested that it might represent the preservation of a sand sculpture. *Sensu strictu*, the symmetrical grooves on its upper surface would be classified as an 'ammoglyph', and the whole feature would more accurately be described as an 'ammo-sculpture', but for convenience, we retain the term 'ammoglyph' throughout.

Stingrays would have been known to hominins who hunted or foraged along this coastline and harvested its marine resources. It is conceivable that stingrays were regarded as creatures of importance or rightly regarded as dangerous or lethal, justifying their reproduction by creating an image in the sand. The aims of this article are to:

- provide a first detailed description of the purported sand sculpture,
- review and interpret the symmetrical attributes of the rock and its surface features,
- consider the possible importance of asymmetrical surface features,
- provide an age estimate using newly obtained data,
- consider its relevance from a perspective of marine biology,
- postulate inferences in the development of palaeoart.

A new medium for the expression of palaeoart

The concept of early modern humans creating patterns in sand is not new. Hodgson and Helvenston (2007: 5) suggested that early art would have been 'likely in sand originally' and that 'scratches in the sand … are seldom preserved from those distant times …'. What is indeed new is the appreciation that patterns and sculptures made in unconsolidated sand on the Cape south coast in the MSA may be preserved and amenable to interpretation, forming a previously undocumented form of MSA human expression.

With this understanding come observations and implications:

1) The large scale of some of the ammoglyphs is unprecedented for the time period (MSA) in which they were registered.
2) The work of creating a pattern or sculpture in the sand must have been orders of magnitude less than the effort required to produce other forms of palaeoart, such as engravings in ochre, which would have first had to be mined and transported, then laboriously engraved. A vast canvas of sand may have been the most suitable and ubiquitous medium for artistic expression and would have been readily available on dunes and beaches along the coast.
3) It cannot be assumed that approaches applied to other forms of palaeoart necessarily apply to ammoglyphs. Sand art would have seemed ephemeral to its creators and destined to be covered or destroyed by the actions of wind and waves. In one of the few ethnographic records on sand art, Morphy (2007) noted how, for the Yolngu in Australia, the temporary nature of patterns and sculptures in sand was tied to their meaning.
4) For the purported sand sculpture analysed here, $n = 1$. A methodology for assessing such works is required, which may become refined as further ammoglyphs are identified.
5) Establishing the reality of ammoglyphs requires initial acceptance of their plausibility, as discussed below. Thereafter, the question becomes whether or not a sufficient standard of evidence has been provided for their existence. This is relevant because other agents, both biogenic and non-biogenic, may cause patterns on these palaeosurfaces. The challenge thus lies in identifying a 'hominin signature'.
6) Awareness of the potential of confirmation bias and the perils of pareidolia mandates a cautious approach, which can begin with separating facts (e.g. objective recording of features) from acknowledged speculation.

The plausibility of ammoglyphs

The plausibility of ammoglyphs uses the following rationale:

- through the regional abundance of track-sites, the capacity of these palaeosurfaces to preserve events that transpired on them when they were composed of unconsolidated sand is evident;
- hominins moved across these surfaces, as shown through the presence of hominin track-sites (Helm et al. 2018a, 2020a, 2023a);
- part of the extensive southern African archive of Pleistocene palaeoart (Bednarik 2013) includes sites on the Cape south coast (Henshilwood et al. 2002, 2014, 2018; Watts 2010);
- the palaeosurfaces containing the possible ammoglyphs and the previously documented palaeoart are from approximately the same time period;
- assumptions that only the footprints of humans travelling on these surfaces are preserved, to the exclusion of other activities, are untenable.

Roberts and Cole (2003) contended that the plentiful occurrence of tracks and traces (and, by implication, ammoglyphs, although they had not yet been identified) in these aeolianites reflected a combination of:

- the cohesiveness of moist sand, which provides an effective moulding agent;
- high sedimentation rates, which promote swift track burial;
- rapid lithification via partial solution and re-precipitation of bioclasts;
- shoreline erosion, which re-exposes the palaeosurfaces.

To the first of these factors can be added the role of microbial activity in binding sandy substrates (Seilacher 2008).

The plausibility of ammoglyphs is thereby established beyond reasonable doubt, along with the possibility that these patterns are amenable to interpretation. Along with other examples of vertebrate traces, they are buried for a considerable time and then re-exposed through coastal erosion. However, the claim for the preservation of a sand sculpture as described herein requires additional justification.

This can be approached through an analogy with natural casts of dinosaur tracks. Such track casts consist of material derived from the overlying sedimentary layer that filled in the tracks. When the track-bearing layers are re-exposed through erosion after millions of years, the often-muddy substrate in which the track was registered may be more easily eroded, exposing a natural cast of the track in hypo-relief. A cleavage plane may form at the top of the infill layer, after which the cast separates and falls or slumps into a creek bed. Sometimes a cast survives the tumble intact, and sometimes it fragments. Dinosaur track casts can then be 'harvested' by walking along canyon floors and finding them where they have come to rest before being destroyed in a flood event.

A similar process can be imagined for a coastal sand sculpture, which becomes buried (say, by windblown sand), perhaps after first being covered by a layer of salty dew or bound by microbial 'bioglue' (Seilacher 2008). This forms a natural separation layer following cementation and re-exposure. The second plane of cleavage is then formed along the base of the original sculpture. The process of possible preservation of the sculpture on a loose rock slab following its dislodgement and tumbling or sliding down a steep slope is the same as for dinosaur track casts, but on the Cape south coast, dislodged rock slabs tend to come to rest near the high-tide mark, where wave action may sort them from smaller debris, and where ichnofossils can be identified before they are destroyed by wave action.

The difference is that dinosaur track casts are preserved in convex hypo-relief, whereas a sand sculpture would be preserved in convex epi-relief as a pedestaled feature. Nonetheless, the geological and ichnological processes are the same, in a sequence of burial, cementation or lithification, re-exposure through erosion, separation, possible survival of tumbling down steep slopes, and identification.

Once the plausibility of ammoglyphs is accepted, the quality of the evidence needs to be considered. A claim that a rock found at the bottom of coastal cliffs represents a sand sculpture can be regarded as extraordinary, which therefore requires a high standard of evidence. Helm et al. (2019a, 2021) explored other potential agents (including diagenetic factors, wind, water, and traces left by plants and invertebrates, reptiles, birds and other mammals) that might create patterns in sand that are now evident in rock. The potential for features to be of recent anthropogenic origin (modern graffiti) was also considered. Strategies were developed to distinguish between ancient anthropogenic patterns, patterns caused by other agents, and more recent graffiti.

Seemingly promising sites were not identified as ammoglyphs if the evidence appeared equivocal. A cautious approach was adopted, recognising that other forms of palaeoart frequently suffered from early misinterpretations (Bednarik 2017) and that because of the profusion of patterns evident in aeolianites, patterns of a random nature might occasionally be encountered that suggest a hominin signature.

Already, in one case (Helm et al. 2019a – Site D), further investigation has revealed that a pattern initially thought to be a possible ammoglyph more likely represents invertebrate burrow traces that had assumed an unusual form. At another site, an anthropogenic origin was considered for 'rainbow patterns' of nested lines, but the evidence was ultimately found to be more consistent with seal traces (Helm et al. 2022). In an evolving, new field, such corrections and new insights are to be expected.

Some lines of evidence can be diagnostic/informative as to the formative processes. For example, the presence of displacement rims on either side of a groove is easy to explain if the groove was made in sand but virtually impossible to account for if the groove was etched in rock. However, rims are easily abraded by wind action or subsequently eroded, and their absence does not exclude an ancient anthropogenic origin. Likewise, partial or complete occlusion of portions of grooves is consistent with the effects of gravity or wind on sand but inconsistent with alternative explanations such as modern graffiti. Conversely, sharp edges to features suggest a recent origin.

Symmetry, although not the exclusive domain of anthropogenic features, is always intriguing, especially in light of comments by Henshilwood et al. (2009: 39) about the engravings in ochre from Blombos Cave:

> the regularity in the profile and outline of incisions indicates precise neuro-motor control … the engraver filled in a blank space by incising two lines to complete the symmetry of the pattern.

Feliks (1998, 2008) and Hodgson (2011) discussed the role of symmetry in hominin creations, going back as far as the Acheulean, and Bednarik (2003) discussed hominin appreciation of symmetry in fossils and crystals. Additionally, Oakley (1973), in describing an Acheulean hand-axe, inferred that the tool-maker avoided flaking an area containing a well-preserved bivalve fossil, allowing it to occupy a central position.

Straight, non-tapering features are likewise of interest, as are tracks occurring in juxtaposition to such features. Standard ichnological principles can be applied in cases where groove features can be examined in profile or where underlying layers are exposed. The latter form the equivalent of transmitted tracks, and in some cases, inferences can be made of a substantial downward compressive force when the grooves were registered. In combination, such considerations allow for informed interpretations to be made.

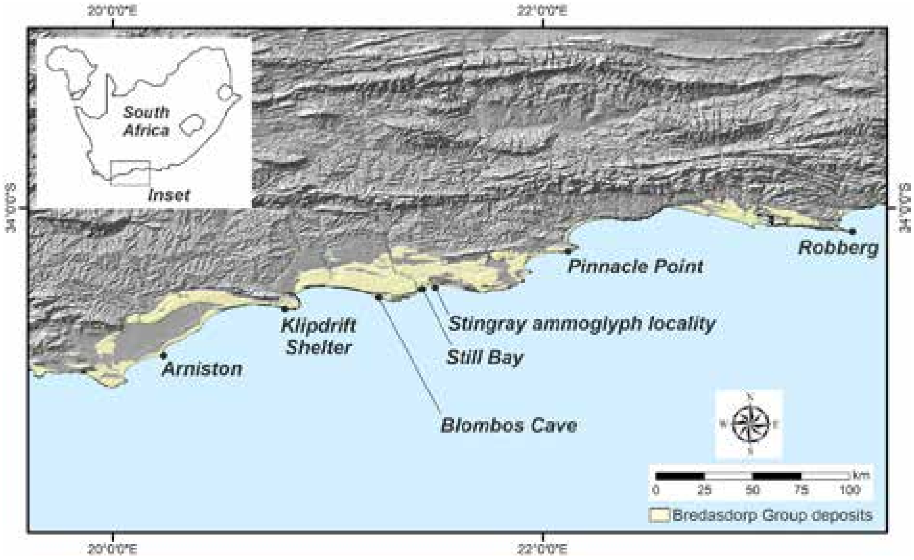

Figure 1. The Cape south coast of South Africa, the purported sand sculpture site, sites mentioned in the text, and the extent of Bredasdorp Group deposits.

From a plethora of identified patterns, the challenge thus involves trying to distinguish a Pleistocene 'hominin signature'. Given the medium of sand and the vagaries of preservation, such a signature may assume subtle forms suggestive of deliberate intent or design or might involve recurrent patterns for which no convincing alternative explanations appear feasible. From such analysis, criteria for identifying ammoglyphs (or assigning probability scores) can hopefully be developed as the number of reported possible ammoglyphs increases.

Geological context

The purported sand sculpture was found on a remote stretch of coastline east of Still Bay, where aeolianite cliffs, as much as 50 m high in places, extend for a distance of 6 km (Fig. 1). The aeolianites (cemented dunes), which characteristically exhibit prominent cross-bedding, form the Pleistocene Waenhuiskrans Formation, part of the Cenozoic Bredasdorp Group (Malan 1989).

The Klein Brak Formation, which consists of marine and foreshore deposits, including lagoonal facies, also forms part of the Bredasdorp Group. Although it frequently outcrops along the Cape south coast, it has not been identified in these cliffs. However, rocks from these two formations are not always easily distinguishable from each other, which is unsurprising given the presence of transition zones between beaches and dunes.

The purported sand sculpture was found close to the high-tide mark amid large fallen blocks and slabs, originating from higher up in the aeolianite cliffs, along with debris, sand and smaller rock fragments from higher elevations (Fig. 2). The smaller rocks, similar in size to the purported sand sculpture and sorted by wave action, occur along a zone straddling the upper limit of the intertidal zone. The layer from which the rock originated, and its stratigraphic position within the cliffs, cannot be determined.

Description of the purported sand sculpture

The loose rock was found in 2018 by Emily Brink. It was recovered and is accessioned in the Blombos Museum of Archaeology in Still Bay (accession number ICH003H). The site lies ~30 km east of Blombos Cave and 1.6 km east of the site containing large geometri-

Figure 2. Aerial (drone) view of the area where the purported sand sculpture was found. The arrow indicates a human figure for scale.

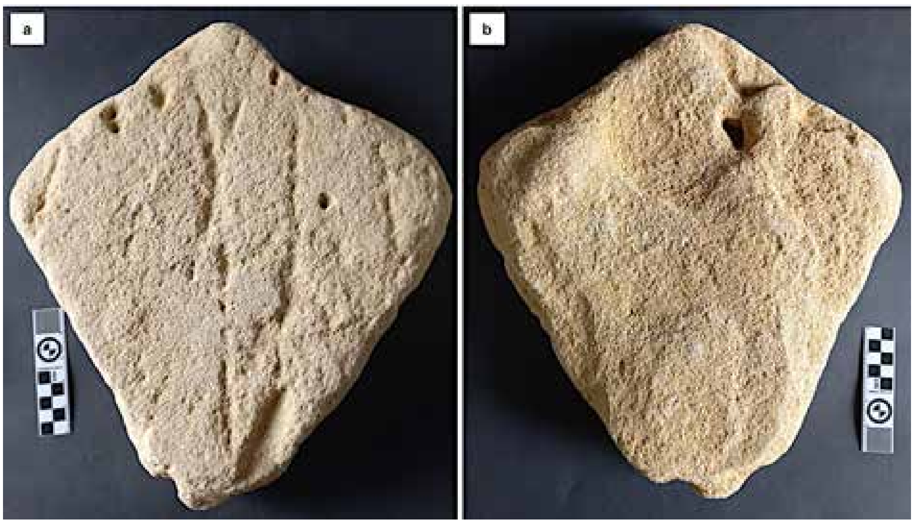

Figure 3. *(a) The upper surface and (b) the lower surface of the purported sand sculpture; scale bars are in cm.*

cally patterned ammoglyphs (Helm et al. 2021). The rock approximates the shape of a kite, a geometric term defined as a quadrilateral with two pairs of equal adjacent sides (Page 2019). Kites contain two diagonals: one forms the axis of symmetry and perpendicularly bisects the other; it also bisects the angles that it meets at the corners (Page 2019). The rock is described here with the more acutely angled corner met by the long diagonal at the proximal (posterior) end (Fig. 3a).

The long and short diagonals (i.e. the length and width of the surface) are respectively 35 cm and 30 cm long. Rock thickness varies from 5 cm to 6 cm. The sides are straight or curvilinear, except for two slight protuberances (one on each side) that are evident 3.5 cm from the 'posterior' corner and a 2 cm, rounded, bite-shaped defect evident in plan view immediately left of the 'posterior' corner. When the 'posterior' corner is examined in profile, it is evident that it too exhibits symmetry and that there are actually two such 'bites', one on either side of a short, stubby posterior midline protrusion which is not obvious in plan view. All the edges of the rock are rounded. The distance between the 'anterior' corner and each lateral corner is 21 cm. The distance from the left lateral corner to the 'posterior' corner is 27 cm, and from the right lateral corner to the 'posterior' corner is 30 cm.

The only feature of note on the undersurface of the rock is a 3 × 1.5 cm cavity which forms the end of a 3 cm tunnel that emerges on one of the sides of the rock (Fig. 3b). However, the upper surface exhibits further features of note (Fig. 4a).

Perpendicular to the long diagonal and along the axis of the short diagonal between the lateral corners lies a row of groove features. In the centre of this row are two intersecting grooves, forming the appearance of a cross. The 'arms' of the cross measure ~10 cm and intersect at an angle of ~30°. They intersect close to (less than 1 cm from) the point of intersection of the two diagonals. On each side of the cross, two further grooves are evident, referred to here as the inner and outer grooves. The (faint) left inner groove lies parallel to one of the arms of the cross feature, and the right inner groove lies sub-parallel to the other arm of the cross feature. Each of these grooves lies ~5 cm from the respective arms of the cross feature. The outer grooves are each positioned ~7 cm from the inner grooves. They lie parallel or sub-parallel to the inner grooves and parallel to the respective arms of the cross feature (the left example is more of a step feature, attributed to erosion rather than an actual groove). The distances from the outer grooves to the lateral edges of the rock are ~4 cm on the right, and ~2.5 cm on the left, i.e. the pattern of grooves lies fairly symmetrically within the rock. The cross feature, therefore, appears in a central position. A posterior extension of one of the grooves that form the cross feature is apparent on the right, 13 cm long and ending just 2 cm from the 'posterior' edge. In places, this extension exhibits partial occlusion. Vestiges of a probable similar groove feature on the left are present, almost fully occluded, thus forming a further possible example of symmetry. These symmetrically aligned features are illustrated in Figure 4b.

As noted above, the symmetry of the portion of the rock at the 'posterior' angle is not fully apparent in plan view. However,

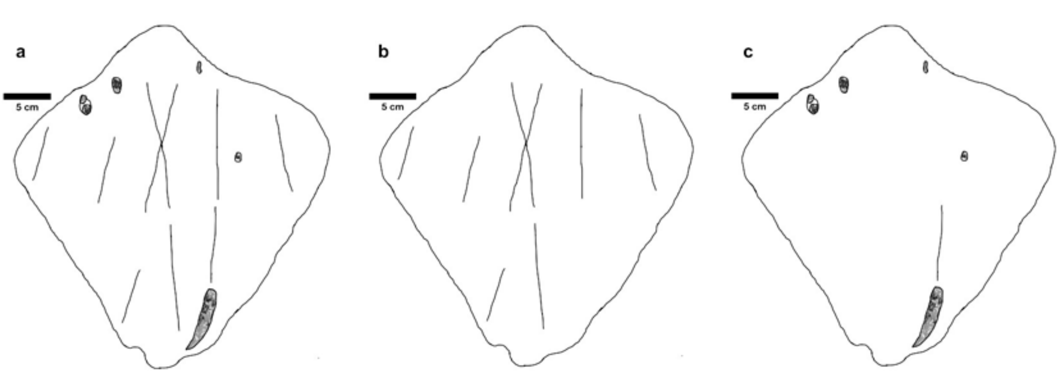

Figure 4. *(a) Features on the upper surface of the purported sand sculpture; (b) symmetrical features; (c) asymmetrical features.*

this is readily apparent in profile view and confirmed by examining this area both from directly behind, and from 'posterosuperior' (Fig. 5a) and 'posteroinferior' (Fig. 5b) perspectives. The stubby midline protrusion (referred to below as the 'tail stub') is ~2 cm long, with a width of ~3 cm, and the 'bites' on either side of it are ~1.5 cm in width and ~2 cm deep. All edges in this region are rounded.

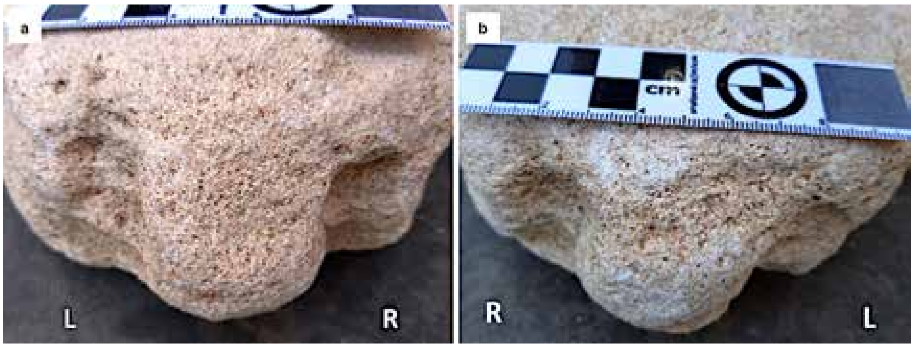

Figure 5. (a) The 'tail stub' area, viewed from a 'posterosuperior' perspective; b) the 'tail stub' area, viewed from a 'posteroinferior' perspective (the rock has been turned over); scale bars are in cm and mm. L = left; R = right.

In addition to these symmetrical features, the following asymmetrical features are apparent and are illustrated in Figure 4c. At least four round or oval indentations are present, two on the left portion of the surface and two on the right. On closer inspection, two of these (far left and upper right) each consist of two adjacent, similar-sized round indentations; hence they present an oval appearance from a distance. These are ~1.2 cm long, 1.0 cm wide and 0.5–1.0 cm deep. The right 'postero-lateral' portion of the surface is generally more eroded than the rest of the surface. However, a deep, wide, flat-bottomed groove (7 cm long, ~2.5 cm wide and >1 cm deep) is evident in this area, extending in a 'posteromedial' direction almost to the 'posterior' corner.

Photogrammetry (Falkingham 2012; Matthews et al. 2016) was performed on the upper surface (Fig. 6). 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 µm). The final images were rendered using CloudCompare (v2.6.3.beta).

Interpretation

Kumar (2021: 25) has drawn attention to a challenge in rock art research: 'We have no idea of the cognition or perception of the authors of rock art, of how they experienced reality or how their brains worked'.

The greater the temporal distance between ourselves and the artists, the greater this problem becomes (Bednarik 2017). We are cognisant of this in interpreting the features of the purported sand sculpture and indicate where we are entering the realm of speculation.

Symmetrical features

The elements of symmetry include:

(a) the rock outline is left-right symmetrical, with the longer diagonal forming the axis of symmetry;
(b) the cross feature occurs in the centre of the row (along the short diagonal) of groove features, and its long axis is the same as the long diagonal of the rock;
(c) the point of intersection of the arms of the cross feature lies very close to the point of intersection of the long and short diagonals;
(d) the groove features lying on either side of the cross feature exhibit symmetrical spacing and alignment (including parallelism);
(e) the lateral corners of the rock are approximately equidistant from the cross feature so that the cross lies in the centre of the widest portion of the rock, and the anterior row of grooves lies perpendicular to the long axis of the rock;
(f) the slight protuberances on either side, close to the 'posterior' corner, are equidistant from it, and what we refer to as the 'tail stub' lies in the midline at

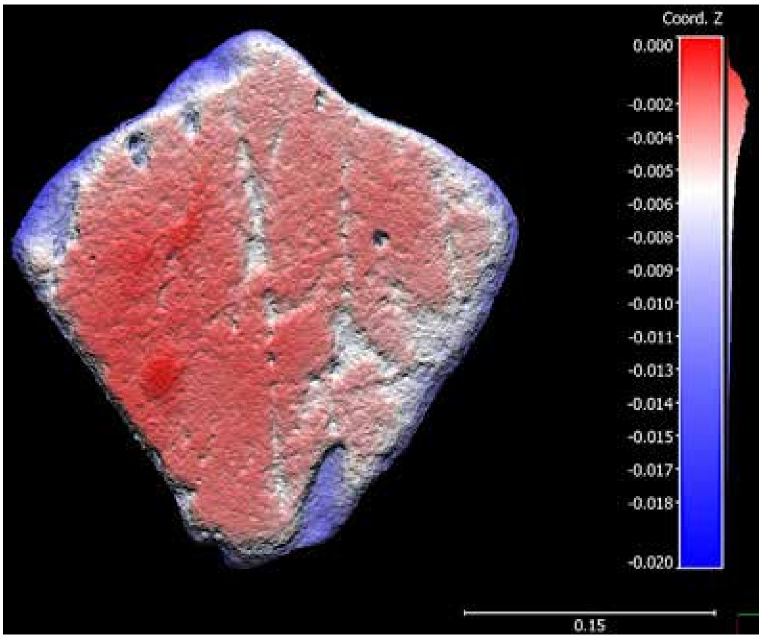

Figure 6. 3D photogrammetry model of the upper surface of the purported sand sculpture. Photogrammetry colour mesh using 23 images. Photos were taken an average of 26.9 cm from the surface, and the reprojection error is 0.542 pix. Vertical and horizontal scales are in metres.

the 'posterior' corner;

(g) the two 'anterior' (shorter) equal sides both have a slightly concave shape, whereas the two 'posterior' sides (one is slightly longer than the other) are both relatively straight.

A sand sculpture may have been created either by removing surrounding sand to an equal depth or by packing new sand onto an existing surface. Either way, a pedestaled feature would result, capable of being preserved and re-exposed.

The shape of the rock resembles that of a stingray (Smith and Smith 1966; Heemstra and Heemstra 2004). The arms of the cross feature intersect very close to the position of the eyes. The row of grooves may be associated with patterns evident on the dorsal surface of a species such as the blue stingray *Dasyatis chrysonota* (see below). The lateral corners correspond to the position of the pectoral fins, and the protuberances on either side of the 'posterior' corner of the rock correspond to the position of the pelvic fins. Slight concavities on either side of the vestigial tail accentuate it. The symmetrical groove pattern also serves to orientate the sculpture on an 'anteroposterior' axis.

Asymmetrical features and 'symbolic wounding'

We speculate on the importance of the asymmetrical features within the context of 'symbolic wounding' described in the palaeoart record (Thackeray 2005a), and the associated *principle* of so-called 'sympathetic magic' (Frazer 1890) or 'empathy' (Thackeray 2019a). In recent decades these concepts have been discredited within the discipline of rock art. For example, Lewis Williams and Dowson (1989: 23–24) stated:

> Mistaken ideas about the mental capacities of so-called 'primitive people' and a lack of close attention to the art itself are the basic ingredients of a recipe for misunderstanding. It was, in fact, this combination that led to one of the earliest interpretations of Bushman rock art — sympathetic magic.
>
> The sympathetic magic explanation proposes that people made depictions of animals prior to a hunt in the belief that the act of depiction or of shooting arrows at the depictions would ensure success … Researchers who had spent much of their lives studying the French and Spanish art brought the idea to southern Africa. This explanation was never as widely held in southern Africa as it was in Europe because there is no evidence that the Bushmen believed in sympathetic magic of that kind and because the art seems too diverse for so restricted an explanation.

However, while such comments may be relevant to southern African rock art of the past few centuries or millennia, they cannot be assumed to apply to all rock art or to more ancient examples, including that of Apollo 11 Cave, as described below, and of MSA sand art.

Furthermore, the following three ethnographic examples run counter to the above-quoted assertion by Lewis-Williams and Dowson (1989). The first was reported by Lebzelter (1934) and translated by Thackeray (2005b):

> Before they go out to hunt, the Bushmen draw the animals in the sand and in a range of ceremonies they shoot their arrows. The place where the figure of the animal is hit is where they believe the wild animal will also be hit.

The second is an account by an anthropologist, Louis Botha, who in 1964 observed the following before a hunt (Thackeray 1986): '/auni and !gomani Bushmen in the southern Kalahari [shot] miniature arrows at an effigy of a small animal modelled in sand'. The third is an account of hunting rituals described by Lichtenstein (1812), summarised by Thackeray (2013):

> A person took on the form of a herbivorous animal, and was symbolically wounded and killed in a ritual in the belief that this was absolutely essential for success in a forthcoming hunt.

Although caution is advised in extrapolating these recent quotations to the MSA, examples in the rock art record suggest 'symbolic wounding' may indeed extend deep into antiquity. These can be divided into three categories: linear incisions, deliberate breaking of images or lines which transect the entire image, and puncture marks.

- A therianthrope image at the Apollo 11 Cave, Namibia, dated to 30 ka (Beaumont and Bednarik 2012; Rifkin 2015), is broken through the middle and has been 'pecked', resulting in cupules/puncture marks (Wendt 1976; Thackeray 2005b, 2013, 2019a; Rifkin 2015). This is hitherto the oldest reported representational art from Africa (Bednarik 2016).
- An engraved ungulate image from Wonderwerk Cave (Northern Cape Province, South Africa), dated to 10.2 ± 0.09 ka (Thackeray 1981), contains incisions that transect the legs, possible cupules and possible symbolic wounds in the rump (pers. comm., J. F. Thackeray May 2022).
- A zebra image engraved on a slab of dolomite (Beaumont and Vogel 1989) from Wonderwerk Cave, dated to 4 ka, contains linear incisions in the rump, ochre traces (potentially symbolic blood), and possible puncture marks (Thackeray et al. 1981; Thackeray 2005b, 2013, 2019a). The image is broken down the middle, through the thorax, an action which would have required substantial force and may have been deliberate (Bradfield et al. 2014).
- An image of a 'wounded eland' from Krugersdorp (Gauteng Province, South Africa) contains puncture marks in the rump (Thackeray 2019b).
- An eland image at Daureb (Brandberg, Namibia) contains peck marks on the rump (Lenssen-Erz and Gwasira 2010; Thackeray 2019a).
- A therianthrope in the 'White Lady' panel of the Brandberg (Namibia), copied in 1947 (Breuil et al. 1955), contains two sets of parallel red stripes painted on the posterior region of the belly (Thackeray 2019a).
- A therianthrope image at Snowhill Cave, Drakensberg, South Africa, occurs adjacent to an image of a 'dying' eland (Vinnicombe 1976). A vertical line

transects the middle of the body of the therianthrope (Thackeray 2005a, 2020).

- One of three therianthropes in a frieze at Melikane, Lesotho, contains three vertical stripes that transect the body's middle (Thackeray and Le Quellec 2007), similar to the line in the Snowhill Cave example described above. In the nineteenth century, the figures were interpreted by San informants as 'sorcerers' ('medicine men') 'who had died at the same time as the antelope' (Bleek 1874; Orpen 1874). These three vertical lines bear a remarkable resemblance to a 1934 photograph from Logageng (Northern Cape Province, north of Wonderwerk Cave) of a 'symbolically wounded buckjumper' under the skin of a roan antelope (*Hippotragus equinus*), in which three vertical stripes appear painted laterally on the skin, interpreted as representing symbolic wounds (Thackeray 2005a).
- About 50 km north of the stingray ammoglyph site, a rock painting of an eland contains multiple vertical red lines across the body and neck — these 'cut-marks' have been interpreted as signifying the importance of the eland as a 'rain animal' (Rust 2019).

In at least three cases, the possible symbolic wounding occurs in the rump, which has large muscles from which poison may be quickly absorbed into the blood circulatory system. Furthermore, the transecting vertical line in the Snowhill Cave example and the transecting vertical lines in the Melikane therianthrope occur in approximately the same region and orientation as the vertical breaks in the rock plaques from Apollo 11 Cave and Wonderwerk Cave.

In this context, we speculate that the purported sand sculpture contains all three of these categories:

- linear incisions are represented by the deep, wide groove, or 'gouge';
- puncture marks are represented by four small round or oval indented areas, including the two double indentations;
- deliberate breaking of images, represented by the amputation of the tail ('decaudation'), as discussed further below.

If features like the 'gouge' or smaller indentations were found to occur in higher concentrations on the purported sand sculpture than on the surfaces of rocks from the same layer with similar lithology, such evidence might be considered to buttress our speculation. However, searching for such evidence is problematic because similar features (including 'double-indentations') do occur on some rocks in the vicinity in possibly similar concentrations but not on others. Which of those rocks might have originated from the same layer as the purported sand sculpture cannot be determined.

In a survey of surfaces of nearby rocks with similar lithology, we found many such depressions. These could be accounted for by differential weathering, associated perhaps with varying sand grain size. Once small indentations formed and were perhaps filled with new sand grains, they could be deepened through the scouring action of wind. It is therefore acknowledged that non-anthropogenic agents might plausibly account for some of the noted asymmetrical features and that a firm conclusion cannot be reached as to their origin. An 'Occam's razor' approach would favour natural erosion processes.

The absence of the tail

In contrast, the absence of a tail in the purported sand sculpture requires an attempt at explanation. The 'symbolic wounding' topic outlined above is germane here, too and involves the possibility of symbolic 'decaudation'. Several explanations of variable plausibility can be envisaged, and these can be categorised based on when the 'amputation' might have happened.

a) Blue stingrays (see below) with missing tails are sometimes encountered. Stingrays are important prey for sharks, and stingray spines have been found in the jaws of several predator shark species. A sand sculpture could have been modelled on a stingray already missing a tail.
b) A stingray was caught (perhaps speared) or washed up on the beach; its tail was cut off to prevent injury and carried to a dune setting, where it served as a model for the sand sculpture.
c) As for b), but its outline was traced rather than copied.
d) A sand sculpture initially contained a tail, but this was 'amputated' in an act of symbolic wounding.
e) The tail was buried and eventually cemented along with the body of the sand sculpture, but did not separate with it upon re-exposure or did not survive the fall or slide to the bottom of the cliffs (the absence of sharp edges to the 'tail stub' counts against this explanation).
f) The tail survived the fall or slide but was subsequently removed in an act of vandalism or by wave action. The absence of sharp edges to the 'tail stub' makes this explanation highly unlikely.

Combinations of the above are possible, e.g. b) and c), or c) and d), but are not mutually exclusive. In relation to b), it can be noted that while there may have been clear safety advantages to removing the tail of a stingray, this is not an easy procedure as the cartilage casing surrounding the spine is strong; a sharp implement would have been required. Furthermore, the accurate outline of the sculpture (see below) suggests that the stingray represented a live or fresh specimen, as the wings and disc of desiccated specimens curl up, creating a markedly different appearance.

The blue stingray

The southern African seas contain at least ten species of whip-tailed stingrays (Dasyatidae), of which

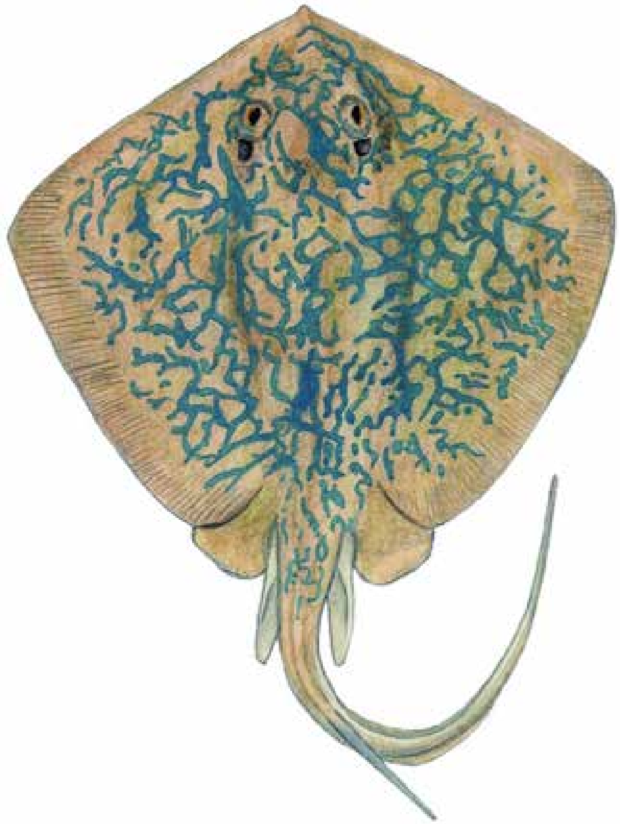

Figure 7. *The blue stingray (illustration by Elaine Heemstra, reproduced with permission from NISC – SAIAB).*

the blue stingray *Dasyatis chrysonota chrysonota* (Fig. 7) is the most wide-ranging: its range extends from the subtropical waters of St Lucia on the east coast to the cooler waters of Angola on the west coast (Cowley and Compagno 1993). Its taxonomic status was established as a separate species from the European stingray (*D. pastinaca,*) and conspecific with the Senegal stingray (*D. c. marmorata*) (Cowley 1997). It is the most common ray species found in coastal waters of the Eastern and Western Cape. It is readily identifiable, with a golden-brown disc that exhibits irregular pale blue blotches and lines (Cowley 1990, 1997). This medium-sized benthic ray attains a disc width of as much as 75 cm and contributes substantially to the fish biomass of the surf zone of the Cape south coast (Lasiak 1982).

From September to February (spring and summer), these common stingrays of the inner continental shelf are encountered on sandy beaches and mudflats, shallow sheltered bays, estuary mouths and coastal lagoons (Cowley 1990). This is when large pregnant females come inshore to pup, whereas in winter, they move to deeper offshore waters. Mating in the inshore zone with the smaller males is thought to occur fairly soon after pupping. The estimated age at first maturity is five years for males and seven years for females (Cowley 1997).

Today the blue stingray is a popular sport-fish among anglers and is quoted by Smith and Heemstra (1986: 137) as 'good eating but seldom utilised'. Its tolerance of a wide range of sea temperatures suggests that there is no reason to think it would not have occurred in Cape south coast waters during the MSA, and it might have been utilised as a food source by ancestral humans in the shallow surf waters of the southern Cape.

Stingrays are notable for barbed caudal spines, which can inflict excruciating and sometimes fatal injuries. These might result from attempting to handle a ray but more commonly occur if inadvertently treading on one in shallow water, where the sting typically penetrates the lower leg or ankle area. The spines, composed of vascodentin, form the hardest part of a stingray.

Stingray palaeontology and archaeology

The oldest reports of stingray fossils are from the Early Cretaceous. The oldest fossilised caudal spines are from Late Cretaceous deposits in the Iberian Peninsula (Marmi et al. 2010).

If this species had been hunted in the MSA for food, this would probably have taken place during summer. This would have been by spearing or pegging them to the sand in shallow, sheltered bays or estuaries. Evidence for MSA fish-spearing has been reported from archaeological sites at Katanda in the Western Rift Valley (Yellen et al. 1995), where a well-developed bone industry, dated to at least 90 ka, including both barbed and unbarbed points, was found in close association with abundant catfish remains.

Despite an extensive archaeological record from the Cape south coast, including bone tool technology demonstrated to date to 80 ka (Henshilwood et al. 2001; Jacobs et al. 2013), stingray spines have not been reported. A single spine, 7.5 cm in length, postulated to have been from an elephantfish (family Chimaeridae or Callorhynchidae) and used as an awl, was reported from a ~3.2 ka midden at Gordon's Bay (Van Noten 1974).

However, the limitations and biases of the archaeological record, which is derived mainly from caves and rockshelters, need to be acknowledged. The remains of larger animals are under-represented in the archaeological record (Perkins and Daly 1968), as it would have been more convenient to butcher (and maybe cook) them on the spot and not laboriously transport them 'home' (Parkington and Poggenpoel 1971; Thackeray 1979). The same concept might apply to a hunted animal with a dangerously pointed barb — it might have been advantageous to remove the tail (as it happens, the part likely to be preserved) and either cook it close to where it had been hunted or transport it home free of the hazard. In either case, finding evidence of stingray spines in the archaeological record would be unlikely.

This concept is buttressed by two nearby examples of the same probable age (see below) as the purported sand sculpture. A giraffe track site 200 m to the east

(Helm et al. 2018b) and a giant tortoise track site 300 m to the west (Helm et al. 2023b) have been reported. However, their presence is inferred only from the ichnological record, whereas the archaeological and body fossil records are silent.

Other pragmatic reasons for removing a stingray tail become apparent through considering the use of the spine for blood-letting rituals in Mayan societies (Haines et al. 2008) or as a spear in more recent Aboriginal societies (Davidson 1934; Nugent 2015). However, there is no evidence of this kind in the southern African archaeological or ethnographic record.

The possibility of tracing

The concept that the initial stage in creating the purported sand sculpture involved tracing the outline of a fresh stingray is unprovable. However, it is suggested by the near-perfect outline and proportions, as shown in Figure 8, by overlaying a modern blue stingray image (Fig. 7) on the photogrammetry model (Fig. 6) of the purported sand sculpture. The close correspondence in shape suggests that the artist was phenomenally gifted in recording such detail, or the image was traced. If it was traced, the disc width of ~30 cm implies it was a male or small immature female. Given the fact that large females enter shallow southern Cape waters to pup in summer and then mate with smaller males (Cowley 1990), the inference is that the purported sand sculpture was probably based on a small male rather than an immature female.

We speculate that tracing in sand might form a possible 'stepping stone' between abstract images (circles, triangles, hashtags, fan and radial patterns) and images of creatures created *de novo*. Compared with more three-dimensional varieties, a flattish animal such as a stingray would have provided a suitable model for tracing. Consequently, we tentatively suggest a possible sequence whereby palaeoart may have progressed from initial tracing in sand to creating images in sand *de novo* (through copying or from memory) and then to representational rock art.

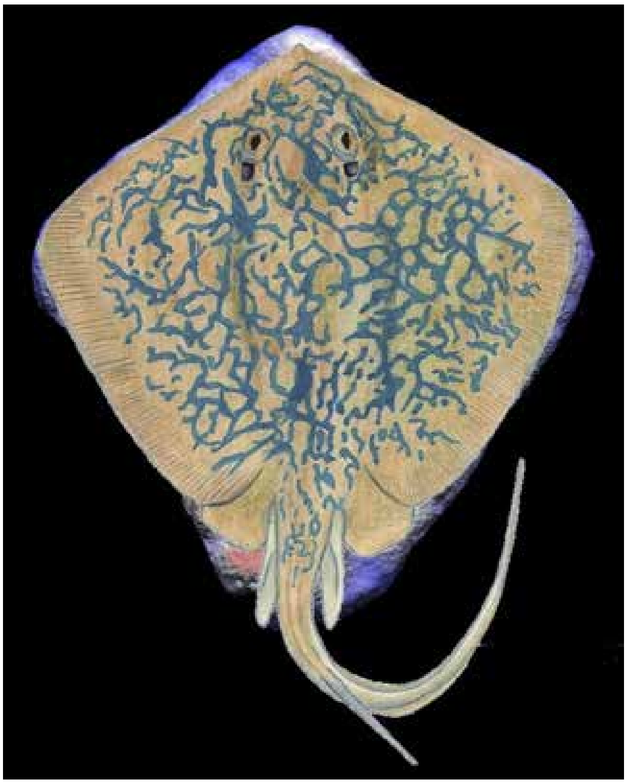

Figure 8. *Figure 7 overlain on Figure 6.*

The interval of tens of millennia between the registration of the stingray sand sculpture and the magnificent western European rock art (beginning at ~40 ka) provides ample time for these skills to be honed. It is a reminder of the rarity of ancient palaeoart and the reality of taphonomic bias (Bednarik 1994). Moreover, it reminds us that rock art has more forms than engraving and painting/drawing. For example, stencilling probably involves placing the end of a limb

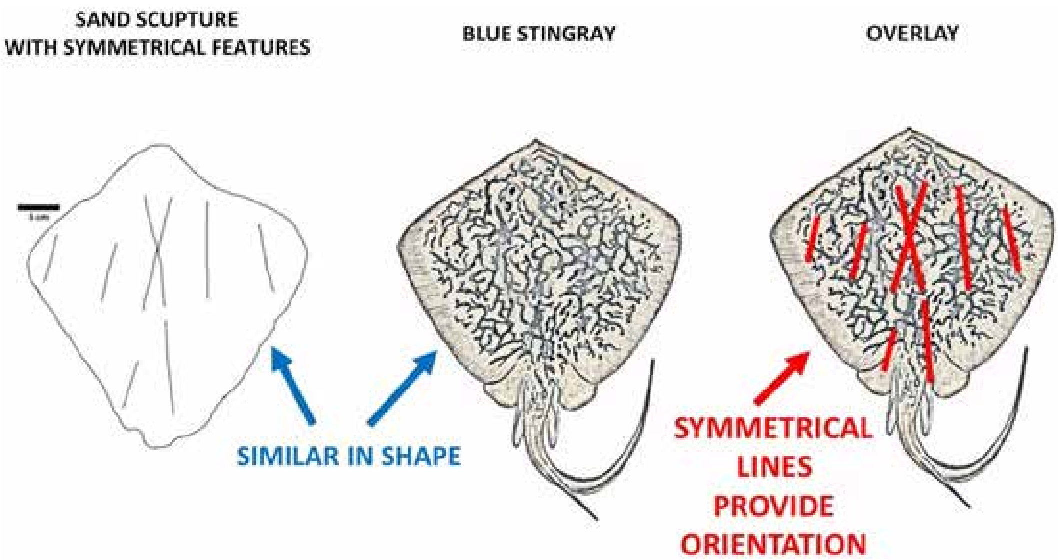

Figure 9. *Overlay of symmetrical pattern of groove features on an image of the blue stingray.*

on a surface and then blowing a pigment onto it, thus creating a negative image. Whereas human hands form the commonest example, Honoré et al. (2016) claimed that the most likely 'hand' used to create small stencilled images in a Holocene cave in Egypt was probably that of a varanid reptile.

The purpose of the addition of the symmetrical pattern of grooves to the purported sand sculpture cannot be determined. However, one effect of this pattern would be to contribute to the 'anteroposterior' orientation once the tail portion was no longer present, as illustrated in Figure 9. The fact that the visible grooves exhibit a symmetrical (rather than random) pattern reinforces the notion that they were deliberately created by hominins.

Estimated age

In the last two decades, numerical ages for the Waenhuiskrans Formation aeolianites have been obtained using optically stimulated luminescence (OSL) dating methods. This method provides an estimate of the time elapsed since grains of sand were exposed to sunlight (e.g. Huntley et al. 1985; Rhodes 2011), which in this instance relates to the time since the burial of grains on the dune surfaces. OSL dates for aeolianites near the present study area were previously reported by Roberts et al. (2008), who sampled multiple layers in a section 300 m to the east. The ages ranged from 140 ± 8 ka to 91 ± 5 ka. Consequently, the cliffs have been inferred to date from Marine Isotope Stage (MIS) 6 through to MIS 5b and to bracket the MIS 5e (Last Interglacial) sea-level high-stand.

Six further OSL age estimates from the area have now been obtained, as summarised in Table 1, and have recently been reported (Helm et al. 2023c, 2022, 2023b, 2023d). The relatively small size of the purported sand sculpture, and the sample size required to perform OSL dating, mean that direct dating is not feasible. However, the age estimates for nearby samples, considered in combination, can lead to an informed estimate of the age of the rock.

The six dated sites extend from 4.8 km to the west of the site to 1.5 km to the east. They comprise a variety of samples from *in situ* deposits and loose blocks lying at the base of the cliffs. Predictably, samples obtained from the basal layers of the cliffs tend to provide older age estimates. In some instances, we have sought to refine the more recent suite of age estimates by considering the effects of a reduction in sample water content associated with cementation (either rapid or gradual) on the dose rate to the sample during burial (Nathan and Mauz 2008). The resulting age estimates, obtained using the *RCarb* model (Mauz and Hoffman 2014; Kreutzer et al. 2022), are inferred to probably be more accurate than the conventional OSL age estimates, although the differences (considering age uncertainties) are often not large, and there are likely site-to-site variations in diagenetic histories that are difficult to account for (see a more detailed discussion in Helm et al. 2023a). In short, the new suite of ages

Distance fr. purported sand sculpture	In situ?	Reported in	Site description	Sample site	Leic name	Leic code	Age (ka)	Modelled age rapid (ka)	Modelled age gradual (ka)
4.8 km W	N	Helm et al. (2023b)	Hatchling turtle	Track-bearing layer	Turtle	21008	134 ± 9	130 ± 10	126 ± 9
3.3 km W	N	Helm et al. (2023d)	Sand-swimming traces	2.2 m up-section from *Eremitalpa* track site	Mole	21005	126 ± 9		
1.7 km W	N, basal	Helm et al. (2023d)	Large equid tracks	Edge of loose track-bearing slab	Horse	20033	161 ± 12		
1.6 km W	N	Helm et al. (2023b)	Ammoglyph, triangular	Edge of ammoglyph-bearing slab	Triangle	20031	139 ± 9	137 ± 9	131 ± 10
0.4 km E	Y	Helm et al. (2023b)	Giraffe tracks	Track-bearing layer, 5 m from tracks	Giraffe	20024	109 ± 9	109 ± 7	104 ± 8
0.5 km E	Y	Roberts et al. (2008)	Roberts' Rock				140 ± 8.3 – 91 ± 4.6	n/a	n/a
1.5 km E	N	Helm et al. (2023c)	Elephant tracks and coprolites	Edge of track-bearing slab	Elephant coprolite	20030	139 ± 10		

Table 1. *List of sites from which samples were taken for OSL dating and ages obtained. The age in ka indicates results using conventional dose rate estimations (using 3 ± 3% water contents). The two right-hand columns provide exemplar age estimates obtained using the RCarb model, which accounts for a reduction in sample water content and formation of 20 ± 5% carbonate cement, either rapidly after burial (first 33% of burial time) or for the duration of burial (~90% of burial time). See Helm et al. (2023a) for a more detailed discussion of this approach.*

is largely in accordance with the results of Roberts et al. (2008) and suggests an MIS 5 age, most likely MIS 5e. This is consistent with the presence of a nearby coastline (and sediment source for the formation of coastal dunes), with sea levels possibly higher than present-day levels. As the precise layer of origin of the purported sand sculpture cannot be determined, and direct sampling is not feasible, this age estimate must suffice.

How does this age range compare with examples of palaeoart from around the world? If the above interpretation and speculation are justified, this would appear to be the oldest example thus far reported of 'representational' palaeoart of another creature. Furthermore, it would appear to be the oldest example of a representational palaeoart sculpture that is not a modification of a naturally occurring rock with pareidolic features. The following summary of early representational palaeoart at a global level, based on extensive work by Bednarik (2016, 2017), highlights the potential importance of the purported sand sculpture.

- Earlier Acheulean proto-sculptures, like the examples from Tan-Tan in Morocco and Berekhat Ram in Israel, comprise grooves that accentuate properties on naturally occurring geological objects that happen to resemble humans.
- An engraving from the Micoquian on a scapula fragment from Oldisleben 1, Thuringia, Germany, may depict a human stick figure.
- Aurignacian (Upper Palaeolithic) representational palaeoart from western Europe may be as old as 40 ka. This occurs on the walls of caves such as Baume Latrone and Chauvet (both in France) and as mobiliary art, exemplified by an ivory sculpture of a therianthrope from Hohlenstein-Stadel, Germany.
- A sculpted animal (probably bear) head from Tolbaga, Siberia, carved on a projection of a woolly rhinoceros vertebra, has been dated to ~35 ka.
- Within Africa, the previously oldest reported representational art of any kind is from Apollo 11 Cave, southern Namibia, dated to ~30 ka (Beaumont and Bednarik 2012). That the therianthrope example from this site (discussed above) contains possible evidence of symbolic wounding suggests that such principles and practices may extend deep into antiquity.

In addition, a site from the Tibetan Plateau, purportedly constrained between 226 and 169 ka, was interpreted as the oldest known example of parietal art (Zhang et al. 2021). It comprised hand and foot impressions, apparently intentionally placed and preserved in a travertine unit. Two juvenile trackmaker artists were postulated. As is the case with aeolianites, which indicate the capacity of 'art' in unconsolidated sand to be preserved, this establishes another suitable substrate (travertine) on which evidence of palaeoart can be sought. However, the dating method (analysis of the U-Th ratio) has been questioned; the reported age range was criticised as a substantial overestimate, and the term 'parietal art' was regarded as misleading (Bednarik et al. 2022).

Further steps

A problem with palaeoart interpretation is that explanations and hypotheses often cannot be falsified and are, therefore, of limited scientific value. In addressing this concern, a first step is to make the rock accessible for study through the Blombos Museum of Archaeology in Still Bay. Interpretations might introduce new concepts that we have not considered.

A second step is to look for further examples of hominin tracks, ammoglyphs, 'ammo-sculptures' and symmetry. While the preservation, re-exposure, recognition and recovery of the purported sand sculpture can be regarded as near-miraculous, it may demonstrate the feasibility of such a geological and ichnological process. Given the rapid cliff erosion rate on the Cape south coast and the resulting dynamic equilibrium of exposure of new ichnological sites and their loss through erosion or slumping into the ocean, active and repeated searching is required. A greater sample set would enable more refined conclusions to be drawn.

A third approach relates to the indentations, interpreted here as possible puncture wounds and at other sites as possible prod marks made with a finger or stick (Helm et al. 2019a, 2020a). The dimensions and the incidence of such indentations or dimples found in close association with ammoglyphs or hominin tracks could be compared with those a distance away from such features on the same surfaces. This was not feasible in the case of the purported sand sculpture, as its layer of origin could not be determined. Our impression that such depressions occur more commonly associated with ammoglyphs needs to be tested and quantified.

A fourth approach involves microscopy, which is applied in assessing and interpreting petroglyphs and pictograms but has yet to be applied to purported ammoglyphs. This would constitute a new field of study. However, for the purported sand sculpture, the potential benefits would need to be balanced with the risks of damaging the surface of a globally unique specimen of palaeoanthropological importance. Finally, non-invasive studies like CT scanning of purported ammoglyphs might also be useful. Internal structures could potentially be demonstrated, which may support or refute hypotheses.

Conclusions

The possibility that the combination of multiple symmetrical features is due to chance alone is, in our view, remote. The findings most plausibly represent a sand sculpture from the MSA, dated to MIS 5e. The close correspondence in shape between the sand sculpture and the blue stingray suggests that it may have been traced from a fresh specimen. In such an interpretation, the symmetrical pattern of surface grooves may be related to the features on the dorsal surface of the blue stingray and serves to orientate it along an anteroposterior axis. Extending this interpretation, the posterior stub would represent what remains of the tail portion, which may have been removed prior to burial in an act of symbolic wounding. The asymmetrical features may be incidental, for which an anthropogenic origin cannot be asserted, although the 'gouge', directed towards the tail, may also represent symbolic wounding. If such postulates are valid, the sand sculpture would qualify as the oldest known representational art of another species.

While large animals such as lions, rhinoceros, hippopotami and crocodiles might have posed a danger for MSA inhabitants along the Cape south coast, we speculate that stingrays might have presented an even greater danger for them while foraging, one that could strike without warning. No matter how different the thought processes might have been for *Homo sapiens* in the MSA (Bednarik 2017), the trauma of seeing a family member or group member stung and maimed by a blue stingray and possibly succumbing must have been significant. Fear, grief and anger might have been legitimate responses, then as now. Creating a sand sculpture of a stingray, possibly beginning with tracing the outline of a fresh specimen and then symbolically wounding it, gouging it and amputating its lethal end, might conceivably follow.

The recognition of ammoglyphs provides an additional medium through which to examine palaeoart. In recognising the potential perils of confirmation bias and pareidolia, we note that the symmetrical surface pattern initially attracted Emily Brink to the purported sand sculpture; this does not represent confirmation bias or pareidolia. The resemblance to the shape of a stingray was appreciated later, along with the symmetry of the tail-stub area, and the multiple degrees of symmetry overcame our initial sceptical approach.

In drawing attention to this purported sand sculpture and thereby potentially expanding the range of ammoglyph types that might be encountered, we emphasise the value of a cautious, rigorous approach, in which claims need to be substantiated with evidence and subjected to scientific scrutiny. In our view, such endeavour, combined with an ongoing search for further examples of ammoglyphs, provides an optimal approach to this new field in the study of palaeoart.

Data availability

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

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