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New insights into human occupation through rock art at Khatm al Melaha archaeological site (Sharjah, United Arab Emirates)

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ABSTRACT

This paper is an approach to the study and documentation of a quite large group of rock art boulders at Khatm al Melaha (Sharjah, United Arab Emirates). More than 150 decorated stone blocks, with almost 400 motifs, have been identified on a hill close to the Arabian Sea coast, highlighting its importance as a control point for communicating the coast and the hinterland. Although a domestic human occupation of the area has not yet been documented, the symbolic significance of this place is reinforced not only by rock art but also by the presence of several dry-stone tombs. Despite the limited studied area, our contribution outlines a preliminary approach to a previously very little studied territory, providing a local chrono-stylistic proposal for those figurative (humans, animals) and non-figurative (signs) engravings attending to different stylistic conventions, techniques, subject matters and varnish colour. Different digital documentation techniques (digital tracings, terrestrial and aerial photogrammetry, web mapping) have been applied in order to create an updated and accurate data corpus allowing future analysis. The ongoing research will try to find new evidence of symbolic occupation of the territory in relation to human settlements and their relationship within a wider landscape.

1. Introduction: on landscape conceptions and rock art

Rock Art has been known to exist in the Middle and Near East since the 18th century (descriptions provided by such travellers as Caignart de Saulcy, Richard Pococke and Carsten Niebuhr), and documented in reports from the late 19th century and early 20th century (A. and W.S. Blunt, J. Euting, Ch. Huber, J.B. Philby, Palmer, Dussaud, Macler) and by scientific fieldwork from the 1930s (Horsefield et al., 1933; Rhotert and Frobenius, 1938), among other studies (al-Hajri, 2003). Nevertheless, Anati was the first to study Middle East rock art from a systematic and global perspective (Anati, 1968a; Anati, 1968b; Anati, 1972; Anati, 1974). Despite that, Middle East rock art is formed by a relatively large and dispersed corpus and systematic studies on the area are still scarce (Betts, 2001; Arbach et al., 2015; Monchot and Poliakoff, 2016; Bednarik, 2017; Guagnin et al., 2017; Olsen, 2017; Charloux et al., 2020), even from a global archaeological perspective: “the significance of the prehistoric archaeological record of Arabia is just beginning to emerge” (Petraglia, 2015: 38).

Although some studies have been carried out on rock art in Arabia

(Al Shahri, 1994; Anati, 1968a; Anati, 1968b; Anati, 1968c; Anati, 1972; Anati, 1974; Bednarik and Khan, 2005; Bednarik and Khan, 2017; Clarke, 1975; Facey, 1987; Fossati, 2015a; Fossati, 2015b; Fossati, 2017; Fossati, 2019; Insall, 2009; Khan, 2007; Khan, 2013; Macholdt et al., 2019; Newton and Zarins, 2000; Preston, 1976; Umm Sinman et al., 2014), those focused on the United Arab Emirates are less numerous (Ziolkowski, 1998; Ziolkowski, 2007; De Ceuninck, 1998; Ziolkowski and Hassan, 2000; Jasim, 1992: 22; Al Tikriti, 2011; Jasim et al., 2016) or even merely almost anecdotal reports (Thomas, 1931: 198).

Rock art in Arabia appears in great stylistic variety with a wide chronological frame and diverse cultural assignment (Adams et al., 1977). Two different rock art areas stand out in the United Arab Emirates: Eastern mountain region and Western desert area (Satchell, 1978), with a larger concentration of engravings in the al-Hajjar mountain range (Ziolkowski, 1996).

The present paper is devoted to the intensive archaeological surveying carried out at Khatm al Melaha (Emirate of Sharjah, United Arab Emirates) between 2015 and 2018. In this time, 368 rock art engravings have been documented in this area, close to the southwest

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border with the Sultanate of Oman (Fig. 1). The engravings were carved on 161 stone blocks with different dimensions and morphologies, which are mostly spread along a 58 m-high isolated slope (AMSL), while some others are distributed on different parts of the hill (Fig. 2). Some of those decorated boulders are in secondary position, having rolled down by natural degradation processes or forming part of some of the structures documented in the area.

Despite the high concentration of open-air rock-art panels, associated archaeological finds are really scarce. Only two small undecorated handmade pottery fragments, a couple of flint flakes and a fragment of a quern were found in a survey. The rock art concentration must be understood from a visual perspective, so from its location, it is easy to understand the N-S communication route (E99 highway), parallel to the Gulf of Oman, as well as the E-W route to the interior through the Wadi al-Hilu (E102 highway), currently connected by the Sharjah-Kalba highway (Angás et al., 2019a; Angás et al., 2019b).

Apart from those artefacts, it is worth mentioning that a large shell-midden was found at the foot of the hill, as well as some circular structures (in different conditions) mainly along the eastern side of the slope, but also at the top of the hill, as well as on the western side. It has not yet been possible to define them as graves, although this association is well defined for some other nearby rock art areas, as in Fujairah (Ziolkowski and Hassan, 2000) or Khatm al Melaha (Jasim, 1992; Phillips, 2018; Angás et al., 2019a; Angás et al., 2019b).

2. Methodology: interoperability of multi-scale geospatial data

The use of a multi-scale methodology has allowed (Angás et al., 2019a) and will allow working with this related information in the same coordinate system. In this way, each of the results obtained on the work scales can be connected for a better global interpretation of the site. The procedure used for recording and identifying open-air rock art should be standardised to provide interrelated 2D and 3D data models in order to establish connections in an archaeological site. Nowadays, Cultural Heritage management requires standardization of processes and data accessibility thus the application of new recording technologies without data interrelation is no longer viable. As a result, we have developed a web repository through multiscale documentation with micro and macro techniques, from the engraved blocks to the archaeological landscape, by using photogrammetry (aerial and terrestrial) at different types of scale and also georeferencing of each decorated site was acquired by Global Navigation Satellite Systems (GNSS) by means of Precise Point Positioning technique (PPP); and photographic documentation on different scales (landscape, block, panel, motive, detail) was used in order to document the engravings and their context (Fig. 3) (Angás et al., 2019a; Angás et al., 2019b). The georeferenced documentation has been made in the UTM zone 40 N EPSG: 32640 coordinate system for each element due to the different techniques used. With this, it has allowed its integration in the same web repository. This factor enables its development at different scales of studies of the entire complex, i.e. at a spatial level by satellite, a statistical study of the panels with rock art and for the digitization of each of the engravings of the stone blocks.

The results in both 2D (web mapping) and 3D (models of each block and the archaeological landscape) are related through spatial logic. The goal was not only to create a recording protocol for conservation but also to use that documentation in order to study rock art from different perspectives: stylistic, thematic, spatial distribution (orientation and elevation), dispersion models and chronological classification. On one hand, documentation allowed the generation of digital tracings of the motifs by means of photogrammetric techniques, which are considered an effective tool for defining motifs, identifying stylistic phases and superimpositions, the connectivity with the volumetric component of the rock, etc, in the first development phase of the project.

Digital tracings were obtained by using *Photoshop*© and *DStretch*© plugin for *ImageJ*©, applying different filters, manual/automatic

selection tools and as many layers as required. This process, generally used in recent rock art studies (Defrasne, 2014; Domingo, 2014; Domingo et al., 2015; Bea and Angás, 2017), is based on author's observation but, despite the implications determined by this method (Le Quellec et al., 2013; Le Quellec et al., 2015), can be defined as a very good approach in terms of the graphical results and preservation of the motifs.

On the other hand, in order to complete the evolution of the archeological landscape, declassified images of the CORONA satellite imagery program were analyzed and compared to historical and archaeological data (Angás et al., 2021). This information from the early 1970s was a prime source for the generation of a Digital Surface Model (DSM) prior to the changes in the current topography. The preliminary results were published (Angás et al., 2019b) and are currently in the complementation phase with the aim of generating a digital model of the terrain from the mid-1970s onwards.

Finally, from this starting point, we have tried to classify the engravings at Khatm al Melaha according to four different parameters: style, technique, subject matter and the colour of the varnish. We have also considered the orientation and elevation of each engraving in the study. For this we have used one of the most common methods is the density-based (DBSCAN) cluster analysis (Fig. 4). This method is used to see and check if certain points or elements are clustered, meaning if they show up multiple times in the same or similar locations. This analysis has been performed for, above all, four different orientations North (N), South (S), East (E) and West (W). DBSCAN is a method for cluster analysis, meaning it can help to identify clusters with the same attributes or simply points. It is based on two parameters: the minimum number of points and the maximum distance between them. For this project, these parameters were consistently set at 3 m for the minimum number of points and 15 m for the maximum distance between them. Thus, there must be at least 3 points with the same orientation (north, south, east, west or horizontal) that have maximally 15 m of distance to one another so that there is a cluster. With fewer than 3 points or if they are more than 15 m apart, the DBSCAN tool does not recognize it as a cluster. A point then belongs to a cluster if it is under 15 m of distance to the next. Although the vast majority are concentrated in the south-eastern part of the hill, it can be seen that there are different clusters of the engravings regarding their orientation and elevation.

3. Engravings

According to the *Dictionary of Art*, 'style' can be defined as "one of the most difficult concepts in the lexicon of art and one of the chief areas of debate in Aesthetics and Art History" (Turner, 1996). Indeed, this term has a quite complex etymology, being applied to many different purposes, but it has been used as "the primary organizing principle and classificatory device" in rock art studies (Francis, 2001: 221).

Apart from terminological and epistemological aspects relating to the convenience or not of using certain terms or considerations about the words 'Art' and 'Style' themselves, frequently discussed in different studies and contexts, we can conclude that they are very difficult words to use successfully, fraught with confusion and subjectivity (Ziolkowski, 1998: 23; Clegg, 1993: 92), so should be used with caution but should not be abandoned.

From our point of view, rock-art studies should look into a way of examining the morphological variations of representations to determine the type of results about prehistoric societies that a stylistic analysis would render. We should investigate which types of formal variables constitute a specific style and try to define the status of the cultural, social and material processes that circumscribe it and materialize it as a cultural characteristic (Roe, 1995: 27; Angás et al., 2019b: 89). The question is to set those goals that let us single out groups of attributes that can be used to identify certain processes from the past (Carr and Neitzel, 1995). We should understand style not only as a means of doing something but rather as the representation of an idea, since the term surpasses its technical specifications (Angás, 2019b: 89).



Fig. 1. Location map of the studied area. The current highways reproduce the old routes W-E and S-N which converge at Khatm al Melaha.



Fig. 2. Khatm al Melaha Hill, where the depictions were engraved, and its surroundings. Arrows show views that correlate to photos below.

Accordingly, we prefer to use the term ‘style’ within a descriptive sense in relation to rock art motifs, essentially focused on morphology or form, allowing us to define visual appearances that could be constant as expressions of individuals or groups framed in more or less specific chronological or cultural periods. That is not an easy approach and poses such questions as: how should conceptual style be differentiated? How should function and technology be distinguished in operational contexts? Which factors determine a style? How important is context in

determining a style? What characteristics of a given style are more or less important when reconstructing processes from the past as well as ancient conditions and social units? (Hodder, 1990; Carr and Neitzel, 1995; Conkey and Soffer, 1997).

Of course, that is a general conception for that term, and it is not always valid. But beyond metaphoric or interpretation reflections and meanings of rock art (Layton, 1991), style gives us a qualitative visual system (Schaafsma, 1985) based on aesthetics that allows us to define

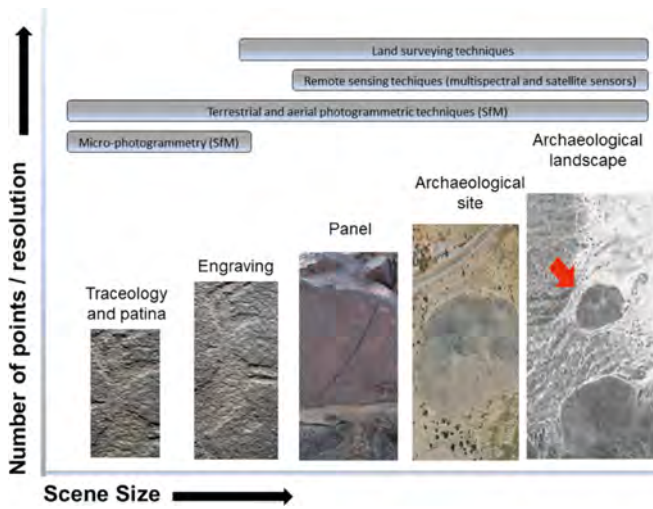


Fig. 3. Analysis of the syntactic interoperability of multi-scale geospatial data for Khatm al Melaha hill.

and organise decoration phases in our study area, taking into account that each style can encompass great variety in regional, geographical or chronological terms (Wintcher, 2011). In this case, we currently only aim to describe forms and not meanings.

Global approaches in stylistic studies could allow a valid overview to be achieved but it might also cover up, or minimise, differences between local or regional groups, emphasizing a false (or at least not real in absolute terms) cultural homogenization. Beyond the validation, or not, of

a global stylistic classification of Arabian rock art (Anati, 1968a; Anati, 1968b; Anati, 1968c; Anati, 1972; Anati, 1974; Khan, 1988; Khan, 1996; Newton and Zarins, 2000; Bednarik, 2017), we have defined up to four different styles in the area of study, some of them with variations that allow subcategories to be discriminated. They can be regarded as descriptive types exclusively based on the definition of attributes Francis, 2001: 236) attending to forms and techniques (Willey and Phillips, 1958) and exclusively related to the rock art at Khatm al Melaha. Thus, the stylistic classification for the motifs has been defined as: Abstract; Schematic; Synthetic, Synthetic Hypertrophied; Stylised and Stylised Hypertrophied. These categories must be understood attending to their morphological values, without any intention to identify human groups or cultures according to particular periods (Lorblanchet and Bahn, 1993; Le Quellec, 2017), something difficult to prove and only for a relative organization of the motifs (always taking into account other complementary data).

Abstract/symbolic, formed by those motifs that cannot be identified by researchers as known objects; elements without a formal connection between signifier and meaning (Lorblanchet and Bahn, 1993). This does not mean that the creators of the petroglyphs would have conceived those motifs as non-representational (Ziolkowski, 1998: 34). In this category, we find sun-like motifs, meandering motifs, parallel lines, circles, concentric circles, semi-circles, cruciforms, etc, together with some that could be interpreted as “wusum” (tribal/ethnic name).

As *Schematic* we define those recognizable figurative motifs depicted with a minimum number of linear traces. The lack of details determines, in many occasions, the impossibility in defining the animal species, so in most cases it is only possible to classify a representation as zoomorph (quadruped) or human. All these cases were depicted by using a direct pecking technique, giving them a rough appearance.

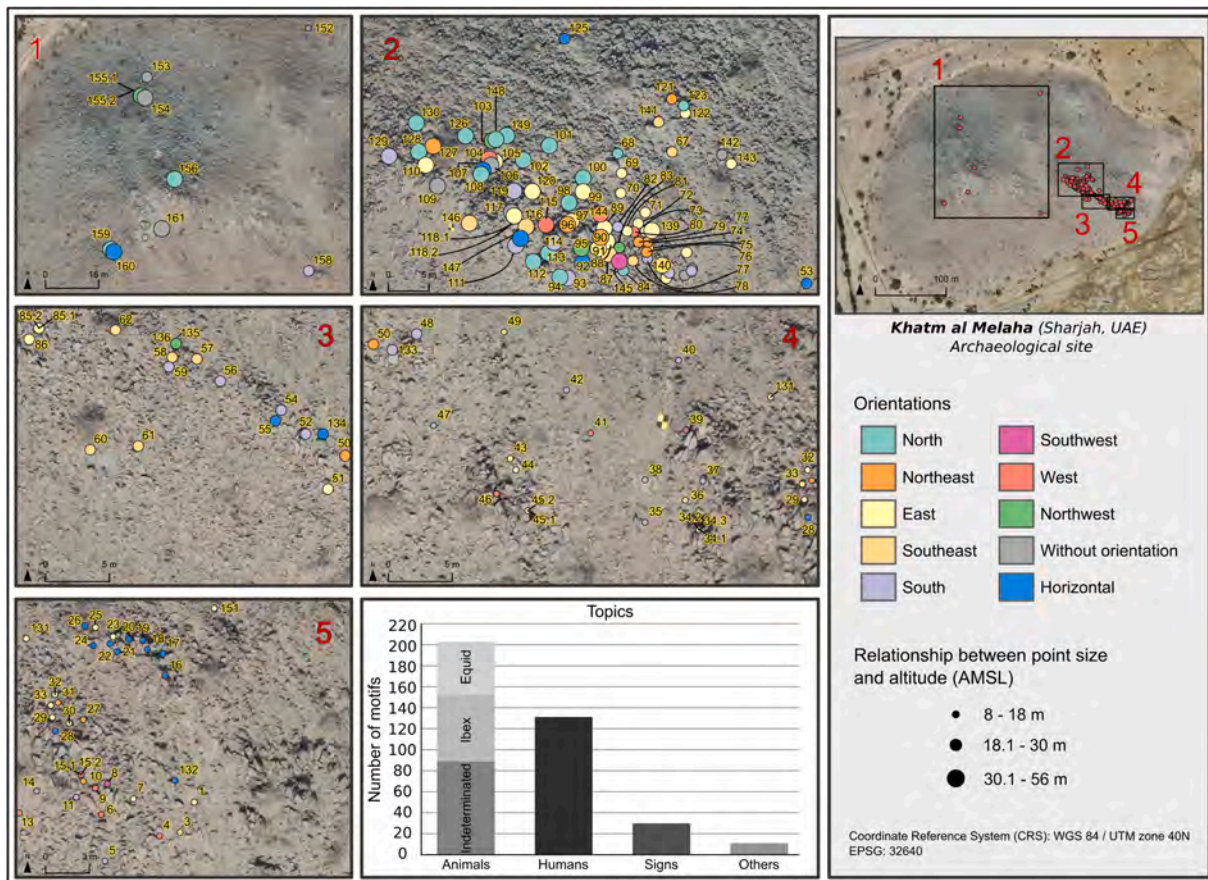


Fig. 4. DBSCAN cluster analysis applied to the highest concentration of engravings based on an orthophoto obtained with low-altitude fixed-wing drone via photogrammetric techniques.

Synthetic are those motifs that incorporate some anatomic details (distinction between different parts of the body and head, legs, ears) and a certainly volumetric treatment of the body, beyond simple linear strokes. However, all those components were depicted in a very simplified way. We have documented different conventions in representing different parts of these motifs, especially in animals. So, attending to a synthetic way of depiction, animals may appear with a more or less ovoid or globular body and two pairs of legs as simple parallel short lines, but also with a particular convention consisting of an arch-shaped body so that the rear leg is compounded by the convergence of the belly and hind-quarter lines.

In some cases, some particular components of the motif appear to be overlarge (abnormal enlargement of the body or horns). These are classed as *Hypertrophied Synthetic* representations.

The fourth, and final category, defined as *Stylised*, is characterised by a more naturalistic form of depiction, with anatomical details (body part differentiation, ears, legs, tails, horns, etc), general good proportions and even elegant. However, this kind of motif does not reach the representational, attractive or realistic level as in, for example, some rock art figures in many other parts of the world (Western Europe Palaeolithic, San Bushman or Spanish Levantine Rock Art, etc). The figures classed in this category seem to have been depicted in a more

dynamic way, with the front legs extended, rampant attitude or even with some singular convention. For example, zoomorphs in Panel ID-091 could be interpreted as equids instead of gazelles (Ziolkowski, 2007: 215), and their apparent horns (curved forwards) could actually be extra-long ears oriented to point of origin of a sound (Fig. 5).

From a technical point of view, these motifs usually display better and more careful treatment, with well-defined edges and polished inner part. Figures can appear only as outlines; with the whole interior pecked; or just the neck and head. In one case some figures seem to have been individualised, as in Panel ID-068 where the inner part of an ibex was filled by small circular cupules while the other specimens were entirely pecked or just outlined.

As in the previous category, some motifs can present an elongated body, with a very thin central part of the trunk and excessively large hind-quarters, and have been classified in a subcategory designated as *Hypertrophied Stylised* (Fig. 6).

In general, motifs in Khatm al Melaha are usually small (<10 cm) or medium size (10–25 cm) (only the zoomorph in ID-158 reaches 50 cm in length) and this characteristic is common to all the described styles. In this initial stage of the study, these categories are merely an approximation and are not expected to fit perfectly into wider chrono-cultural frameworks.

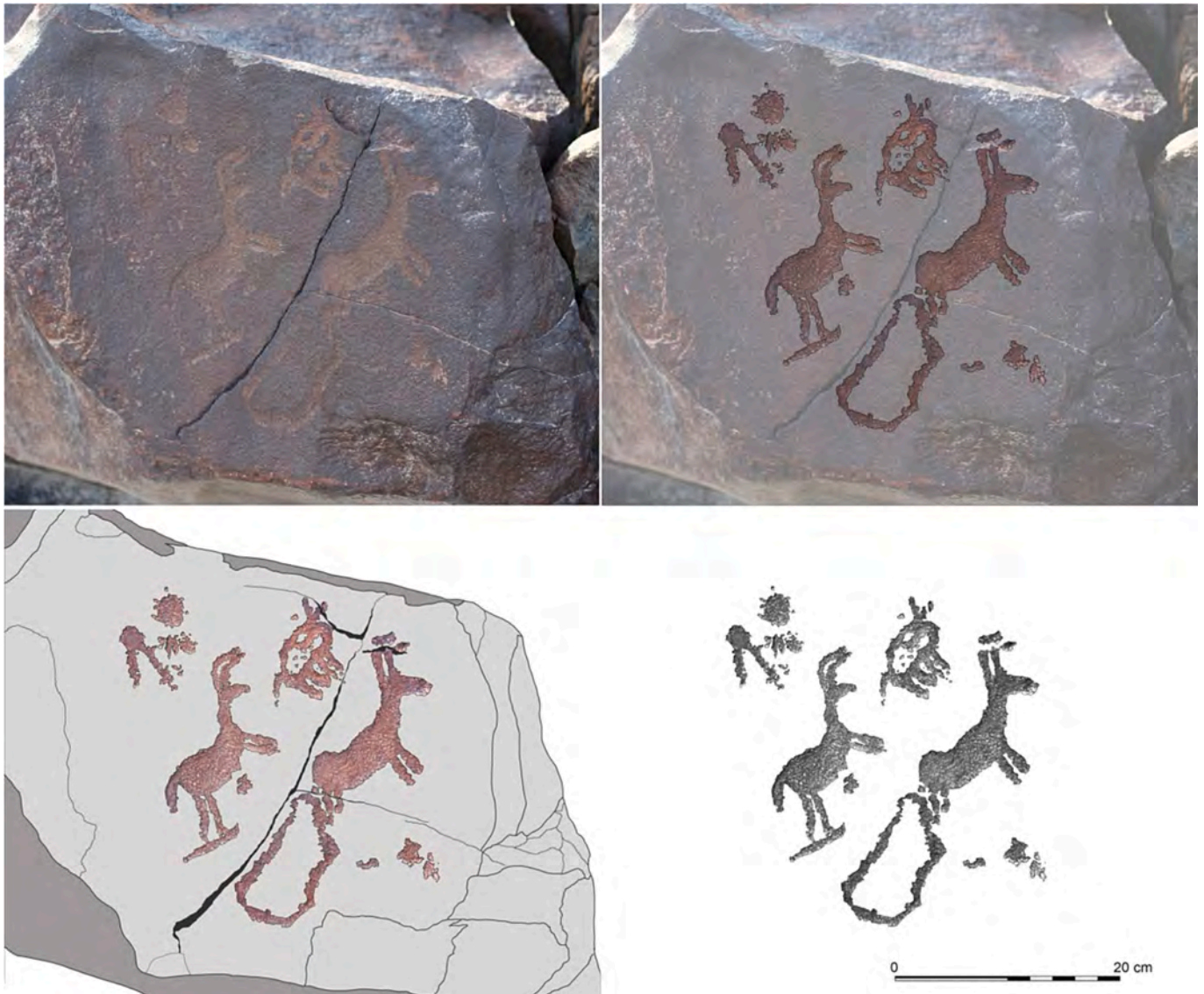


Fig. 5. Picture and digital tracings of ID-091.







Abstract/symbolic	
Schematic	
Synthetic	
Synthetic hypertrophied	
Stylised	
Stylised hypertrophied	

Fig. 6. Preliminary chart with the main styles identified in the area of study.

3.1. Technique

Two main techniques are used in rock art graphic expression: painting and engraving, where the latter is the most common and with a

wider geographic distribution in the Middle East. Regarding the extractive techniques, if engravings, carvings and petroglyphs are understood as synonymous terms, three basic methods can be differentiated: Friction (incision and abrasion or polish); Pecking (direct or indirect percussion); and Drilling. In our limited area of study, we have not documented “incision” in any motif. Direct pecking is the most recurrent technique, as it is in Central Arabia too. It should be stressed that polished engravings (the outline of the motifs seems to have been done with indirect percussion) are relatively well represented at Khatm al Melaha, providing some motifs with better execution and finishing and more careful treatment (Fig. 7). These techniques (percussion and friction) are also the most common in the surrounding territories, as in Wadi al-Hayl (Ziolkowski, 1998: 24).

In any case, motifs show different technical conventions: outline; outline + internal marking; outline + partial infill (head, neck or belly); and whole pecked surface (rough or smooth). For those with internal marking patterns, it is possible to establish three main combination forms: 1. vertical lines from back to belly; 2. vertical and horizontal combined lines; 3. spaced dots. Nevertheless, it is not possible to determine the chronology attending to the technique, so a wide chronological framework has been proposed for directly pecked engravings (from the first phases up to current times).

Future experimental work together with the analysis of the carvings through 3D models would allow us to determine the type of tool used for each technique as well as its material (lithic, metal). Through this study (Zotkina and Kovalev, 2019), it could be possible to build a relative



Fig. 7. Different techniques documented in the Khatm al Melaha engravings: pecking and abrasion.

chronological organisation for the motifs, as another contrasting tool to validate (or not) some other relative classification parameters (style, theme, varnish colour, etc).

According to the varnish colours, four different categories have been defined: 1. A very dark varnish, almost identical to the stone external colour; so it was quite difficult to discern the engravings; 2. Red/Brown; 3. Reddish/orange/light brown; 4. Light/beige colour, contrasting with the dark colour of the stone (Fig. 12). In some cases, light-coloured spots that could be interpreted as carbonate concretions can be observed over the engravings.

3.2. Subject matter

Focusing on the themes, three main elements were represented: signs, humans and, above all, animals (Fig. 8). Among zoomorphs, very few species are depicted: only ibex (identified by their characteristic horns and compact proportions of the body) and equids (ass or horse) can be recognized. Some other figures do not contain enough details to be classified in any animal species, so they remain as indeterminate. It is interesting to highlight that, in a quite large number of cases, the male sex was represented with emphasis and, in some cases, as a long trapezoidal shape, so it could be defined as a penis sheath. These cases could indicate a symbolic treatment of the representation.

Within the total number of animal motifs, those defined as indeterminate are the most numerous (88 graphic units – 23.9%). Nevertheless,

and despite the rough aspect of these figures, they can quite probably be defined as equids. Among the recognizable zoomorphs, ibex is the most abundant (67 graphic units – 18.2%). Some of these representations possess a long pair of curved horns so they could be defined as *Capra ibex nubiana* (Alkon et al., 2008) specimens, a more likely species than *Capra aegagrus* or even domesticated caprids (goats rarely appear in the rock art of Arabia) according to Tchernov (1974: 209 and 243). In any case, in the area of study, ibex were depicted on isolated boulders or at least singular panels, although they also often appear together with human figures (always underlying them) or, less numerous, in groups but never in clear hunting scenes. In fact, ibex is one of the most important iconographic motifs in South Arabia throughout Prehistory, both in Neolithic and in the Bronze Age, and possible earlier (Andreae et al., 2020; Avanzini, 2005). An interesting aspect to be mentioned is that those ibex motifs were usually depicted in a static way, emphasising the horns and their length. In contrast, equids tend to be represented in a more flexible and dynamic way.

Equids form the third most frequent animal group (48 graphic units – 13%) but possibly the most important one from a symbolic point of view and the oldest one according to the dark varnish colour. Equids were depicted following a stylised pattern, with elegant proportions and dynamic attitudes (front pair of legs parallel and extended ahead) as well as using careful and accurate lines to delimit the motif. The technique used was relatively varied but in most cases of a high quality with precise and smooth lines in the outline, and either partial infill or



Fig. 8. Some examples of animal representations at Khatm al Melaha.

covering the whole internal surface. This theme usually appears in isolation, in pairs or even in groups of three but not in larger ensembles and, except in one case (ID-074), they do not share the space with any other figurative representation. However, only equids seem to be related, in some cases, to a particular kind of sign.

Human figures are relatively rare in this area, and only 28 specimens have been documented (7.6% of the engravings). In every case, they can be classified as schematic or synthetic figures, while some of them display a particular convention in the extremities or head. There are very few examples with a dark varnish, so human figures seem not to be generally part of the oldest decoration phase.

The anthropomorphic topic is the second largest group of figurative motifs (Fig. 9). Indeed, this is a special category, where schematic or synthetic conventions are the only ones used; none of these figures display a naturalistic tendency in their forms, not even an approximation as can be documented for animals. Among this category, male figures (with an explicit representation of the sex) seem to be more numerous than females.

In any case, all those motifs were depicted following a rigid pattern (arms crossed or in a diagonal position) and in frontal perspective. In most cases they do not hold any implement in their hands but there are some special motifs (all of them males) with a disproportionate size of the extremities: hands (ID-045.1, ID-46) and in one case the feet (ID-092) or with straight sort lines arising from head (ID-42, ID-46.1, ID-54, ID-92, ID-118.2, ID-143).

There is also another interesting asexual human type classified as schematic but with a partly circular body with a central point inside (ID-009, ID-101) that could be interpreted as a sort of shield or possibly particular clothing.

Signs are one of the most difficult categories to be defined as they consist of a large group of abstract elements, *wusums*, cup-marks, lines, dots or non-figurative motifs (128 motifs, 34.9% of the total engravings) (Fig. 10). They appear isolated or together with other signs but also there are some cases in which signs seem to be consubstantial part of a scene or related to a figurative motif, especially animals. That is the case of the so-called *wustum*, ethnic or tribal marks, normally associated with equid motifs, maybe indicating property.

There is still one special category that cannot be classified in any of the previous ones: feet/sandals and hands. It is not a very numerous topic (only 8 feet/sandals and 1 hand: 2.4% of the engravings) but is worth highlighting these depictions, especially those that appear in

groups (ID-058) and another one in the same panel as an indeterminate animal.

From a general perspective, it is not possible to establish the existence of real scenes; on the contrary most of the panels seem to be merely a juxtaposition of motifs: a composition of a group of figures. Among the engraved panels there are motifs that could share something more than the space, but even in those cases the relationship (action) between them is not clear. There are two cases (ID-034 and ID-054) where a human figure was superimposed on a caprid (Fig. 11.6). Some other schematic human figures (males and maybe one female) could be connected with a herd of stylised ibex running, all of them with the same varnish colour (Fig. 11.4).

In ID-076 a human figure seems to watch a group of equids. The apparently lack of action in the anthropomorph could reveal a marginal role on the scene, but a real one in any case. In some other examples, although it is not possible to determine a clear interpretation, we can infer a symbolic (or maybe just a naturalistic) scene where an animal, or a group of them, seem to walk to or to be associated with a solar or star-like sign: ID-043, ID-056, ID-075 (Fig. 11.1-3).

Clear scenes can only be defined in two panels: ID-074 with a human figure riding a quadruped, killing it (by holding the animal by a horn and using a knife with the other hand) or maybe only appropriating it by grabbing the horn or ear (Fig. 11.5); and Panel ID-068, the panel with the largest number of motifs, where a group of caprids seem to be controlled by different human figures strategically distributed on the decorated surface. It is also remarkable that the fact that, at least, most part of ibex engravings seem to show males, taking into account that only adult males have large horns).

3.3. Varnish

Varnish is defined as a natural desert varnish or coating formed on rock surfaces. It is a worldwide phenomenon especially in desert or arid territories (Dorn, 2006), and has provided interesting results in different areas (Cremaschi, 1996; Watchman, 2000; Dietzel et al., 2008; Macholdt et al., 2019). Patination colour can vary depending on different aspects: individual composition of the host rock, topography, environment, weathering, exposure to the elements, biotic enhancement, erosion, depth of the engravings, surface geometry, orientation of the decorated panel, etc. Owing to these factors, some studies point out that patina cannot be considered a global chronologic indicator (Macdonald, 1996: 171; Bednarik, 2002). Nevertheless, within a very specific geographical area (Khatm al Melaha Hill), for which alteration factors (environmental conditions, type of host rock, exposure to common natural elements, etc) can be assumed to be the same for the whole engraving corpus, we consider that different varnish colour patterns can be considered a valid approach for a relative chronological organization of the motifs on a micro-geographical scale.

Although studies in different parts of the world have focused on dating engravings by analysing varnish (Dorn, 2001; Liu, 2003; Le Quellec, 2004; Dietzel et al., 2008; Whitley, 2012), interesting attempts, some of them quite recent, have applied to Middle East rock art (Betts, 2001: 792; Guagnin et al., 2017; Macholdt et al., 2018; Macholdt et al., 2019; Andreae et al., 2020; Degli Esposti et al., 2020).

4. Results and discussion

4.1. Method and technology results

The preliminary results provided interesting data in two different ways: one strictly technological (Angás et al., 2019a; Angás et al., 2019b); and the other focused on rock art itself. In the second case, as regards the subject matter in terms of the chronological classification, some interesting points can be noted. First, some common themes in many other parts of the Arabian Peninsula are not represented at Khatm al Melaha. These are bovids and camels, both of them assigned to well-

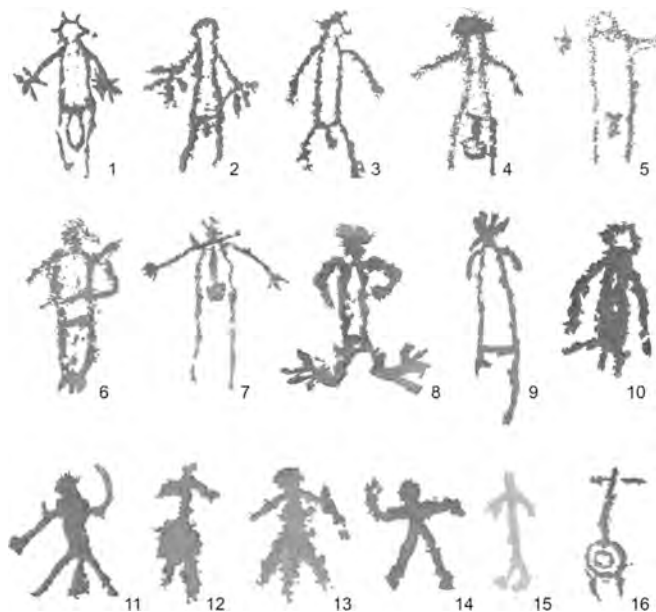


Fig. 9. Anthropomorph figures at Khatm al Melaha.

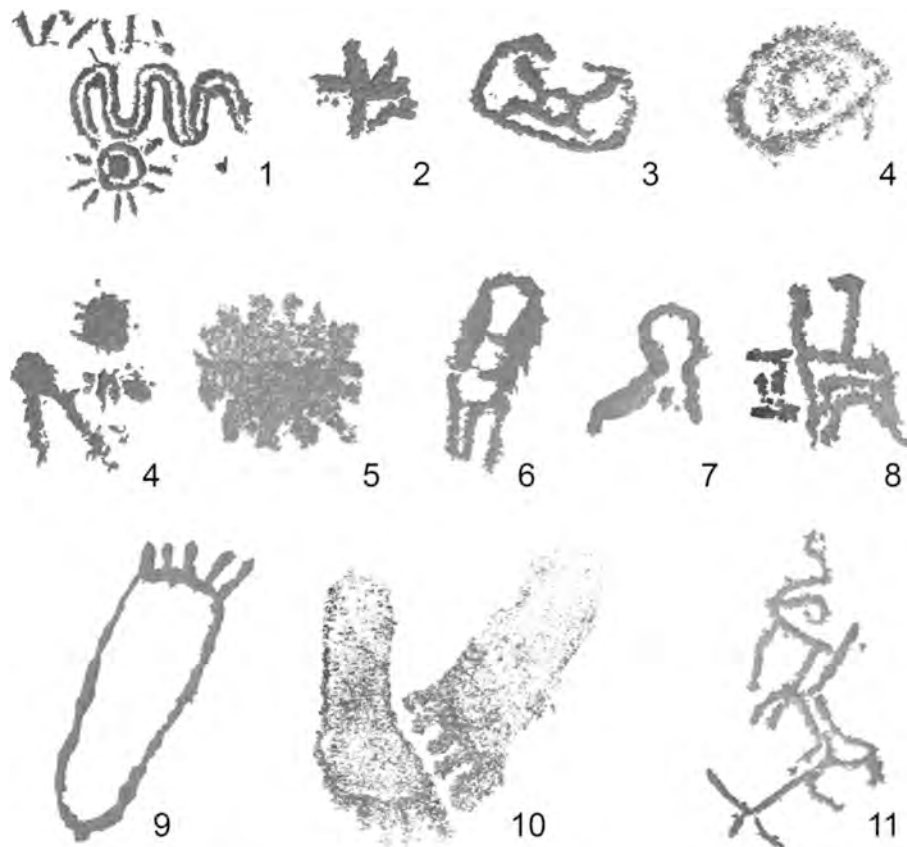


Fig. 10. Different sign categories documented at Khatm al Melaha.

determined chrono-cultural periods: Neolithic for bovids, while camel representations became widespread from the Iron Age in South Eastern Arabia.

Among the studied petroglyphs there are no fat-tailed sheep/goats, which are well-known for recent phases. On the contrary, every anatomical detail seems to point to wild species, characterised by large horns. Thus, Nubian ibexes (with long thin horns which extend up and then backwards and down) are supposed to be depicted in the area of study. According to this interpretation, the represented species indicates some interesting aspects about the environmental context in which the petroglyphs were made. The Nubian ibex lives in desert mountain territories, forming herds consisting of females, young and males up to about three years of age, while adult males tend to be solitary. We can deduce that at the moment in which the ibex motifs were engraved the landscape would be quite similar to the present.

Regarding equid representations, some studies have noted that different species have been bred since the third millennium BC. The use of horses, as an introduced species, is dated in the north and east of Arabia to around the second half of the first millennium BC (Macdonald, 1996: 73). Riding scenes are not frequently represented in the area of study. Only one panel (ID-074) can be interpreted in those terms. Nevertheless, in Wadi al-Helo (only a few kilometres from Khatm al Melaha) there are several horse-riding scenes in which horses share the same stylistic conventions as the Stylised depictions in our area. The study of the engravings at Wadi al-Helo, planned for the next archaeological fieldwork season, will shed light on this question.

In any case, there are no hunting scenes or even anthropomorphs clearly holding weapons (bow, spears, daggers, etc), and equally no conclusive herding or domestication scenes either. Only ID-068 shows a group of caprids associated with several standing human figures in a sort of probable (but not definitive) herding scene.

Regarding the rock art distribution on the hill, the vast majority of

the engraved stones are on the south-eastern slope, following a linear arrangement with a more numerous groups of decorated panels at the top. The location of some of the boulders dispersed on other parts of the slope could be a secondary position due to erosion and rolling. Only six decorated blocks are distributed on other parts of the hill, and just four of them are close to stone-built structures. Although all the different styles are represented across the whole distribution area, we can conclude that “Abstract” and “Schematic” motifs are distributed over the whole area while “Synthetic” and “Stylised” styles seem to occupy, preferentially (but not only), higher places on the hill (Fig. 13).

There are some stone-built structures (walls) and circular dry-stone structures on the south-eastern part of the hill and preferentially at the top. Those constructions have been defined as cairns, although their date and function are unclear (Ziolkowski, 2007: 215).

These kinds of structures are interpreted as “megalithic” tapered constructions or circular dry-stone tombs (cairns) corresponding to the so-called “above ground tomb” type, lightly excavated or not at all. In general, this small kind of burial has been classified as part of the “Hafit phase”, the oldest Bronze Age sub-period in the area (starting about 3100–2700 BCE), with maybe some transitional characteristics to the “Umm an-Nar” (2500–2000 BCE) period for some of those located at the top. Some other parallels documented in proximate areas, at Kalba, are also dated in those periods (Phillips, 2018).

This type of burial (similar both in morphology and distribution on mountain crests or prominent positions) is well studied in relatively near areas, as in Jebel al-Buhais (Jasim, 2018) and all across the Oman Peninsula (Potts, 1990; Bortolini and Munoz, 2012; Deadman et al., 2015; Méry and Tengberg, 2009; Munoz, 2015), and have been interpreted as territorial markers owing to their wide visibility (Cleuziou and Tosi, 2007: 116), occupying mountain crests or the top of elevated areas, particularly overlooking inland oases and coastal plains (Weeks, 2017: 1603). The landscape in Khatm al Melaha seems to be controlled, as a



Fig. 11. 1–3. Animal association with solar signs; 4. Detail of a larger scene where a schematic human figure seems to interact with a group of ibex; 5. Probable riding or appropriation scene; 6. Human figure superimposed on an ibex motif.



Fig. 12. Examples of different varnish colours that point to a possible different chronology for the motifs.

territorial sign of identity, by two of the more important symbolic human creations: rock art and burials, creating a veritable symbolic landscape. After 2500 BCE, with the generalization of the economy of the sedentary oasis, collective burials in high visible places seem to disappear.

In Khatm al Melaha some of the decorated blocks seem to form part of some of the structures, such as a wall on the SE slope of the hill, or occupy places close to the tombs. A similar relationship (structures/rock art) has been noted at Wadi Ashwani (Fujairah), where some stones fallen from the cairns were decorated with schematic petroglyphs (Jongbloed, 1994: 24; Ziolkowski, 2007: 212); nevertheless, the subject matters in the two areas are quite different.

No other archaeological remains were documented on the hill except three small handmade pottery fragments without any decoration, a flint flake and a sandstone quern fragment that were found on the surface during surveying carried out in 2018 and 2019.

5. Conclusions

It must be stressed that this is a preliminary report on the fieldwork carried out in the area, and the science moves slowly. Some new aspects of the research, e.g., related to absolute dating or the modelling of the coastline throughout different periods of Prehistory, are still pending for the new fieldwork season. Nevertheless, this research provides some

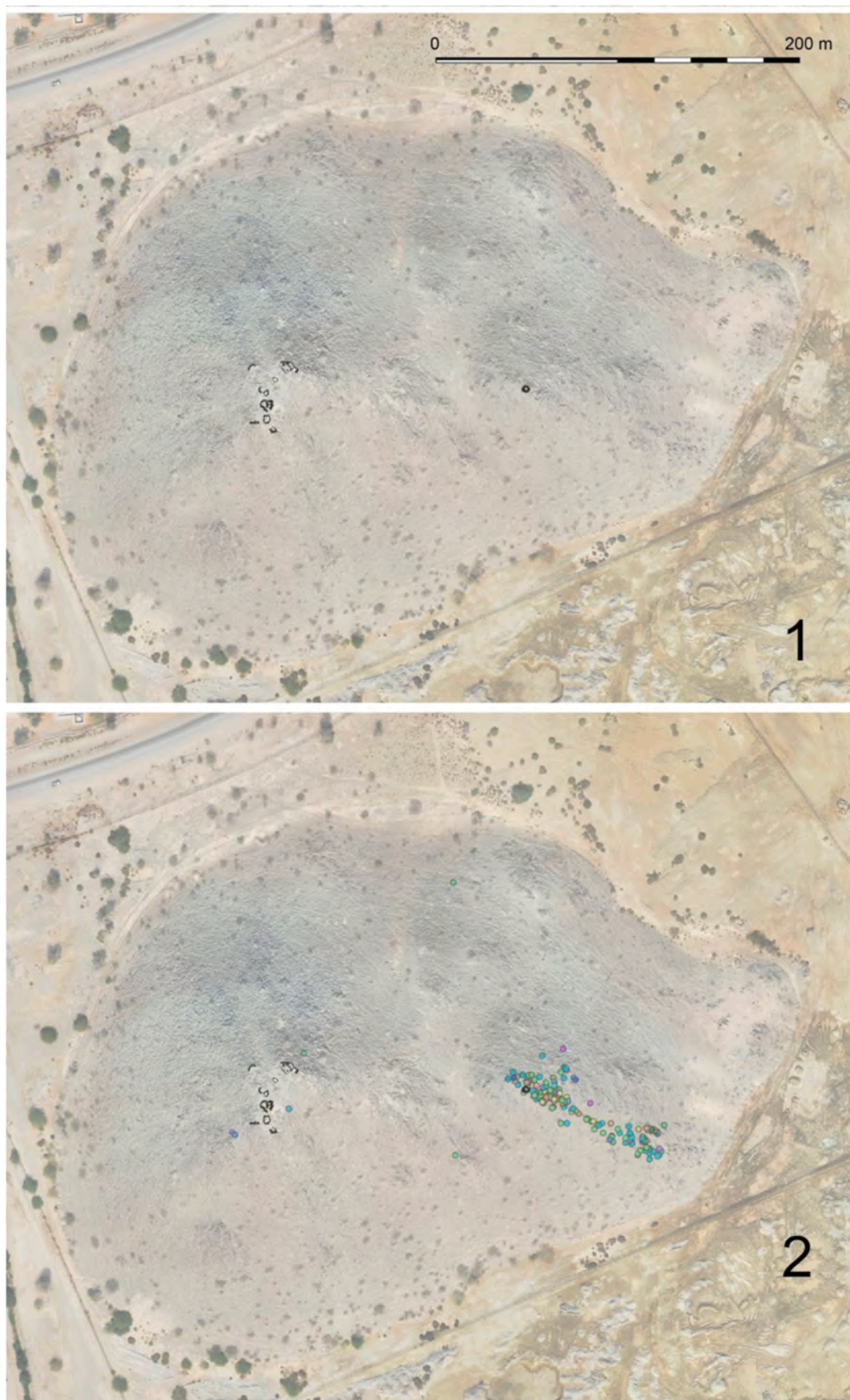


Fig. 13. Distribution of the circular stone-built structures in relation to the decorated panels: 1. Stone-built structures; 2. Stone-built structures and engraved panels.

interesting results in terms of the documentation methodology: integration and analysis of the data in the three surveys carried out. In consequence, this paper proposes, in the first place, an approach to the generation of a 2D and 3D online data repository in order to investigate common stylistic patterns of engravings, dispersion models and detailed study of each of the engravings through a common web page. Secondly, the objective is to find a method that allows the integration of interrelated models at different scales through a web platform (*threeDcloud*) without the need for additional software or plugins. Finally, the integration of all these geomatic techniques will allow us to advance in preventive control, conservation and interpretation of the rock art. The multi-scale analysis procedure - still in the work phase and under continuous review - has allowed the integration of a spatial logic in each of the analyses carried out and, without a doubt, we believe that it is the only way that this site can be analyzed and investigated in the future, using either micro- and macro- spatial logic. The studied rock art ensemble is lacking the spectacular compositions in other Arabian areas. We cannot find complex hunting or pastoral scenes (except possibly in ID-068), depictions of conflicts between riders or warriors, or those impressive motifs from the “oval headed” or “long haired” people typical from some other territories (Anati, 1968a; Jung, 1991; Khan, 1998). Animal species represented are not diverse, so dromedaries/camels, carnivores (lion, hyena, wolf, etc), *Dama dama*, *Sus scrofa*, domesticated or wild bovines (Ox; *Bos taurus mesopotamica*; *Bos indicus*, etc) or other well-defined species (e.g., fat-tailed sheep) were not represented. Neither are there representations of recognizable objects (weapons, decorative elements, etc) or clear inscriptions.

Indeed, Khatm al Melaha presents a quite reduced repertoire in which equids and ibex are featured. Nevertheless, specifying the animal species through rock art engravings is quite complex but some studies point to *Capra ibex nubiana* as the more probable species (Tchernov, 1974: 209) at the expense of *Capra aegagrus*, *Arabitragus tahr* or even domesticated livestock, since goats rarely appear in the rock art of Arabia (Tchernov, 1974: 243). However, panel ID-068 represents a probable domestication scene, which is a quite interesting novelty for the rock art in the area.

Different possible equid species might be represented: *Equus caballus*, *Equus asinus* and, based on the fauna present in Arabia during the Holocene, also *Equus africanus* and *Equus hemionus*, the only one wild equid species in Arabia until the introduction of domesticated horse (Rachad, 2007: 76; Monchot and Poliakoff, 2016: 84). These specimens were commonly represented in Neolithic rock art (Guagnin et al., 2020; Olsen, 2013) and appear as hunted species in some sites, as in Shuwaymis and Jubbah (Macholdt et al., 2018). Attending to the morphology of the documented representations (especially to the long ears) they could be interpreted as asses, although from a symbolic point of view it has been pointed out that horses could be considered a symbol of prestige, whereas asses never gained an importance equal to that of the horse (Tchernov, 1974: 247). Regarding this second possibility, it has been noted for some other rock art groups in Arabia that *wusum* or ethnic symbols (like those documented in our area) are usually associated with horse motifs (property/family/ethnic mark?) an aspect that, together with the introduction of horses into Arabia in recent times (Monchot and Poliakoff, 2016; Olsen, 2017), should determine a recent chronology for these engravings. Nevertheless, according to our observations, equid engravings at Khatm al Melaha could be perfectly interpreted as wild asses, an animal species well adapted to desert environments, and this matches an older chronology than the one considered for the introduction of horses in Arabia. An older dating for this topic (and its identification with donkeys) could also be pointed out by focusing in the fact that domesticated horse never was represented isolated, as it is our case in Kalba, but together with human riders (Monchot and Poliakoff, 2016: 84).

Considering that some of the motifs (especially those ibex representations) could have been created over a long period of time in a wide territory (Levant and Arabian Peninsula (Eisenberg-Degen and Rosen,

2013; Guagnin et al., 2020; Khan, 2007), we can suggest a relative and very preliminary classification for the rock art at Khatm al Melaha:

1. The oldest phase, with the darkest varnish colour, characterised by zoomorph motifs (especially equids and, to a lesser extent, also ibex or some other motifs) in a Stylised style made with a high-quality technique, well defined edges and polished infill. Some of the equid figures seem to be related to signs or *wusum*. There are also a few special motifs, such as sun-like figures, meanders, concentric semicircles or even feet in the same dark varnish colour. Some of these motifs, especially ibex-like figures with parallels in different areas of Arabia (Insall, 2009; Khan, 2013; Fossati, 2015a; Fossati, 2015b), have been classified at the earliest decorative phases in some other areas (like Oman), so Fossati (2015a: 2) proposed that they were probably made in the fourth millennium BC by hunter groups.
2. In the second phase there is a predominance of animal representations, although human figures seem to gain importance. In most cases, these motifs are a red-light brown colour and were depicted in a Synthetic style, with different variants (two pair of legs or legs grouped forming an arch-like shape). Technically, all these motifs display a poorer degree of quality, using only the pecking technique for outlining or depicting some internal markings.
3. The last phase is formed by those figures with lighter colour varnish, coinciding with Schematic and some Abstract motifs (animal, human and signs). These figures would be part of a more recent phase, as it was also proposed for the rock art in Oman (Fossati, 2015a; Fossati, 2015b).

Nevertheless, establishing an absolute chronological classification for the rock art at Khatm al Melaha is evidently difficult, or even impossible at the moment. According to previous studies, some of the motifs documented at this area could be dated in the Iron Age, that is the case of “snakes” and “ovoid” (foot) motifs (Ziolkowski, 2007: 221), since some of them (snakes) were only engraved during the Literate and Islamic periods (Tchernov, 1974: 250). Nevertheless, if we consider the dark varnish colour for those representations, especially for ID-045 (site 20: Khor Kalba (B), P6 after Ziolkowski’s study) we might suppose a relatively old date for them or, at least, that dark varnish can be formed in relatively recent times (Fig. 14). Therefore, if the Iron Age date for these motifs (snakes, horses) is valid, we must assume that the rest of the motifs should be more recent. However, that would not be compatible with the structures related to the rock art nor with the rest of the represented themes. As mentioned above, some rock art blocks form part of or seem to be related to the stone-built structures. Although the age of those structures is unclear, and recent research in NW Arabia points out also a date from Neolithic to recent past (Thomas et al., 2021), a Bronze Age chronology is generally accepted for them, so at least part of the rock art in the present area of study could be dated in that period.

Undoubtedly, it is difficult to propose a chronological classification for rock art in the United Arab Emirates. Most of it was considered to be undated or just broadly dated until not too much time (Betts, 2001: 812), being difficult to date Khatm al Melaha rock art group due to the subjective and almost always imprecise dating (Betts, 2001: 791). Nevertheless, this panorama has changed in recent years, at least from a general point of view focused on the Arabian Peninsula, thanks to recent studies and different dating methods or classifications (Eisenberg-Degen and Rosen, 2013; Khan, 2013; Arbach et al., 2015; Monchot and Poliakoff, 2016; Olsen, 2017; Macholdt et al., 2019; Andrae et al., 2020; Degli Esposti et al., 2020; Guagnin et al., 2017; Guagnin et al., 2020), questioning previous Anati’s chronological approaches (Betts, 2001; Bednarik and Khan, 2005; David and McNiven, 2018). In our study, the proposed stylistic organization must be understood as a mere classification tool not as a chrono-cultural assignment. Nevertheless, we can suggest a preliminary and generic development for Khatm al Melaha rock art at least from the Neolithic-Upper Bronze Age with a persistence, at least, in the Iron Age, based on:

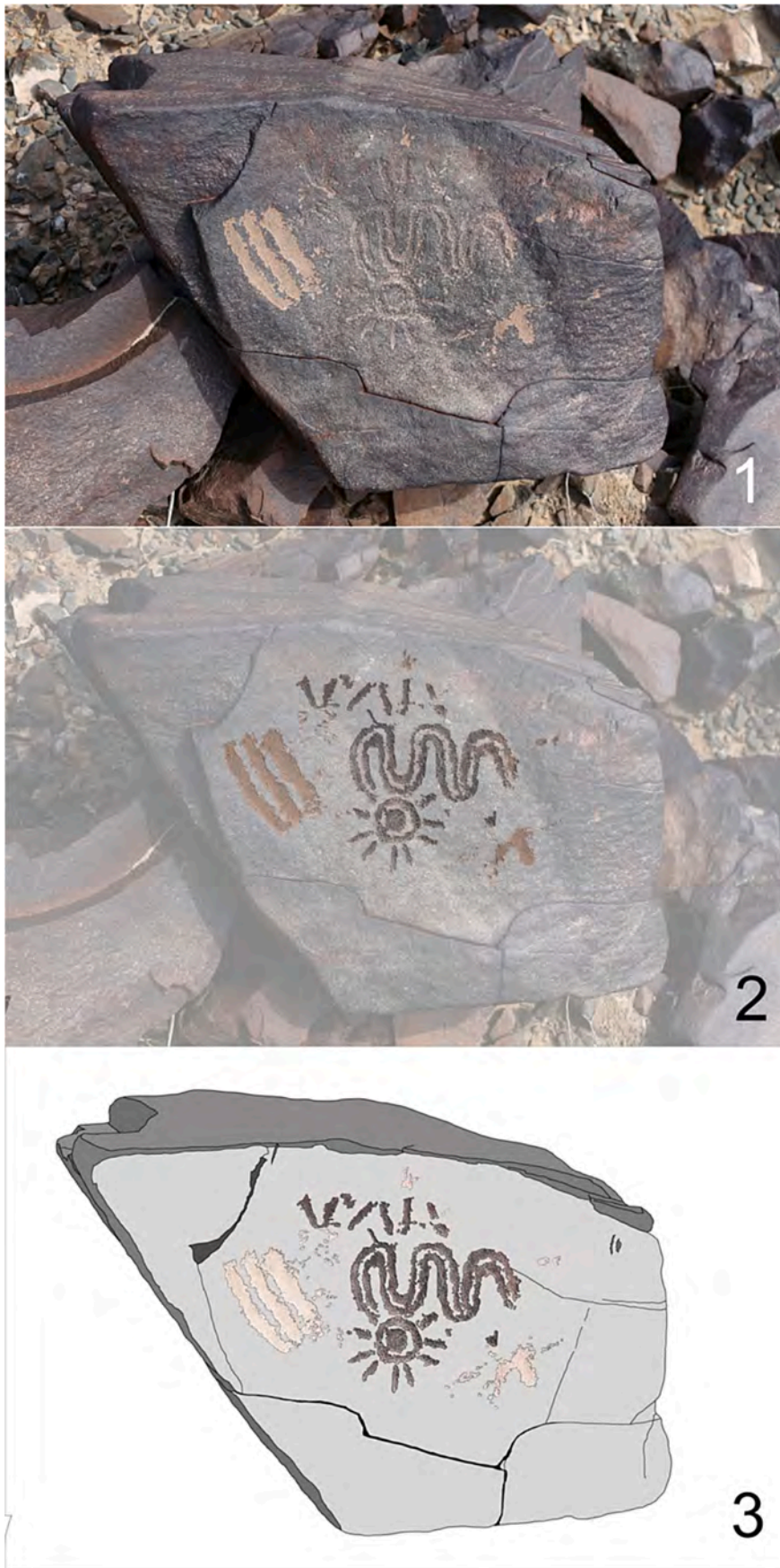


Fig. 14. ID-045, abstract motifs: 1. Photograph; 2 and 3. Digital tracings.

- Subject matters depicted: despite the lack of cattle representations, that should be related to a more humid climate (Anati, 1972; Garrard et al., 1981; Khan, 1998) and normally assigned to the early Holocene (Magee, 2014) and Neolithic (García and Rachad, 1997; Le Quellec, 2017; Rachad, 2007; Bednarik, 2017) the main animal species represented (ibex and equid, especially adapted to arid and rocky environments) (McCorriston and Martin, 2009: 241), could also be common during Holocene Humid Period or even evidences of domestication for caprines could also point out earlier dates in Arabian Peninsula, between 6.800 and 6.200 BCE (Drechsler, 2007; Drechsler, 2009). In any case, as it is in some other areas of the Arabic Peninsula, ibex motifs were depicted throughout a wide period of time with different significance in each moment (Eisenberg-Degen and Rosen, 2013). The domestication of equids seems to be more recent in eastern Arabia, dated in the late 4th and early 3rd millennia BP (Driesch et al., 2008; Uerpmann and Uerpmann, 2012a; Uerpmann and Uerpmann, 2012b; Magee, 2014; Guagnin et al., 2020) or even later (Olsen, 2017). In those cases, domesticated horses appear always in relation to riders (Monchot and Poliakoff, 2016), so for Khatm el Melaha, equid motifs without riders seem to represent wild species and could indicated a Neolithic (or even pre-Neolithic) chronology.

- The regional arid phase during the Bronze Age (ca. 4300–4000 BP) (Parker and Goudie, 2008) could have caused a propitious environment for the expansion especially of ibex, providing a *post-quem* dating for these representations or an even more recent one for domestic equids.
- The closest archaeological context is also based on the Bronze Age tombs documented on the same hill, but taking into account a wide chronological frame for these structures (from Neolithic to recent times) in other Arabian territories.
- Schematic motifs with a freshly pecked varnish should be classified in a generic Iron Age phase, indicated for some other nearby areas (Bednarik, 2017; Guagnin et al., 2017: 145; Jasim, 1992: 23), considering that they could have persisted until very recent times.
- The reality observed at Khatm al Melaha seems to be more complex than the one pointed out by Anati. Different styles seem to have been depicted in the same scene at the same time (i.e., schematic + synthetic or stylised + abstract) if we consider not only morphological characteristics but also technique and varnish color.

As we have stressed, this is a preliminary report on the first documentation fieldwork carried out at Khatm al Melaha. The large number of decorated panels and engraved motifs emphasizes the complexity of the study, its lengthy occupation during different chrono-cultural phases (multi-period panels), but also its importance, especially its connection with tombs. Symbolism (rock art and mortuary context) and geographic strategic emplacement, near the coastline and on a communication route to the interior (favouring human movements, cattle-caprine routes or hunting and seafood resources), allow us to consider this place as a relevant point on the map.

This is only an initial study on a very specific area and the information provided by rock art is still scanty. Fitting it into the global horizon of rock art and human occupation in this part of the Arabian Peninsula will be our next step.

CRediT authorship contribution statement

Jorge Angás: Conceptualization, Investigation, Writing - original draft, Methodology, Software. **Manuel Bea:** Conceptualization, Investigation, Methodology, Writing - original draft. **Sabah Abboud Jassem:** Project administration, Funding acquisition. **Paula Uribe:** Methodology, Software, Writing - review & editing. **Mercedes Farjas:** Project administration, Investigation, Writing - review & editing.

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