ARABIAN ARCHAEOLOGY AND EPIGRAPHY

The PalaeoEnvironments and ARchaeological Landscapes (PEARL) project: recent findings from Neolithic sites in Northern Oman

Journal:	*Arabian Archaeology and Epigraphy*
Manuscript ID	Draft
Wiley - Manuscript type:	Original Article
Date Submitted by the Author:	n/a
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Keywords:	Neolithic, Holocene, Oman, Palaeoenvironments, Excavation
Abstract:	The PalaeoEnvironments and ARchaeological Landscapes (PEARL) research project is a joint German-British project with the principal objective of developing a framework of past human occupation and landscape change in Southeastern Arabia. Fieldwork during 2018 and 2019 involved the systematic survey and excavation of sites in the Rustaq and Ibri regions of Northern Oman, with the aim of establishing the nature and timing of human occupation and landscape change during the Early Holocene period (ca. 10-7,000 years BP). Further to the findings previously reported, results from recent excavations of the site Hayy al-Sarh in Rustaq revealed the presence of animal remains, stone and shell beads and stone structures, indicating a large Neolithic settlement with burial areas. In addition, preliminary excavations at a rock shelter site near Ibri have revealed stratified archaeological remains, including a Fasad type assemblage. Future fieldwork will further develop archaeological and palaeoenvironmental records to help build a framework for studying cultural and natural developments in northern Oman.

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The PalaeoEnvironments and ARchaeological Landscapes (PEARL) research project is a joint German-British project with the principal objective of developing a framework of past human occupation and landscape change in Southeastern Arabia. Fieldwork during 2018 and 2019 involved the systematic survey and excavation of sites in the Rustaq and Ibri regions of Northern Oman, with the aim of establishing the nature and timing of human occupation and landscape change during the Early Holocene period (ca. 10-7,000 years BP). Further to the findings previously reported, results from recent excavations of the site Hayy al-Sarh in Rustaq revealed the presence of animal remains, stone and shell beads and stone structures, indicating a large Neolithic settlement with burial areas. In addition, preliminary excavations at a rock shelter site near Ibri have revealed stratified archaeological remains, including a Fasad type assemblage. Future fieldwork will further develop archaeological and palaeoenvironmental records to help build a framework for studying cultural and natural developments in northern Oman.

Key words: Neolithic, Holocene, Oman, palaeoenvironments, excavation

Introduction

The PalaeoEnvironments and ARchaeological Landscapes (PEARL) research project is a joint German-British project with the principal objective of establishing a framework for studying prehistoric human occupation history and its relationship to paleoenvironmental change in southern Arabia. This objective is underpinned by the development of securely dated archaeological and palaeoenvironmental records, which together will provide important information regarding the relationship between climatic/environmental change and human prehistory in arid zones. While the scope of the PEARL project geographically includes the entirety of southern Arabia (U.A.E, Oman), and chronologically includes records from both the Pleistocene period (> 12,000 BP) and the Early to Mid-Holocene (ca. 12,000 to 4,000 BP), we focus in this paper on the latter period and records from Northern Oman. Here the sites of Hayy al-Sarh – a stratified Neolithic site near the town of Rustaq and IB19 – a rock shelter sequence near the town of Ibri, form the basis of the PEARL project's current research on the Neolithic in the region. While the project is in it's early stages and as such, final conclusions from these records remain untested, we believe that the information gained thus far can be used to explore potential implications within a wider context in inter-regional palaeoenvironmental and archaeological investigations.

Project Background

The Early Holocene/Neolithic period is generally well understood with respect to chronology and material culture in comparison with other archaeological periods in Southeast (SE) Arabia (Charpentier 2008, Uerpmann et al. 2013, Crassard and

Drechsler 2013). Similarly, the palaeoenvironmental record for the region is also well developed, and indicates a widespread increase in rainfall from ca. 10 ka leading to an increase in freshwater availability and subsequent rise in terrestrial net primary productivity (e.g. Parker et al., 2006; Fleitmann et al., 2007; Lézine et al., 2010; Preston et al., 2015). While there is broad agreement that improved (wetter) climatic conditions would likely have facilitated inter-regional biogeographic connectivity during the Early Holocene, a number of key issues remain unresolved. In particular, the Palaeolithic/Neolithic transition and associated shift in subsistence strategies is poorly understood, as are the relationships between coastal and inland sites, and the responses of communities to climatic variability (Crassard and Drechsler, 2013).

These gaps in our knowledge are inherently linked to scalar issues of spatio-temporal resolution. Principally, the spatial distribution of both archaeological and palaeoenvironmental sites across the region is intermittent and insufficient for resolving questions of landscape change/usage and subsistence strategies. In particular, data from stratified inland sites are distinctly underrepresented in comparison with evidence from coastal regions, where the vast majority of the region's excavated sites are located (Mery and Charpentier, 2013). Existing data from inland sites in SE Arabia (e.g. Uerpmann et al., 2000; 2013; 2018; Kallweit et al., 2005; Lemée et al., 2013; Rose et al., 2014) suggest repeated phases of occupation of the interior between the 9th and 5th millennium BC, interspersed with phases that lack evidence for human occupation (Drechsler, 2010; Uerpmann et al., 2013). The absence of evidence, however, should not be taken as evidence for absence; while climatically mediated landscape changes may have played an important role in demographic variability during the Early Holocene period, at present, large spatial gaps in our understanding of site distribution patterns remain. A key objective of the

PEARL project, therefore, is to address this issue through the identification and investigation of sites within a range of inland geomorphic settings, which may then be placed within a local-regional framework of landscape and resource change.

In order to develop this framework, a greater range of palaeoenvironmental sequences than currently exist, are required from regions such as Northern Oman. While the speleothem record from Hoti Cave provides an excellent master record of Indian Ocean Summer Monsoon (IOSM) variability (e.g. Fleitmann et al., 2007), there is currently a paucity of environmental data that provide information about the way in which the landscape of the region has responded to climatic changes during the Holocene. The geomorphic setting of SE Arabia is remarkably varied, and during the Early Holocene would have comprised a mosaic of habitats and ecotones featuring mountainous regions, well-watered alluvial plains, savannah grasslands, stable dune fields and productive coasts. Depending upon the spatial and temporal variability of seasonal rainfall, these regions would have periodically been hydrologically interlinked, affording greater biogeographic connectivity and resource availability. In the present day, SE Arabia is characterised by steep rainfall gradients across a range of landscape settings: Daqeeq in the Northern Oman Mountains is in receipt of 175.4 mm mean annual rainfall, while desert regions of the UAE receive 74.9 mm (Kwarteng et al., 2009; Sherif et al., 2014). Such climatic and geomorphic variability has led to a great diversity of biogeographical distributions and centres of endemism, with the Western Hajar Mountains being one of the richest floristic regions within Arabia (Patzelt, 2014). The region is currently home to 24 endemic plants species including evergreen woodland communities indicative of a former continuous belt of xeromorphic woodlands (Patzelt, 2014), and three species of freshwater fish endemic to mountainous wadis and pools (Feulner, 1998). It is possible, therefore, that

favourable environmental conditions may have facilitated occupation continuity in some regions of SE Arabia during the Holocene. Consequently, detailed records of geomorphic and ecological variability from a range of landscape settings are critical for our understanding of changes in past resource availability. To achieve this, a second key objective of PEARL is to adopt a 'source-to-sink' approach when conducting palaeoenvironmental investigations, whereby evidence of landscape change and ecological variability from proximal, medial and distal settings within regional catchments is reconstructed.

Systematic survey and excavation conducted within Northern Oman during 2018/19 identified Early Holocene and Neolithic surface and stratified sites, including Hayy al-Sarh in Rustaq (Bretzke et al. 2018) and IB19 near Ibri (Fig. 1). Excavations at both sites, along with geoarchaeological and palaeoenvironmental analyses are ongoing, and will be successively reported in future publications.

Rustaq

Regional Landscape and Palaeoenvironmental Setting

The town of Rustaq is situated along the foothills of the Western Hajar Mountains, which are dominated by the Semail ophiolite nappe, and run in a parallel arc to the coast of the Gulf of Oman. Weathered material from the mountains is the predominant sediment source for much of the alluvial plain immediately north of the town, with rainfall across the mountain catchment activating the northeastwards flow of surface and subsurface drainage towards the coast. The town of Rustaq is situated within the proximal alluvial fan zone, where relict landforms indicate a substantially wetter

climate than that of today. These occur as a series of small hills extending northeastwards from the mountain front and comprise coarse, poorly sorted, highly cemented polymict conglomerates. These earliest deposits have been altered by subsequent fan aggradation and channel flows, which are found either banked against the side of the older, larger fan system, or have incised through the relict fan lobe to leave terraces of stacked fan channel sediments immediately adjacent to the modern channel floor. The Neolithic site Hayy al-Sarh (Fig. 2) is located at the base one such channel ridge. Adjacent to these are a series of younger (likely Mid-Late Pleistocene) terraces upon which Neolithic material has been identified, and on which the Hayy al-Sarh site is located. These terraces were also observed within the proximal fan zone as stream flow and sheet-flood sediments. They are typically characterised by fining-up sequences and channelized beds of gravels and gravelly sand, underlain by a thick sequence of silt-sands. The fining-upwards of sediments from gravels to sand is indicative of the waning of alluviation, following a steady decrease in rainfall across the region.

Adjacent to the main channel, and approximately 3 m lower than the terrace on which Hayy al-Sarh is located, a small conglomerate terrace (HAS19) was identified (Fig. 3). Geomorphological investigation suggests that the terrace represents a phase of Holocene channel aggradation, based on relative position to both the main channel (i.e. the most recent 'wet phase') and that of the large Pleistocene terrace to the south. Given this, and the presence of the Neolithic site of Hayy al-Sarh, the small terrace section was logged in the field with samples extracted for optically stimulated luminescence (OSL) dating and palaeoenvironmental analyses. The sequence at HAS19 S1 comprises a ca. 4.5 m section of stratified fluvial gravels and palaeosols, indicative of braided channel flow and incipient soil formation in the Rustaq region

during the Holocene period. Samples for luminescence dating were obtained from within the main palaeosol so that a chronology for hydrological changes during the Holocene can be developed. Given the paucity of terrestrial Holocene palaeoenvironmental records in Northern Oman, developing a record of hydrodynamics for the region for this time should be considered a high priority. Further fieldwork will seek to expand upon the work conducted in the Rustaq region, and extend geomorphological investigations towards the medial and distal parts of the alluvial plain.

Hayy al-Sarh: Preliminary Results

Bretzke et al. (2018) have recently introduced the site and provide details on its archaeology as well as chronology, from which we summarize here. Excavations at the site recovered two archaeological horizons (AH I & II). AH I contains artifacts indicating typical Arabian Neolithic bifacial reduction likely related to the Suwayh culture defined by Charpentier (2008). AH I also contained pierced marine shells probably of the species *Polinices mammilla*, which date the occupation between 7,500-7,000 years before present. AH II currently remains undated. Searching the surface adjacent to the excavation, the team observed potentially artificial accumulations of larger stones. Their function remained unclear, but the team decided to excavate them in the following season.

Fieldwork in 2019 revealed the multifunctional character of the site, which is likely composed of a settlement area and an area related to burial activities. Three of the previously observed surface stone structures were selected for excavation. While excavations could not securely identify a function of these structures, two of these

stone features produced archaeological remains embedded in the excavated sediments (Fig. 4). The majority of these come from excavation of a roundish accumulation of bigger (>20 cm) stones located at the foot slope of the terrace forming the western end of the site. Besides unspecific stone artefacts, these include a stone hemisphere, pierced shells from two new species and animal remains (Fig. 4). All these finds fit well with known assemblages from the 5th to 6th millennium BC. At a depth of about 10 cm below surface, a second stone accumulation was recovered. This comprised a roundish structure resembling a tomb (Fig. 4). Since this was discovered on the final day of fieldwork, it was decided to protect this finding for future work by re-filling the trench.

Ibri

Regional Landscape and Palaeoenvironmental Setting

The hydrology of the Ibri region is dominated by the Oman Mountains, which are composed of Mesozoic rocks of the Neotethys margin, Late Cretaceous-Paleogene thrust faults, Paleogene sediments and post-orogenic faults (Glennie et al., 1974; Lippard et al., 1986; Searle and Cox, 1999; Rodgers and Gunatilaka, 2002). Weathered material from the mountains is the dominant sediment source for much of the geomorphology surrounding in the area, while rainfall across the mountain catchment activates the flow of surface and subsurface drainage towards the Rub al Khali and the Umm as Sammim. In order to construct a framework of climatically driven landscape change for the region, initial field survey focused on a geomorphological analysis of landforms extending southwest from the Ibri piedmont region in proximal and medial locations, and identifying and logging sedimentary

deposits suitable for future palaeoenvironmental reconstruction and dating. Field survey during 2019 identified at least two distinct phases of alluvial fan and drainage activation in the Ibri region. The oldest evidence of alluvial fan drainage activation is found within the medial alluvial zone approximately 20 km from the mountain front, where relict landforms indicate a substantially wetter climate than that of today. These occur as a series of sinuous, low hills inverted relative to modern drainage, which extend southwestwards from the mountains and comprise coarse, poorly sorted, highly cemented polymict conglomerates. Within the proximal zone, an area of dark, indurated gravel terraces were identified ca. 500 m from the mountain front. These comprise stratified sequences of conglomerates and palaeosols that have been incised by more recent flow, and represent a more recent phase of drainage development than that observed within the medial zone. A ca. 7 m sequence (IB19 S1) (Fig. 3) adjacent to the Ibri Sports Ground was logged in the field, with block samples extracted for OSL dating.

The sequence at IB19 S1 represents the development of extensive grasslands and fluvial systems under much wetter conditions than those of today. The thick palaeosol units within the sequence represent generally well-developed aridisols that would likely have formed over several hundred, if not several thousand years. In addition, evidence of channelised flow indicates the extension of rivers from the mountain front. The sequence of landscape changes at the site, therefore, indicates the periodic extension of rivers within the Ibri region, followed by either a reduction in discharge or the avulsion of channels and the subsequent development of grasslands. The wider feature, of which IB19 S1 is just a part, was mapped with further exposures logged for possible future analyses. Future work will include investigations further south towards the Rub al Khali to establish the extent of channel flow, and also within the upper

catchment/source area. The development of a chronology, combined with palaeoenvironmental data will represent the first such study from the region and as such, is considered a high priority, and particularly in light of the recent archaeological studies outlined in this report.

Ibri Rock Shelter: Preliminary Results

In 2019 excavation commenced at a rock shelter site identified in 2018. This rock shelter is located around 8 km west of the centre of Ibri. The rock shelter is 6 m wide and 2.5 m deep, while sedimentary deposits in front of the rock shelter form a horizontal terrace under the present roof and a slope further outside (Fig. 5). Excavation was undertaken within a 3 by 1 m trench. In total 135 lithic artifacts from three AHs have been documented (Tab. 1). Besides lithic artifacts and naturally occurring terrestrial snails, no other find classes were found during this excavation. The upper most archaeological horizon (AH I) occurs between 4 and 10 cm below the modern surface. Angular debris, which always occurs during the knapping process, forms the majority of finds. Only six flakes larger than 2 cm were found. Since no specific tools occur, an age estimate based on the archaeology is not possible.

The next layer is between 20 and 30 cm thick and occurs at depths between 10 and 40 cm below present surface. It contains AH II with 55 lithic artefacts. Among them are one Fasad point (Fig. 5) and one small unidirectional flake core. The Fasad type point is well known in Oman and was produced by human groups living in southern Arabia about 10,000 years ago (Charpentier and Crassard, 2013).

A total of 13 lithic artefacts were recovered from the currently deepest layer, which was named AH III. None of the artefacts from AH III feature characteristics that allow it's assignation to any known period. However, given that this layer underlies AH II, which can be placed into the eighth millennium BC, AH III likely represents a phase of Pleistocene human occupation. This conclusion is supported by the observation of patina on lithics from AH III. No other AH from our excavation contains patinated artifacts. Four sediment samples for OSL dating of the exposed archaeological stratigraphy were collected at the site and these results, along with those of further excavations, will be reported in future publications.

Summary Conclusions

Results of the 2018/2019 field campaign by the PEARL project confirm the presence of stratified archaeological material in the Ibri rock shelter and extend the spatial distribution of stratified material at Hayy al-Sarh. Despite its explorative character, the 2018/2019 fieldwork has led to some important observations. First, the presence of a stratified Fasad assemblage at Ibri rock shelter is a rare find and provides an exciting opportunity to study the Fasad lithic tradition in greater detail and contribute to a better understanding of the chronology of this archaeological entity. Moreover, given at least one underlying archaeological assemblage in addition to potential for deeper excavations, Ibri rock shelter provides promising potential for contributing to scientific debates about the Late Palaeolithic period and the transition to the Neolithic about 8,000 to 10,000 years ago.

With its diverse archaeological record and finds such as animal remains, stone and shell beads, and stone structures occurring in an area of at least 60 by 60 m, the

Neolithic site Hayy al-Sarh in Rustaq has very good potential for future research on human settlement in inland regions and their contacts to coastal communities about 7,000 years ago. The available radiocarbon dates clearly indicate that Hayy al-Sarh is a Neolithic site with settlement and burial areas. Given that Neolithic tombs usually occur not as single items but in often greater number, Hayy al-Sarh probably compares with important Neolithic burial sites such as Ras al Hamra 5 (Marcucci, et al., 2011) or Buhais 18 (Uerpmann, et al., 2000).

Alongside the archaeological sites excavated by the PEARL project, the identification of excellent palaeoenvironmental sequences in close vicinity, indicate that continuing work in these areas will provide important contributions for developing our understanding of changing climatic and landscape conditions in the past and their impact on humans in prehistory. Future fieldwork and analyses will increase archaeological assemblages and palaeoenvironmental data to help build a framework of cultural and natural developments in northern Oman.

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Title:

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Running title:

Neolithic settlement and landscapes of Northern Oman

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Conflict of Interest statement:

The authors have no conflict of interest to declare.

Acknowledgements:

We thank the Oman Ministry of Heritage and Culture for kind permission to conduct field work in the regions of Rustaq and Ibri. The Anglo-Omani Society in London generously funded the RBAS project. KB wishes to thank the research project "The role of culture in early expansions of humans" of the Heidelberg Academy of Science and Humanities for a travel grant and the Gerda Henkel Stiftung (AZ 06/V/18) for financial support of research in Oman. AP wishes to thank the RGS Thesiger-Oman Fellowship for financial support with continuing fieldwork as part of the PEARL project, and Sam Woor for his assistance in the field.

Tables

Table 1. Overview of archaeological finds from the excavation at rock shelter site IB19. Chips = flakes < 2 cm, AD = angular debris.

GH	AH	total artifacts	cores	Tools	flakes	chips	AD	artifacts/m²	comment
1	I	55	0	0	6	16	33	18.3	
1.a	II	57	1	1	9	17	29	19.0	Fasad point
2	III	13	0	0	5	0	8	4.3	patinated flakes

Figure Legends

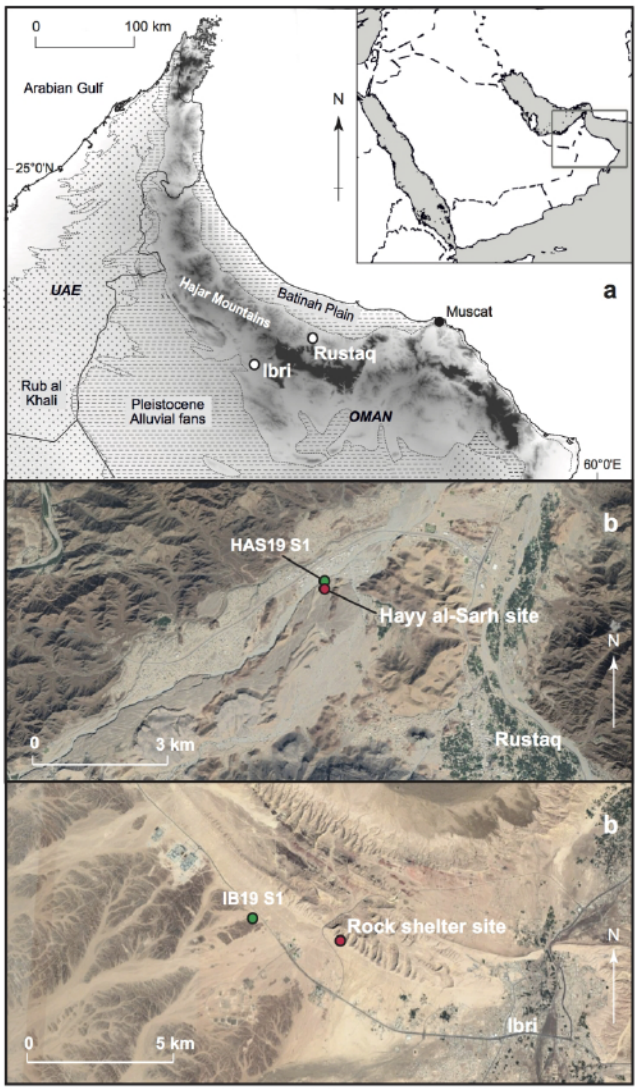
Figure 1. Location of the Rustaq and Ibri study regions (a) within wider regional setting (inset), Rustaq study area showing location of Hayy al-Sarh site and HAS19 S1 palaeoenvironmental sequence (b), and Ibri study area showing locations of the rock shelter site and IB19 S1 palaeoenvironmental sequence (c).

Figure 2. Overview of site Hayy al-Sarh (drone photo), showing location of features outlined in Figure 4.

Figure 3. Photos showing palaeoenvironmental sequences comprising stratified gravels and well developed palaeosols adjacent to both the sites: a ca. 4.5 m section (HAS19 S1) near Hayy al-Sarh (a), and a ca. 7 m section (IB19 S1) near the Ibri rock shelter site (b).

Figure 4. Overview of area excavated in 2019. Circles indicate excavated features. While Feature 1 (right circle) did not contain archaeological remains, pierced marine shells have been found at Feature 3 (middle) and Feature 4 (left). Excavations of Feature 4 also produced animal remains and a stone hemisphere (upper left corner), as well as a roundish stone package resembling a tomb (lower left corner).

Figure 5. Rock shelter site IB19. A) Overview (view to west). B) Orientation of excavated trench. C) Fasad type point found in AH II. D) Drawing of the eastern profile at x=61 m showing the vertical distribution of archaeological horizons (AHs) and geological horizons (GHs) as well as the location of OSL samples collected from this profile.



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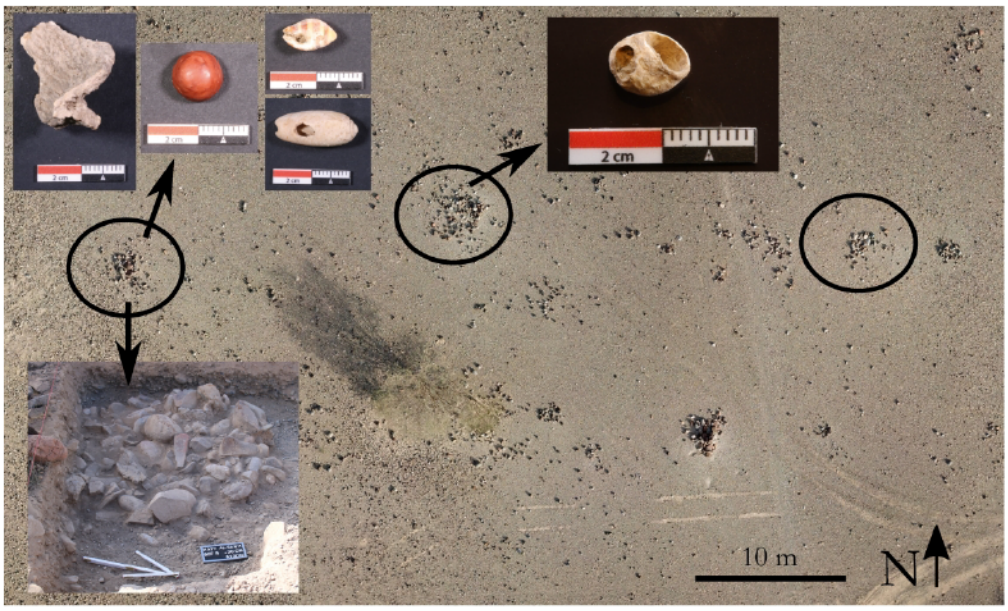

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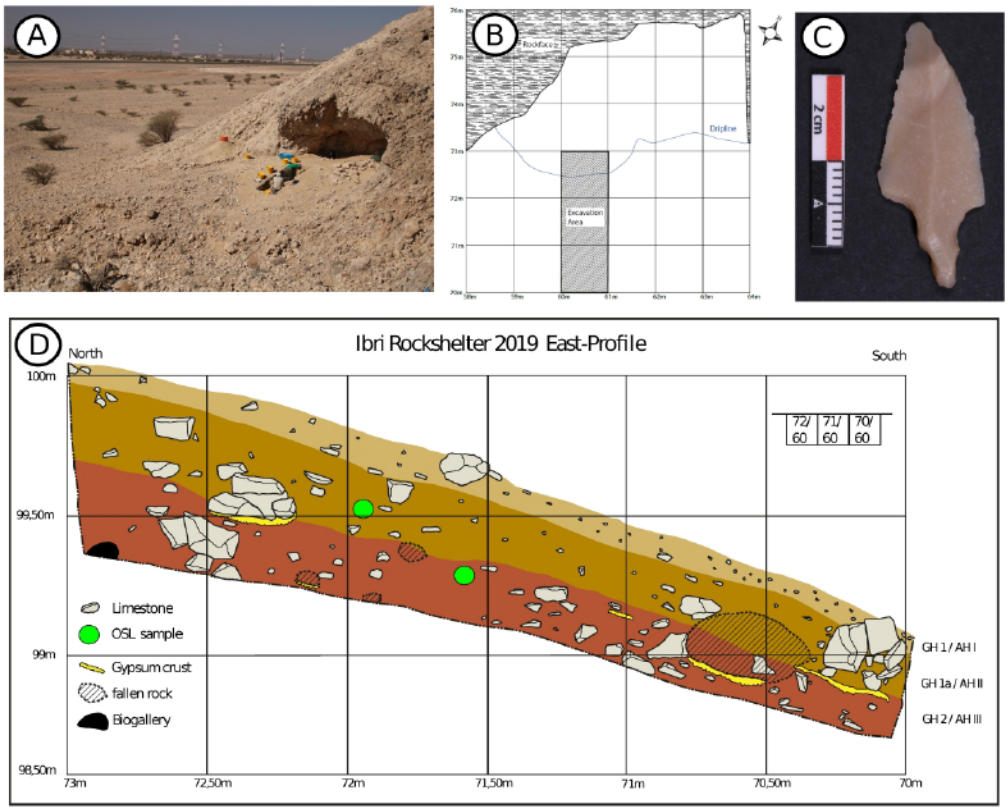

Figure 5. Rock shelter site IB19. A) Overview (view to west). B) Orientation of excavated trench. C) Fasad type point found in AH II. D) Drawing of the eastern profile at x=61 m showing the vertical distribution of archaeological horizons (AHs) and geological horizons (GHs) as well as the location of OSL samples collected from this profile.

362x290mm (300 x 300 DPI)