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Advances in UAE Archaeology

Proceedings of Abu Dhabi's Archaeology Conference 2022

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Foreword

The Department of Culture and Tourism - Abu Dhabi operates an emirate-wide archaeological programme in line with the organisation's mandate to preserve, protect and promote the ancient history and cultural heritage of Abu Dhabi. The emirate contains some of the most prized and unique cultural and historical attractions and finds in the region and internationally. Unlocking the secrets of history through world-class archaeological explorations, we are committed to protecting and celebrating our historical treasures and sharing these discoveries with the world.

The roots of archaeological discovery in the emirate go back to even before the unification of the Emirates. In 1959, archaeologists began their work on Umm an-Nar (Sas Al Nakhl) at the invitation of the Ruler of Abu Dhabi, Sheikh Shakhbut bin Sultan Al Nahyan. During that year, Sheikh Zayed bin Sultan Al Nahyan invited the same archaeologists to come to Al Ain, where he was the Ruler's Representative before becoming the UAE's Founding Father in 1971. Their work around Jebel Hafit revealed 5,000-year-old tombs from the beginning of the Bronze Age and marked the inception of a journey of discovery that led to Al Ain being declared a UNESCO World Heritage Site in 2011.

Sheikh Zayed's foresight in inviting archaeologists to the area reflected not only his deep interest in the history of our country but also his belief that Al Ain, in particular, was a place of enormous historical importance in which there must be archaeological evidence of a distant past.

This intuition reflected what Sheikh Zayed learned growing up in Al Ain, where he listened to people talk about their city's history. This history had been told and retold for centuries. An early-19th-century English explorer of Abu Dhabi described an encounter with Sheikh Zayed's ancestor, Sheikh Tahnoun bin Shakhbut Al Nahyan, in the following terms: "Tahnoun the late Shaikh of Abothubee [Abu Dhabi], in 1822, offered to escort a party of us to what he described to be an ancient city, situated in a most fruitful country, seven days journey from the sea." Many experts agree that this fruitful ancient city is likely Al Ain with its verdant oases.

From these early beginnings, we know that the UAE has a deep archaeological past that stretches back over a quarter of a million years. At that time, the ancestors of early humans walked across this land and eventually populated the world from Europe to Australia. During the Neolithic period, over 8,000 years ago, communities adapted to a changing environment and forged a prosperous society built upon a selective and sustainable use of resources. Sustainability remained a key characteristic of our ancient societies and is best represented in the invention of *falaj* irrigation 3,000 years ago, which is still seen in Al Ain.

Discoveries of our more recent past have highlighted that there were flourishing Christian communities on the islands of Sir Bani Yas in Abu Dhabi and Siniya in Umm Al Quwain, pointing to a long history of peaceful co-existence that is still characteristic of our society today.

The papers presented in this volume report on the many discoveries that have taken place in the last few years. Importantly, they also indicate that there is still much to uncover; and with every new find brought to light comes more questions that will drive future research. It is particularly gratifying to see in this volume the results of the hard work and inquisitive minds of many young Emirati scholars who have inherited Sheikh Zayed's passion for understanding our history.

Mohamed Khalifa Al Mubarak
Chairman
Department of Culture and Tourism – Abu Dhabi

Stones in the landscape
Recent discoveries of Palaeolithic sites in the Eastern Region of Abu Dhabi emirate

Marc Händel, Norbert Buchinger, Ali Abdul Rahman Al Meqbali and Peter Magee

Abstract: Artefacts of Palaeolithic character from the Eastern Region of Abu Dhabi emirate were first reported in 1984. Although singular suspicious finds, usually without spatial context, have been observed in a few cases since, an intensification of fieldwork in the Eastern Region, in particular around Jebel Hafit and the Al Jaww Plain, started only in 2019. These new investigations resulted in the discovery of several Palaeolithic surface sites and findspots in their according geomorphic contexts. The techno-typological spectrum of the collected lithic artefacts ranges from the Acheulian to the Upper/Late Palaeolithic. Geoarchaeological approaches identified the lithic raw material sources and illuminate local site formation processes. The new sites fundamentally enhance our knowledge of the Palaeolithic record in Abu Dhabi emirate and contribute to understanding human occupation in Southeast Arabia during the Pleistocene.

Keywords: Palaeolithic occupation, Abu Dhabi, lithic raw material, Acheulian, Middle Palaeolithic, Upper/Late Palaeolithic, site formation

Introduction

Hitherto, the Palaeolithic record of Abu Dhabi emirate was focussed mainly on Jebel Barakah, an isolated outcrop of red-coloured sandstone located on the Arabian Gulf coast in the Western Region. Palaeolithic artefacts were discovered and first published by McBrearty (1993 and 1999). Subsequent fieldwork identified further findspots (Wahida *et al.* 2008; 2009 and 2012). Although the later publications agree upon a technologically homogeneous assemblage with clear Middle Palaeolithic attribution, the claimed presence of handaxes represented a peculiar detail hindering a straightforward techno-typological and chronological placement within the regional record. Recently, a reassessment of the Jebel Barakah assemblages was conducted by us and confirmed the techno-typological Middle Palaeolithic attribution; however, it did not confirm the presence of Nubian technology nor of handaxes. The

Figure 1: HTM0123 is today a protected site within Jebel Hafit Desert Park. (Photo © DCT Abu Dhabi/ Marc Händel)

latter have instead been classified as bifacial preform respective centripetal core (Händel *et al.* 2023).

In the Eastern Region, prior to our work, only Gebel (1984) reports the occurrence of a few pre-Holocene lithic artefacts from the wider Al Ain area, whereas lithic scatters attributed to the Neolithic (or Holocene) are abundant. At Jebel Hafit, Neolithic find scatters on shallow mounds in the plain east of the mountain were briefly investigated in the course of the first French Archaeological Mission to Abu Dhabi (Cleuziou 1977). In the course of later campaigns, Gebel and colleagues (Gebel *et al.* 1989) established a stratigraphic framework for the Early Holocene focussing mainly on the area west of Jebel Hafit, where Holocene sedimentation rates and dynamics are particularly high. The Abu Dhabi site database lists site HTM0123 (Figure 1), where Gebel excavated a small test trench on one of the shallow mounds east of the mountain.

In between 1984 and 2019, there have only been very few (unpublished) observations of isolated objects with potential Palaeolithic character in the Eastern Region, including in the area east of Jebel Hafit; however, none of these provided contextual information, nor have these objects been studied. A more recent observation by interested amateurs triggered a small-scale survey in spring 2019 in what is today Jebel Hafit Desert Park. The main target was the localisation of site HTM0123 as well as the identification and first assessment of the shallow mounds reported by Cleuziou (1977) and Gebel *et al.* (1989). We identified two groups of shallow mounds covered by allochthonous dark-coloured Harzburgite cobbles, one of which is site HTM0123. On all mounds, Harzburgite cobbles occur together with knapped lithic artefacts and siliceous raw materials. Bifacial preforms, i.e. unfinished points or arrowheads, a local *fossile directeur* for the Middle Holocene Arabian Bifacial Tradition (ABT), dominate among the diagnostic artefacts. In addition to Holocene material, however, there were a few suspicious pieces of potential Palaeolithic character. The raw material of both artefacts and siliceous raw pieces correspond and include mainly metamorphic rocks such as jasper, chalcedony and quartzite.

This discovery triggered two main questions: what is the typo-technological spectrum of these sites, and where do the siliceous raw materials come from? Our team subsequently conducted more extensive surveys aimed at addressing these questions.

Development of a recording system of the knapped lithics

Stone artefacts collected from exposed surfaces can represent several unrelated events of production and discard over time, rather than closed coherent units. Therefore, these assemblages may display multiple technological, typological, functional and chrono-cultural attributes.

In order to subdivide and classify surface collections into separate units despite their palimpsest nature, a recording system for the techno-typological characteristics was created following the technological terminology by Hahn (Hahn 1991) and Inizan and colleagues (Inizan *et al.* 1999). This system comprises the categorisation of the various artefact classes including cores, flakes, blades, bladelets, chips, debris, preparation debitage, crested flakes and tested raw material. Among other attributes, USM retouching (edge damage caused by usage, post-depositional movement in the sediment or post-excavation activities) was documented. In addition to the typological classification, the position of the reduction, divided into unifacial and bifacial preparation on tools and preforms, was recorded. For core documentation, the classification of Conard *et al.* (2004) and Bretzke *et al.* (2016) was applied and partially adapted.

Nuclei can be divided into the two main categories, platform cores and surface cores, providing a versatile frame to analyse respective technological features in a diverse techno-chronological setting. According to the direction of their removals, platform cores are classified as unipolar, opposed, orthogonal and multipolar. Further categories include number of preserved striking platforms, number of reduction surfaces, targeted blank production and cause of rejection. Surface cores can be subdivided into parallel surface cores, inclined surface cores and discoidal surface cores. For parallel surface cores, a further distinction was made between preferential and recurrent reduction method (Boëda 1995). The degree of modification of the reduction surfaces was recorded for one (parallel surface cores and inclined surface cores) or two (discoidal surface cores) surfaces. In addition, the direction of core preparation was also recorded as centripetal, orthogonal opposed and unidirectional.

The lithic assemblages presented here not only show differences in technology and typology, but also highly varying degrees of patination and weathering. We are aware that these processes of physical and chemical transformation are dependent upon both environmental factors and individual characteristics of the raw materials, but consider the possibility that they may also function as (relative) chronological indicators, under the premise that pieces from stable surfaces have generally gone through similar post-depositional processes. To allow for testing potential correlations with technological and typological traits, we documented the degree of patina and weathering for each individual artefact in our attribute analysis. The predominant colour of patination was documented using the Munsell colour system. In addition, to document signals of desilicification, we also recorded the degree of chemical weathering.

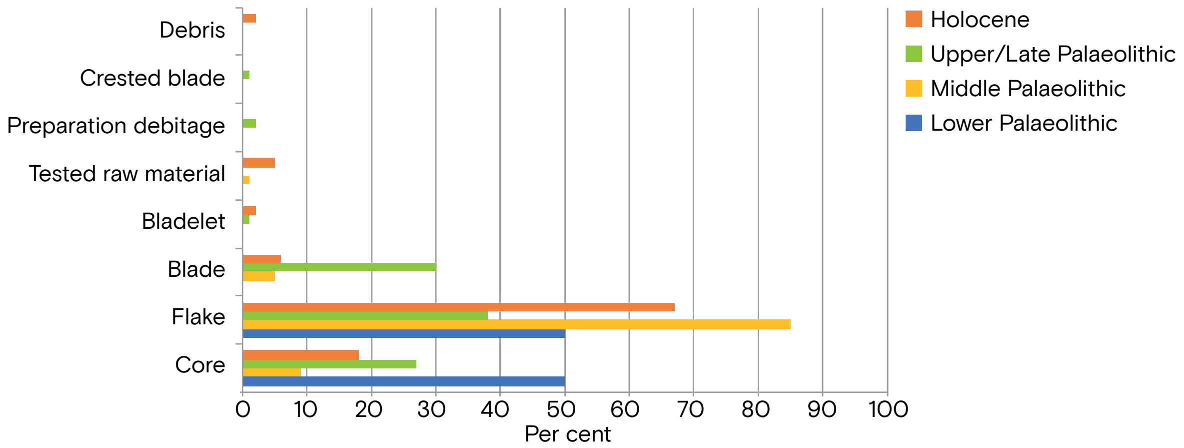
Survey area and field approach

The surveys were conducted to assess Palaeolithic site potential and possible occupational patterns south of the city of Al Ain around Jebel Hafit and east across the Al Jaww Plain to the west edge of the Hajar Mountains at the UAE-Oman border. The survey area includes a high diversity of topographical and geological features and geomorphic settings, ranging from the Jebel Hafit anticline in the west to the Malaqet-Mundassa anticline in the east. In addition to the glacis, slopes and terraces connected to these mountain ranges, the area also encompasses the Al Jaww Plain, a foreland basin covered with (Mid to) Late Holocene alluvial deposits. The total area measures more than 350 km²; however, a greater part of it is settled, used for agriculture or recreation/sports, or fenced for other reasons and thus inaccessible for survey (ca. 170 km²), or consists of bare rock resp. steep cliffs (ca. 10 km²). In addition, the mainly Late Holocene sediments covering the Al Jaww Plain (110 km²) have obviously very little potential for a preservation of earlier Prehistoric contexts. For a small team, the remaining area of around 60 km² is obviously still too large for applying strictly systematic survey strategies with tight coverage. We therefore applied a more qualitative approach based on geomorphological and geological considerations.

We targeted both knapped lithic artefacts and lithic raw material sources. Sampling was selective and aimed at collecting representative assemblages with regard to typology and technology. All sites and raw material sources were described and recorded by GPS. The main aim, in this first research step reported here, was to explore and document the occurrence of lithic technocomplexes in their geomorphic context as well as the spatial relations of chipped stone scatters to lithic raw material sources.

Site	Classification	n types	n artefacts
HTM 0123	Middle Palaeolithic	0	11
	Upper/Late Palaeolithic	0	1
	Holocene	11	32
	Undefined	0	1
0124	Middle Palaeolithic	0	2
	Upper/Late Palaeolithic	0	12
	Holocene	46	163
	Undefined	1	11
0125	Middle Palaeolithic	0	5
	Upper/Late Palaeolithic	6	17
	Holocene	2	3
	Undefined	1	6
0126	Lower Palaeolithic	14	20
	Middle Palaeolithic	26	75
	Upper/Late Palaeolithic	5	38
	Holocene	13	17
	Undefined	5	77
0127	Middle Palaeolithic	0	1
	Upper/Late Palaeolithic	0	1
	Undefined	0	1
0128	Middle Palaeolithic	0	4
	Holocene	9	21
	Undefined	0	3
0129	Upper/Late Palaeolithic	0	2
	Holocene	5	45
0130	Holocene	3	11
0131	Holocene	1	12
0132	Middle Palaeolithic	0	1
	Upper/Late Palaeolithic	1	10
	Holocene	21	102
	Undefined	0	4
0133	Holocene	11	37
0134	Holocene	6	19
0135	Undefined	0	12
Others	Middle Palaeolithic	0	1
	Holocene	5	8
	Undefined	0	1
Total		**192**	**787**

Figure 2: Artefacts and types of the Eastern Region of Abu Dhabi emirate listed per site and technocomplex. Please note that thus far, only site HTM0123 has been attributed a letter code.



Artefact class	**Holocene**		**Upper/Late Palaeolithic**		**Middle Palaeolithic**		**Lower Palaeolithic**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Core	86	18	22	27	9	9	10	50
Flake	315	67	31	38	85	85	10	50
Blade	30	6	24	30	5	5	0	0
Bladelet	8	2	1	1	0	0	0	0
Preparation debitage	1	0	2	3	0	0	0	0
Crested blade	0	0	1	1	0	0	0	0
Tested raw material	22	5	0	0	1	1	0	0
Debris	8	2	0	0	0	0	0	0
Total	**470**	**100**	**81**	**100**	**100**	**100**	**20**	**100**

Type	**Holocene**		**Upper/Late Palaeolithic**		**Middle Palaeolithic**		**Lower Palaeolithic**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Handaxe	0	0	0	0	0	0	1	7
Cleaver	0	0	0	0	0	0	2	14
Preform LCT	0	0	0	0	0	0	11	79
Perforator	3	2	2	17	2	8	0	0
Bifacial	0	0	0	0	2	8	0	0
Levallois point	0	0	0	0	3	11	0	0
Scraper	5	4	1	8	6	23	0	0
Notched/laterally retouched piece	29	22	7	58	13	50	0	0
Denticulate	3	2	2	17	0	0	0	0
Point (arrowhead)	2	1	0	0	0	0	0	0
Bifacial preform	88	67	0	0	0	0	0	0
Undefined preform	3	2	0	0	0	0	0	0
Total	**133**	**133**	**12**	**100**	**26**	**100**	**14**	**100**

Figure 3: Distribution of typological classes in the technocomplexes at the sites in the Eastern Region of Abu Dhabi emirate.

Knapped lithic collection

In total, the analysed lithic collection consists of 787 artefacts, including 192 types, and was collected from 13 different sites (Figure 2). We should point out that the high proportion of types reflects the selective character of our collection, which was not focused on including specimens for the complete lithic production sequences, but on typologically and technologically diagnostic objects. Therefore, artefact classes such as debris, preparation debitage, chips and bladelets are significantly underrepresented (Figure 3). Besides, it should also be taken into account that small objects such as chips and bladelets usually occur less abundantly on surfaces due to general formation processes.

Based on our analysis, we assign 20 objects to the Lower Palaeolithic (Figure 4). These include large cutting tools (LCT) such as handaxes and cleavers, occurring both as preforms and as finished tools, and are produced on large cores or flakes. The Lower Palaeolithic technocomplex is only documented at Site 0126. Based on their morphologies, the objects can be more precisely assigned to the Acheulean technocomplex.

Figure 4: Selected Lower Palaeolithic artefacts from the Eastern Region of Abu Dhabi emirate. 1) Cleaver; 2) LCT preform; 3) Handaxe. Please also note the degree of patina and weathering. (Photos and graphics © DCT Abu Dhabi/Hélène David-Cuny)

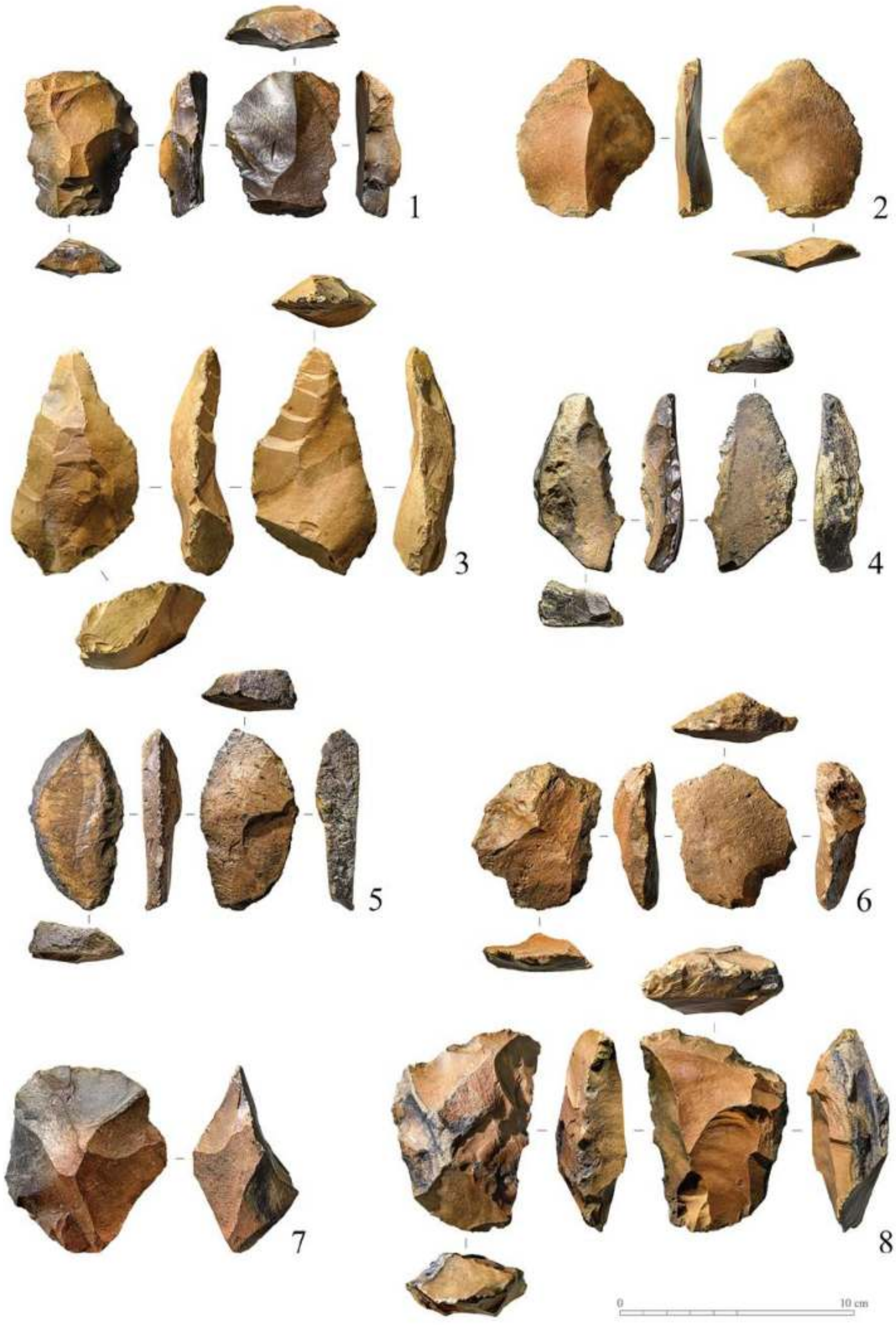


Figure 5: Selected Middle Palaeolithic artefacts from the Eastern Region of Abu Dhabi emirate: 1, 4-5) Side scraper; 2, 6) Flakes; 3) Levallois point; 7-8) Cores. Please also note the degree of patina and weathering. (Photos and graphics © DCT Abu Dhabi/ Hélène David-Cuny)

The Middle Palaeolithic technocomplex is represented by 100 artefacts (Figure 5), which are documented at seven different sites. The presence of Levallois technology is illustrated based on the core analysis: Five parallel platform cores with preferential reduction represent the main reduction method. In addition, we recorded three inclined surface cores and one discoid surface core. All cores were used for flake production and display centripetal negatives on their reduction surface. Typical Levallois elements were also recorded with three Levallois points. The tool spectrum is composed of notched/laterally retouched pieces, side scrapers and perforators, illustrating the predominance of domestic types. The majority of the types were produced on flakes; blades and cores were used in lesser quantities.

The Upper/Late Palaeolithic technocomplex comprises 81 artefacts (Figure 6). The central element is the presence of platform cores. The cores demonstrate a systematic production of narrow blanks including blades, bladelets and elongated flakes. Core reduction displays a clear hierarchy between striking platform and reduction surface, and shows no preparation of the cores' backs. The majority of the 22 cores have single striking platforms and reduction

Figure 6: Selected Upper/Late Palaeolithic artefacts from the Eastern Region of Abu Dhabi emirate. 1–5) Blades; 6–8) Cores. Please also note the degree of patina and weathering. (Photos and graphics © DCT Abu Dhabi/ Hélène David-Cuny)

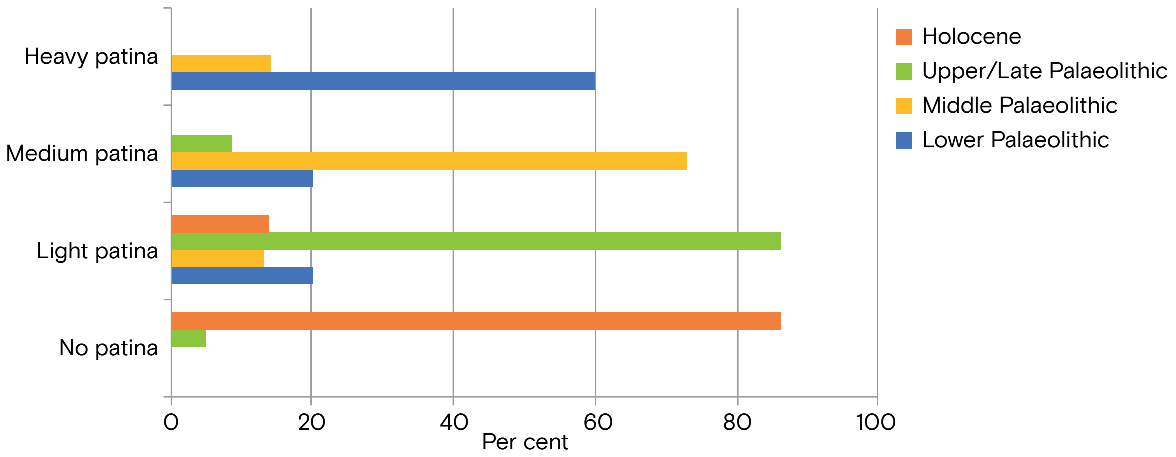
surfaces; dorsal scar patterns in the form of parallel negatives were mostly produced applying unipolar reduction. Blanks used for tool production illustrate a tendency towards elongated narrow forms. The typological spectrum is composed of notched and laterally retouched pieces, perforators, denticulates and end scrapers, all representing domestic activities.

With a total of 470 lithics, we assign the majority of the collected objects to the Holocene, whereby flakes account for the largest portion. Some artefacts within this group can be assigned more precisely to the Arabian Bifacial Tradition (ABT) technocomplex, which includes bifacial points and preforms, mainly manufactured on flakes and exhibiting distinct dorsal and/or ventral negatives from pressure reduction (Edens 1982). The ABT technocomplex is usually assigned to the Neolithic; however, it has recently been shown that a congruent reduction strategy can also be attested for the local Early Bronze Age (Buchinger *et al.* 2020; Ochs 2020). Core technology is characterised by the opportunistic use of suitable striking angles for flake production: Nuclei display one, two or multiple striking platforms and reduction surfaces. Equally, the direction of reduction is variable, including unipolar, multipolar, orthogonal and opposed reduction sequences. The tool assemblage is dominated by bifacial preforms representing preliminary stages in the production of points/arrowheads that can be assigned to the ABT. Completed arrowheads are represented in the inventory with two pieces only. In addition, the tool spectrum comprises objects associated with domestic activities such as notched/laterally retouched pieces, scrapers, denticulates and perforators. Blanks used for tool production illustrate the dominance of flakes, which account for 90 per cent of the tools, while blades were rarely utilised.

For 116 pieces, no secure assignment to a specific technocomplex can be made.

We observe a clear correlation between the degree of patination and chrono-technological assignment (Figure 7). This suggests the presence of generally stable surfaces and/or preservation factors, resulting in comparable

Figure 7: Distribution of patinated artefacts per technocomplex at the sites in the Eastern Region of Abu Dhabi emirate.



Holocene	Upper/Late Palaeolithic	Middle Palaeolithic	Lower Palaeolithic
• cores and blanks indicate various, irregular operational schemes and reduction strategies mainly targeting the production of flakes (cores feature multiple striking and reduction platforms, blanks display multidirectional radial dorsal scar patterns)	• cores and blanks illustrate a rather uniform, standardised production of artefacts of elongated shape (negatives on platform cores resulting from systematic reduction, regular dorsal scar pattern on blanks) • cores show a clear hierarchy between striking platform and reduction surface	• cores and blanks show distinct technological features deriving from preferential or recurrent reduction (corresponding morphology of cores and dorsal scar pattern on blanks, application of hard hammer percussion)	• cores and/or large flake blanks were used for production of tools • types are composed of Large Cutting Tools (handaxes, cleavers) and preforms
no weathering or patination	low degree of weathering and patination	medium degree of weathering and patination	severe degrees of weathering and patination

Figure 8: Simplified breakdown of main characteristics of the different technocomplexes.

environmental impacts on the lithic artefacts. A comparable, although somewhat less pronounced, pattern emerges with regard to the degree of weathering.

Figure 8 provides a simplified breakdown outlining the main characteristics of the lithic industry.

Palaeolithic sites and lithic raw material sources

Our field investigations started in 2019 in what is today Jebel Hafit Desert Park (Figure 9). First, we re-identified two areas with shallow dark-coloured mounds where Neolithic find scatters had already been reported and briefly investigated (Cleuziou 1977: 8/9, 36). One of these localities was the site recorded by Gebel that was already included in the Abu Dhabi site database: Site HTM0123 is a group of seven shallow mounds where lithic raw materials and artefact scatters are associated with Harzburgite cobbles. The technological spectrum ranges from the Middle Palaeolithic to the Holocene. The latter includes ABT for which bifacial preforms are the principal local *fossile directeur*, as well as undiagnostic artefacts.

A second group of mounds, Site 0124, with comparable composition and artefact distribution is located farther north (Figure 10A). The mounds are more dispersed and extend along the course of a wadi. The site is more affected by fluvial erosion, in particular the smaller mounds located upstream. Despite a technological spectrum similar to HTM0123, Middle Palaeolithic types are constricted to one mound, whereas the Upper/Late Palaeolithic is better represented. Bifacial and unspecific Holocene production can be attested for the large majority of artefacts. We observed a general decrease in artefact density downstream. Despite the presence of the same raw materials and no apparent

Figure 9: Location of sites mentioned in the text. A) Important Lower and Middle Palaeolithic sites in the UAE. B) Sites classified by technocomplex and lithic raw material sources in the study area in the Eastern Region of Abu Dhabi emirate south and south-east of Al Ain. A few other findspots with Holocene industries that have not been studied in the scope of this paper are plotted but remain unnamed. Please note that only raw material sources that have been confirmed on the ground are included. Localities A-F are shown in Figure 10. (Map data © 2022 Google Earth; a. Image Landsat / Copernicus. Data SIO, NOAA, U.S. Navy, MGA, GEBCO; b. Image © 2022 Airbus, Image © 2022 Maxar Technologies, Image © 2022 CNES / Airbus)

Figure 10: Selected geomorphological contexts of the study area (see Figure 9 for location). A) View to the south of a part of Site 0124 from one of the highest mounds on the right wadi bank. The area between the mounds is periodically flooded by run-off from Jebel Hafit after rains. B) Dispersed hearth at the wadi edge of Site 0132. View to the north-west; Jebel Hafit in the background. C) Al Jaww Plain, where 3-4 m sequences of Holocene gravel are exposed in a wide wadi bed. D) Site 0126 near the border to Oman, the richest and most extensive raw material and knapping site identified. The ophiolite-limestone interface is clearly visible on the ridge of Jebel Mundassa in the background. E) Flat mound at Site HTM0123. Harzburgite gravel has here been partly covered by limestone material. Limestone in the foreground; in the background mixed Harzburgite/limestone cover. F) Late Holocene alluvial sediment exposed in a gully in the southern part of Jebel Hafit Desert Park. If Pleistocene sediments are present here, they must be deeply buried. (Photos © DCT Abu Dhabi/ Marc Händel)

difference in quantity and/or quality, it seems that the mounds located farthest north were not exploited as intensely. We thus assume that this occupational pattern was driven by other factors such as increased exposure or distance to other activities.

Artefacts of Palaeolithic character are absent at Site 0133, the third group of six mounds. Holocene preparation and blank production, however, as well as ABT are well documented. Remarkable is the preference for jasper exploitation on one of the mounds, where it was used for the production of bifacial arrowheads. Given the rather low knapping quality of the local jasper, this can only be explained by aesthetic considerations, not from a technological perspective. The mounds are low and often heavily impacted, mainly by car tracks. They are located at the confluences of tributaries running north-east, with the main wadi running north towards Al Ain.

The mounds of all three sites are covered by Harzburgite gravel, mainly ophiolite and serpentinite, in association with metamorphic siliceous materials. None of these materials occurs locally. The nearby Jebel Hafit anticline consists of Early Eocene to Miocene formations (Rus, Dammam, Asmari, Gachsaran/Fars), i.e. limestones and gypsum formed in shallow marine environments (Aly *et al.* 2001; Kirkham 2004). The metamorphic siliceous materials, in contrast, derive from earlier formations occurring along the west edge of the Hajar Mountains, in the contact zone between (Cretaceous) Semail ophiolite and the superimposed Tertiary limestone sequence (Feulner 2005; Glennie 2006). This agrees with the dominance of Harzburgite over limestone gravel on the mounds, which is also the reason for the mounds' dark colour. The surrounding alluvial plain, in contrast, consists mainly of lighter-coloured limestone gravel, the source of which is Jebel Hafit. The common geographic origin suggests that the metamorphic siliceous materials were deposited together with the Harzburgite gravel.

The lithic workshops and secondary raw material deposits on the mounds are surrounded by sites with chipped stone scatters that are not connected to raw material occurrences, but suggest the use of the mounds as sources. Most of these sites display ABT or undiagnostic Holocene technology; only Site 0132 (Figure 10B) has a diachronic spectrum ranging from the Middle Palaeolithic to the Holocene. Palaeolithic artefacts, however, were only found in more elevated positions.

A survey along the glacis and slopes of Jebel Hafit's east side provided only an isolated knapping workshop, Site 0135, featuring a >13 kg core (Figure 11). Degrees of weathering and patination suggest a Palaeolithic context, but the finding cannot be placed into a specific technocomplex.

Neither geological publications (e.g. Kirkham 2004) nor our field observations indicate Harzburgite outcrops in the alluvial Al Jaww Plain east of Jebel Hafit. The primary source of the materials found on the mounds must

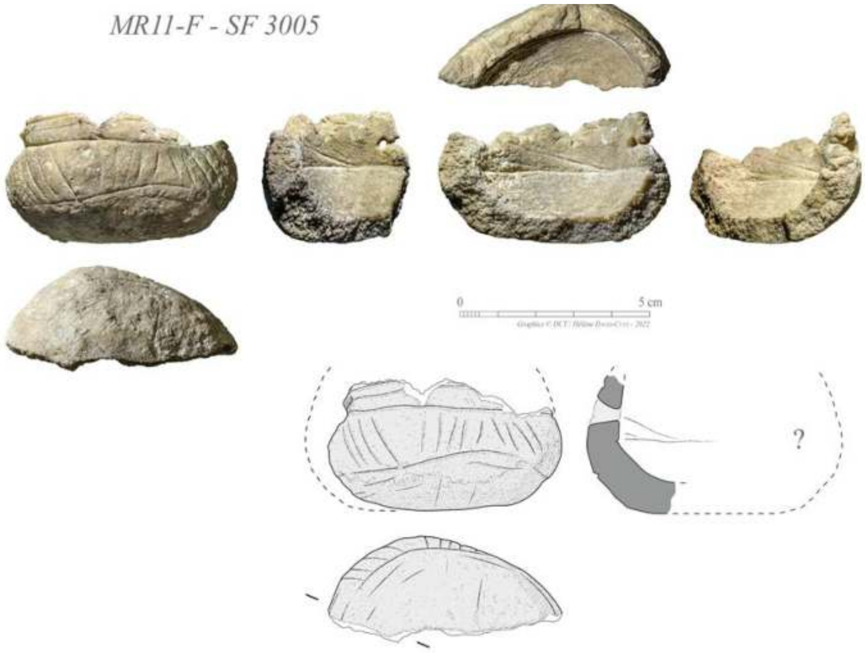


Figure 11: a) Glacis and slopes of Jebel Hafit's east side provided only one knapping workshop, Site 0135 with a >13 kg core and some production debris. b) The large core with a few refitted flakes. Degrees of weathering and patination tentatively suggest a Palaeolithic context, but the finding cannot be placed into a specific technocomplex. (Photos © DCT Abu Dhabi/ Marc Händel)

therefore be located in more elevated terrain farther east. It can be tracked by geological maps, and the formation is easily recognised in the field.

Artefacts of ABT but also Palaeolithic character found on the mounds are often produced on an ochre-coloured material, jasper, often associated with other metamorphic materials such as chalcedony and quartzite. Jasper artefacts are common at many Neolithic inland and coastal sites in the Northern Emirates. Primary sources occur in the hills east of Fili in Sharjah emirate where it occurs together with quartzite (Uerpmann *et al.* 2008). Jasper outcrops extend north to the area west of Shawka. Sources for metamorphic siliceous materials including jasper, chalcedony, agate and carnelian are also known from the area east of Dhaid (Uerpmann *et al.* 2008), and from Jebel Al Mataradh in Ras Al Khaimah emirate (Brunet 2014; Charpentier *et al.* 2017). All these localities are situated in geologically similar positions along the west edge of the Hajar Mountains.

The closest similar geological formation can be found east of the Al Jaww alluvial plain at the Malaqet-Mundassa anticline near the border to Oman. The Al Jaww Plain is mainly covered by ophiolite and serpentinite gravel deposited after the pluvial phase of the Holocene optimum (Figure 10C). This makes finding Palaeolithic or Early to Mid Holocene sites very unlikely.

The Malaqet-Mundassa anticline consists of three bedrock formations, Jebel Malaqet in the north, Jebel Mundassa in the middle and Jebel Saah in the south-east (Ali *et al.* 2008). All provide chipped stone artefacts and siliceous raw materials.

The by-far richest and largest chert knapping and raw material site discovered in our survey is Site 0126 at Jebel Mundassa (Figure 10D). Siliceous material occurs as nodules still bound in a primary calcareous matrix, without a preserved matrix, as tested nodules, cores, primary production waste, blanks and tools. Techno-typological characteristics and different states of patination and weathering document a wide diachronic spectrum. Artefact analyses show a co-occurrence of Acheulian, Middle Palaeolithic, Upper/ Late Palaeolithic and ABT types and technologies. The site extends along the southern part of Jebel Mundassa's west face and stretches over a total area of ca. 120 ha, whereby a core area of almost 40 ha exhibits a significantly higher chert density. The site is located on a glacis covered by a colluvium of calcareous cobbles with a high portion of siliceous materials ranging from quartzite and silicified sandstone to siliceous limestone, and different varieties of chalcedony and jasper. The main primary outcrop is located on the mountain ridge and consists of fractured calcareous blocks of the Upper Cretaceous Late Campanian/Late Maastrichtian Simsima formation (Abd-Allah *et al.* 2013) at the immediate contact zone to the Semail ophiolites (Figure 12). Middle Palaeolithic knapping workshops (Figure 13) are concentrated in the site's core area. Activities beyond mining and lithic primary production are documented by the presence of domestic tools.

While quarzites are more common for Lower Palaeolithic artefacts, a light-coloured beige-greyish chert with a tendency to desilicify was preferred for Middle Palaeolithic production. Chalcedony and jasper were diachronically used in similar portions.

Farther south on a limestone outcrop that forms part of Jebel Saah is site 0125 (Figure 14). It extends onto the glacis of the south side of the ridge. Typologically, the artefacts range from Middle Palaeolithic to Holocene, whereby general artefact density is rather low. The outcrop shows no embedded cherts; however, primary sources can be found on adjacent parts of the anticline to the east (Oman) and north (Jebel Mundassa).

Located at the south-east tip of Jebel Malaqet is Site 0127. It displays a dense scatter of lithic raw materials with few artefacts on a colluvial surface. The spectrum of raw material is comparable to Site 0126. The few collected artefacts from the small accessible area range from Middle Palaeolithic to Holocene. Jebel Malaqet exposes not only the Simsima but also the Qahla formation, which is more pronounced here than at Jebel Mundassa, and includes conglomerates with cherts. The raw material used could therefore derive from either formation. Jebel Malaqet is already located too far north and can therefore be excluded to be part of the potential catchment area for the mounds in Jebel Hafit Desert Park. The presence of sites 0125 and 0127 illustrates that 0126 does not represent a single case but stands for a consistent raw material procurement and occupational pattern.

Investigations in the north part of Jebel Hafit led to the localisation of another important primary lithic source, the main chert sequence of the

Figure 12: a) Ridge of Jebel Mundassa atop Site 0126 with fractured calcareous blocks of the Upper Cretaceous Late Campanian/ Late Maastrichtian Simsima formation in the foreground and on the right side, with Semail ophiolite hills below on the left side (view to NNW). In the far background is Jebel Malaqet, where Site 0127 is located. b) Calcareous block with chalcedony nodule. (Photos © DCT Abu Dhabi/ Marc Händel)

Lower Eocene Rus formation, besides providing new chipped stone scatters. The surfaces north-west of Jebel Hafit are heavily disturbed and suggest formation by Late Holocene sedimentation, confirming Gebel's (Gebel *et al.* 1989) stratigraphic framework, intact palaeosurfaces with prehistoric sites are preserved north of the mountain on the terraces of Wadi Tarabat.

Site 0128 is a large scatter of lithic artefacts showing varying artefact densities. The collected assemblage displays undiagnostic Holocene and ABT production. The presence of a single artefact of Middle Palaeolithic character should not be overinterpreted and could reflect relocation. The lithic raw material consists mainly of Rus chert and must have been brought to the site, most probably from the nearby primary sources.

Figure 13: Site 0126. a) View from the dense scatter of siliceous pieces to Jebel Mundassa, where the Simsima formation sits atop the Semail ophiolite. All brown-coloured material is suitable for chipped stone tool production. The scatter also includes many artefacts, mostly primary production debris. b) Middle Palaeolithic knapping workshop at Site 0126. (Photos © DCT/ Marc Händel)

Figure 14: Jebel Saah. a) View along the limestone ridge to the west. Site 0125 is located to the right of the ridge. b) A glimpse into past human behaviour: A tested chert nodule with a hammerstone at Site 0125. (Photos © DCT Abu Dhabi/ Marc Händel)

On a mound on the wadi's west edge, Site 0129, a small knapping workshop was recorded. Holocene artefacts dominate, but the assemblage also includes blades of Upper/Late Palaeolithic character. Rus chert in primary position is exposed at the base of the mound, which is probably a remnant of an earlier terrace.

Site 0130 is a loose artefact scatter located on the lowest, i.e. youngest terrace of Wadi Tarabat. The lithics appear unusually 'coarse' but lack any patina or weathering, or signs of fluvial transport. We therefore assume that the material is younger than the terrace and place it posterior to the Holocene pluvial phase, tentatively into the Bronze Age.

Rus chert sources are only partially exposed in some areas of Wadi Tarabat, but we located the entire 5m-thick main Rus chert sequence of the Lower Eocene in the upper Wadi Nahayan, as well as in the northernmost part of Jebel Hafit (Figure 15). Identification of the Rus formation followed descriptions in Kirkham (2004) and Hansman and Ring (2018). Secondary deposits of Rus cherts can be found in the alluvial sediments of Wadi Nahayan and in the terraces of Wadi Tarabat; however, the chert from secondary deposits is usually highly fractured and appears not well suited for production. Rus chert shows a high variability in colour, ranging from light-coloured grey and pink hues to orange, beige, brown and deep red. In contrast to metamorphous raw materials, fossil inclusions are far more abundant and much better preserved. We observed the use of this material for Holocene artefacts only. Given the low quality of the material from secondary sources, we assume extraction took place directly at the primary sources.

We also surveyed the west fringes of Jebel Hafit but did not collect artefacts. Based on our first impression, the documented chipped stone clusters appear exclusively Holocene in character, and the lithic raw material is mainly local Rus chert.

Figure 15: Jebel Hafit. a) A more than 4m-thick outcrop of the main chert sequence of the Rus formation in a tributary gully of the upper Wadi Nahayan. b) Rus chert nodules reach up to 0.4 m in size. (Photos © DCT Abu Dhabi/ Marc Händel)

Framing the new discoveries in the regional context

The new fieldwork in the Eastern Region of Abu Dhabi demonstrates the presence of the major regional Palaeolithic and Holocene technocomplexes, whereby hitherto, Lower Palaeolithic artefacts are only documented at Jebel Mundassa. Given Arabia's geographic position between East Africa, the Levant and South Asia, the Palaeolithic record of Arabia is particularly important for the interpretation and understanding of the migration of archaic hominins out of Africa.

So far, the earliest evidence of archaic hominins outside Africa was documented in central China and dated to ~2.1 Ma (Zhu *et al.* 2018). Very early hominin fossils were also recorded in Java dated to 1.5–1.6 Ma (Zaim *et al.* 2011). This first wave of migration is also represented at Dmanisi in Georgia, where it is attributed to the Oldowan technology and dated to 1.77–1.85 Ma (Lordkipanidze *et al.* 2007). The Oldowan technocomplex evolved in East Africa, with its earliest finds recovered in Ethiopia dating to 2.58–2.61 Ma (Braun *et al.* 2019). Whether Oldowan assemblages occur in Arabia is still under dispute; sites are so far only reported from Yemen (Amirkhanov 1991 and 1994).

Later hominin dispersal is linked to the Acheulean, which is characterised by the occurrence of large bifacial stone tools such as handaxes, picks and cleavers (Leakey 1971). Dating to 1.76 Ma, the earliest Acheulean inventory was documented in Kenya. In South Africa, it is dated to 1.7 Ma (Lotter and Kuman 2018), while it dates to 1.67 Ma in North Africa (Duval *et al.* 2021). Outside Africa, the earliest Acheulean sites were documented in the southern Levant at ʻUbeidiya and dated to 1.5 Ma (Belmaker *et al.* 2002). A similar age of 1.51 Ma was recorded at Attirampakkam in South India (Pappu *et al.* 2011). Acheulian sites are typically associated with *Homo erectus* (Haslam *et al.* 2011; Lepre *et al.* 2011; Shipton *et al.* 2018; Groucutt *et al.* 2021).

Whether this early migration also led to hominin occupations in Arabia remains uncertain. Acheulean sites are reported from several regions of the Arabian Peninsula (Whalen *et al.* 1983; Petraglia 2003; Shipton *et al.* 2014 and 2018; Jennings *et al.* 2015; Bretzke *et al.* 2016; Hilbert and Crassard 2020; Händel *et al.* 2023). The majority of these sites, however, are unstratified and lack numerical dates. It has been suggested that *Homo erectus*, and hence the Acheulean tradition, initially spread along coastal areas and eventually followed river valleys into the interior (Petraglia 2003; Petraglia, Drake and Alsharekh 2009). The earliest stratified assemblage of the Arabian Peninsula at Khall Amayshan in the central Nefud is dated to 0.4 Ma (Groucutt *et al.* 2021). The first attested occupation is therefore connected to interglacial, i.e. more humid environmental conditions during MIS 11 (Lisiecki and Raymo 2005).

In the UAE, the Acheulean technocomplex was previously only documented at Suhailah 1 in Sharjah (Bretzke *et al.* 2016). The Jebel Mundassa inventory represents the first evidence for Acheulean occupation in Abu Dhabi (see also Händel *et al.* 2023). In contrast to Suhailah, cleavers are part of the Jebel Mundassa tool kit. It cannot be clarified at the present whether this refers to different chronological or functional settings. A clear chronological assignment is not possible for either site, due to lack of stratification, but a connection to occupation by *Homo erectus* during one or more pluvial phases in the Early to Middle Pleistocene, between 1.5–0.4 Ma, seems likely.

In Abu Dhabi emirate, Middle Palaeolithic occupation is now documented for both the Western and Eastern Region: at Jebel Barakah and in the vicinity of Jebel Hafit (Händel *et al.* 2023). Comparable to the significance of the Arabian Lower Palaeolithic for the expansion of archaic hominins, the investigation of Middle Palaeolithic occupation in Arabia is of great importance for understanding the dispersal of Anatomically Modern Humans (AMH) from Africa into Eurasia. The earliest directly dated Middle Stone Age assemblage associated with *Homo sapiens* fossils was recorded at Jebel Irhoud, Morocco, and placed at 349–281 ka (Hublin *et al.* 2017). In East Africa, AMH fossils were dated to >200 ka (Vidal *et al.* 2022), in Europe to > 210 ka at Apidima Cave in Greece (Harvati *et al.* 2019), and in the Levant to 194–177 ka at Misliya Cave, Israel, where the human remains are associated with Levallois technology (Hershkovitz *et al.* 2018).

In Arabia, early AMH fossils are rare. A phalanx from Al Wusta in the Nefud was dated to 95–85 ka and is connected to a late MIS 5 humid period, i.e. MIS 5c or 5a (Groucutt *et al.* 2018). Documented throughout Arabia are Middle Palaeolithic inventories without human fossils. These are placed into a wide time frame, from 240–200 ka (Crassard *et al.* 2019) to 55 ka (Delagnes *et al.* 2012). In the UAE, Middle Palaeolithic artefacts were not only recorded in Abu Dhabi, but also in Ras Al Khaimah and Sharjah from surface sites (Scott-Jackson, Scott-Jackson and Rose 2009), and more importantly stratified at Jebel Faya in Sharjah (Armitage *et al.* 2011). The Faya rock-shelter site (FAY-NE1) provided OSL ages for Middle Palaeolithic occupations going back to 210 ka (Bretzke *et al.* 2022). Since numerical ages are not available for the assemblages of the Hafit area, the hypothetical time frame for occupation remains rather wide. From a climate perspective, expansions of AMH in Arabia before MIS 5e could have been connected to interglacial conditions during MIS 7 (Lisiecki and Raymo 2005; Schaebitz *et al.* 2021), or to subpluvial interstadials in MIS 6 (Parker 2009). A placement into MIS 6 is also suggested by the earliest OSL ages obtained at the Faya rock-shelter (Bretzke *et al.* 2022).

In Abu Dhabi, artefacts of Upper/Late Palaeolithic character have so far only been documented in the Hafit area (Händel *et al.* 2023). In Southern Arabia, however, assemblages characterised by a higher portion of elongated blanks have already been reported from a range of sites (Amirkhanov 1994; Bretzke *et al.* 2014; Rose *et al.* 2018; Bretzke 2020; Mateiciucová *et al.* 2020).

Blade and bladelet production were also documented in Northern Arabia and assigned to the Upper Palaeolithic (Hilbert and Crassard 2020). These assemblages show partly individual technological and typological attributes. This diversity can either be linked to varying chronological, functional and/or behavioural aspects, or indicate autochthonous regional developments (Armitage *et al.* 2011). Due to the sparse chronological data, this must at present remain unclear. At Jebel Faya, the latest Palaeolithic find layer dates to 45–40 ka. It is covered by a layer of oxidised aeolian sand, dated to 30 ka and marking the beginning of a local occupation hiatus that lasts into the early Holocene (Bretzke *et al.* 2013). Climate data suggest more humid and therefore potentially more favourable conditions during interstadials in the earlier part of MIS 3 (Parton *et al.* 2015) and after the LGM from ca. 17 ka (Clark *et al.* 2009), while stadial conditions were connected to periods of extreme aridity.

Conclusions and outlook

Our surveys provide evidence for the occurrence of the main Palaeolithic technocomplexes attested elsewhere in Southern Arabia, also in the Eastern Region of Abu Dhabi emirate, suggesting a long history of occupation by archaic hominins and AMH. A key factor for the abundant record of Stone Age sites in the Hafit area is the presence of rich primary and secondary lithic raw material sources. However, it should also be considered that the newly discovered sites are located near (palaeo-) alluvial contexts with a potential of providing the biodiversity and -productivity required for sustaining hunter-gatherer populations under more humid environmental conditions.

From a geomorphological perspective, the area displays several types of palaeosurfaces preserving the Palaeolithic record. These include remnants of alluvial sediments deposited prior to the Middle Pleistocene immediately east of Jebel Hafit, appearing today as shallow dark-coloured mounds covered by Harzburgite cobbles and metamorphic siliceous raw materials (Figure 10A). North of Jebel Hafit, the older terraces of Wadi Tarabat preserved Palaeolithic contexts. And along the west face of the Malaqet-Mundassa anticline are stable glacis surfaces (Figure 10D) that remained largely unaffected by post-occupational fluvial and colluvial processes during the Middle to Late Pleistocene and the Holocene. Here, Palaeolithic and Holocene lithic scatters extend to the edge of the Al Jaww alluvial plain, where Late Holocene gravels cover the foreland basin between the Hafit and Malaqet-Mundassa anticlines (Figure 10C). No prehistoric lithic scatters are found here. The main drainages to the north and south are located west of the Al Jaww Plain. To the west of these wadis are the dark mounds. The gravel bodies forming these mounds are partly covered by calcareous cobbles and gravel deriving from Jebel Hafit (Figure 10E). Here, the surfaces show mainly Holocene sites, and only few Palaeolithic contexts are preserved in more elevated areas (Figure 10B). Due to high sedimentation dynamics along the glacis and slopes of Jebel Hafit's east side (Figure 10F), only one unspecific lithic context was preserved (Figure 11). Sedimentation dynamics are even higher on Jebel Hafit's west side, where the drainage system is more juvenile (Hansman and Ring 2018: Figure 13). Here, lithic scatters are only found in protected rock shelters and some more elevated patches of the glacis.

While the Palaeolithic record in the Eastern Region of Abu Dhabi still raises numerous questions and requires findings in datable sedimentary context in order to collect isochronous, more technologically homogeneous assemblages, it also shows the immense potential for further research that can provide significant contributions to a better understanding of human occupation in Southeast Arabia and enhance our perception of hominin dispersals during the Pleistocene.

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Filling in the gaps
New evidence for Middle and Upper Palaeolithic occupations in the central region of Sharjah

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Abstract: Archaeological records from the United Arab Emirates feature currently gaps regarding human occupation during the late Middle Pleistocene (c. 250–130 ka) and the terminal Late Pleistocene (ca. 60–12 ka). In this paper we will provide an overview of recent field work of the Sharjah Archaeology Authority and University of Tübingen joint project on the Palaeolithic occupation of Sharjah. Results from more than a decade of work question models linking human occupation of Southeast Arabia exclusively with global climate change. Instead, we conclude that considering a more complex interplay of global climate developments with regional landscape characteristics and resource distribution patterns is more promising.

Keywords: Middle Paleolithic, Upper Paleolithic, excavation, Sharjah, paleoenvironment

Introduction

Palaeolithic records from Arabia are chronologically and spatially scattered, which often led researchers to conclude that the Pleistocene history of human occupation of the peninsula was characterised by long occupational gaps interrupted by brief phases of (re-)occupation. Changing climatic conditions are thought to be the main factor determining this pattern. In this model, increased precipitation is assumed to have enabled flourishing and widely distributed human populations in Arabia, while periods of desiccation are thought to have led to the breakdown of inter-regional connectivity linked to either contraction into refugial areas, large-scale extinctions or dispersals into neighbouring regions (Armitage *et al.* 2011; Bretzke *et al.* 2022; Petraglia *et al.* 2011; Rose *et al.* 2011). Researchers identified one of the most pronounced increases in precipitation in prehistoric Arabia for the period between about 130 ka and 70 ka (Fleitmann and Matter 2009; Rosenberg *et al.* 2011). In accordance with these results, researchers recovered a comprehensive archaeological record showing human presence in many parts of the peninsula (Armitage *et al.* 2011; Delagnes *et al.* 2012; Groucutt *et al.* 2018; Crassard *et al.* 2019; Jennings *et al.*

2016; Rose *et al.* 2019a; Scerri *et al.* 2015). The relatively dry phases before and after this period of intensified settlement, however, provide only scarce evidence for human settlement in Arabia. It has thus been concluded that Arabia was largely unoccupied about 190-130 ka, 70-60 ka and 40-12 ka ago.

We will present here new data from more than a decade of fieldwork in the emirate of Sharjah that will question these conclusions by filling in gaps in the archaeological record and demonstrating human presence in Southeast Arabia during supposedly arid phases. A rich record of both surface and stratified archaeological assemblages makes Sharjah's central region a promising area to test diachronic models of prehistoric settlement patterns and cultural evolution. To promote research and documentation of the Stone Age history, the Sharjah Archaeology Authority (SAA) and the University of Tübingen (Germany) initiated a joint project in 1995, which builds on earlier collaborative work by the SAA and French teams conducted in the 1980s (Boucharlat *et al.* 1997).

Archaeological sites

Research of the joint Sharjah-Tübingen archaeological project produced a wealth of data on the Palaeolithic and Neolithic of the region during continuous fieldwork over the past 27 years. We focus here on results illuminating the Palaeolithic history of Sharjah's central region. Crucial in this context are two stratified sites (Figure 1) that provide securely dated evidence on repeated human occupation between about 230 ka and 15 ka ago.

Site FAY-NE 1 at Jebel Faya was first discovered and test-excavated by a French team during their field work in Sharjah in the 1980s. This work was directed by Rémy Boucharlat (CNRS, France) and established the presence of stratified prehistoric material at the site. In 2003, archaeologists from the University of Tübingen, headed by Hans-Peter and Margarethe Uerpmann, started systematic and large-scale excavations at the site, which revealed the presence of stratified Palaeolithic material (Armitage *et al.* 2011). FAY-NE 1 provides a unique archaeological sequence with evidence of seven periods of occupation during the Pleistocene (Armitage *et al.* 2011; Bretzke *et al.* 2014). Because of distinct depositional settings, the archaeological content of site FAY-NE 1 has been described in two sequences. One, the Faya Terrace Sequence, is located in front of the rock shelter and was excavated from sediments that accumulated mostly outside the sheltered area. By contrast, the Faya Shelter Sequence contains archaeological layers deposited under the protection of the rock shelter. Both sequences can be stratigraphically correlated (Bretzke *et al.* 2014). The Faya Terrace Sequence was published by Armitage *et al.* (2011) and, with regard to the Palaeolithic, consists of four archaeological layers named A to D, from the youngest to the oldest

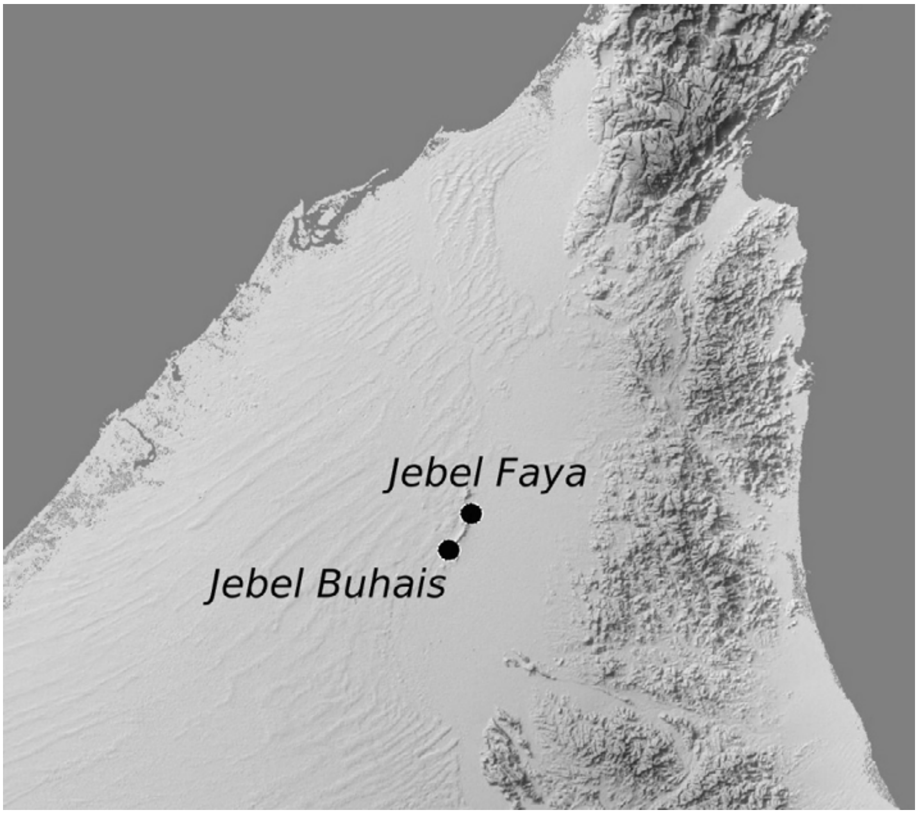


Figure 1: Map showing the location of the Paleolithic sites FAY-NE1 at Jebel Faya and Buhais Rockshelter at Jebel Buhais in the central region of Sharjah emirate.

assemblage. While Assemblages A and C are dated to about 40 ka and 125 ka respectively by optically stimulated luminescence (OSL), Assemblage B currently remains undated (Armitage *et al.* 2011). OSL results for Assemblage D revealed a deposition at about 212 ± 19 ka (Bretzke *et al.* 2022).

The second sequence of archaeological layers, the Faya Shelter Sequence, contains six Palaeolithic occupation periods. These are named archaeological horizons (AHs) II to VII, with AH II being the youngest and AH VII the oldest layer (Bretzke *et al.* 2014). Available OSL results from this sequence indicate that the oldest layer, AH VII, was deposited at 172 ± 9 ka ago, while AHs VI and V were deposited at 134 ± 7 ka and 123 ± 10 ka respectively (Bretzke *et al.* 2022). The top of the Faya Shelter Sequence (AHs IV-II) remains currently undated. Based on typological observations, however, these layers most likely represent Middle Palaeolithic occupation phases.

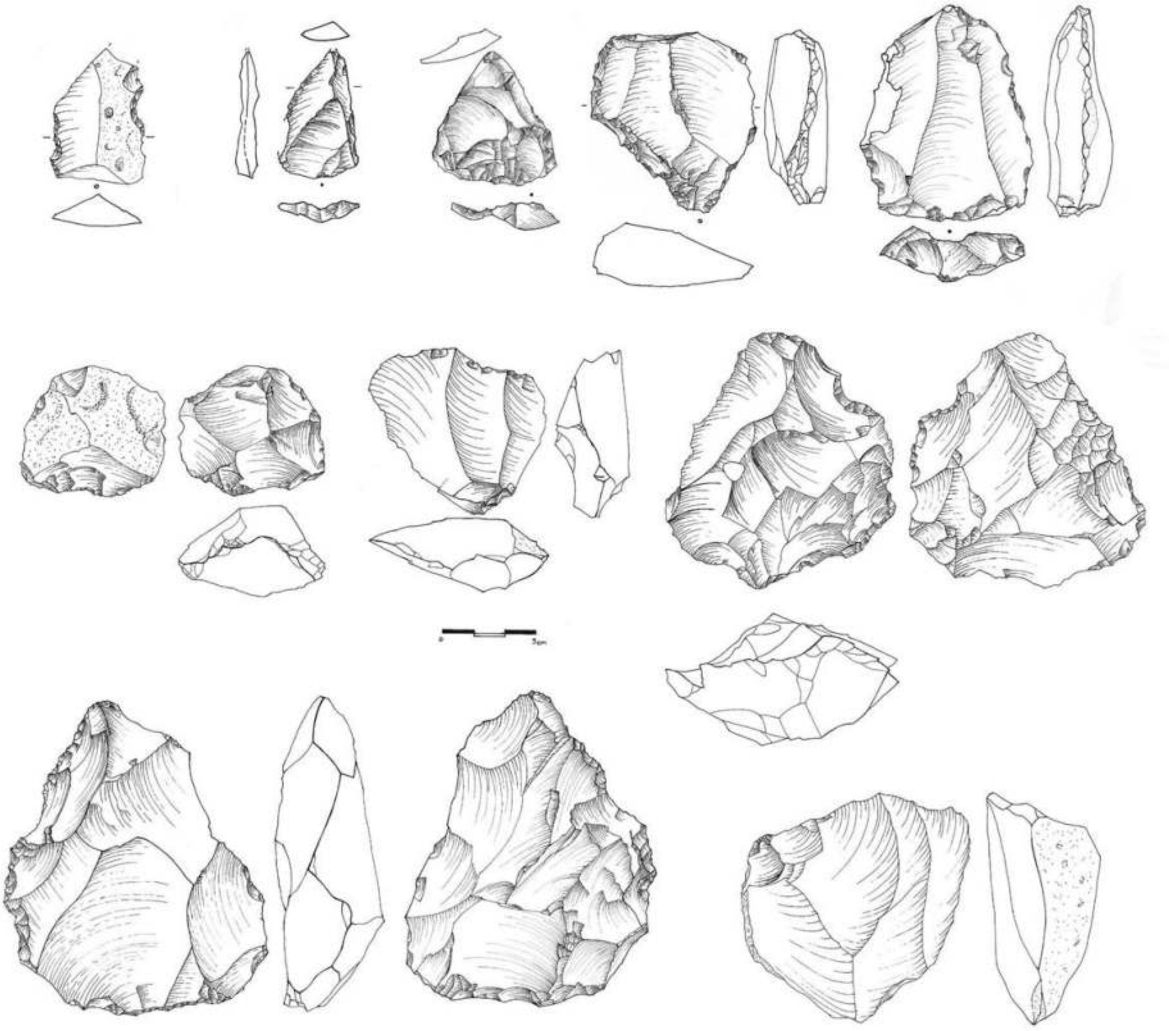
The second key site with regard to Palaeolithic occupation history is site BHS 84 at the southern end of Jebel Buhais. It was discovered and first excavated by a team from the SAA as part of their intensive fieldwork at Jebel Buhais during the second half of the 1990s. This work was directed by Sabah Jasim (2012). The SAA work concentrated on the site's Iron Age burials. Re-evaluation of the potential for older material led to the resumption of excavations at the site in 2017. Four excavation campaigns at the site exposed a Paleolithic sequence containing three layers of Palaeolithic material. Samples for age estimates based on OSL have been collected from all archaeological layers. Available results suggest a terminal Pleistocene age for the deposition of the two youngest Palaeolithic layers, AHs I and Ia.

The early Middle Palaeolithic (c. 240–130 ka)

Due to an abundance of sites, Middle Palaeolithic research in Arabia often focused on the first half of the Late Pleistocene period with mid-Middle Palaeolithic assemblages. In contrast, earlier occurrences and the transition from the Lower to the Middle Palaeolithic remain weakly understood. However, intensified fieldwork over the past years provides first data from northern and central Saudi Arabia (Crassard *et al.* 2019; Groucutt *et al.* 2021; Scerri *et al.* 2018), which sheds first light on the earlier phase of the Middle Palaeolithic. Well-dated archaeological records from southern Arabia, in contrast, were unavailable until recently. Archaeological and chronometric research at Jebel Faya now began to fill in the Late Middle Pleistocene gap in the archaeological record. Jebel Faya's Assemblage D (c. 210 ka) and AH VII (c. 170 ka) both provide new data and insight into the Early Middle Palaeolithic period in SE Arabia (Bretzke *et al.* 2022).

Assemblage D is a small collection (n = 171) of lithic artefacts from a depth between 2 and 3 metres below surface, excavated from an area of about 4 m^2. The lithic artefact assemblage indicates the presence of a flake technology based on the reduction of cubic cores. The few tools are dominated by side scraper types. Although the small sample size hinders final conclusions regarding technological details, the clear dominance of flake production and side scrapers fits well with a Middle Palaeolithic classification of the assemblage.

Lithic artefacts from AH VII again indicate the presence of a flake technology. This time, however, reduction was mainly conducted on relatively flat, hierarchical cores along the circumference or from one direction, creating centripetal and unidirectional scar patterns, often using platform preparation such as faceting. A second reduction strategy identified in AH VII involves (semi-)prismatic single and multiple platform cores. In addition to the production of flakes, the AH VII assemblage shows an established production and use of bifacially retouched artefacts. In contrast to Assemblage D, where evidence for bifacial retouch is scarce, in AH VII this technology is well presented. The tool assemblage is, in addition to bifacial tools, characterised by side scrapers, denticulates and points (Figure 2). Finds from AH VII were the first evidence for human occupation of Arabia during MIS 6, a period thought to be characterised by hyper-arid conditions in Arabia. It has been argued that late Middle Pleistocene hunter-gatherer groups were able to explore Southeast Arabia due to a favourable local hydrogeological setting and the occurrence of brief wet phases (Bretzke *et al.* 2022).



The mid Middle Palaeolithic (c. 130–70 ka)

Figure 2: Examples of lithic artefacts from AH VII of the Jebel Faya Shelter sequence.

With the onset of increased precipitation during MIS 5, occupation of Arabia seemed to become more widespread and intense compared to the situation during the Middle Pleistocene. This is demonstrated in an increase in the number of archaeological records found in many regions of the Arabian Peninsula (Bretzke *et al.* 2022; Crassard *et al.* 2019; Groucutt *et al.* 2021; Rose *et al.* 2019a). The mid-Middle Palaeolithic sequence at Faya starts with AH VI and Assemblage C. It is interesting to note that lithic artefact assemblages from these layers share marked typo-technological similarities with the latest early Middle Palaeolithic layer AH VII, including Levallois-type reduction, bifacial tools and faceting of striking platforms for example. There is also no significant shift in the tool types observed between AH VII and AH VI/Assemblage C. Still, scraper and denticulates form the majority of tool types identified in these assemblages (Bretzke *et al.* 2022).

The succeeding sequence of layers AHs V-II and Assemblages B and A provides lithic assemblages that feature broadly comparable typo-technological

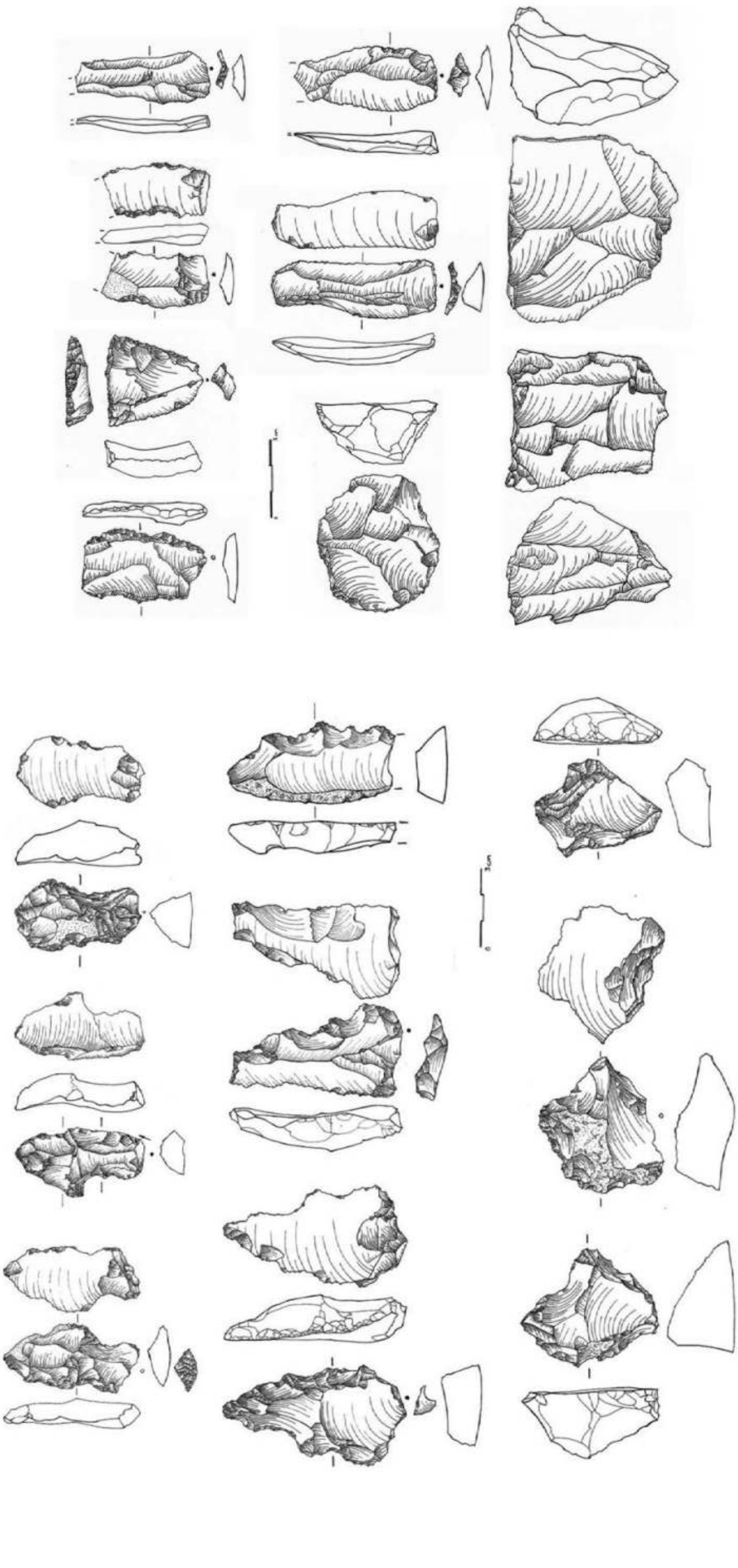


Figure 3: Examples of lithic artefacts from AH IV (left) and AH II (right) of the Jebel Faya Shelter sequence.

characteristics with a broad range of technologies available for the Middle Palaeolithic inhabitants. Based on the overlap of the available reduction strategies in the different layers, it has been argued that the observed differences in the frequency of core reduction systems represents shifting preferences rather than significant technological turnovers (Bretzke and Herkert 2023). Levallois technologies with tool assemblages often dominated by side scrapers and denticulates form the majority in all assemblages (Figure 3). A more pronounced shift in the preference for the reduction of lithic raw material can be observed in the AH II assemblage, where bi-directional reduction clearly dominates. Likely linked to this technological orientation is the identified increase in the efficiency of raw material use in AH II (Bretzke and Herkert 2023). Other remarkable observations include the occurrence of stemmed artefacts in AH IV and the presence of cores on flakes (e.g. Kombewa) in AHs IV-II.

Despite intense chronometric research at Faya, a precise chronology for AHs V-II is not straight forward. Preliminary results from AH II indicate that the top of the Palaeolithic sequence is formed by an assemblage deposited about 70 ka ago. Available chronometric results and stratigraphic order of the single archaeological layer allow the conclusion that the FAY-NE1 Shelter sequence from AH VI to II represents human occupation during MIS 5.

The late Middle Palaeolithic (c. 70–40 ka)

Currently, there are no archaeological records from the Faya region dating to the late Middle Palaeolithic period. This key period for the evolution of modern humans coincided with a period of increased desiccation and hostile climatic and environmental conditions. Whether this gap in the archaeological record is due to a real absence of hunter-gatherer societies or linked to the relatively short research history on the Palaeolithic period of the region remains an open question.

The Upper Palaeolithic (c. 40–12 ka)

Traditional models about the prehistory of Arabia often conclude, from the lack of archaeological records and supposed hyper-arid conditions (linked to the maximum extend of global ice sheets in this period), that Arabia was hostile and unpopulated during the Upper Palaeolithic period. The first evidence contradicting this view, however, came from Dhofar in southern Oman. Here researchers found stone tools that were dated to about 33 ka ago (Rose *et al.* 2019b). Further evidence is now available from Sharjah's central region. About 15km south of Jebel Faya, Jebel Buhais Rockshelter contains a Palaeolithic sequence that provides evidence for Upper Palaeolithic human occupation of the region. This site is known since the late 1990s as an Iron Age burial site (Jasim 2012).

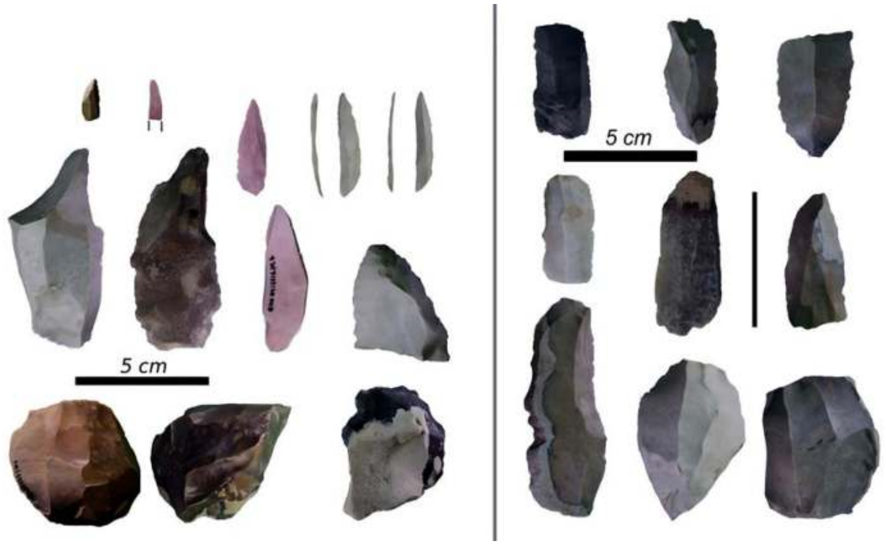


Figure 4: Examples of lithic artefacts from Buhais Rockshelter AHs I (left) and Ia (right).

Re-examination of the potential for earlier archaeological layers revealed the presence of a sequence of at least three Palaeolithic layers. The upper two layers (AH I and AH Ia) contain lithic assemblages that were markedly distinct from what is known from Jebel Faya. While both layers feature blade technologies, the younger one (AH I) also contains evidence for the systematic production of bladelets (narrow blades, width < 10mm). Tool types include end scraper, burins and backed bladelets (Figure 4). These typotechnological characteristics place the assemblages into an Upper Palaeolithic context. Preliminary chronometric data supports this conclusion by providing an age for AH Ia of about 35 ka. Although details still have to be worked out, it is now clear that there is an Upper Palaeolithic occupation phase in Sharjah's central region.

Conclusion

Evidence presented here for human occupation of Sharjah's central region during Middle Palaeolithic and Upper Palaeolithic periods extends the known archaeological record into periods previously thought to be too hostile to allow an occupation by hunter-gatherer societies. Observations regarding similarities in technological and tool spectra of Jebel Faya's AHs VII and VI allow us to conclude a continuation of lithic traditions from the late Middle to the early Late Pleistocene. Accepting this typo-technological continuation would also support the idea of a re-occupation of the Faya region from spatially relatively close areas which provide conditions that allow surviving climatically harsh periods. Our results are in accordance with paleoenvironmental results indicating brief periods of increased hydrological activity during MIS 6 and MIS 3-2 (Mueller *et al.* 2022). We argue here that this demonstrates that regional climatic and hydrological characteristics are important factors determining conditions for human occupation of the region. Based on our observations, we would further argue that global climate change is not the sole driver of human demography in Southeast Arabia.

While our work filled in some of the gaps in the archaeological record for MIS 6 and MIS 3/2, others remain. Most strikingly, there is no evidence of human presence at about 55 ka, despite sufficient data for increased hydrological activity in the Faya region, including the formation of water bodies (Parton *et al.* 2013). Another important gap in the archaeological record can be identified for MIS 4 (70-60 ka). While we conclude for the moment that these periods lack human presence in the central region of Sharjah, our results from more than two decades of research in the region also encourage us to remain open to the possibility of human presence during these supposed gaps.

Acknowledgements

Sharjah Archaeology Authority kindly provided permission for and support of the fieldwork at Jebel Faya and Jebel Buhais. This work was further supported by the German Research Foundation through grants to KB (DFG BR 5562/2-1, BR 5562/6-1) and by the ROCEEH ('The Role of Culture in Early Expansions of Humans') research project of the Heidelberg Academy of Sciences and Humanities. We would also like to thank Hans-Peter and Margarethe Uerpmann for their support and insightful discussions on the Arabian Stone Age.

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Understanding the late-stage Flandrian Transgression and palaeogeographic evolution of the Abu Dhabi islands using remote sensing and marine geophysics

Richard Thorburn Howard Cuttler, Noura Hamad Al Hameli and Peter Magee

Abstract: Low- and high-resolution bathymetric data were used for the purposes of mapping the submerged palaeolandscape around the islands of Ghagha, Dalma, Al Bazm Al Gharbi, Al Fiyay, Marawah, Jananah, and Abu Al Abyadh in the Southern Arabian Gulf. This was used in combination with a sea-level curve generated from Sea-Level Index Points (SLIPs) dating to the past 10,000 years, to provide a chronological framework for palaeolandscape mapping and flood models of late-stage Flandrian Transgression.

The results of the palaeolandscape mapping and flood modelling informed a season of marine geophysics to the south of the islands of Al Fiyay, Marawah and Jananah, in an area known as the Khor Al Bazm. The mapping was used to identify areas of raised seabed topography to investigate the hypothesis that such areas would once have been islands. These islands were probably favourable for Early Neolithic settlement during periods of lower sea levels. Side-scan sonar survey revealed the presence of four prominent geophysical anomalies on a raised topographic area to the south of the island of Jananah. Side-scan sonar data also revealed numerous north-south aligned ridges in deeper water to the south of Al Fiyay and Marawah. Diver inspection was not able to confidently confirm the origin of the geophysical anomalies (anthropogenic mounds or natural rock outcrops); however, a 'mosaic' of the side-scan sonar transects shows that these north to south ridges are continuous within the marine area. Current hypothesis is that these are relict beach ridges relating to a decline in the magnitude/rate of late-stage Flandrian Transgression between 8.8 and 8.4 kya.

Keywords: Flandrian Transgression, marine geophysics, Arabian Neolithic, side-scan sonar, Arabian Gulf

Introduction

The marine environment of Abu Dhabi emirate is an area of almost 37,000 km², with a high potential for archaeological remains (i.e. submerged landscapes) that predate the late-stage Flandrian Transgression. Note that Flandrian is used here in concordance with the formal name for the present interglacial stage following the recommendation of the Quaternary Era Sub Committee (Michell *et al.* 1973) and the arguments expressed by Hyvflrinen

(1978 cf. Paepe *et al.* 1976; Mangerud and Berglund 1978). In addition, the area has a good potential for the survival of remains relating to the maritime history of Abu Dhabi from ~8 kya onwards.

Global Sea-Level Index Points (SLIPs, Bird *et al.* 2007; 2010; Chappel and Polach 1991; Stanford *et al.* 2011; Chua *et al.* 2021; Mann *et al.* 2019; Parker *et al.* 2020) indicate that the marine areas of Abu Dhabi were subject to late-stage Flandrian Transgression between ~10.5 and 7.5 kya. Prior to marine inundation, this landscape was probably exploited by Early Neolithic groups living within the Southern Arabian Gulf and was possibly part of an environmental refugia favourable to early human settlement (Rose 2010). Recent archaeological research shows that between ~8.5 and 7 kya substantial island settlements and extensive trade networks were established by the Neolithic population. Excavation of these settlements has revealed remarkable stone-built buildings, such as at Marawah (King 1998; Beech *et al.* 2005; 2008; 2019; 2022; Pavlopoulos *et al.* 2020; Al Hameli *et al.*, this volume) and Ghagha (Al Hameli *et al.* 2023). Prior to excavation, these sites were recorded as large 'mounds', some 20 to 30 m across and surviving to a height of 2 to 3 m. Other Neolithic settlements, while extensive in area and deeply stratified, have little or no surface expression (such as at Dalma Island), with such sites discovered through the collection of surface artefacts (Beech and Elders 1999; Beech *et al.* 2000).

A principal aim of the project was to ascertain if the preference for island settlement observed between ~8.5 and 7 kya was a continuation of settlement patterns when sea levels were lower, between 10 and 8.5 kya. To investigate this hypothesis, low- and high-resolution bathymetric data sets were combined with remote sensing analysis and marine geophysics (side-scan) to map the seabed morphology. A sea-level curve for the past 10,000 years was developed to provide a chronological context to the evolution of the Southern Arabian Gulf shoreline. This work identified areas of raised seabed topography that may have been islands between 10 and 8.5 kya, that were then targeted for side-scan sonar survey.

While seabed modelling identified multiple areas of high potential, logistical issues limited fieldwork to the Khor Al Bazm. This area is a protected environmental bioreserve, largely free from dredging with a relatively undisturbed seabed. The project aimed to evaluate the effectiveness of marine geophysics for the identification of seabed anomalies relating to human occupation, early maritime trade and natural features within the former subaerial landscape. All Sea-Level Index Points (SLIPs) are referenced to Present Mean Sea Level (PMSL) unless referenced otherwise. Dates are referenced as 'years Before Present' (BP), or as 'thousand years ago' (kya).

Bathymetry data and sea level index points

Low-resolution bathymetry

Small-scale topographic maps of the Southern Arabian Gulf were generated using General Bathymetric Chart of the Oceans (GEBCO 2020) data, with a horizontal resolution of 45 m. This resolution is not sufficient to identify cultural heritage sites, however the dataset is excellent for mapping large, natural landscape features such as former endorheic basins, ridges and channels. GEBCO data was imported into ArcGIS 10.6 to generate models of marine transgression at vertical intervals of 2 m (-30 m to -8 m). Referenced to the sea-level curve developed for this paper, the GEBCO data is sufficient to produce low-resolution maps showing the chronological advance of former shorelines.

High-resolution Satellite Derived Bathymetry

The identification of smaller landscape features required access to higher resolution data, such as Satellite Derived Bathymetry (SDB). SDB is generated from multi-spectral satellite imagery using algorithms that correct raw satellite imagery for the loss of visible and near-infrared spectral information that occurs when light travels through the atmosphere and the water column (Kay *et al.* 2009). By resolving these light-transfer issues, the optical properties of the environment can be used to normalise seabed reflectance measurements and provide relative water depth estimations. Relative depth information is then calibrated to the 'real world' topography using known water depths.

Depending on the opacity of the water column, SDB can be effectively deployed to generate bathymetric data in seawater up to a depth of 15 m. The great advantage is that this can be used to analyse the topography of large areas with a relatively low investment in time and resources. Around coastal areas in the Southern Arabian Gulf, the opacity of the water column means that SDB is normally not effective where the water column is greater than 10 m in depth. However, this has still provided bathymetric data for most of the Abu Dhabi coast, and for many areas up to 30 km offshore. The SDB data for this project was collected between 2012 and 2017 by the Environment Agency – Abu Dhabi (EAD) and the Abu Dhabi Digital Authority (ADDA) and has a horizontal resolution of 2 m. This data was imported into Global Mapper 1.6 and used to generate colour-graded topographic models in localised areas within the Khor Al Bazm.

Palaeo sea-level change from 10 kya onwards

The volume of water released from melting ice sheets between 19 and 7 kya resulted in a global eustatic sea-level rise of over 120 m (Clark *et al.* 2009). While this equates to a mean rate of sea-level rise of ~10 mm/year, the rate

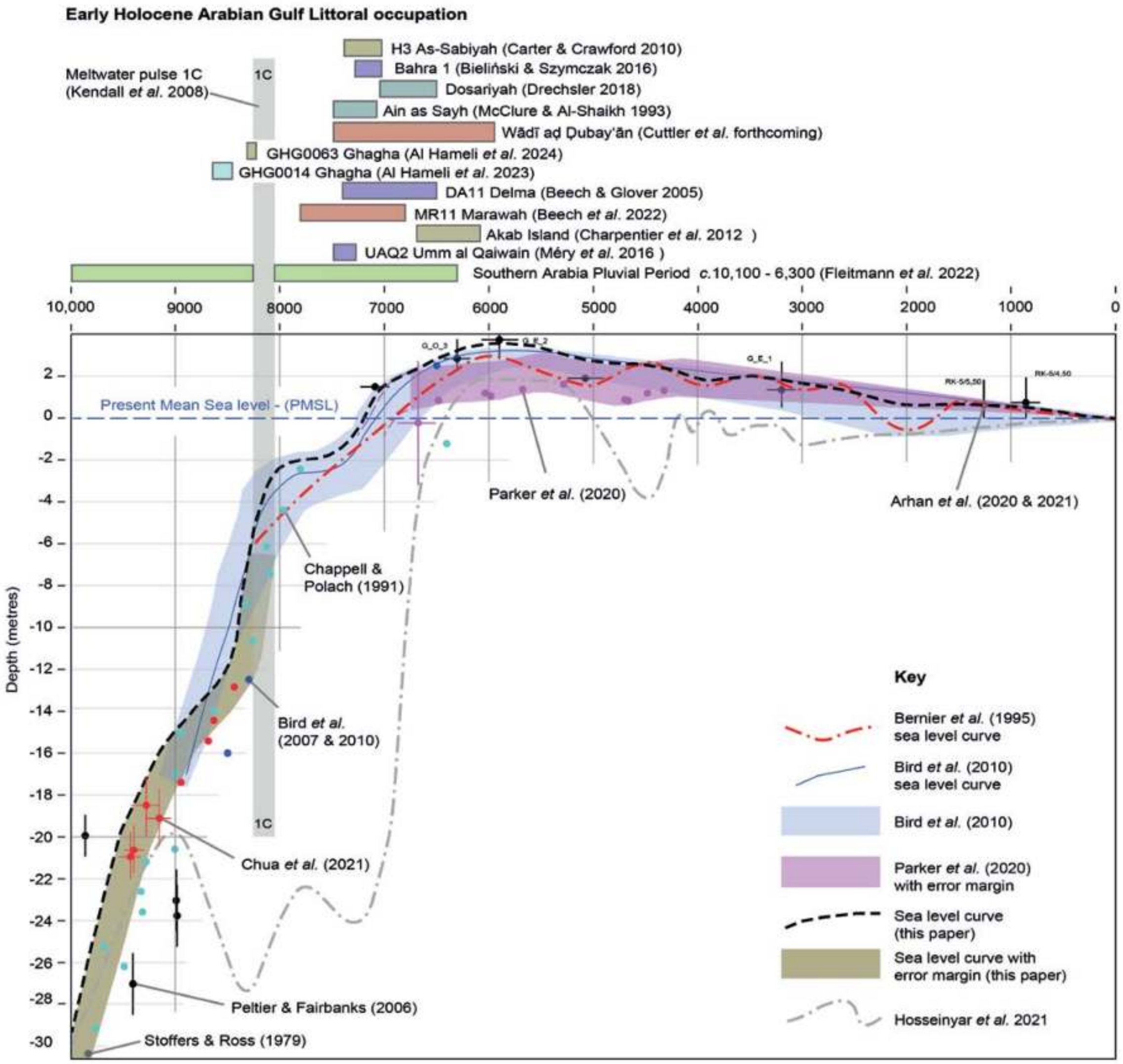


Figure 1: A distribution plot of far-field sea level index points providing a sea level curve from 10 kya onwards.

of sea-level rise was far from constant throughout this period. The intervals of still-stands and the magnitude of sea-level rise during different periods are continually being updated and refined as new data becomes available. This is particularly the case for the Mid- to Late Holocene, where significantly more information is available than for earlier periods (Chappel and Polach 1991; Lambeck *et al.* 1996; Flemming *et al.* 1998; Tamura *et al.* 2009; Bird *et al.* 2010; Stanford *et al.* 2011; Benjamin *et al.* 2017; Parker *et al.* 2020).

Early iterations of sea-level curves did not have the advantage of the comprehensive and wide-ranging Sea-Level Index Points (SLIPs) now available. Most curves describe a broad period of time (from the end of the last interglacial) at low-resolution. Furthermore, most SLIPs from the Arabian Gulf region are samples derived from onshore or intertidal zones. This has produced a wealth of SLIPs for a sea-level high stand (~7.5 kya onwards), but very few for the period between 10 kya and 7.5 kya. For this reason, a curve (Figure 1) has been plotted using global SLIPs between 10 kya and 7.5 kya and SLIPs from the

Southern Arabian Gulf from 7.5 kya onwards (with the exception of Stoffers and Ross 1979). It should be noted that due to tectonic movement, SLIPs from one region may not be representative of sea-level change in another. Indeed, localised buckling, tectonic movement, salt diapirs, subduction and hydrostatic pressure may mean a slight difference in SLIPs, even from different parts of the Gulf. However, the sea-level curve presented here is sufficient to provide a low-resolution curve for the purposes of investigating the chronological change in the shorelines of the Southern Gulf.

Detailed above the sea-level curve is a graph showing early Holocene littoral Arabian Gulf Neolithic sites and their periods of occupation relative to sea-level change. The sites were established during periods of increased rainfall across the southern extent of the Arabian Peninsula (Fleitmann *et al.* 2022), with the earliest site (GHG0014) established during a period when sea levels are thought to be around -12 m PMSL, although the faunal assemblage may indicate otherwise (Al Hameli *et al.* 2023). Sites GHG0014 and GHG0063 are of particular interest as they predate meltwater pulse 1C (Figure 1), dated to around 8.2 kya. (Kendall *et al.* 2008). This meltwater pulse is associated with a period of hyperaridity lasting ~160 years across the Southern Arabian Peninsula. It should be noted that this sea-level curve is generated using multi-proxy data from geological and geomorphological indicators only. The time span of different Neolithic settlements detailed at the top of Figure 1 was not used to provide archaeological indicators of relative sea-level change (Pavlopoulos *et al.* 2012) but provides an indication of sea-level change during the period of occupation for each site.

The sea-level curve in Figure 1 indicates that by 10 kya sea levels had most likely risen above -30 m PMSL, with a near-uniform rate of rise between 10 and 9 kya. This is consistent with most other sea-level curves, which generally indicate an average rate of rise of 15 m / kya between ~11.4 and 9 kya (Lambeck *et al.* 2014). The curve also shows a reduction in the magnitude of sea-level rise of ~1 m per 100 years between ~9 and 8.5 kya, and then a sharp increase of ~9 m between ~8.5 kya and ~8.1 kya, representing a magnitude of 3 m per 100 years. This increase in magnitude coincides with the collapse of the Laurentide Ice Sheet that led to a 'meltwater pulse' (1C, Figure 1) into the North Atlantic. This is generally referred to as the 8.2 kya event (Kendall *et al.* 2008) and coincides with a short period of hyperaridity across the Arabian Peninsula (Parker *et al.* 2006; Cuttler *et al.* 2007; Preston *et al.* 2015; Petraglia *et al.* 2020).

While the paucity of early Holocene SLIPs presents issues for the resolution of sea-level curves, the disparity between data sets highlights that SLIPs provide few absolutes. SLIPs are not a record of mean sea-level elevation but rather a point-in-time record of the elevation of the seabed. The mean sea-level at a point in time is likely to be higher than the recorded SLIP and may in some cases be significantly so. In addition, material dated by SLIPs may have been deposited at a point higher than mean sea level by former high-energy events and storm surges. For these reasons, a margin of error is included within the projected Holocene sea-level curve in this paper.

Isostatic drivers

Work around the island waterway north of Qeshm Island, at the western extent of the Straits of Hormuz, approximately 4 km off the coast of Iran, indicates a divergence from sea level curves for the Southern Arabian Gulf (Hosseinyar *et al.* 2021). Figure 1 shows that this curve is similar to other curves at ~10 kya but diverges significantly between ~9 kya and 6 kya. While this indicates consistently lower sea levels around Qeshm Island, the difference may be due to tectonic movement and land subsidence along the Zagros fold and thrust belt. Clearly more work needs to be done to clarify and reconcile the discrepancies in the data from each area.

Despite these discrepancies, most researchers concur that eustatic rather than isostatic forces have been the predominant driver for sea-level change within the Southern Arabian Gulf. A few researchers have argued for extensive regional uplift (Wood *et al.* 2012), but there is currently little evidence for tectonics or hydrostatic loading having been a significant factor (Purser 1973; Lambeck 1996; Uchupi *et al.* 1996; Lokier *et al.* 2015). Where uplift is a factor, it is mostly localised and due to active salt diapirs (such as evidenced on the islands of Dalma and Sir Bani Yas). This has been confirmed by the recent analysis of beach rock deposits along the coast of Abu Dhabi, whereby minor uplift of around 0.2 mm per year commenced before 6.5 kya (Arhan *et al.* 2020). This indicates a maximum rate of uplift of ~1.3 m over the past 6.5 ky, suggesting only a minor effect from isostatic drivers.

Models of marine transgression in the Southern Arabian Gulf

Marine encroachment into the Arabian Gulf commenced around 14 kya with shorelines advancing through the Strait of Hormuz. By ~7.5 kya levels similar to the present day were reached, with more than 250,000 km^2 of land changing from a subaerial to marine environment (Lambeck 1996). Bathymetric models indicate that the marine areas of Abu Dhabi were entirely free of marine influence for most of the Younger Dryas (~12.8 to 11.7 kya). At the start of the Holocene (~11.7 kya), marine transgression began to advance southwards from the central areas of the Arabian Gulf, with shorelines established in northern parts of the emirate before 10 kya. Figure 2 shows the modelled extent of transgression by ~10 to 9.6 kya.

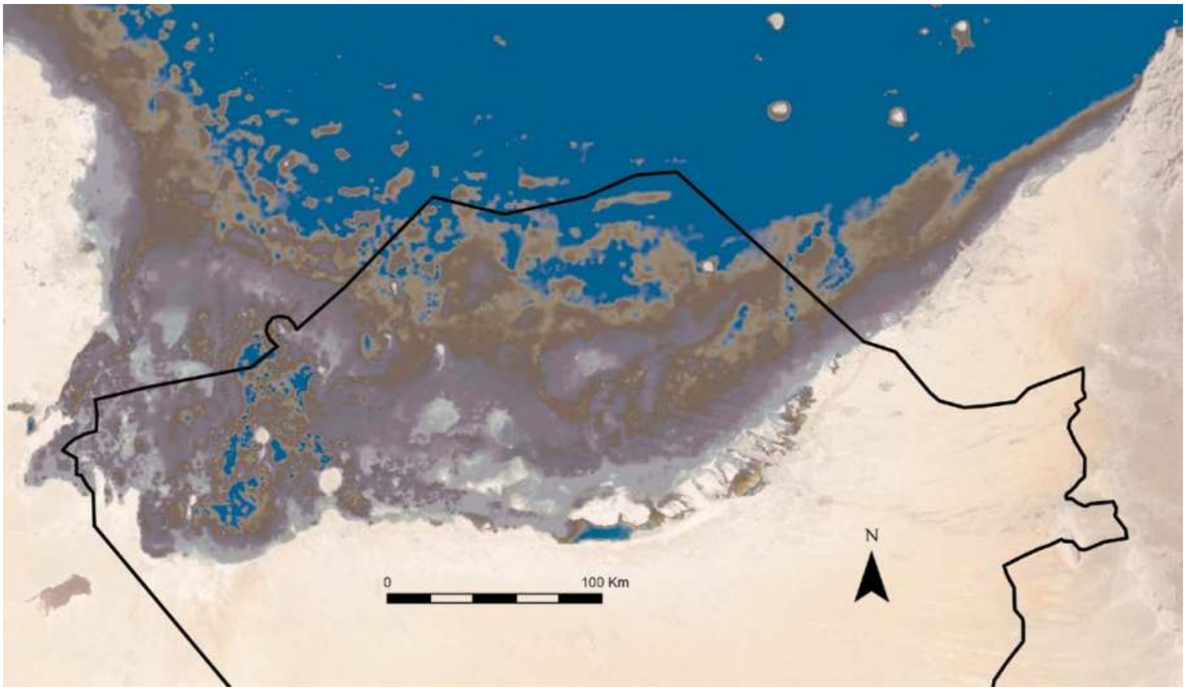


Figure 2: The approximate extent of marine transgression within the Southern Arabian Gulf at -30 m PMSL shown in blue. This shoreline would have been reached sometime between 10 and 9.6 kya. (the black line indicating the border of Abu Dhabi Emirate). This suggests the marine areas of Abu Dhabi would have been free of marine influence until the Holocene Period (11.7 kya).

Between 9.7 and 9.4 kya, sea levels rose above -25 m. Shortly after this, the southwards progression of the Southern Arabian Gulf shoreline was halted by a ridge of higher ground (Figure 3). The ridge is aligned north-west/south-east and is now submerged at a depth of -10 m PMSL. This former subaerial landscape feature is important because it forms the northern extent of a large endorheic basin that extends almost to the present-day Abu Dhabi coast. While the basin averages 25 to 30 metre metres in depth, the ridge of higher ground temporarily restrained Flandrian Transgression with much of the basin more than 10 m below sea level for an extended period. As sea levels rose above -15 PMSL, sometime between 9 and 8.5 kya, the Dalma Basin was flooded through a former (now submerged) river channel at the eastern end of the ridge. The Dalma Basin and outflow river channel are likely part of a larger Miocene river system, which on land includes the Sabkha Matti in the Western Region of Abu Dhabi. The Sabkha Matti is about 60 km across and extends southwards from the coast for almost 150 km. Central to the basin is the island of Dalma, a salt diapir that formed due to deep layers of salt deposited during the Ediacaran period (635-541 million years ago). These layers of salt were later sealed by heavier volcanic rock, limestone and sandstone. As the tectonic plates moved during the middle to late Miocene epoch (16 to 5.3 million years ago), the pressure of the heavier rock forced the salt upwards, fracturing the surface of the plate and forming the island of Dalma. The upwards pressure of the salt produced a 'cone' shape, bringing deeply buried minerals to the surface. Dalma would have become an island following the flooding of the basin sometime after 9 kya.

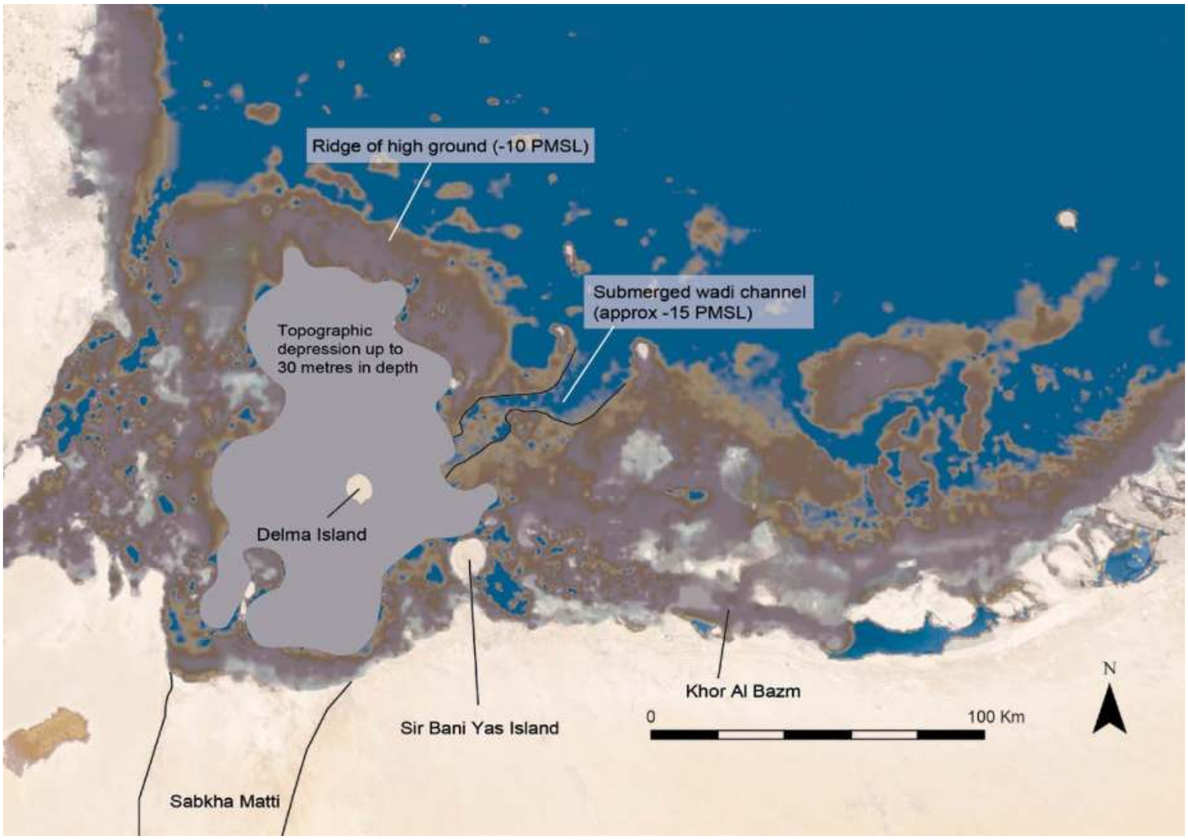


Figure 3: Transgression modelling showing sea-levels at ~-17 m PMSL, probably reached between 9.1 and 8.6 kya.

Late-stage Flandrian Transgression in the Khor Al Bazm

Once the Dalma Basin was subjected to marine influence, it was possible for marine transgression to continue eastwards into the Khor Al Bazm. The Khor Al Bazm lies to the south of a former peninsula that included the islands of Al Bazm Al Gharbi, Al Fiyay, Marawah, Jananah and Abu Al Abyadh. Lower ground at the western extent of the Khor (between -15 and -12 m in depth) was probably subject to marine transgression sometime between 9 and 8.3 kya, while an increase in magnitude in sea-level rise would have seen the eastern extent of the Khor (between 12 m and 6 m in depth) fill rapidly between 8.3 and 8.1 kya. The sheltered waters of the Khor Al Bazm would have provided more favourable conditions for boat travel, fishing etc. As sea levels rose, the peninsula to the north of the Khor Al Bazm became the archipelago of islands that are present today.

The Marawah submerged landscape and Neolithic settlement patterns

The area around Marawah is an EAD Marine Protected Area, with a seabed that is relatively undisturbed by modern activities such as dredging, infrastructure projects, fishing and artificial island development. It is a key location as it is located close to Neolithic settlements first occupied shortly after 8 kya. The focus of settlement for Neolithic communities appears to have been on

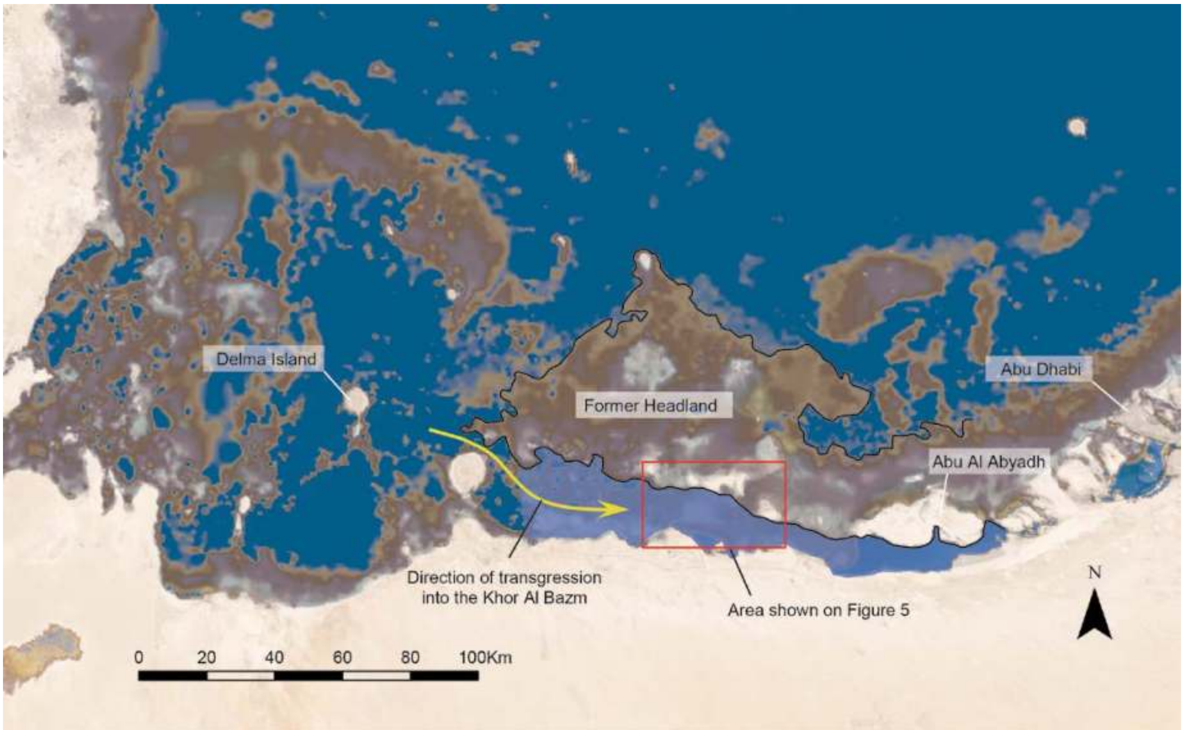


Figure 4: A bathymetric model of the marine area of Abu Dhabi with sea-levels at -16 to -14 m PMSL.

islands rather than the mainland. Neolithic settlements on Marawah (MR1, MR2.5 and MR11) are located on high ground at the southern and western extents of the island, overlooking the Khor Al Bazm. At the Neolithic site of MR11, the mounds are over 20 m in length and are between 2 to 3 m in height. All the Neolithic sites on Marawah are located on rock outcrops that have a vantage over adjacent areas. The choice of location for these sites may help to identify the kind of topography and signatures that submerged landscape features might display as side-scan sonar anomalies.

Side-scan sonar survey areas

SDB data for coastal areas was provided by the EAD and ADDA (with a horizontal resolution of 2 m). Both low- and high-resolution vector data sets were imported into Global Mapper to generate seabed topographic models that were exported as georeferenced geotiffs and imported into EdgeTech Connect navigation software.

A total of five areas in the Khor Al Bazm were subject to side-scan sonar survey (Areas A to E, Figure 5). The analysis of SDB data to the south of Al Fiyay island (Areas A and B) identified the presence of north-south anomalies. Area C was of particular interest as the SDB data highlighted the presence of four areas of raised ground. Area D was located to the south-east of Marawah Island and selected for the investigation of the performance of the side scan in shallow water. Several areas of interest were located to the east and north

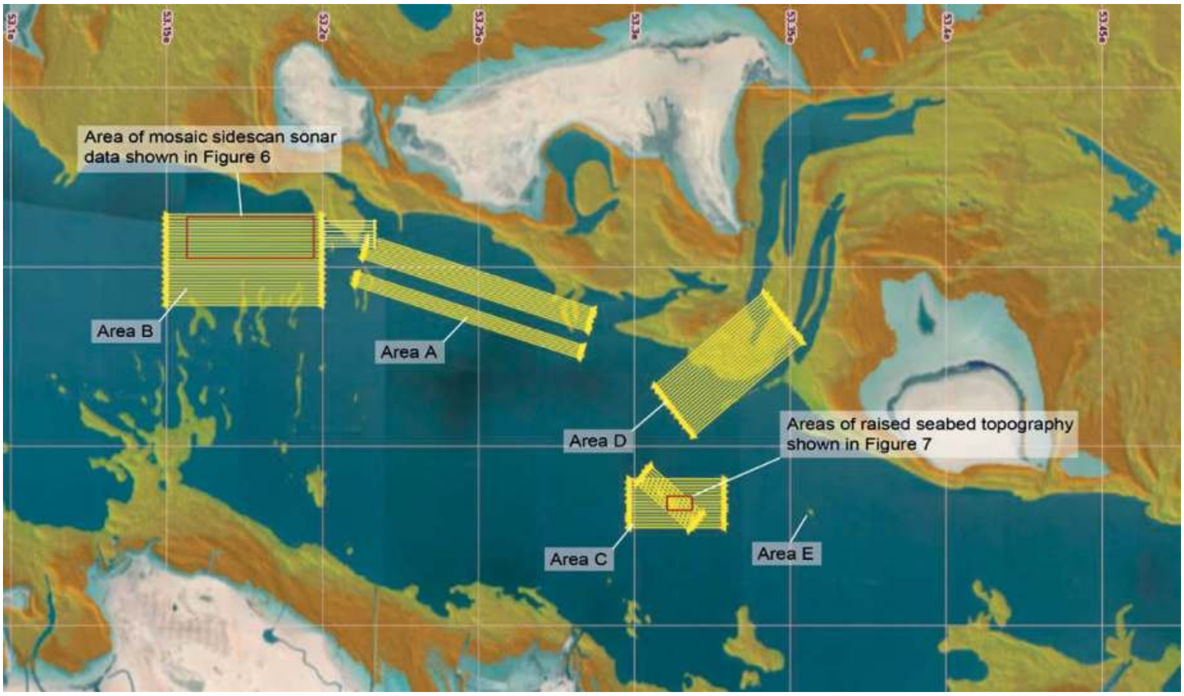


Figure 5: Areas of targeted side-scan sonar survey A to E.

of Marawah but due to shallow water depths were deemed unsafe for further geophysical survey.

Side-scan sonar

Side-scan sonar was undertaken using an EdgeTech 4125 with simultaneous dual frequencies (high and low frequency) at 400/900 kHz or 600/1600 kHz. Most of the survey was undertaken in water depths of between -12 and -6 m. Given the shallow water depths, it was found that the optimum swathe width for low frequency data collection was 200 m (100 m either side of the towfish) and a total swathe width of 100 m for the high frequency (50 m either side of the towfish). Navigation was provided by a Garmin GPSMAP 62 (handheld GPS). Data was collected in both JSF and XTF formats, with sonar transects assembled as a mosaic in Chesapeake SonarWiz V7.08.00 software. For most transects, there is enough overlap between transects to create a 'continuous seabed mosaic'.

Side-scan sonar data analysis

In most areas, the data revealed a very uniform, flat, sandy seabed with some areas of seagrass. There are man-made anomalies within all the areas surveyed. Most are clearly of modern origin, while the nature of some anomalies is difficult to determine without further inspection or seabed coring. Large anomalies, such as seabed ridges or pipelines, can be seen to traverse several of the survey transects and are particularly evident in the data mosaic. The detection of smaller anomalies can only be seen by reviewing individual survey lines in both high and low frequency.

Areas A and B

The seabed in Areas A and B is mostly a sandy flat topography. However, within Area B there are multiple north-south-aligned ridges (Figures 6a and 6b). Some of the prominent ridges were evident in the SDB data, but the side-scan sonar successfully detected many more ephemeral ridges. These ridges measure ~10 to 15 m across and vary between 1 and 3 m in height. Most of the ridges meander in a general north-south alignment across Area B with occasional breaks. These features are likely to be the result of either geological processes or marine deposition. However, given that they are only evident in the marine environment and do not continue into the terrestrial environment on the mainland to the south or on the islands to the north, marine deposition seems the most likely explanation for these features. All the ridges are semi-parallel to the models of the advancing late-stage Flandrian shoreline within the Khor Al Bazm as proposed in this paper. Beach ridges are typically deposited in a low-wave energy environment, semi-parallel to low-gradient shorelines that have abundant sediment supply.

If these features are relict beach ridges, they could be expected to have formed between 8.8 and 8.4 kya when the magnitude of sea-level rise decreased, and therefore they have the potential to provide important data regarding the timing of marine transgression. Modelling suggests that transgression into the Khor Al Bazm progressed from west to east, which would imply that the westernmost ridges are the earliest, with shorelines being progressively later farther to the east.

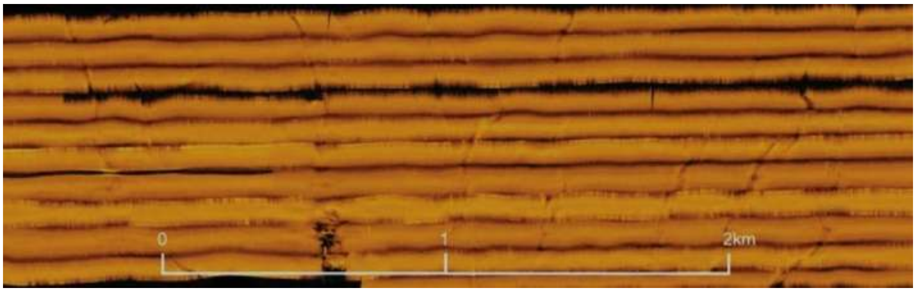


Figure 6a: A composite mosaic of survey transects from the northern extent of Area B. This detected the presence of north-south aligned ridges on the seabed.

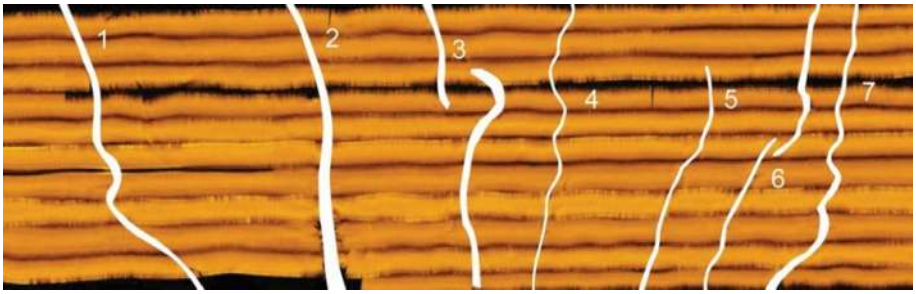


Figure 6b: Interpretation of the above image showing north-south aligned ridges highlighted in white.

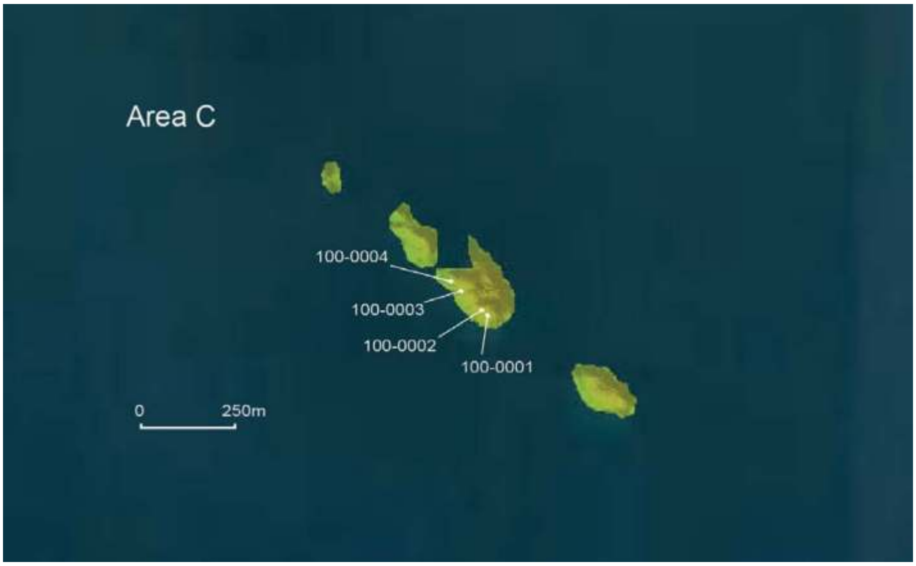


Figure 7: Bathymetric modelling in Area C showing areas of raised seabed topography and the location of anomalies 100-0001 to 100-0004.

Areas C and E

Analysis of the SDB revealed the presence of raised seabed topography in Areas C and E. Area C was of particular interest having four distinct areas that were conspicuously higher than the adjacent seabed (Figure 7). These four areas averaged around -8 to -6 m in depth, with the adjacent water depth being ≥ 10 m. Side-scan sonar survey within Area C revealed the presence of four seabed anomalies within the southern-central raised area. These appeared as four anomalies on a north-west to south-east alignment (Targets 100-0001 to 100-0004, below), with the tops of the anomalies at ≥ -4.5 m below sea level. No anomalies of potential interest were recorded in Area E.

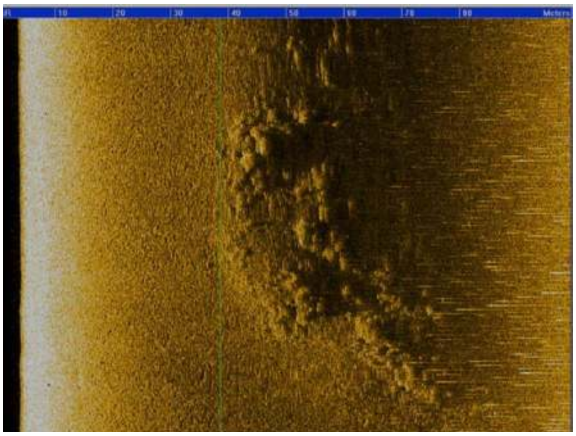
Side-scan sonar anomalies in Area C

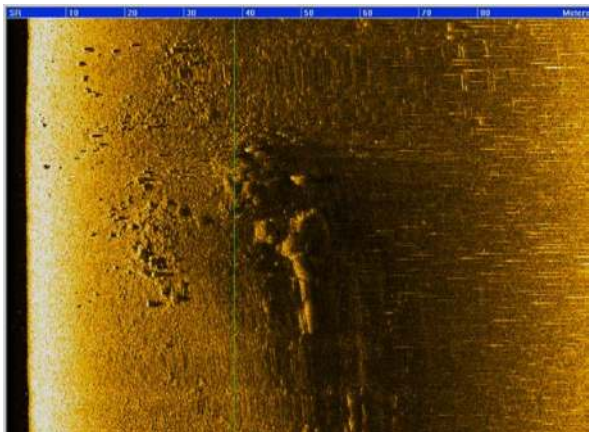
At its highest point, Anomaly 100-0001 (Figure 8a) is in a water depth of ~5 m. This is a mound or outcrop ~27 m in length, 20 m in width and around 2 m in height.

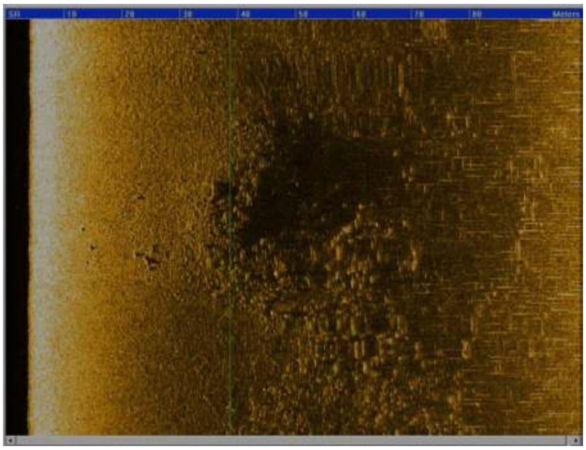
Anomaly 100-0002 (Figure 8b) is ~24 m in length, 20 m in width and 1.5 m in height. Most of the anomaly is aligned north-west to south-east and is

Figure 8a (left): Anomaly 100-0001 facing northeast. Starboard side, low frequency, towfish seabed altitude 4.8 metres.

Figure 8b (right): Side-scan sonar Target 100-0002. Starboard side, low frequency, towfish seabed altitude 3.9 metres.







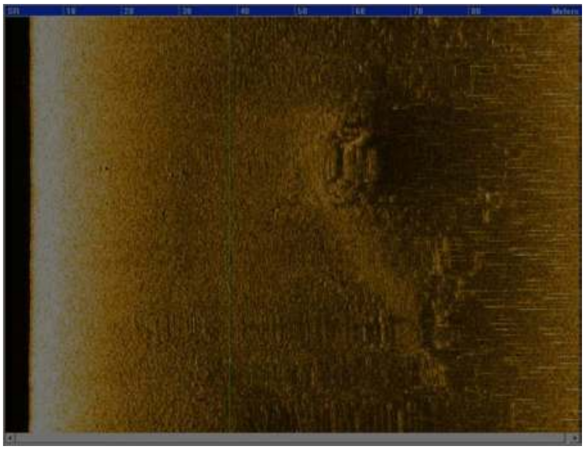


Figure 9a (left): Side-scan sonar Anomaly 100-0003, starboard side, low frequency, towfish seabed altitude 4.7 metres.

Figure 9b (right): Side-scan sonar Anaomaly 100-0004, starboard side, low frequency, towfish seabed altitude 5.1 metres.

approximately 1 m in height above the surrounding seabed. The highest point of the anomaly is at a depth of ~5 m below PMSL.

Anomaly 100-0003 (Figure 9a) is a mound or outcrop located ~160 m to the north-west of Anomaly 100-0002. The anomaly is 25 m across with a height of 1.6 m and is a circular in plan with a central depression. The depression is accentuated by what appears to be a single, large rock that protrudes vertically from the western side of the mound. However, it is possible that this may be two mounds ~12 metres apart, with a rock-filled depression between the two.

Anomaly 100-0004 (Figure 9b) is a mound or outcrop located within a slight, curvilinear scour and is aligned approximately east to west with a high point at the western extent. The anomaly measures ~25 m long and 14 m in width and has a height of ~1.5 m at its highest point.

To the south of the islands of Marawah and Jananah, the seabed is mostly flat and sandy. The anomalies described above are located within an area of raised seabed that would once have been islands within the Khor Al Bazm. As such they are in an area where early Neolithic activity might be predicted. However, geophysical anomalies can be deceptively anthropogenic. For the purposes of interpretation, it is legitimate to consider them as possible man-made mounds, such as shell middens, burial or settlement mounds (Astrup *et al.* 2020; Cook Hale *et al.* 2021); however, without further investigation it is impossible to confidently confirm the origin of these features.

Visual inspection of geophysical anomalies

The southern extent of Ridge 2 (Figures 6a and 6b) and the mounds in Area C were subject to diver inspection. However, it proved impossible to determine the origin of these features due to the extensive coral growth, particularly over the mounds in Area C. Sediment in these areas is clearly deep and would require a marine archaeological dredge to reach the bottom of the profile. Where hand fanning and excavation with a geological hammer was undertaken, the substrate was generally found to be a thick layer of dead coral that had accumulated on the seabed. It was not possible to remove enough material to either reach the natural ground surface or an archaeological layer. While the corals are likely to have developed on elevated stone areas, it is still not clear if the entire extent of these ridges are stone or dispersed sandbanks. In addition, the section of Ridge 2 that was subject to visual inspection is the largest and most prominent of the ridges and may not necessarily be representative of the entire length of each ridge.

Discussion

The analysis of Sea-Level Index Points

Bathymetric modelling and a review of global SLIPs have significantly improved our understanding of the timing and impact of late-stage Flandrian Transgression in the Southern Arabian Gulf. This has been achieved through the analysis of both low- and high-resolution SDB data. Flood models and SLIPs detail the timing and extent of marine transgression around Dalma Island and into the Khor Al Bazm. In addition, high-resolution SDB allowed for targeted side-scan sonar survey, leading to the identification of linear features, interpreted as relict beach ridges.

Due to the irregularity of the seabed, the interpretation of SLIPs without a clear understanding of the regional bathymetry is an issue. This is because higher terrain closer to advancing shorelines can prevent marine ingress into areas of lower elevation for significant periods of time. For example, the timing of the flooding of areas around Dalma is an example of this as advancing marine transgression was delayed from entering the basin by a ridge of higher ground around its northern extent. Areas of the basin where the elevation is ≥ -30 m would see a delay to marine ingress of more than 1.5 kya than would otherwise be expected if the topography rose at a uniform rate. Therefore, if we were to take cores from these areas, we should be aware that SLIPs for the onset of marine conditions would provide a date for marine transgression that is delayed by ~≥ 1.5 ky.

The GEBCO 2022 data set was suitable for low-resolution mapping of the Arabian Gulf but unsuitable for detailed mapping. High-resolution mapping around the Abu Dhabi islands was carried out using satellite derived bathymetry data sets, which was sufficient to identify former wadi channels, endorheic basins and headlands around the islands of Ghagha, Dalma, Al Bazm Al Gharbi, Al Fiyay, Marawah, Jananah and Abu Al Abyadh. The sea-level curve plotted from far-field index points indicates marine transgression in this area between ~9.2 and 8 kya.

The Dalma Basin

For much of the period between 9.7 and 8.5 kya, the Dalma Basin remained an open landscape, despite sea levels being as much as +15 m above the base of the basin. As sea levels rise, there is a corresponding rise in the hydrostatic pressure of groundwater. This may have resulted in an increase in groundwater particularly at the base of the Dalma Basin. This potentially could have encouraged the development of a micro-environment of flora and fauna between ~9.7 and 8.5 kya. As sea levels rose above -15 PMSL, sometime between 9 and 8.5 kya, the Dalma Basin would have been flooded and any freshwater resources within the endorheic basin would have been lost. As the Dalma Basin flooded, Dalma would have been an island from at least 8.5 kya onwards. This would tend to suggest that Dalma would have been favourable for occupation from 8.5 kya onwards; however, the earliest C14 dates from Dalma indicate occupation from the second half of the sixth millennium BCE (7.5 kya) onwards (Beech *et al.* 1999).

Early occupation on Ghagha Island

Another issue of concern is that the recent excavations are indicating a disparity between the period of occupation of Neolithic sites around the Southern Arabian Gulf and SLIPs. In particular, the dating of GHG0014 places occupation of the site in the middle of the 7th millennium BCE (8.5 kya), while the faunal assemblage indicates exploitation of marine resources (Al Hameli *et al.* 2023). The Holocene sea-level curve presented in this paper indicates that when the site was occupied (~8.5 kya), sea levels were between 14 to 16 m lower than PMSL. Bathymetric models show that a sea level of -14 to -16 m PMSL places the palaeo-shoreline some 40 km to the north-east of GHG0014. The disparity between data sets is problematic and suggests that at 8.5 kya, sea levels should be higher than indicated by SLIPs. However, if the data is correct, then other issues may need to be investigated, such as isostatic change, the presence of deep-water channels to the north of Ghagha or the presence of a wider trade network connecting Ghagha to coastlines to the north.

On GHG0014 the extensive mollusc assemblages observed on other Neolithic coastal sites (such as Dalma and Marawah; Beech and Elders 1999; Beech *et al.* 2000; 2005; 2008; 2019; 2022) are almost entirely absent. The reason for this could be because localised transgression was a very recent phenomenon, and molluscs (unlike many species of fish) take longer to populate recently submerged environments since habitats appropriate to molluscs take longer to become established. While the fish assemblage from GHG00014 does contain a number of larger fish remains such as groupers, requiem sharks and rays, the larger majority comprised mostly smaller-sized fish that were caught in relatively shallow waters. The faunal assemblage from GHG0014, therefore, might indicate that the settlement was established shortly after a period of rapid inundation. While fish populations were becoming established, it may be that insufficient time had elapsed since transgression for habitats suitable for mollusc populations to develop.

Relict beach ridges in the Khor Al Bazm

The discovery of north-south aligned ridges in Areas A and B is very significant, and a future programme of targeted coring will help to determine their date and origin. Since these features are exclusive to the submerged areas of the Khor Al Bazm, it is possible that they are relict *(chénier)* beach ridges associated with ancient shorelines. These shorelines would have been established between 9 and 8.3 kya as the magnitude of sea-level rise slowed to an average of ~1 m per 100 years. The side-scan sonar mosaic enables the location of these submerged landscape features to be accurately plotted to inform a programme for future coring. The bathymetric data suggests that early marine transgression within the Khor Al Bazm commenced in the west, gradually moving to the eastwards as sea levels rose. If the ridges are relict beach ridges, they should preserve an important record of early Holocene sea-level fluctuation within the Khor Al Bazm, with the earliest ridges being located to the west and the later ridges being to the east. The analysis of flood models and side-scan sonar mosaics suggests that targeted coring of each ridge may provide a series of dates for late-stage Flandrian Transgression into the Khor Al Bazm.

Relict beach ridges (shorelines) within the Southern Arabian Gulf region are important for archaeological research, as they are known to have been a focus for Early Neolithic communities exploiting both marine and terrestrial resources. Sections excavated across a relict beach ridge at Wadi Debayan in Qatar revealed different phases of Neolithic activity throughout a stratigraphic sequence of more than 1.5 m. This activity included middens, hearths and flint scatters, with archaeological layers sealed by layers of marine sand. The final phase of deposition included a layer of marine-worn clasts, most likely associated with a high-energy event, possibly a tsunami, towards the 3rd millennium BCE (Cuttler *et al.*, forthcoming). It is possible that this high-energy event has been recorded by some authors as a high stand (c. 1.25 to 1.5 m) during the Umm an-Nar period (2700-2000 BCE) in the UAE (Pavlopoulos *et al.* 2020).

Areas C, D and E

SDB data were used to successfully identify areas of raised seabed topography. These are areas that may have been islands favourable for Early Neolithic settlement during periods of lower sea levels. Four possible former islands were identified in the Khor Al Bazm, one of which was shown to contain side-scan sonar anomalies. Unfortunately, visual inspection of these anomalies was insufficient to determine the origin of these features. The Khor Al Bazm has been a submerged landscape for more than 9,000 years. Both natural and man-made features are covered with extensive seagrass, corals and marine deposition. Determining the nature of side-scan sonar anomalies through visual inspection is problematic. While the use of ROVs or sub-bottom profilers might help to resolve this issue, it seems likely that without some form of intrusive investigation, it will not be possible to draw firm conclusions. Intrusive investigation might include the use of an underwater dredge for small-scale marine excavation or targeted coring in order to extract profiles though each anomaly.

While the SDB data indicates that during later stages of marine transgression in the Khor Al Bazm these areas were once islands, the Holocene sea-level curve presented in this paper suggests that they may not have been islands for an extended period of time. Much of the seabed around Area C is around -12 to -10 m, with the raised seabed topography at a depth of -8 and the mounds reaching a maximum height of -4 m. The rate of rise indicated by the sea-level curve suggests that this area would have been rapidly inundated between 8.5 and 8.2 kya with a rise of ~9 m (or a magnitude of 3 m per 100 years). So, a combination of bathymetric modelling and data from the Holocene sea-level curve indicates that the likelihood of extended settlement within this area is low.

During the Marawah 2020 excavation season, a series of cores was taken from within the terrestrial areas of Marawah Island. Of particular interest were three cores (MRW11-M, N and O) extracted from an area of low-lying *sabkha* to the south of the Neolithic site of MRW0011. These cores reached a depth of 2.85 m, much of which was marine-deposited sediment (Pavlopoulos *et al.* 2020). This revealed that the area to the south of the Neolithic site of Marawah had once been a lagoonal area that provided access to the open water of the Khor Al Bazm. Samples from the marine cores provided dates from marine shells in ranges between 7381 and 6420 cal BP. The local marine reservoir effect suggests that marine calibrated dates are often 500 years older than the real date and can be up to 1,000 years older (Lindauer 2019). However, this process has demonstrated the viability of marine coring for obtaining radiocarbon dates and understanding regional landscape change.

As sea levels rose further, the peninsula to the north of the Khor Al Bazm that included the islands of Al Bazm Al Gharbi in the west to Abu Al Abyadh in the east gradually formed the archipelago of barrier islands we now know as Al Bazm Al Gharbi, Al Fiyay, Marawah, Jananah and Abu Al Abyadh. Flood models of the south-eastern Arabian Gulf are now placing the early Neolithic settlements of the Al Dhafra region into a much wider context. It is of particular note that the Neolithic settlements of MR1, MR2.5 and MR11 on Marawah Island are located with access to the south. The north of Marawah, even with present sea levels, is very flat and realistically far too shallow for boat access. Even a few kilometres offshore, the water depth is less than a metre during the low tides. Access to the south would have provided access to the open but protected Khor Al Bazm, which offered less risk than navigating the open waters of the Southern Arabian Gulf to the north of Marawah.

The visual inspection of seabed anomalies rarely provides conclusive evidence regarding the origin of an anomaly. The reason for this is that both natural and man-made mounds within the submerged landscape have been subject to marine digenesis for at least 8,000 years. This will include burial by marine sediment, coral growth, seagrass and marine cementation. Furthermore, low water column visibility and strong currents can hinder the identification of targets. Any future marine section wanting to conclusively verify the nature of geophysical anomalies will need the capacity to undertake some low-level excavation or coring on the anomalies. Low-level excavation might include the capacity for an archaeological marine dredge, while marine cores require a boat fitted with a lifting arm and winch. Normally lighter-weight equipment can core to a maximum depth of around 4 to 5 m; however, this depth is more than sufficient to understand the nature of the seabed and an anomaly in any given area.

While the project has not identified man-made submerged landscape features, the discovery of possible relict beach ridges within the Khor Al Bazm is very significant, as this enables future targeted coring of these features to better understand the late-stage Flandrian Transgression within the Khor Al Bazm. The value of such a targeted programme of coring is that each ridge may represent a distinct time period of lower sea levels, enabling the construction of a high-resolution, late Holocene sea-level curve for the southern Arabian Gulf. Analysis of bathymetry data is invaluable for understanding seabed topography and targeting marine geophysics data capture. Regional bathymetry data is important for understanding SLIPs, as higher terrain may have stalled marine transgression into areas of lower elevation for significant periods of time.

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Funerary practices within Mortuary Complex F
New insights from recent excavations on Marawah Island

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Abstract: The most recent seasons of excavation on MR11 – Area F have led to the discovery of several interments inside the cells of the main structure. This season uncovered the UAE's oldest example of a primary Neolithic interment within a central cell of the building. Several other individuals have been buried in the neighbouring cell of the structure, with a minimum count of at least five individuals in one single cell. Radiocarbon dates have placed the associated deposits of two of these burials at around 5700 cal BCE, which also provides more earlier dates for the MR11 site. This paper will focus on the possible mortuary rituals observed from Area F along with some key finds from the excavations and place these burials within the broader context of the Neolithic burials in the region.

Keywords: Neolithic, burial practice, plaster vessels, lithics, architecture, Abu Dhabi, Marawah, United Arab Emirates

Introduction

The site of MR11 is located on Marawah Island in the Al Dhafra Region of Abu Dhabi. The island is made up of rocky cores of Pleistocene limestone linked by areas of Holocene carbonates (Evans *et al.* 2002). Initial surveys of the island found 13 sites, among which MR11 was recorded as a series of large mounds thought to date to the Neolithic period (King 1998). While Areas A to C have been thoroughly excavated and well published (Beech *et al.* 2005; 2019; 2022), the excavations on Area F were only completed in December 2022. Area F has revealed several inhumations in its main structure complex, and evidence for an established mortuary tradition dating back to at least 5700 BCE on MR11. This contribution reports on the latest findings from the excavations, as well as providing interpretations from the preliminary study of the skeletal remains, artefacts, architecture and observed mortuary practices.

Overview

The main structure in Area F is the best surviving set of stone-built architecture at MR11. The building is constructed using several courses of medium-large limestone blocks and has traces of several postholes and physical alterations on the surface of the bedrock. The structure is made up of four cells in the latest identifiable phase of construction. The cells are oval and clustered, with most of the access points being external. Two internal openings were made in Cell 11: one leads into Cell 12 to the south-western extent of Cell 11 and one into Cell 13, towards the western extent of the Cell. A further external passage is made externally in the north-western extent of circular wall [1041] of Cell 12.

All the walls within Area F were constructed using limestone with occasional fragments of beach rock. These slabs appear to have sheared between sedimentary faces to form larger, irregular slabs that could have been easily collected from areas immediate to the site. Most of the walls are constructed with at least two lines of coursing, one on the inner and one on the outer face, that are then bonded with larger slabs lain across the wall. The width of the walls varies between 0.54 and 0.65 m and most survive several courses, to a height of 0.50 m. Each cell usually has multiple doorways, which are generally located within the northern or southern walls, and rarely more than 0.50 m in width.

The level of survival of archaeological deposits in general is better towards the centre of the mound, where the walls survive up to 1.10 m in height. Here the density of deposits and overburden has preserved not only the height of the walls but also both of the lintels' passages in situ, which has added further to our understanding of the construction techniques associated with this complex. While the construction methodology is generally similar between walls of different phases, there are marked differences in the quality of construction. This not only differs between various cells, but also within different phases and realignments of the same walls, emphasising the extent of change and rebuild over an extended period.

Three open-air platforms were installed around the structure. Platform 1, a raised bedrock surface with a stepped profile encompassing the easternmost extent of Cell 16, was the first to be excavated. Platform 2 is separated from Platform 1 by a short wall (maximum of two courses) that has five vertical orthostats pressed against the western-facing side of it. Platform 2 also has a very prominent paving around the slope of the bedrock to level the surface. Small pebbles are also used to level the undulations of the bedrock on these platforms. Lastly, Platform 3 is just north of Cell 13 and is visibly the smallest in size. Platform 3 seems to be the most worn down or least renovated. It was levelled crudely with small limestone slabs but seems to have had the stones robbed out and repurposed and had a minimum of two cells built on the southern and eastern extent of it.

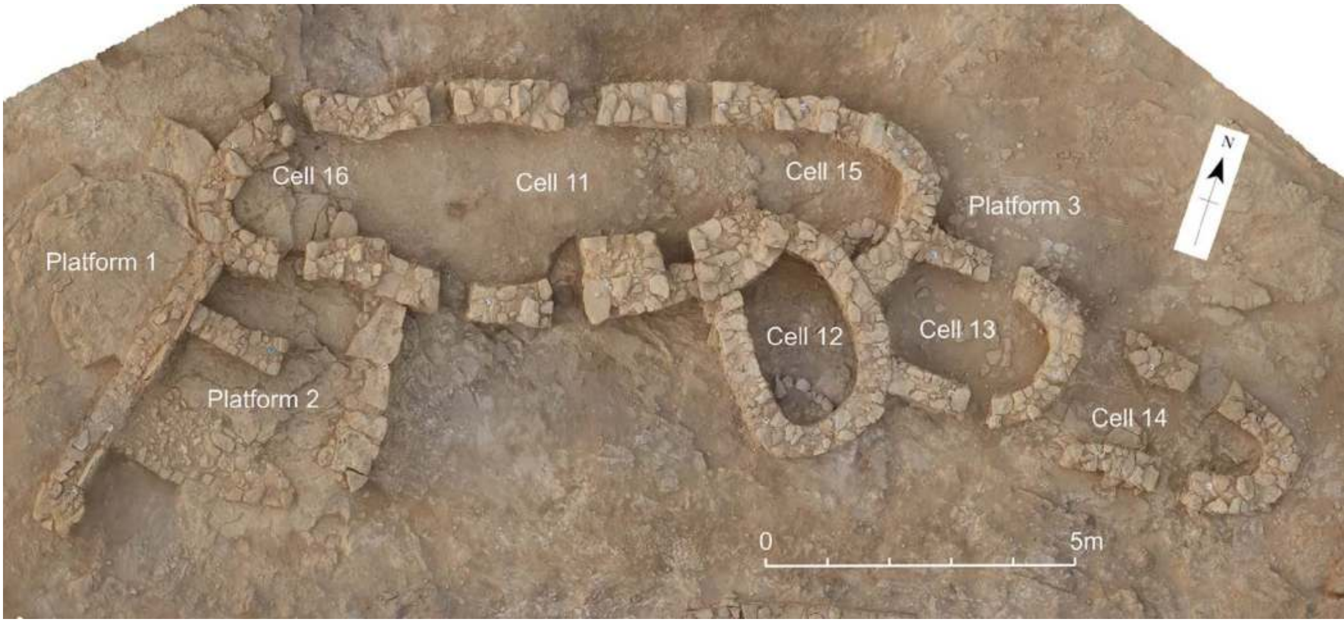


Figure 1: Plan of Area F at MR11.

Phasing the structure

A total of six phases of activity have been identified within Area F. These phases are largely based on changes to the main structures and the associated deposits. The phasing also accounts for the addition of new structures such as a platform or cell. It should be noted that this phasing is preliminary, as it is based only on the stratigraphic relationships and may be subject to revision once the radiocarbon samples and the finds are subject to analysis. In the absence of radiocarbon dates, the chronological relationship of Area F to the structures in Areas A to C is unclear. The main six periods of activity within Area F have been preliminarily phased as follows:

Phase 1: Layers predating later construction and early buildings. This phase groups together postholes under the walls and other early architectural fragments where associated structures have been removed or repurposed by later phases of activity. This phase also includes the construction of a small platform associated with the raised bedrock at the western end of Area F.

Phase 2: This is the earliest phase where the walls of extant structures can be defined as cells. This phase sees the earliest phases of construction and occupation within Cell 11 and its later extension westwards towards the platform, which continued to be extant.

Phase 3: Occupation continues in Cell 11, and further cells are added to the east (Cells 12 and 15) and to the west (Cell 16). This phase also sees the addition of a larger platform to the south of Cell 16.

Phase 4: The apsidal eastern end of Cell 11 is removed, creating one larger room with Cell 15. Cells 13 and 14 are added to the east of the main structures. This represents the last phases of building and occupation within Area F.

Phase 5: This phase is associated with the skeletal remains interred in Cells 12 and 13. The main activity in these cells are funerary practices where internal structures are built to reinforce the buried individuals, and the existing inhumations are reorganised around the cell with the introduction of newer ones.

Phase 6: General collapse and abandonment of the complex. The final phase, one last skeleton is secured under a collapsed entrance (Cell 14).

Excavation of the Neolithic burials

Cell 13 – Burial cluster 1077/1078

Excavation of this layer revealed a cluster of bone (1077) and a dense concentration of artefacts including, *inter alia*, many plaster vessel fragments and turtle bone carapace fragments. The artefacts and human remains might represent a single burial event. The human remains were not articulated, and preservation was variable, ranging from well-preserved bone to very poorly preserved fragmentary elements.

The long bones were placed in a bundle, accompanied by other skeletal elements including ribs, cranial fragments, a small number of vertebrae and other bones. No facial elements or teeth were recovered. Several loose foot bones were recovered 60 cm south from the femoral heads, a location that is anatomically incorrect. This suggests post-depositional disturbance, re-opening or possible manipulation of remains.

The disarticulated remains of this burial were overlain by several irregular angular stones (1078) that do not appear to form any deliberate structure. However, the burial may have been disturbed or deflated by post-depositional processes. In addition, human bones were recovered away from the main group, which indicates that the remains may represent more than one individual. The nature of deposition suggests that the bones may have been recovered from elsewhere before being bound and deposited within Cell 13 as a secondary burial.

During the excavation of Layer 1078, around 140 fragments of plaster vessels were collected. It was noted that the fragments predominantly lay with their concave surfaces facing upwards. In some places, as many as five layers of vessel fragments were apparent.

Grave goods above the main plaster vessel cluster, and to the west of the burial, were several turtle carapace fragments. Other artefacts recovered within and below the human bone include a worked gypsum plate (SF2284) and fragments of a dark grey/black imported stone (SF2281-2).

Items recovered from the side of the femur (SF2248) include a *Codakia tigerina* shell (SF2245, possibly a container), a flint 'dagger' (SF2246), and a possible flint core (SF2247). The flint dagger measures approximately 10 cm

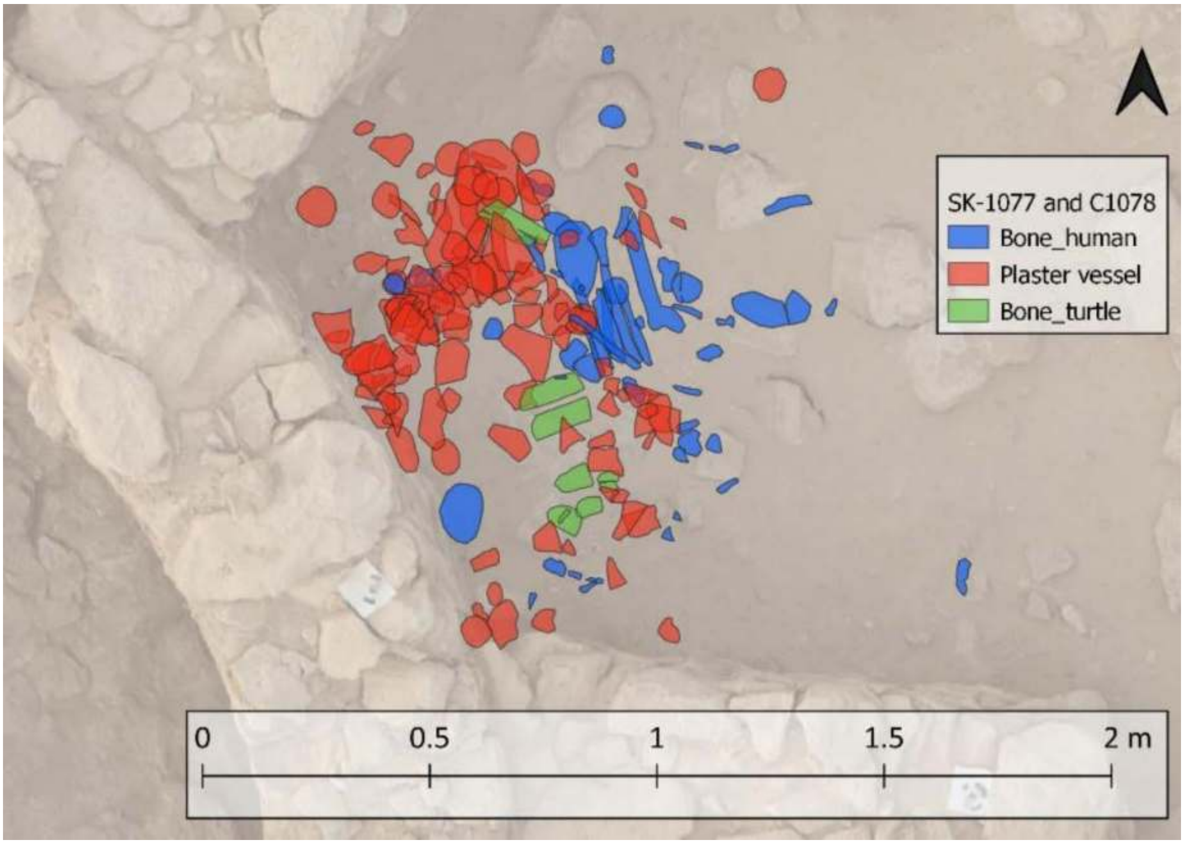


Figure 2: Plan of Burial 1077, Cell 13.

in length and is somewhat coarse in production, with no apparently functional sharp edges.

Cell 12 – Burial 1115

A primary burial of an older female adult (1115) with her neck and skull missing was uncovered on top of a stone platform (1143). The individual is interred with the stones beneath her, keeping her in place during the funerary process. In her hands were two foreshafts made of human bone, with a third underneath where her head would have been, and a fourth where the top of her humerus would be.

No cut was apparent for the burial, and the sediment associated with burial was similar to the main infill of Cell 12 (1094). Notably, the head (cranium and mandibula) were missing, along what was originally thought to be a cut (1117) in the northern extent of Cell 12. The second thoracic vertebra (T2) was collected during the excavation of the fill (1095) of the later 'cut' (1117). Most of the bones from the neck are missing. Conversely, the leg bones survived quite well, and most of the bones remained completely intact.

The lumbar (L1-L5) and thoracic vertebrae (T3-T12) were all intact and well articulated. The ulna and the radius from both arms were fragmented on the right side possibly by post-abandonment collapse. Both humeri were heavily damaged and recovered in pieces. The ribs on the right side were partially

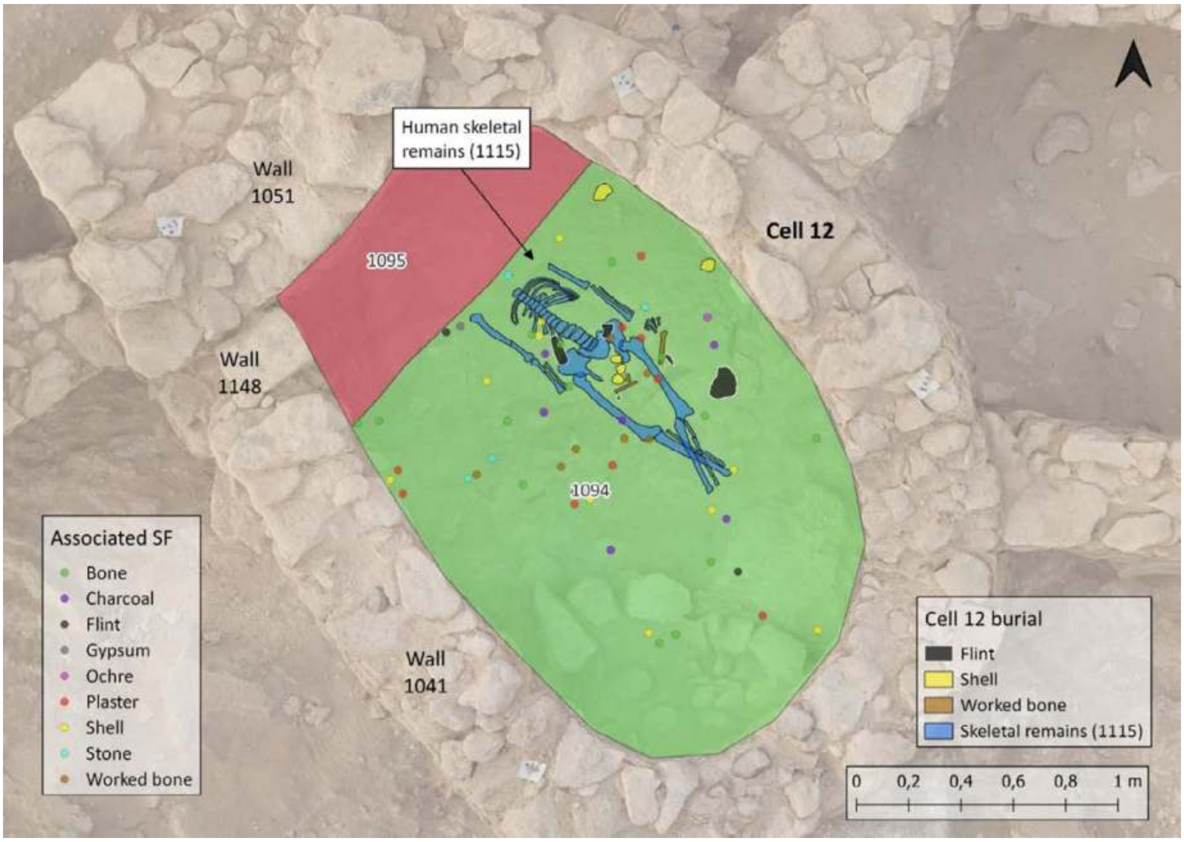


Figure 3: Plan of Burial 1115, Cell 12.

crushed by a heavy flint dagger that was placed on top of the body. The ribs on the left side of her body survived in a better condition but were still quite fragmented. Most of the phalanges and metatarsals of the right hand and both feet were dispersed in the sediments of Context [1115] and the stone setting (1143 and 1144). The fingers of the left hand were the best articulated, with most phalanges easily identified and recovered. This is a result of the entire left limb being held in place by the row of stones installed before her interment, and most of the collapse being centred in the western extent of the cell over her right side.

From various measurements of the pelvic bones, the individual is likely to be a female, with a 98 per cent probability. The sciatic notch is very wide and almost forms a right angle, typical of a female's skeletal anatomy. Although the iliac crest is not very obviously rounded, postcranial variations make it more difficult to interpret the morphology of the human bones. Furthermore, the pelvis was projected in a more upright and vertical manner, which caused some initial confusion and was easier to identify in retrospect. This individual had a minimum age of 40 years and seems to have suffered from *spina bifida* and an injury to her lower back, observed on the lumbar and the sacral vertebrae. In the post-excavation study of the skeletal assemblage, another individual was represented by a set of talus and calcaneus bones.

Figure 4: Photograph of finds in situ, Burial 1115.

The burial included a large number of grave goods and a considerable number of worked Socotra cormorant (*Phalacrocorax nigrogularis*) ulnae dispersed on top, under and around the skeletal remains. Shell beads, shell scrapers, flint implements, painted/incised plaster vessel sherds and raw materials were common finds around the burial. The left hand of the skeleton was secured on a row of stones in order to place a worked human bone foreshaft (SF2858) within the fingers of the deceased, which held an associated flint projectile point (SF2857). A second smaller human bone foreshaft (SF2862) and a barbed and tanged arrowhead (SF2863) were collected from near where her right-hand bones have slid down towards the pelvis.

A flint tool (SF2733), typologically identified as a 'dagger', was placed on top of the chest and later dropped into the rib cage. A large tabular flint piece (SF2719) was found by the left femur. A large *Codakia tigerina* shell (SF2860), which was potentially used as a container and a bone spatula (SF2861), were located directly south of the sacrum. Other grave goods included a number of shark-tooth pendants, two Violet asaphis (*Asaphis violascens*) scrapers (SF2901 and SF3047), a *Ficus gracilis* shell adornment (SF2965), flint projectile points (SF2995 and SF3090), a pebble tool (SF3004), a plaster vessel bowl fragment with incised patterns (SF3005), two elongated polished stones (SF3018 and SF3029), a gypsum crystal plaque (SF3019) and a large tile knife (SF3020).

Cell 13 – Burial 1116

In the easternmost corner of Cell 13, a secondary burial was uncovered in the form of disarticulated skeletal remains interred against an apsidal wall [1042]. The bones were not in a good state of preservation as they seem to have been moved and rearranged post-internment, and the weight of the structure [1121] placed atop has caused further damage. The skull seems to have been manipulated, and various skull fragments were rearranged on different sides of the individual. The mandible was removed from the individual and placed atop the burial cluster, on a tibia in the middle of the torso. The facial bones (maxilla up to the frontal bone) were found at the northern extent of the cluster of remains, while the posterior and inferior cranial bones were located at the southern extent. The atlas and axis were still intact and in close proximity to the cervical vertebrae and separated maxilla, which is not anatomically correct.

The main individual interred seems to be an adult female. The sex of the main articulated skeleton was estimated from the wide sciatic notch and the very well-rounded iliac crest. In general, the bones looked very gracile. The initial sex estimation was carried out on-site, as the bones would break apart upon lifting. In a post-excavation study of the skeleton, a secondary sex estimation was carried out using the postcranial morphology of the bones from Jebel Buhais as a reference. The measurements of this skeleton fit well in the range for female measurements. It must be noted that this method is not the most reliable and is subject to variability. This individual is at least 50 years of age, as indicated by the coxal measurements and late fusions of the bone.

The grave goods associated with this burial are significantly less than burial (1115) in Cell 12. A very sharp worked/polished sheep/goat metapodial (SF3337) was recovered from between a cluster of long bones and some toes. A shark-tooth pendant was found right under the disarticulated mandible (SF3203).

Clusters of painted and incised sherds of plaster vessels were collected from around the extent of the burial. Shell tools and adornments were also found: shell scrapers (SF3187, 3291), a perforated and polished *Conus sp.* shell bead (SF3290), numerous shell beads (SF3277, 3278, 3391, 3402) and a plastered *Vasticardium lacunosum* shell (SF3297). There were two flint finds as well: a finger scraper (SF3185) and a tile knife (SF3294). Many charcoal samples were collected from all throughout the excavation of these bones. These will later

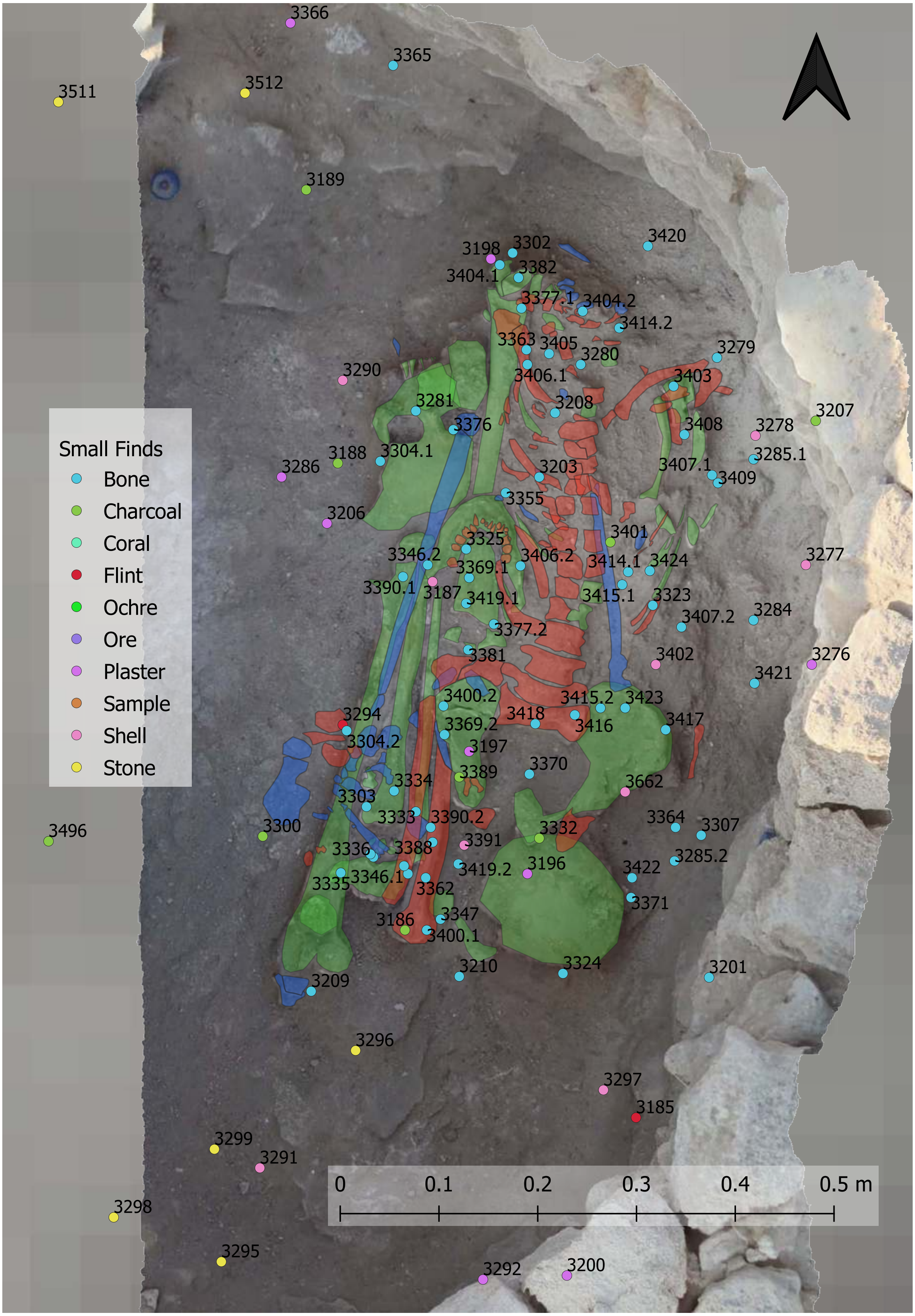


Figure 5: Plan of Burial 1116, Cell 13.

be processed to provide an approximate date; the teeth from this burial have been sampled and will be sent for apatite dating.

Overlaying the skeletal remains was a stone structure or surface [1121], to the east of the northern and southern entrances and enclosed by the apsidal wall [1042]. Layer 1121 was formed of small- to medium-sized horizontal slabs each measuring ~0.20 m. These stones were loose in the sand; however, two stones separating the burial were placed on their side on top of a plastered portion of the bedrock and defined the limit of the burial.

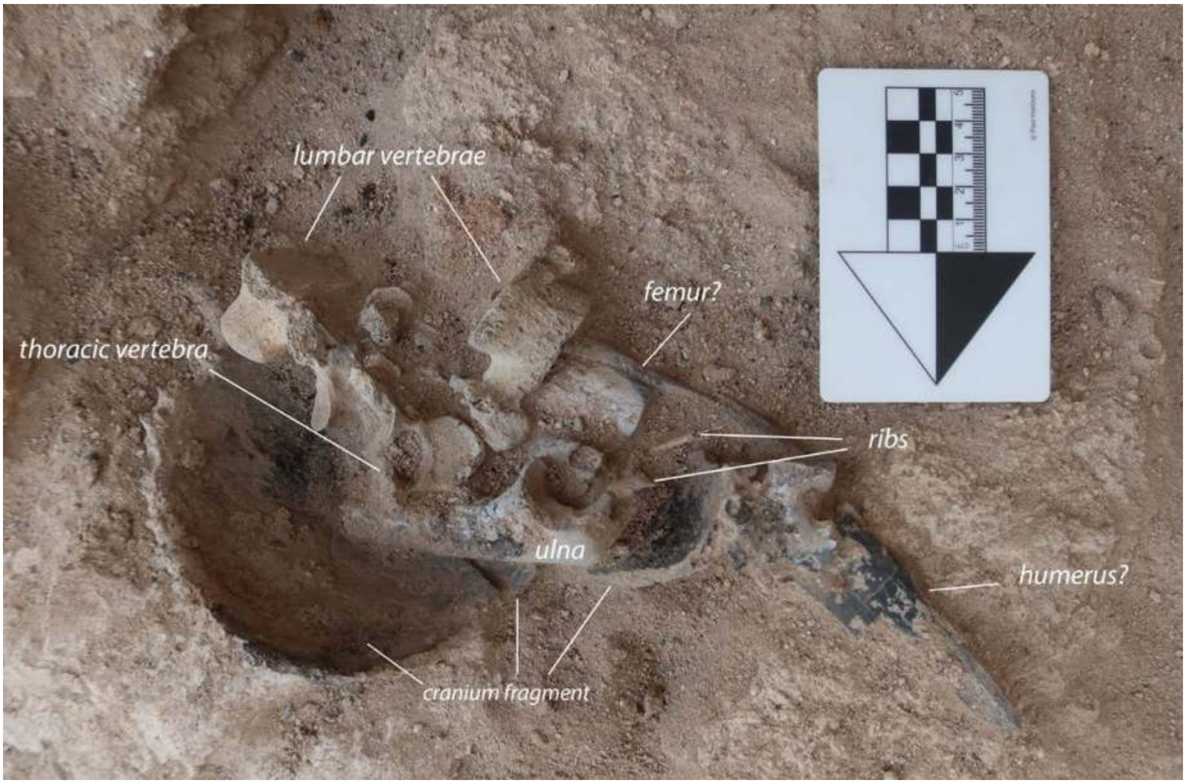
Cell 13 – Cremated remains 1183

1183 is the ashy soft deposit in the southern extent of Cell 13, with human bone remains frequently found throughout its extent. In the south-western corner of the cell, a cluster of charred human remains was uncovered. What remained of the long bones, ribs, vertebrae and other bones was gathered and placed into a burned cranium. The 'cranium container' was largely the parietal bone, with some other parts of the cranium loosely intact. These bones are mostly scorched white/black on the cortical bone and charred black in the cancellous bone.

Due to the state of these remains, it was very difficult to identify most of what was left of them. The identifiable bones are as follows:

1. Rib fragments (SF3568, 3569, 3570, 3579, 3605, 3616, 3621)
2. Thoracic vertebra (SF3607, 3618)
3. Lumbar vertebra (SF3619, 3622)
4. Cervical vertebra (SF3562)

Figure 6: Labelled photograph of cremated remains 1183, Cell 13.



5. Ulna (SF3566, 3617)
6. Femur (SF3595, 3608, 3612, 3613, 3625)
7. Cranial fragments (SF3558, 3601, 3614, 3615, 3624, 3626)
8. Humerus (SF3623)
9. Coxal (SF3556, 3571)

There were several other phalanges, tarsals and carpals that were also recovered from this context. A large number of grave goods were associated with this context; a very large volume of plaster vessel sherd clusters, with exterior painted layers and interior plain layers, dispersed from the southern entrance to the 13/15 lintel passage. In addition to this, shell beads were also retrieved directly from the skeletal remains and around the deposit.

A stone plate with scorch marks was retrieved from this layer. This plate was broken into four identifiable parts, smoothed down on one face to make a flat surface and rounded on the other side. A translucent gypsum plaque was also recovered directly beside the charred skull; it has a small suspension hole carved into the side of it.

Underneath the lintel – Burial 1127

A secondary burial of human remains (1127) was interred in an internal passage below a lintel between Cells 15 and 13. The individual is likely an adult female, above the age of 50 years, as suggested by the measurements and fusions noted from the coxal. The interment (1127) was not articulated and

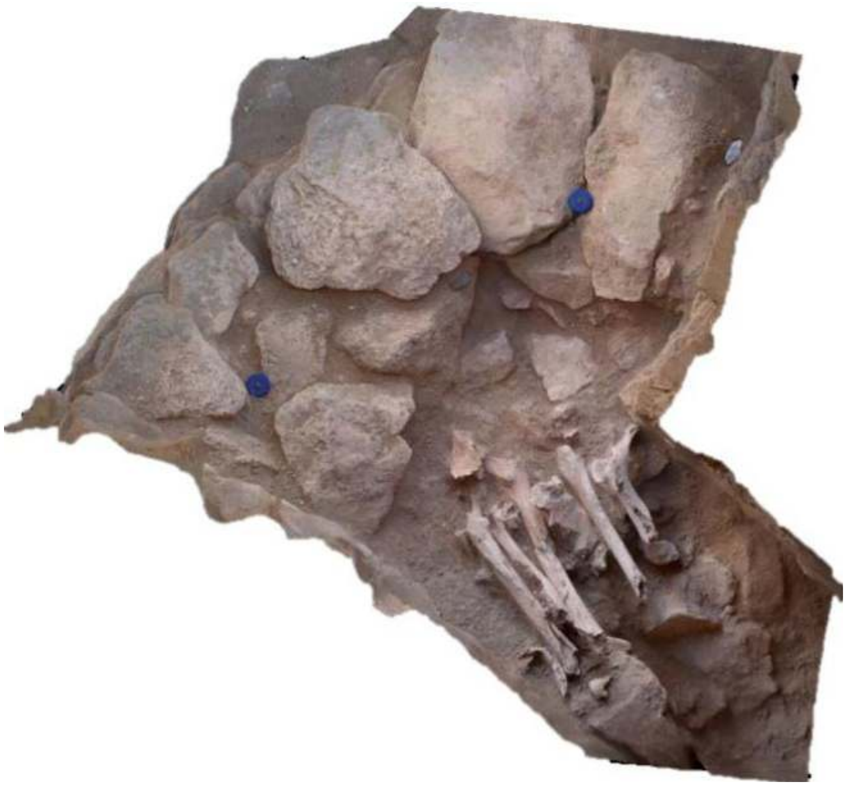


Figure 7: Orthophoto of Burial 1127, underneath the lintel between Cells 13 and 15.

included mostly the long bones (radius, ulna, femur, tibia and fibula), some vertebrae, ribs, a partial mandible and part of the pelvis. Much of the body had probably been disarticulated or decomposed, before being bound and interred in the doorway. The upper half of the doorway was later sealed by a layer of sediment (1125) approximately 0.30 m in depth.

Radiocarbon dates

Two radiocarbon samples from the site were submitted for analysis. One sample (Beta-624287) from the Cell 12 primary burial (1115) was calibrated to 5676–5563 BCE (7625–7512 BP). The second sample (Beta-624288) collected from the interment underneath the lintel (1127) was calibrated to 5736-5636 cal BCE (7685 – 7585 cal BP).

Both samples were submitted to Beta Analytic and calibrations were carried out at 95.4 per cent probability using IntCal20 (Bronk Ramsey 2009; Reimer *et al.* 2020).

Discussion

The use of Area F as a mortuary complex appears to be intentional, and one of the building's primary functions. It is clear that when these individuals were interred, there was no rubble collapse within the interior of the cells. All of the burials are stratigraphically below the level of abandonment and collapse, and there is no evidence of any cuts through these layers that might suggest they are later. Large orthostats from the tops of the walls cover the burials, which suggests that the roof was still in place when the burials were interred, and collapse took place afterwards.

Burial 1077/78

Although the skeletal remains (1077) are in extremely poor condition, the burial itself is quite substantial. The burial comprises the largest assemblage of large painted plaster sherds of different bowls and turtle carapace fragments. The flint implements are also homogenous with the primary interment in Cell 12, specifically the barbed and tanged arrowhead and the flint dagger. Flint daggers were only found in these two burials and nowhere else on the site.

There are far too many smaller bones and cranial parts that are missing, and the surviving bones are in total disarticulation. This suggests the transport of the bones and their redeposition into the cell. This interment is the highest of all the burials in stratigraphy and was possibly the most exposed to post-abandonment collapse. While this might provide grounds for argument that the funerary process is not as linear or straightforward as we think, there are still plenty of commonalities to suggest a tradition from an older shared culture. Much like funerary proceedings today, there will be variability due to numerous factors associated with the circumstances of the individual's death, as well as possibly their sex, age and stature. These variabilities in turn affect the overall implementation of mortuary traditions that we can identify or observe. The fact of the matter is that there is no one streamlined procedure, but rather a number of different indications that allude to a common practice.

Burial 1127

The interment (1127) was probably carried out by the transfer of the bones in a perishable material bag, perhaps made of leather or vegetal fibres, that has subsequently disintegrated, leaving just the bone cluster. Although it would have been entirely possible for the occupants of the structure to physically distribute the bones in a certain arrangement, the long bones look too deliberately placed within the area under the lintel for it to have been haphazardly spilled from a decomposing bag. Rodent teeth marks on the bones from (1127) were identified. These bite marks will be studied by a specialist to determine the species of the animal and additionally help us to understand different facets of the occupation such as the climate, local vegetation, etc.

Burial 1183

Similar to the secondary interment under the lintel (1127), the cremation in the corner of 1183 (Cell 13) seems to be another case of deliberate redistribution. Firstly, the bones were processed away from the structure and then redeposited into the cell. There were no signs of burning from within any of the cells associated with the burials, and in Cell 11 where there was some burning activity, there was no evidence for cremation. After the treatment of the bones, they were collected and placed into the cranium of the individual. There are many bones missing from this individual, most notably finger and toe bones. The entire face, most of the ribs and most of the pelvis were also missing. It seems that collecting all the remains after the individual was burned was not possible.

Burial 1115

The individual interred in Cell 12 has provided us with the most substantial evidence for indications of an established funerary tradition taking place at MR11. Just this one burial has been key to furthering our understanding of the mortuary practice upheld during the occupation of the site. From this individual, we have observed tailored architectural features, curated selections of remarkable grave goods, manipulation of skeletal remains and a possible tradition of skull removal.

There were no cranial fragments or cervical vertebrae remaining in the interment to indicate that the removal of the head and neck was an accident.

If it was stumbled upon accidently during a clearing of the passages, then the skull and neck would be redeposited in pieces either with the rest of the body or at least on the site. The cervical vertebrae are mostly lost altogether, which suggests they were removed with the skull while some forms of fleshy remains were still intact. Further to this, clearing the stones and the bones down to bedrock, but leaving the grave goods makes very little sense. A plausible explanation is that there was no cut, it was always left empty and gradually filled in over time. Leaving this space empty would provide access from either opening in the walls into the burial/cell. In addition to this, it would leave room for the skull to gradually decompose off the shoulders of the deceased, as it is not supported.

Burial 1116

Burial 1116 in Cell 13 is interpreted as a very premeditated rearrangement of skeletal remains. The anterior cranium is buried north, the posterior cranium and inferior skull to the south and an unhinged mandible central on the top of a tibia sitting on the articulated vertebrae of the body. Furthermore, the long bones of the skeleton are all aligned north/south and mainly bundled together to the west of the central articulated body. The upper torso down to the left femur are also aligned north/south.

The deliberate placements of the skeletal parts make human intervention a lot more transparent in this instance. From what is observed in the stratigraphy, we can tell that at least one femur and posterior cranium were the last elements to be moved, as they sat higher up in the stratigraphy and made very little sense even in placement with the rest of the redeposited skeletal remains.

The interred remains seem to suggest that the placement of these bones was premeditated. The process of arrangement and the significance behind the distribution of the bones is yet to be fully understood. The long bones placed to the west of the torso were intact, with proximal and distal epiphyses surviving in most cases. This could mean that the collection of these bones happened after the individual had skeletonised.

There are no fragmented cranial pieces collected anywhere from this interment; this could mean that the skull was not fractured naturally. This makes sense, as there is a very straight clean chop on the anterior skull, near the cranial fusion of the forehead, that starts from the left zygomatic process and curves diagonally into the natural right cranial fusion, which looks to have been worked smooth. The preparation of the skull had to have been done out of the structure prior to the interment of the individual. There are missing pieces of the inferior skeleton that are not found in the associated sediments, and there is no indication of the preparation of bones within Cell 13.

Funerary practices

Evidence from the site depicting various features of mortuary rituals was observed throughout the excavation of all the interments mentioned above. The following section will attempt to identify and synthesise the evidence associated to funerary practices.

The seven main identifiable burial features are:

1. Architectural elements
2. Alignments of the articulated/semi-articulated skeletons
3. Manipulation of the skeleton remains
4. Missing or worked skulls
5. Cremation
6. Grave goods
7. Post-burial offerings?

There is variability evident in the funerary practices seen with the interments of these skeletons. This could be due to several factors, which will become clearer after a more thorough inspection of the skeletons. Some of these factors include, but are not limited to, age, sex, social stature, tribal traditions, time or place of death, and causes of death.

1. Associated architecture

The architecture in Area F is very monumental, with several features of architectural innovation that are substantially different to what we have seen so far in the other Neolithic sites in Abu Dhabi. The inclusion of and tailoring of some of the construction of the structure to be in line with differing mortuary practices is also interesting.

Burial 1116 is associated with structural remains of a stone barrier [1121], internal to Cell 13 to isolate it from the room. The burial is placed directly on the bedrock, which was also semi-coated in white plaster-like material under the stone barrier and around the burial itself. The very lowest course of stones, placed on their side, were almost adhered to the bedrock and were rather difficult to remove. They were very firmly held in place, with a white substance visible underneath them after their removal. The architecture in this instance seems to seal off this one individual, with the intention to leave them undisturbed.

In the very lowest layers of stratigraphy in Cell 13 are the cremated skeletal remains (1183), nestled in a very odd square-shaped undulation in the bedrock. This undulation, whether natural or intentional, preserved the secondary position bones placed in situ, in addition to containing the associated burial goods.

Skeleton 1115 was secured on a stone bed to hold the skeletal remains in place, whilst they then placed the goods on top or against some of the stones and bones. Evidence from the site, such as the elongated stones that lined the underneath of the left arm, preserving the articulation of the fingers around the bone foreshaft tool, support the idea that the layout and curation of stones were all conscious decisions. We see the shapes and sizes of the stones changing to better fit certain body parts. The stones end towards the north, at the interface between the torso and the skull. A single slanted stone might have been used to sustain the integrity of the post-cranial skeleton, whilst letting the head and neck decompose and drop off.

This is only one of several theories regarding the burial in Cell 12, but there are parallels to the practice in other PPN Pre-Pottery Neolithic burials in the Levant, where the architecture is arranged to facilitate the eventual removal of the skull, and the individual is interred with that intention (Mithen *et al.* 2015). Viewing Cell 12 as an antechamber that allows for the gradual decomposition of the body provides us with a plausible explanation for the architecture, stratigraphy, distribution of goods and presence of charcoal in the deposits. The second individual represented by another set of ankle bones also suggests a possible clearing and reuse of this cell as an antechamber, rather than a setting for a burial.

Burial 1127 is underneath the lintel of an opening in the eastern apsidal wall of Cell 15. It connects Cell 15 to Cell 13, where various other bodies were interred. There is a semicircular stone threshold in Cell 15 that marks the extent

Figure 8: Profile of stone setting (1143) underneath skeleton 1115, Cell 12.

of the interment (1127). The long bones placed in this passage are limited by the span of this structure, acting as a threshold, so the bones themselves are not completely in either cell. This might be due to the gradual filling of Cell 13 with other individuals, or it could be that the architecture is suggesting something more intentional. There is the possibility that the funerary ceremony or proceedings for this individual were not over, and therefore they could not yet be fully interred into a room. We view Cell 11 as the main ceremonial area where there are several layers of activity abandoned, paved over and repurposed. The lintel passage gives a full view of these skeletal remains from Cell 11. The structure by the lintel provides a small, elevated surface, putting the skeletal remains on full display in Cell 13 and Cell 15. These might be the last set of bones on full display for the inhabitants to easily access. Around and underneath the interred bones (1127) are various forms of offerings. These included several net sinkers, large amounts of plaster vessel sherds, articulated fish bones and shell tools. These are just some of the current ideas about these burials; further studies of this material will undoubtedly enhance our knowledge of the specificities of the cultural practices on Marawah at this time.

2. North/south alignments of the articulated/semi-articulated skeletons

The length of the skeletons evident in two of the main burials are aligned north to south. In Cell 12, the skeletal remains indicate that the skull was positioned in the north portion of the cell and the feet to the south. A similar orientation of skeletal remains can be observed with Burial 1116 in Cell 13.

Although it can be argued that this is coincidental, both the semi-articulated neolithic burials in Area A were also aligned head north and feet south (Beech *et al.* 2022). This alignment occurs too regularly to be dismissed as an arbitrary occurrence. While the orientation of the rooms seems to change and the structures vary, the orientation of the skeletal remains themselves seems to be consistent. This could be a strictly local tradition, as alignments seem to be inconsistent in the literature, or it could just be a mere coincidence.

3. Manipulation of skeletal remains

Manipulation of skeletal remains is very common in prehistory, especially during the Neolithic. The entire skeletal assemblage from Area F has been manipulated post-mortem to varying extents. The excavation of burial 1077 uncovered a skeletal assemblage that was interred as a cluster in complete disarticulation and missing body parts. The better-articulated individual interred in the eastern extent (1116) had her skull completely removed, with the face worked and reinterred with different parts also deliberately positioned in disarticulation. The cremated individual (1183) was completely burned out of the structure and reinterred, using their cranium as a bowl to hold the rest of their charred skeletal remains.

Burial 1115 was made to hold objects in their hands whilst suspended over a bed of stones, without support for the neck or head. The head and neck are also collected at some point and have not been found anywhere in Area F, even after the complete excavation of both interior and exterior deposits. What makes this specific burial intriguing is the idea that the foreshafts in their hands are made of human bone, and the intentionality behind the act of making the deceased hold them must carry some significance that we currently cannot fully understand.

Burial 1127 was collected and reinterred in pieces, with an odd selection of fragmented bones being made. None of the bones of this burial were intact upon interment; the lintel passage was filled with an aeolian sand that preserved the bones in situ.

In the Neolithic settlement of UAQ2, a multiple burial was discovered in which several men were interred in a tomb and rearranged on their sides facing the same direction, with their arms and legs overlapping each other slightly. This was done upon interment and was interpreted by the archaeologists as being "united in death". This burial dates to around 5500–5300 BCE and overlaps with the dates of occupation in MR11 (Méry *et al.* 2016).

4. Missing or altered skulls

While the procedure of skull removal could be grouped with the funerary process mentioned previously, there is substantial evidence to demonstrate that while they are similar in nature, they are different in both significance and procedure. While torsos, long bones and smaller bones survive in better states, the recovered cranial remains do not seem to survive in good articulation for the most part.

The crania from the skeletal assemblages of MR11F are either missing, physically altered or in fragmentary pieces that are not very obviously attributable to any singular set of remains. In the case of 1077, 1127 and 1183, the latter seems to be the case. Albeit it is easier to match (1183) charred cranial pieces with the other charred bones, there is a record of burned bones in Area A (Department of Culture and Tourism 2022a; 2022b) and other pieces of charred bones higher in the stratigraphy in the walls of Cell 13.

Although a fragment of a mandible was identified in the lintel burial (1127), the rest of the cranium is missing. The skull, more specifically the face, is what is believed to be the most important identifier of a person. This is notably missing from the interred cluster of bones.

The cranial remains interred in Burial 1116 is a demonstration of how significant a skull is in the funerary process. The main articulated remains (the torso, pelvis and left femur) most likely belong to a female. While it is not yet certain if the mandible, anterior cranium, posterior cranium and inferior cranium are all from the same individual, it is likely to be the case. The mandible

Figure 9: Photographs of worked cranium from Burial 1116, Cell 13.

is very rounded and smooth, which leads us to believe that it belongs to a female. The sexual dimorphism in a male mandible appears to be a lot more angular and robust. Similarly, the anterior skull tapers very gently near the forehead and the angle of the frontal bone slope is a lot more vertical, typical of a female's face. A male's face has a more pronounced glabella, as opposed to a female (Nikita 2017).

Even if the cranium does not belong to the individual, the fact that the cranium was removed and repurposed before reinterment remains. The face seems to have been separated or sawed with a tool and smoothed down to make a regular curving diagonal cut across the top of the forehead from beneath each temple. The posterior and inferior cranium were placed south of the pelvis. While the face was redeposited near the neck bones, the rest of the skull was reinterred below the pelvis. Assuming these are deliberate distributions, these choices might bear a larger significance just by these conscious placements.

The interment in Cell 12 (1115) demonstrates the intentionality behind the burials. Our best assumption is that the individual was interred with the intention of eventual re-entry and skull recovery. Whether or not we view Cell 12 as an antechamber and the stone setting deliberately constructed for this purpose, this still provides evidence to imply a possible pseudo-systematic processing of the inhumations. An odd patella, a loose incisor, a cervical vertebra and what seemed to be an extra ankle bone were found in this grave. The possibility that they used Cell 12 for processing and thoroughly cleaned it out is valid.

Burial practices observed in PPNB sites provide evidence for funerary practices that alter the skeletons by way of skull removal. This tradition is not anomalous to earlier Neolithic cultures and is well documented in the literature (Mithen *et al.* 2015). One recently documented example would be records of graves comprising the skeletons of two adults (with neither crania nor mandibles) near a circular stone structure documented in Beisamoun in the Upper Jordan Valley. The site is dated to the late PPNB-PPNC between 7200–6400 BCE. There is also mention of clustered bone deposits in front of the entrances in the structure, placed directly onto floors in organised bone bundles. No crania or mandibles are present in these bone piles (Bocquentin and Nous 2022).

It has been previously noted in the literature that PPNB period burials traditions have been summarised into three interrelated systems, the third of which mentions the secondary removal of adult skulls from graves with their eventual reburial in a cache. It is also noted that these burials are premeditated and require a certain level of involvement from the community (Kuijt and Gorin-Morris 2002). While there is no question behind the explicit expressions of intentionality and community involvement in the Area F interments, these systematic interpretations of mortuary traditions are not completely adopted in totality and do not perfectly align with what is observed at MR11. The fact is Area F is devoid of pottery; the only wares recovered from the occupation layers are plaster vessels, made exclusively of lime and gypsum aggregates. This places the site in a more complex context. The earliest dates from the site place it roughly around 5800 BCE (Beech *et al.* 2022); however, not all radiocarbon samples of the earlier layers have been processed, and almost all the contexts from Area F (except for the two burials) have not yet been dated.

5. Cremation

Cremated skeletal remains 1183 are not common within the skeletal assemblage at MR11. Trying to understand their presence is very difficult and poses a plethora of questions about the conditions by which inhabitants feel inclined to cremate an individual. In the case of this cremation, the individual's corpse was burned external to the structures and placed back inside Cell 13. It is more likely that his or her remains were processed near the site, as they are somewhat articulated with smaller bits of bone that typically are not recovered in secondary burials.

Table 1: Table of estimated burning temperatures based on discolouration of selection of bones, 1183, Cell 13.

Find	Context	Description	Discolouration	Estimated temperature
3556	1183	Burned pelvic fragments	Black	500-600 °C
3558	1183	Charred cranial fragments	Black - white	Over 700 °C
3566	1183	Burned radius	Black	500-600 °C
3568	1183	Burned rib	Black	500-600 °C
3570	1183	Burned rib fragments	Black - white	Over 700 °C
3573	1183	Burned long bone fragments	Black	500-600 °C
3595	1183	Charred femur	Black	500-600 °C
3596	1183	Charred vertebrae	Black	500-600 °C
3597	1183	Burned ribs	Black - white	Over 700 °C
3598	1183	Long bone fragments	Black- white	Over 700 °C
3599	1183	Burned vertebrae	Black - brown - white	400-500°C
3601	1183	Cranial fragments	Black - white	Over 700 °C
3605	1183	Charred rib	Black - brown	400-500°C
3607	1183	Burned thoracic vertebrae	Black - white - brown	Over 500°C
3612	1183	Burned femoral head	Black - brown	400-500°C
3613	1183	Burned femur fragment	Black - grey	Over 500°C
3614	1183	Cranial fragments	Black - white	Over 700 °C
3616	1183	Rib fragments	Black - white	Over 700 °C
3617	1183	Ulna fragments	Black - white	Over 700 °C
3618	1183	Thoracic vertebrae	Grey	Over 500°C
3619	1183	Lumbar vertebrae	Grey - brown	Over 500°C
3621	1183	Rib fragments	Black - white	Over 700 °C
3622	1183	Lumbar vertebrae	Black - grey	Over 500°C
3623	1183	Humerus	Black - white	Over 700 °C
3624	1183	Cranial fragments	Black	500-600 °C
3625	1183	Femur	Black - white	Over 700 °C
3626	1183	Posterior cranium	Black - white	Over 700 °C

Most of the bones have been charred black, deep into the cancellous bone, and some have been burned white on the cortical bone. For a primary cremation to take place, defleshing rather than burning of dry bones at temperatures of over 500 degrees Celsius are required. An open air bonfire will be too difficult to maintain at these temperatures and will roughly sit around 320 to 400 degrees Celsius (Imaizumi 2015). This, in turn, would suggest the use of a kiln or pit, where heat is contained and easily fuelled. Plenty of fuel is required to begin the cremation process, as body fats will only aid the flames later in the process rather than at the start (Bocquentin *et al.* 2020). No such kiln or pit has been found at this point in time on MR11, as excavations so far have been limited to the structures within the area, with the exception of some test pitting between the mounds. The articulation of the bones suggests that the burning of this individual could not have been far from the site.

At the site FAY10-NE, in the emirate of Sharjah, fragments of cremated bone of different individuals were recovered from a small cave. The radiocarbon dates from the associated context indicate that the activity periods in FAY10-NE of 6500–5800 BCE (Kutterer *et al.* 2012) overlaps with MR11 (Beech *et al.* 2022).

The emergence of cremation during the transition from PPNB to PPNC has been documented in the Neolithic site of Beisamoun in the Upper Jordan Valley. The in-situ cremated remains of a young adult were excavated from within a pyre pit, where their remains were processed. This example is the earliest occurrence of intentional primary cremation in the Near East and gives us a chronology of the regional funerary practice (Bocquentin *et al.* 2020).

Another parallel to this would be the cremated human remains found in Kharaysin, a PPN site in Jordan where a secondary burial with burnt human bones was uncovered, Burial SU-815 dated to the Late PPNB (7058–6825 BCE); this contained a clustered burial with burnt and unburnt skeletons of at least three adults. Results from the analysis provided evidence that the bones were almost dry upon burning. They were then gathered and transported for a final interment (Santana *et al.* 2020).

6. Grave goods and manufacture

Manufacture of goods and tools seems to be largely associated with Cells 11, 15 and 16, and this is reflected in the finds. Large shells that have not yet been worked, plaster manufacture tools, hammerstone/possible pestles, borers to make ornaments and sharpened bone points are some of the frequent finds of Cell 11, 15 and 16. Consistent with the rest of the site, artefacts from Area F depict geometric patterns in etchings and paintings on bone and gypsum/plaster. Many of these manufactured goods are then placed along with the interred individuals in the burial cells.

The interred individuals usually had a few unique finds or personalised items interred with them that are not found in other spaces of the structure (gypsum crystal plaques, human bone foreshafts, bone beads, etc.). A great amount of plaster vessel sherds was found in Area F during the latest excavations in MR11. Many specimens are decorated by monochrome and bichrome crude painting or incisions following geometric patterns. A few examples showing finger imprints are also recorded. At least two types of distinct fabrics are observed at Area F: (1) a chalky white plaster ware with a gritty texture; (2) a harder greyish plaster ware with a fine-grained texture. Generally, plaster vessel sherds of different wares and qualities were found throughout the site, but they were very concentrated in close proximity to the burials.

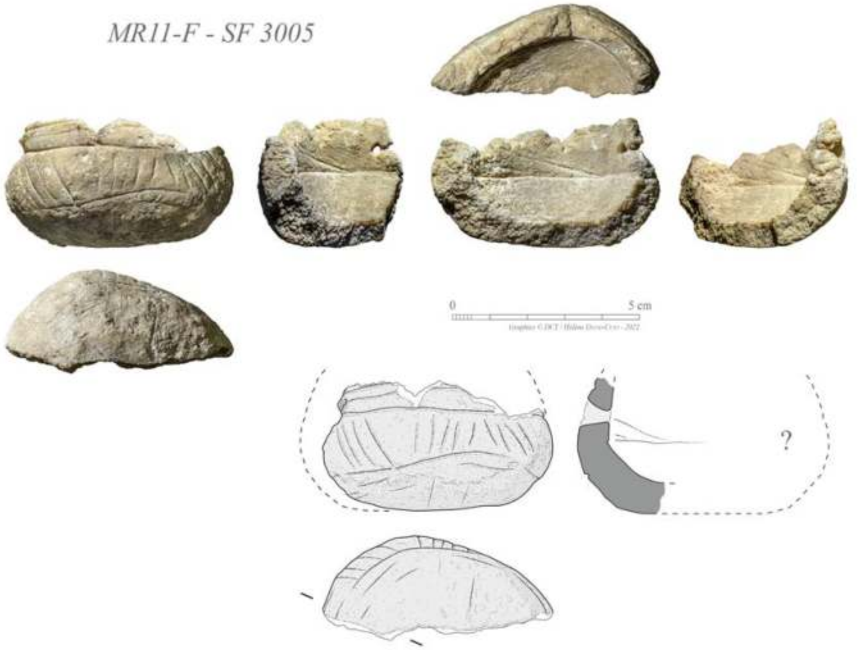


Figure 10: Incised plaster vessel from Burial 1115, Cell 13.

Several complete plates associated to B1077 in Cell 13 were recovered, as well as a fragment of a small globular plaster vessel fragment (SF3005) with incised patterns depicting various alternating lines, as well as a mending hole associated to B1115 in Cell 12. The curvature of most plaster vessel sherds suggests that the bowls are mostly open vessels. A few plaster nodules were found in Area F (SF2278 and 2462). Similar finds have been made in Area C during the previous seasons. It suggests that production of plaster vessels

Figure 11: Painted plaster vessel recovered from burial 1077, Cell 13.

took place directly on site, and in some rooms of the buildings in Area C and Area F. Furthermore, this possibility is strengthened by the recent discovery of a stone mortar showing residual layering of plaster on its concave surface (SF2788 from 1118). One can assume that plaster was heated, crushed and mixed with water in the mortar.

Shell valves (a specimen of *Anadara ehrenbergi* and at least two others of *Asaphis violascens*) containing residues of plaster have been found. Preliminary observations of the latter shell have revealed the presence of micro-polish on their ventral margins, confirming their use as scraping tools involved in the production of plaster vessels, and that they were not only used as simple containers. The regular discovery of ochre and haematite fragments at different locations of the site seems linked with the preparation of pigment powder used for the decoration of plaster vessels.

When considering an interment like 1115, the number of finds associated with the skeleton is quite substantial. The artefacts placed along with the skeleton were pristine in some cases, while some seemed to be more weathered and used. It appears that while some of the objects were created specifically for the burial, a couple of objects were curated from what they had already owned and used. Shell and bone beads from pendants, anklets and bracelets were also collected from near the chest, arms and neck. These accessories are mostly different varieties of smaller gastropod beads and shark teeth.

Four human forearm foreshafts were recovered from Burial 1115 in Cell 12. Three of the bone foreshafts are repurposed radii, and one has been identified as an ulna. Two of the radii were collected from the right (SF2862) and left (SF2858) hands of the individual, with a third radius (SF3063) recovered from underneath where the skull would have been. A fourth bone foreshaft made from a repurposed ulna (SF2763) was discovered above the left humerus and only identified in the post-excavation analysis of the human bones. The foreshafts are heavily polished, worked and hollowed to secure flint projectiles into the shafts. Evident around the circumference of the ends of each foreshaft are strong worked indents where some kind of organic material can be tied to secure a flint projectile point. Both epiphyses on the forearms are sawed/cut off and filed down to create a smoother surface. SF2858 is a robust right radius placed in the left hand, SF2862 is a gracile right radius, SF3063 is a gracile left radius and SF2763 is a right ulna. These indicate a minimum number of at least two individuals' arm bones that have been repurposed to create these artefacts.

Understanding the artefacts associated with the dead and the connotation of their existence is pivotal to grasping the abstract concept of death and the beliefs associated with death at the time. Why is it important that an individual is buried with a familiar object, and similarly, why is it important that

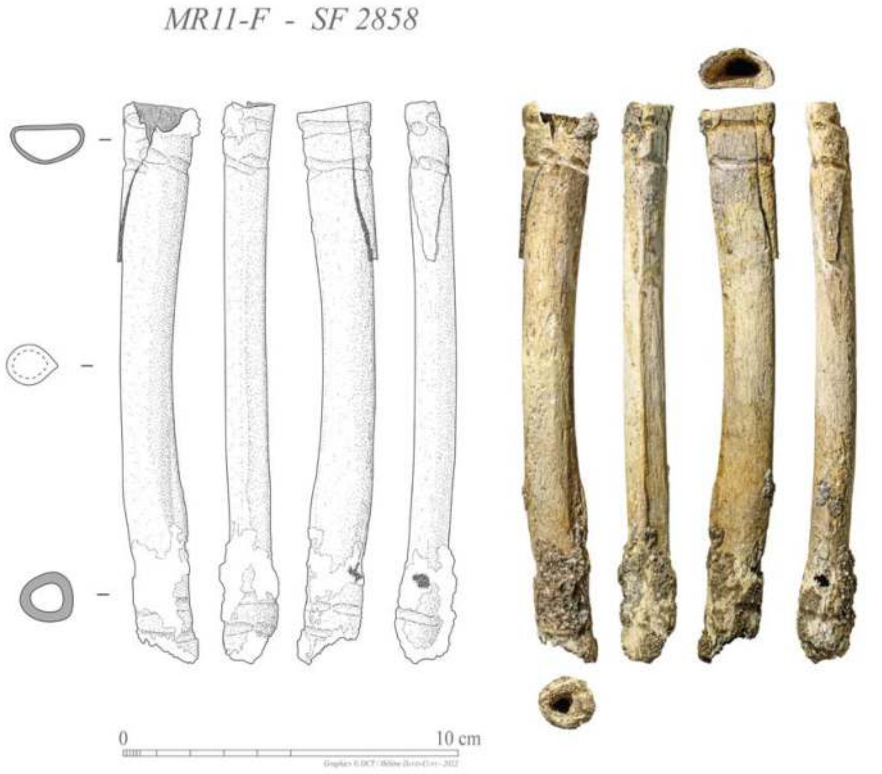


Figure 12: Human bone foreshaft (SF2858), Cell 12.

Figure 13: Flint point associated with foreshaft (SF2858), Cell 12.

Figure 14: Human bone foreshaft (SF2862), Cell 12.

Figure 15: Barbed and tanged arrowhead (SF2863) associated with foreshaft (SF2862), Cell 12.

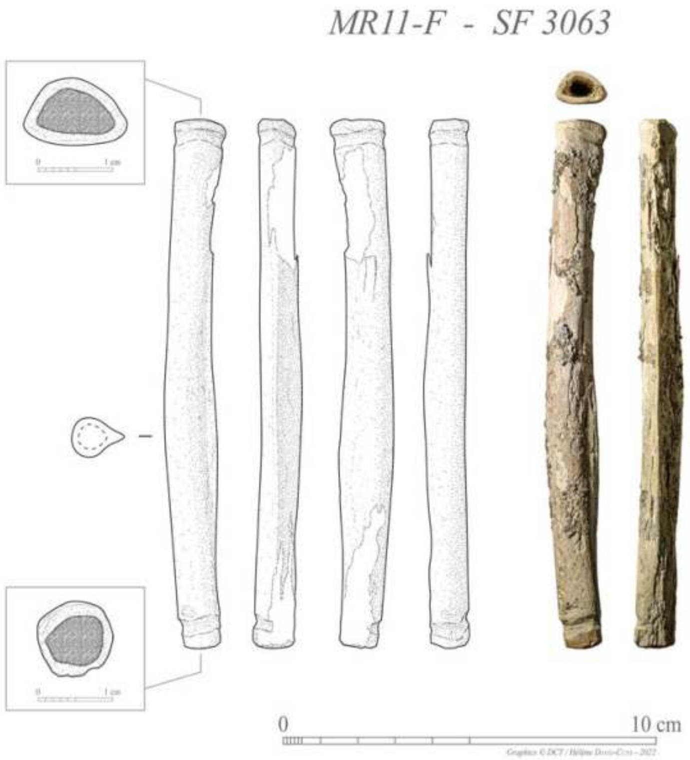


Figure 16: Human bone foreshaft (SF3063), Cell 12.

an individual is buried with freshly created objects? Classifications of these objects also help us understand what type of afterlife the Neolithic population might have envisioned.

7. Continued offerings

If Marawah 11 is viewed as a centre place for various tribes in the surrounding coastal settlements to meet and participate in communal activity, then the offerings in the form of grave goods and food remains around the skeletons make a bit more sense. In the case of the two main burials and the lintel burial, there are articulated fish bones, sea mammal bones and plaster vessel fragments distributed with other spreads of finds. While this could be entirely domestic, and the fills of the burials could have come from domestic layers, the fact that there is evidence to suggest they could be associated with the burials cannot be negated. Ultimately, more analysis on the faunal assemblage, the plaster vessels, and more dating evidence would greatly help clarify whether there is any association.

Conclusions

Early research on MR11 focused on the feasibility of a community of fishermen to establish a more sedentary settlement that could be occupied all year round. An examination of their subsistence strategies through the analysis of the faunal assemblages indicated that this was possible. The emergence of local artisans and the expansion of the architectural structures indicates that the populations could have expanded the settlement. The evidence for a domestic sedentary life based on marine resources is available; however, it is also possible that there may have been seasonal habitation or at least intermittent communal visits.

The latest excavations in Mortuary Complex F provide evidence for some funerary practices that somewhat conflict with previous studies from other Neolithic burial sites in the United Arab Emirates (Phillips 2002; Kiesewetter 2003; Kutterer 2010; Kutterer *et al.* 2012). During the Neolithic, and especially in the Near East, there is little to no regard for spatial distribution between the deceased and the living. More often, the inhabitants would share the same spaces during the Pre-Pottery Neolithic (Haddow 2017). As we see it, the dead have been spatially and culturally integrated into the settlement of MR11 and are regarded as a fundamental aspect of the local culture.

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Preliminary comparative lithic analyses from the Neolithic sites of Marawah and Ghagha islands (emirate of Abu Dhabi, UAE)

Rémy Crassard, Noura Al Hameli, Mark Jonathan Beech and Richard Thorburn Howard Cuttler

Abstract: The lithic assemblages presented here come from two archaeological sites on Marawah and Ghagha islands (emirate of Abu Dhabi, United Arab Emirates): the well-dated stratified Neolithic sites of MR11 and GHG0014. Lithics from both sites are homogenous but show clear differences between each other. This probably implies a cultural change in a time range of a few centuries between the two main occupations on the two islands. Ghagha GHG0014, which is older (mid-7th millennium BC), yielded an industry of bifacial thin or thicker projectiles with no trihedral points, nor tile knifes. Marawah MR11, which gave younger dates (mid-6th millennium BC), shows the use of rather opportunistic tile knives and highly-refined arrowhead technology from various types, from the typical South Arabian trihedral points to the more ubiquitous bifacial barbed and tanged arrowheads with symmetric or asymmetric flat sections. The lithic assemblages are also associated with a strong tradition of organised settlements made of perennial houses/buildings which span several centuries. These lithic assemblages represent a unique opportunity to understand better the evolution of regional lithic traditions on the scale of Southeast Arabia and the whole Arabian Peninsula.

Keywords: Neolithic, Marawah, Ghagha, lithics, Abu Dhabi

Introduction

Lithics, tools crafted from stone by ancient humans, are widespread globally and serve as valuable artefacts for archaeologists and prehistorians. They offer insights into the traditions, cultures, techniques and cognitive development of our common ancestors. The study of lithic industries yields extensive data sets that shed light on the intricate technical systems employed in tool production. By analysing and comprehending these individualised technical systems, critical data emerge, enabling assessments of how a particular group fits within a cultural framework. The interconnection between tradition, culture and technique forms a shared cultural register, facilitating understanding of human societal evolution, trade patterns and communication practices.

Regarding the Neolithic of the Arabian Peninsula, which is still a poorly documented region of the world on this topic, lithics are common from many surface sites, which unfortunately cannot be properly dated because of the lack of stratified contexts. This is why the discovery of two exceptional Neolithic sites in the emirate of Abu Dhabi, UAE will probably change our understanding of the regional Neolithic in Southeast Arabia.

We present here a preliminary overview of the lithic assemblages from two important stratified contexts: the Neolithic sites of GHG0014 on Ghagha Island and of MR11 on Marawah Island. Both sites have the exceptional specificity to present architectural remains of dry-stone-built houses/buildings arranged in several multicellular structures. The sites are, in fact, in chronological succession and have also well-dated stratigraphical sequences. Lithics from these archaeological layers are therefore particularly indicative of the evolution of traditions during the Neolithic period.

Geographical and archaeological contexts of the two sites

The older Neolithic site on Ghagha Island, GHG0014, is situated about 280km west of Abu Dhabi Island, which exhibits distinct topography characterised by elevated rocky islands, *sabkha* areas, intertidal lagoons and a south-facing sandy shore, approximately 1km from the modern UAE mainland. Unlike other islands in the Al Dhafra region, Ghagha lacks mud flats and mangroves that typically support shellfish habitats (Al Hameli *et al.* 2023).

Archaeological surveys conducted by the Abu Dhabi Islands Archaeological Survey (ADIAS) in the early 1990s revealed Neolithic occupation of Ghagha Island (King and Tonghini 1999), while subsequent surveys by the Department of Culture and Tourism - Abu Dhabi (DCT) in the 2010s and 2020s further explored the site (Strutt *et al.* 2013; Al Hameli *et al.* 2023). After initial findings dated to the Islamic period, GHG0014 has been identified as an important Neolithic site. Excavations there have yielded rich prehistoric material cultural remains, including lithics.

GHG0014 is a multiphase site featuring two main stone structures (1-2) and four areas (1-4) positioned on and around a stone outcrop, providing a vantage point overlooking a lagoonal area. Structure 1 consists of six circular cells reminiscent of similar structures on Marawah Island (MR11 site), with radiocarbon dating placing its occupation by 6500 BC. Structure 2, located west of Structure 1, is a small circular building that likely existed contemporaneously but lacked associated deposits for radiocarbon dating. Excavations at GHG0014 concluded in November 2021, encompassing the exploration of both exterior and interior spaces down to bedrock, thus revealing the earliest known domestic architecture in the region (DCT 2019; Al Hameli *et al.* 2023).

The second Neolithic site studied here is MR11 on Marawah Island. Marawah is part of a chain of barrier islands on a shallow ridge and is located some 110 km west of Abu Dhabi and 170 km east of Ghagha Island. A 2002 survey revealed the island's composition of Pleistocene limestone cores and Holocene carbonates (Evans, Kirkham and Carter 2002). ADIAS explored Marawah Island in 1992, uncovering 13 archaeological sites spanning the time from the Late Stone Age to the Late Islamic period (King 1998). Among them, the MR11 site was identified, consisting of at least seven mounds (Areas A to G), with homogeneous lithic assemblages datable to the Neolithic period. Since 2003, excavations at MR11 are reshaping our understanding of Neolithic architecture, particularly the spatial layout of settlements, and each area's excavation has revealed distinct architectural features. Radiocarbon dating of charcoal fragments confirms that this settlement was inhabited from approximately 6000 to 4500 BC (Beech *et al.* 2005, 2008, 2019, 2022).

The MR11 lithic assemblage, predominantly sourced from stratified contexts, is consistently homogeneous across different excavation areas and structures, featuring diverse arrowhead technology. Polished stone artefacts are also present. The lithics primarily consist of imported flint, with occasional other rock types. Raw materials might originate from Delma Island, Sir Bani Yas Island and the mainland coast of Abu Dhabi emirate, encompassing thin flint of lower quality and potentially distant sources of fine-grained knappable stones in the form of wadi pebbles (Kallweit and Beech 2020).

The lithic assemblages from the Ghagha GHG0014 site

The present study discusses the lithic artefacts from the 2019, 2020 and 2021 seasons on Ghagha Island, during which the excavation of GHG0014 site has been carried out.

As observed at MR11, the raw material used for the lithic industries on Ghagha Island are essentially made of flint, a rock that does not naturally appear in local outcrops or sources, although some brownish flint outcrops can be found on the way to the island in several localities at Ras Ghumais. This observation will need to be confirmed and documented to clarify the original source(s) of raw material used for the Neolithic artefacts on the island. It is still possible that some of the raw materials might come from more distant sources.

The 2019, 2020 and 2021 lithic assemblages from GHG0014 consist of 103 finds inventoried as individual artefacts ('special finds') and 195 lithic/stone elements recovered from the sieve. The three seasons of work have completed the excavation of the entire GHG0014 site, which means that the lithic assemblage from the three seasons perfectly represents the whole occupation at the site (thus 298 pieces in total). Tools are numerous (n = 30; Table 1), while the majority of the lithics (more than 50 per cent) collected from the dry sieve are mostly unworked small pebbles of white quartz that must be local. Some of them look as if they have been worked and maybe used, such as cortical flakes, and one potential core was made on a larger pebble.

Table 1: Number and types of tools from the GHG0014 excavation.

Tool types	Number
Tile knife/tested thin tabular nodule	2
Simple tanged bifacial point	1
Bifacial short point with long tang and short wings	5
Bifacial piece	3
Bifacial triangular point with short tang and long wings	4
Long bifacial point with long tang and short wings	7
Polished stone	1
Hammerstone	2
Retouched blade/flake	4
Large triangular point with long tang and long wings	1
TOTAL	**30**

Only two tile knife fragments have been found in the assemblage, but their fragmentary nature does not confirm that they are proper tile knives, as they can be found in high numbers at MR11. They can, for example, just be fragments of a tabular flint nodule that has been opportunistically used or that has been tested (just a few flakes have been knapped from it) and then abandoned. As they are not convincing enough to be clearly defined as tile knives, we can assume that this tool type is absent from the GHG0014 assemblage.

This observation is important, as the series reveals being clearly different from Marawah MR11. Another type is absent in the GHG0014 assemblage: the trihedral points (the classical main type, or any sub-type observed in Marawah, for example). Instead, the arrowhead types are all characterised by bifacial thin points with a symmetrical section, and 17 of them are barbed and tanged (Table 2), of four distinctive types, being from short to long, with more or less long wings and a tang (Figure 1).

The presence of fragmentary bifacial pieces made of allochthonous beige fine-grained quartzite is also very peculiar and was not observed at MR11. Other tools discovered are a few hammerstones and retouched flakes (including elongated ones, almost looking like proper flint blades), obviously made from non-local raw material.

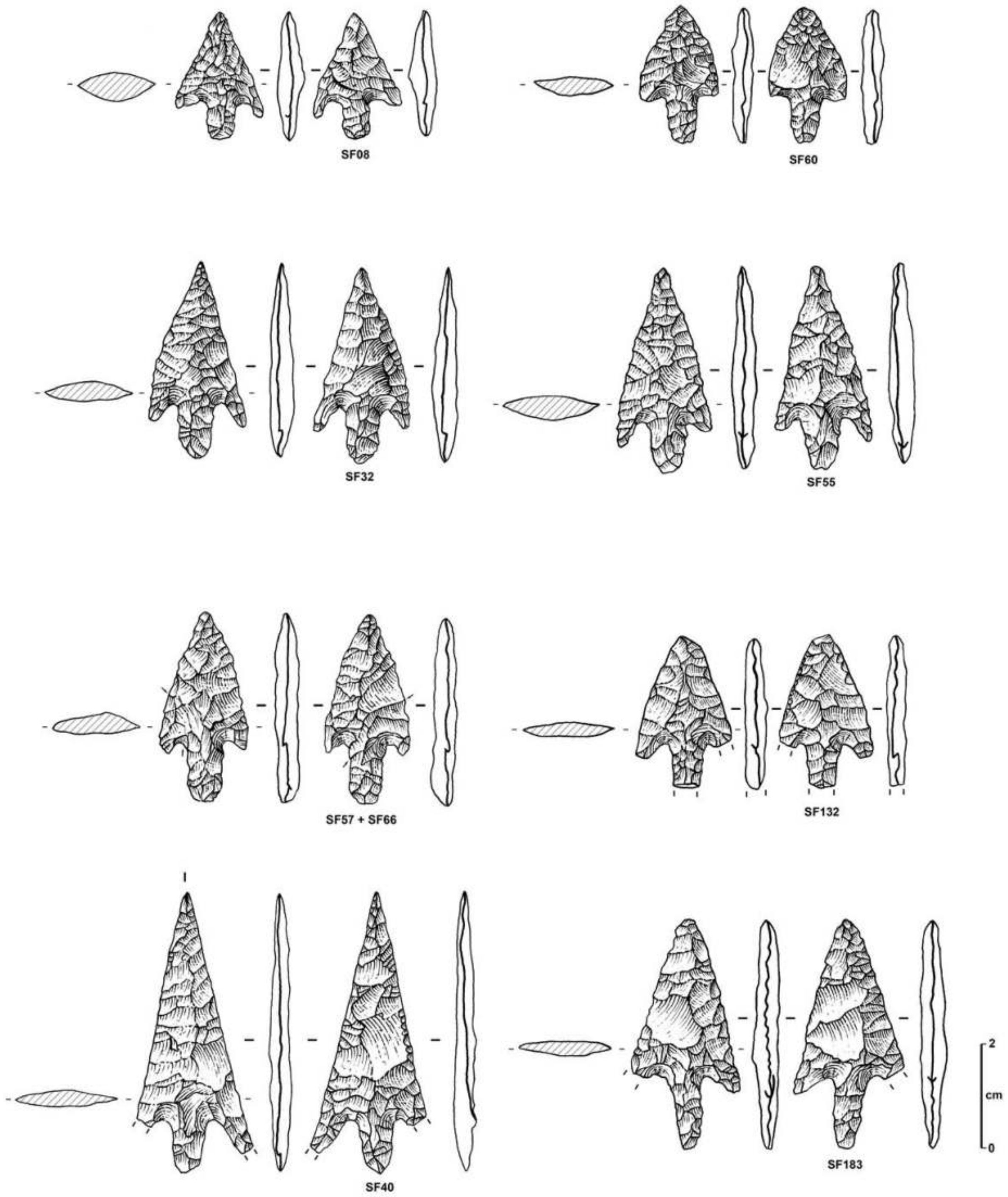


Figure 1: Flat bifacial barbed and tanged arrowheads from the Ghagha GH0014 Neolithic site.

The lithic assemblages from the Marawah MR11 site

The lithic analyses presented here are based on the assemblages collected between 2003 and 2022 during excavations at the MR11 site. The lithics come from different areas of the site, but are consistently dated to the Neolithic period, between 6000 and 4500 BC.

The total number of lithics reaches 2389 pieces that have been studied so far for the MR11 site, which constitutes a very important lithic series for a single Neolithic site in the whole region of the Arabian Gulf. These pieces have been directly plotted on the site during excavation or retrieved from the systematic dry sieving (note that dry sieving on the excavation was carried out using 4mm mesh screens). Among these artefacts, 434 are described as 'tools' (18.8 per cent of the total).

Flint (or chert) is not available naturally on the island, and necessarily comes from somewhere else. Nevertheless, the raw materials do not necessarily come from very far away. Several flint sources have been previously identified in recent years by the DCT team. We have already mentioned the sources from Delma Island and the actual mainland of Abu Dhabi emirate, facing Marawah. These places mostly offer thin tabular flint of rather low quality, while fine-grained knappable stones are found in the form of small wadi pebbles (most probably coming from more distant places). A selection of Delma raw material available at DCT suggests a very close nature of the raw material that has been used for producing some of the tile knives recovered at MR11. There is also an interesting collection of unknapped natural flint nodules from Ras al-Jila' and from around Al Hamra (close to Jebel Barakah). Ras Ghumais is another potential source with small brownish flint outcrops, on the way to Ghagha Island. These first elements of raw material origins will serve as a basis for future research on flint sources in the emirate of Abu Dhabi. Once properly identified, mapped and sampled, it will be possible to clearly link the sources and the discovered artefacts. It will then be possible to assess if there are artefacts using raw materials from more distant sources.

In general, little *debitage* (flakes, blades, etc.) is present at MR11; it is mostly composed of undetermined fragments (chunks) and tinier debris (small flakes less than 2 cm long). The identified flakes that are more than 2cm are in majority wider than they are long, and they often come from the use and/or fabrication of the tile knives. This shows a not necessarily controlled flaking out of the tile knives, and the existence of these flakes is more due to the percussive action on the active edge of the tile knives on a worked surface (wood or other?).

There are only rare flakes that come from bifacial shaping, and there is almost no debris or any flake that could indicate a production or even a resharpening of the arrowheads on the site. Either the production places of the arrowheads have not been excavated at MR11, or they were produced elsewhere and brought to the site. Cores are almost absent in the whole assemblage, showing no flake/blade-oriented production at MR11.

Of the 434 tools from MR11 (Table 2), 121 are complete or fragmentary tile knives. They are made of thin tabular flint nodules of different degrees of quality. In general, their shaping is rather irregular, with short scalariform retouches that are usually bifacial along one long edge (or more rarely along both edges of the thin nodule). It is interesting to note that the tile knives' single edge, the active surface, seems to have been percussed, rather than used as a cutting tool. A program of replication/experimentation of tile knives, using natural thin tabular flint nodules, would complete the study of this type of tool and will clarify their function.

Table 2: Number and types of tools (complete or fragmentary) from the MR11 excavation.

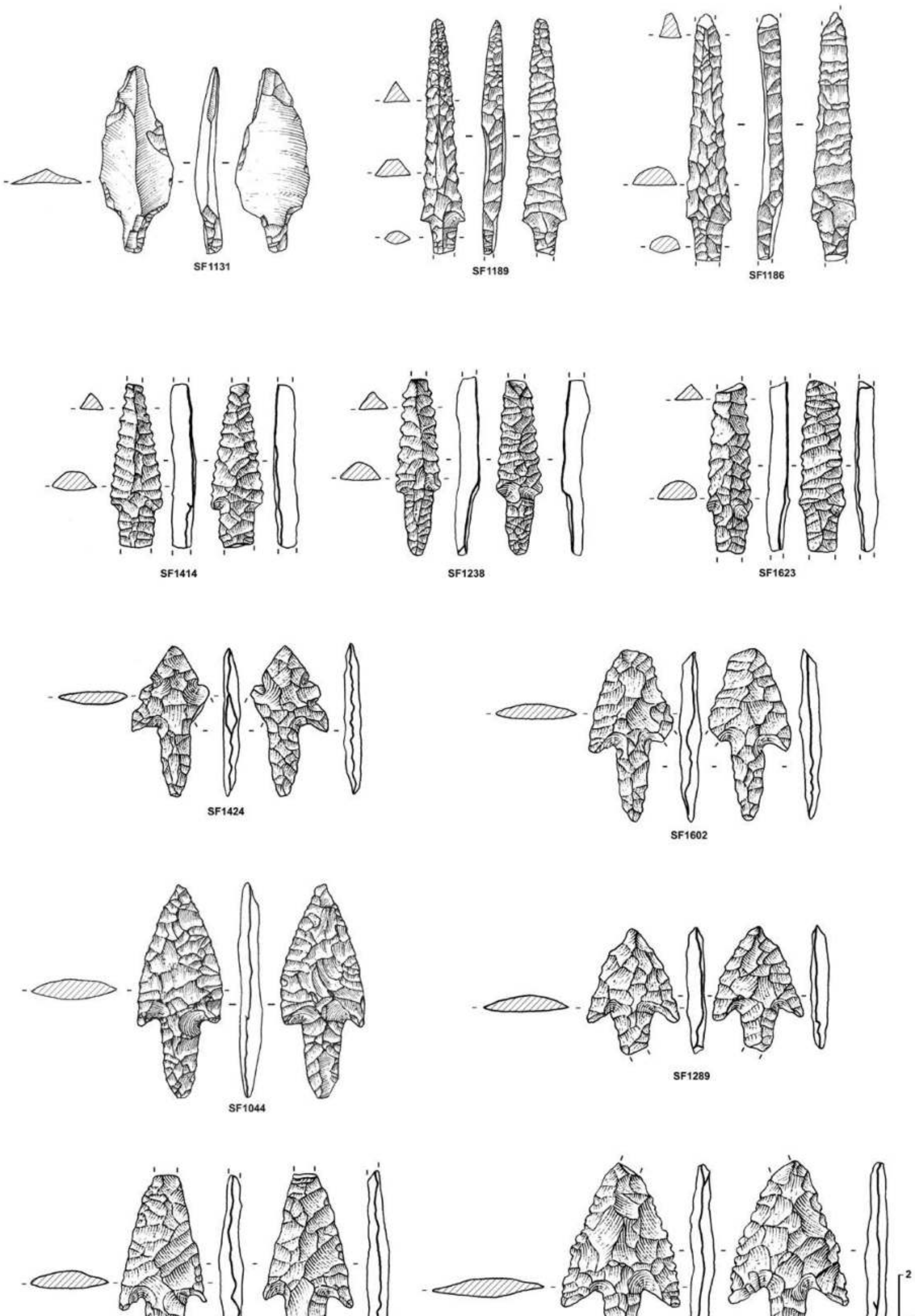
Tool types	Number
Tile knives	121
Trihedral points	116
Bifacial arrowheads	59
Other bifacial tools	27
Other tools and retouched flakes	111
TOTAL	**434**

Arrowheads from MR11 are definitely the main types of tools that yield the higher level of information in terms of technological and cultural traditions (Figure 2). Two main types are the trihedral points (bifacial, sometimes trifacial, with a triangular or subtriangular section), and the flat bifacial arrowheads with a symmetrical section.

Marawah MR11's arrowheads present a high degree of standardisation, especially the 116 complete or fragmentary trihedral points, with the presence of barbs along each edge, a tang that is slightly out of the longitudinal axis alignment, and the formation of pseudo-wings forming a T-shape with the rest of the piece. The typology of the trihedral points will be refined by further studies.

Other arrowhead types are the 59 bifacial barbed and tanged ones, mostly with a symmetrical flat section, sometimes asymmetric, but always very regular and finely made. The other 27 bifacial pieces, sometimes proper tools such as projectile points, sometimes just preforms or unfinished pieces, indicate a strong tendency to produce bifacial tools, made by pressure flaking, and in a more exquisite way than the cruder tile knives. Both types of tools had different purposes, which will need to be explored.

The general shapes of the arrowheads show a very careful production of trihedral points and other flat bifacial points. The trihedral tradition is very similar to the one known from the second half of the 7th millennium BC in western Yemen, up to the end of the 6th millennium BC, beginning in the 5th millennium BC in the Oman Peninsula (e.g., Charpentier 2008, Maiorano *et al.* 2020). However, the absence of fluting indicates a tradition influenced by the eastern sphere of the trihedral tradition (Crassard *et al.* 2020). Finally, the presence of a projectile point that was clearly made on a flaked blank can be associated to the 'Fasad' type, sensu stricto (Charpentier and Crassard 2013). While this point has been found on the bedrock during the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2020 excavation season, at the bottom of a rubble and ashy area to the exterior of the main built structure of Area C at MR11, it is still difficult to interpret its presence as it should indicate a rather older dating than the older period of occupation admitted for MR11. This Fasad point could also represent an interesting example of a lithic tradition that survived at a later period than expected. This will be confirmed by further radiocarbon dating.

Other stone tools are also present, made of igneous rocks of a probable exogenous magmatic origin. They are most of the time interpreted as being fragmentary net sinkers and fragments of hammerstones. Some polished stones, made of the same raw material, were also used at the site.

The MR11 assemblage shows an interesting and very clear and homogeneous lithic assemblage. There is a quite evident dichotomy between the use of rather opportunistic tile knives and the highly refined arrowhead technology of various types, from the typical South Arabian trihedral points to the more ubiquitous bifacial barbed and tanged arrowheads with symmetric or asymmetric flat section and the unique example of a Fasad-like point. Future work will be focused on the spatial distribution of the points related to the different excavation areas and their associated stratigraphy, to explain the different arrowhead counts per context.

Figure 2 (opposite): Different types of arrowheads from the Marawah MR11 Neolithic site. Two upper rows show trihedral points (except SF1131 is the 'Fasad-like' point); three lower rows show flat bifacial arrowheads with symmetrical sections of various types.

Comparative approach between GHG0014 and MR11 lithics and perspectives

The absence of a trihedral tradition at GHG0014, associated with the exclusive presence of flat bifacial barbed and tanged arrowheads and other specific tools, indicates a clear change in lithic traditions between the mid-7th millennium BC (GHG0014) and the mid-6th millennium BC (MR11). This confirms the anteriority of the flat bifacial barbed and tanged arrowheads when they are found as the single arrowhead type, and not associated with any trihedral points. This specificity was already observed in Hadramawt, eastern Yemen, where trihedral points seem to appear later than the barbed and tanged flat bifacial points. At these sites (HDOR 538, HDOR 561; e.g., Crassard 2009; Crassard and Khalidi 2017), the stratigraphic contexts and the number of finds could not fully confirm this hypothesis. It now seems, however, that the comparison between the two very well-dated sites of MR11 and GHG0014 can confirm a shift in lithic traditions. This goes quite in a different direction than the commonly accepted appearance of the Arabian Bifacial Tradition (ABT) after the trihedral points (Magee 2014). This ABT tradition might not have existed as it was thought, especially when evidence of more complex lithic traditions seems to have occurred. This is especially the case when Neolithic sites from the Gulf and other parts of the southern Arabian Peninsula yielded both trihedral and bifacial flat arrowheads, but now we can discuss a more complex image of the lithic traditions thanks to these new discoveries from Abu Dhabi emirate.

The two Neolithic stratified Sites MR11 and GHG0014 yielded homogenous lithic assemblages showing clear differences between each other. It probably implies a cultural change in a time range of a few centuries between the two main occupations on the two islands. The Ghagha Neolithic sites are extremely interesting to compare with the Marawah Neolithic sites, especially the two well-dated sites presented here. They represent a real tradition of organised settlements made of perennial houses/buildings that are in use for several centuries. This is a unique opportunity also to better understand the evolution of regional lithic traditions. They are so homogeneous and strict that they represent an ideal reference for recent prehistory at the scale of the Arabian Peninsula. Resuming excavations on Ghagha Island, especially of the ongoing excavations at the GHG0063 site as well as the further excavation of new sites along its northern coast, will necessarily add crucial information to our understanding of Neolithic development at a subcontinental scale.

Once the lithic analysis is completed, when the ongoing Neolithic excavations are finished, a comprehensive report will be needed, with definitive counts, proportions and statistics, as well as a spatial analysis of the lithic artefacts related to the excavation areas and their stratigraphic contexts. A functional analysis will be needed as well (use-wear analysis, traceology) on tile knives, combined with a flint sourcing project and an experimental and replicative project, exploring in more detail the hypothesis of their use as percussive rather than cutting tools. The arrowheads, with their wide range of types, are the main typological category present at the Neolithic sites. Their use will need to be detailed, as their state of conservation is often excellent, and this will allow further studies to illustrate and document this very peculiar and rich Neolithic material culture that is starting to be better understood. Finally, the ultimate goal will be to define the nature and reasons for the observed change in traditions at the turn of the 7th to 6th millennia BC, combining a wider approach and interdisciplinary studies related with environmental, climatic and regional cultural proxies.

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Recent archaeological investigations at Umm an-Nar Island (Sas Al Nakhl)

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Abstract: The Department of Culture and Tourism - Abu Dhabi has initiated a new programme of archaeological fieldwork at the site of Umm an-Nar Island (now known as Sas Al Nakhl). Over the last three seasons of fieldwork, the site has been recorded in detail using a range of digital techniques and extensive new excavations of the settlement area of the site undertaken. In the Umm an-Nar period (c. 2700–2000 BCE), this island was home to a settlement that played an active role in long-distance exchange; artefacts from as far away as ancient Mesopotamia and the Indus Valley civilisation (modern-day Pakistan and India) have been found. This paper presents the results of the recent archaeological excavations, which suggest the site had a longer and more complicated occupation history than previously thought. Evidence of large fires and possible feasting deposits suggest the island may have been a focal point for seasonal gatherings, rituals and exchange.

Keywords: Bronze Age, Umm an-Nar, excavation, exchange, domestic, architecture, Gulf

Introduction

The coastline of Abu Dhabi is characterised by a large number of islands sitting beyond areas of sabkha, supratidal mud or sand flats that can be up to 30 km wide. Following the Flandrian Transgression sea level along the Abu Dhabi coastline would have reached an upper limit of potentially several metres above the current level in the mid 4th millennium BCE. This was followed by a period of regression, with a rapid fall in sea level leading to the development of supratidal flats with sabkha development, which probably occurred in the later 3rd and 2nd millennium BCE (Evans *et al.* 1969; Lambeck 1996; Parker *et al.* 2020). During much of the 3rd millennium BCE these areas of sabkha would have likely represented shallow lagoons, possibly consisting of mangrove forests (Eddisford and Phillips 2009). When excavations were first undertaken at Umm an-Nar Island in 1959 it was close to the mainland; however, during its occupation in the 3rd millennium BCE Umm an-Nar was located c. 12 km off the coast of Abu Dhabi (Figure 1). Extensive land reclamation in the previous decades means today the site is located within the urban Abu Dhabi.

Figure 1: Location of Umm an-Nar Island in relation to the 3rd-millennium BCE coastline and the airport site (based on 1985 EAD Landsat Imagery).

Originally Umm an-Nar Island measured c. 3 km by 2 km (Al Tikriti 2011: 9). Today the protected archaeological site covers an area of 700 m by 450 m (Figure 2). The rocky island of Umm an-Nar is very different to the other low-lying sandy islands in the vicinity. A central plateau measures 480 m by 300 m and consists of a raised area of limestone, c. 5m above the surrounding area; the edge of the plateau forms low white limestone cliffs that would have been an obvious landmark. The plateau is occupied by an extensive Umm an-Nar cemetery with an associated settlement on its southern and eastern sides. The geology of the island is of some significance, as it provided a source of building material for the settlement and tombs as well as allowing water collection and storage in cisterns. A mid 20th-century cistern is located on the northern side of the plateau, and the people of Abu Dhabi Island used to visit Umm an-Nar Island to collect water that accumulated there (Al Tikriti 2011: 9).

Umm an-Nar should be translated as 'Place of Fire', presumably a reference to the black archaeological charcoal deposits that cover the settlement area of the site; however, it has been suggested the name relates to the fact that gunflint was collected from the island (Frifelt 1991: 14). A team of Danish archaeologists, who were digging in Bahrain, were taken to the island in 1958 by Sheikh Shakhbut; the presence of ruined structures at the site were known to the local inhabitants, and several stone figures had been found there (Frifelt 1991: 14). The Danish team that excavated the site between 1959 and 1965 focused on excavating seven tombs; however, limited excavation of the settlement was undertaken before the work was halted (Frifelt 1991; 1995).

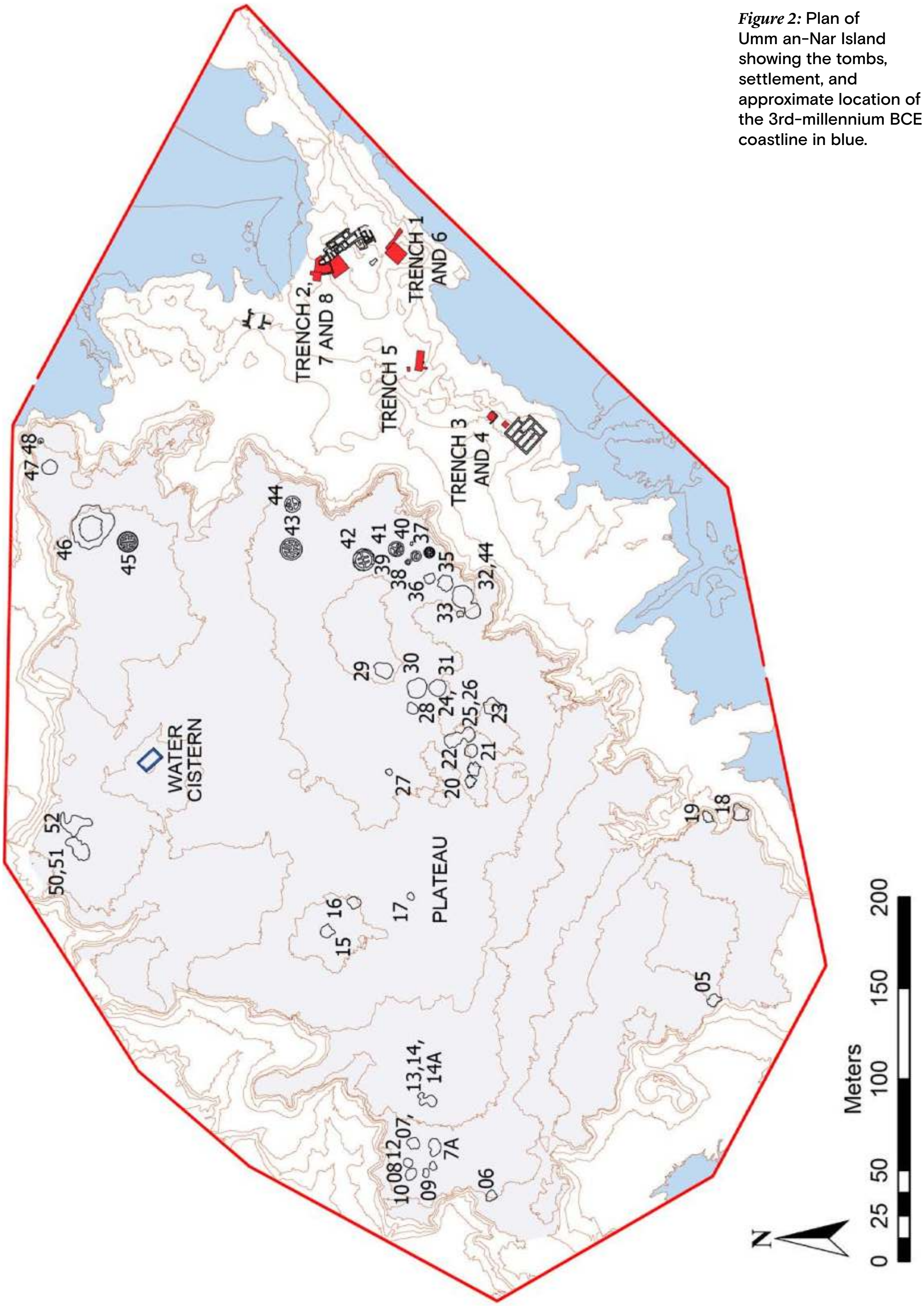

Figure 2: Plan of Umm an-Nar Island showing the tombs, settlement, and approximate location of the 3rd-millennium BCE coastline in blue.

Further excavations of the tombs and settlement were carried out by an Iraqi team in the 1970s, along with the reconstruction of a number of elements of the site (Al Tikriti 2011). New archaeological investigations were started by the Department for Culture and Tourism - Abu Dhabi in 2021, including a detailed recording of the site and extensive excavations of the settlement area.

As the first Bronze Age site excavated in the region, Umm an-Nar Island has given its name to the 'Umm an-Nar culture', defined by distinctive tomb architecture and characteristic artefacts, such as locally produced painted ceramics, that are now known from sites across UAE and Oman. In the 3rd millennium BCE, Umm an-Nar Island was home to a settlement that played an active role in long-distance exchange; artefacts from as far away as Eastern Arabia, Mesopotamia (modern-day Iraq) and the Indus Valley civilisation (modern-day Pakistan and India) have been found at the site. At this time, copper and stone from the Hajar mountain range were exchanged for imports, including woollen garments and possibly dairy products and oils (Eddisford 2020). The settlement is located on the eastern side of the island, where a rocky promontory probably provided a sheltered harbour (Figure 2). The raised plateau in the centre of the island was used exclusively as a cemetery and contains over 50 above-ground tombs. The only other contemporary archaeological site nearby is the Airport Site, located to the east on what would have been the mainland at the time (Figure 1). Surface pottery from the site indicated sporadic occupation from the Hafit period (c. 3100–2700 BCE); two abraded Mesopotamian bevelled rims from the site are comparable to vessels found in Hafit tombs. A more significant phase of Umm an-Nar occupation occurred in the second half of the 3rd millennium BCE, however, the finds were mostly from disturbed contexts (Beech *et al.* 2004; De Cardi 1997).

The cemetery

The central plateau contains over 50 above-ground tombs, but no evidence of occupation or other contemporary activities (Figures 2 and 3). The circular tombs range in diameter from 6 to 12 metres, are several metres high and are often divided into chambers accessed through small entrances. A few of the tombs are faced with well-dressed limestone blocks, some of which are decorated with animal motifs, including oryx, oxen, snakes and camels. An isolated tomb was located on a ridge, c. 100 m north-east from the main plateau, but this was destroyed by road-building activity. Four more tombs were located south of the plateau (Nos 1-4 in the Danish catalogue), outside the protected area, and were destroyed during construction work (Al Tikriti 2011: 32). The larger and more elaborate tombs are located on the eastern side of the plateau, overlooking the settlement.

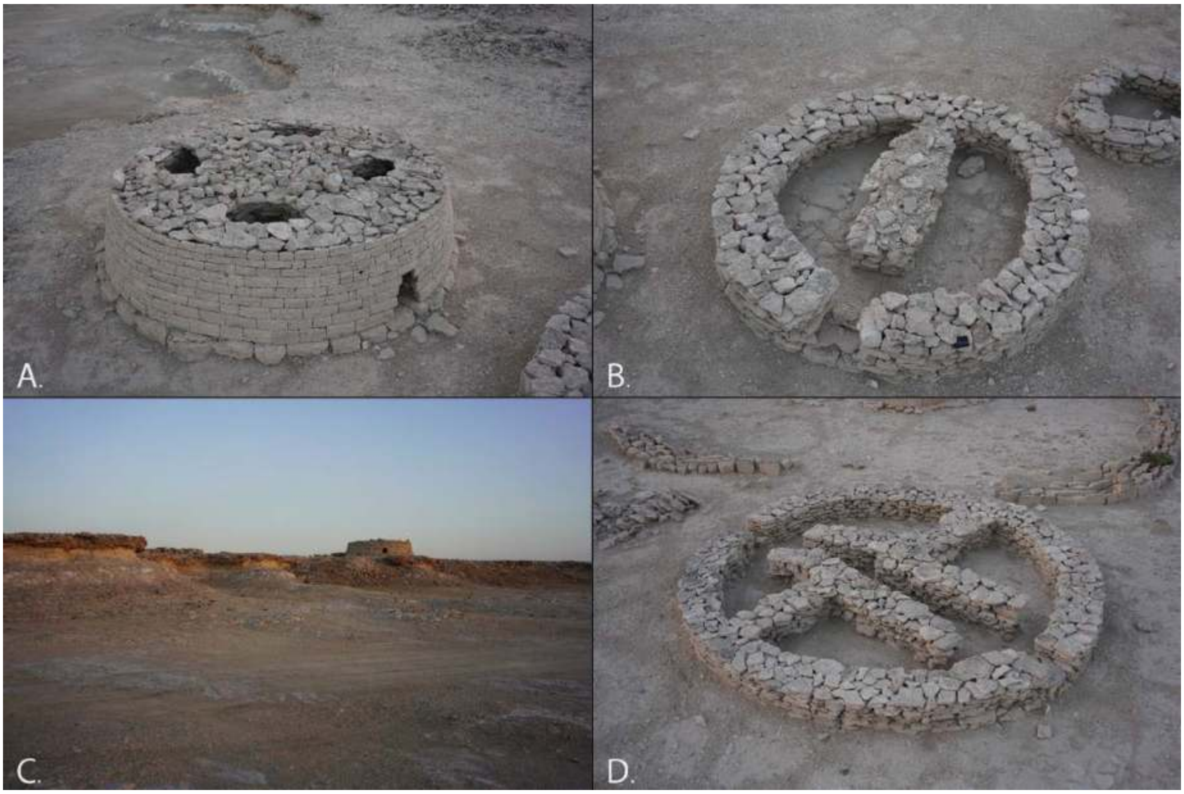

Figure 3: The Umm an-Nar cemetery. A) Grave 37; B) Graves 38 and 39; C) Grave 37 showing the raised central plateau; D) Grave 41.

There are no reliable C14 dates available for the previous excavations at the site. Of the seven graves excavated by the Danish, only five can be dated, as Grave VIII was empty and Grave IV contained very few finds. A chronology for the remaining graves was established based on comparisons of the excavated artefacts, mostly ceramics, with those from Hili as well as sites in Mesopotamia and Bampur. Based on the form and decoration of the locally produced ceramics, Frifelt suggests graves V and VII (and probably Grave IV) belong to the earliest phase of the site and are contemporary with Hili 8 Period IIa-IIc1 (Frifelt 1991: 125-126; 1995: 239, Table 12). These graves contain several jars (some of which were spouted) in a red sand tempered fabric that are imported from Mesopotamia or Eastern Saudi (see Piesinger 1983) and are likely of ED I or EDII date. Graves V and VII were likely used in the mid third millennium BCE.

Frifelt dates Graves I, II and VI to a later phase of the site and suggests they are contemporary with Hili 8 Period IId-e. The presence of grey wares in Graves I and II support this conclusion, as these appear in Period IIe at Hili 8 (see Cleuziou 1989). Imported Mesopotamian pear-shaped vessels from Graves I and II find parallels in Mesopotamia in contexts of ED III or earlier date (Frifelt 1991: 125-6; 1995: 239, Table 12). These graves are therefore likely to have been in use in the third quarter of the 3rd millennium BCE.

Based on later excavation by the Iraqi team, Al Tikriti (2011: 33) divides the tombs into three types. Type A are the most elaborate and well built, with two entrances and well-dressed facing stones; Type B are less elaborate and do not use dressed stones; Type C are smaller, single burial chambers built of rough stones. However, Al Tikriti does not see these tomb types as being chronologically significant, rather all belong to the same period (contra Vogt 1985). As there is no detailed publication of his excavations, it is hard to assess the strength of this argument; elsewhere, there is some evidence that the elaborate tombs represent a later development (McSweeney *et al.* 2008).

Earlier excavation of the settlement

The archaeology of the settlement consists of houses made from rough-cut stone ranged along the shoreline on the eastern and southern sides of the island. There are no C14 dates for the excavations at Umm an-Nar Island, and the dating of the settlement is therefore based on parallels to a more firmly C14-dated sequence at Hili, as well as with reference to imported artefacts from Mesopotamia, Syria and Iran (Frifelt 1995: 237-239). The phasing of the settlement relies heavily on the evidence from Section 1014, in which three superimposed periods were defined. Period 0 represents the earliest occupation and is built directly on bedrock and with no stone buildings and was dated 2700–2600 BCE; Period I consists of well-built stone structures and was dated 2600–2425 BCE; Period II consists of later more poorly built stone structures and was dated 2425–2200 BCE (Frifelt 1995: 40, Table 12, 239).

In assessing the chronology of the settlement, we are hampered by the coarse nature of the excavations and the loss of data that occurred in the decades between excavation and publication. House Complex 1014 contained at least two major architectural phases and several possible sub-phases; however, these separate phases were not identified during excavation and artefacts from them were not separated (Frifelt 1995: 237). Warehouse Structure 1013 was destroyed before the settlement was abandoned, suggesting it dated to the earlier phases of the site. However, there was some reuse of the building, with rooms cleared out and some midden dumping occurring (Frifelt 1995: 237); it is not clear to what extent this was identified during the excavation. An early date for Warehouse 1013 is supported by the fact it did not contain any Buraimi Ware, a distinctive domestic sandy ware that appears in the Hili 8 sequence in the mid 3rd millennium.

When interpreting the nature of the settlement, previous authors have focused on the role of external merchants in establishing the site. Bibby described the settlement at Umm an-Nar Island as “a short-lived settlement of colonists from the Persian coast opposite, who had come and a generation or so later had gone without having had any contact at all with the ingenious people of the interior; if indeed there had been any people in the interior until a thousand years later” (Bibby 1970: 299). Similarly, Frifelt concludes that the site was an entrepôt that thrived as a result of an intensification of the trade in copper between Mesopotamia and Southeast Arabia in the 3rd millennium BCE. Frifelt suggests that the demand for copper was driven by the needs of the Mesopotamian economy and trade conducted by Mesopotamian merchants who followed well-established trade routes that passed through settlements in Arabia (Frifelt 1995: 240). However, our recent work at the site is beginning to challenge this chronology and interpretation.

A more extensive excavation of the settlement area was undertaken by an Iraqi team in the 1970s (Al Tikriti 2011), and a series of rooms were exposed to the north-west of Danish House Complex 1014. Al Tikriti suggests there are two main phases of occupation, a later phase of stone-built buildings seals a thick burnt midden layer with no structural remains. Sadly, the phasing of the buildings was not recorded in detail, and the material from the excavations remains unstudied. The most significant finding of the Iraqi excavation was a relatively large rectangular space (Room 14), which contained several enigmatic stones that may have been orthostats, idols or alters; a stone carved with a human figure in relief was found on the spoil heap from the excavation of this area (Figure 4). This room was named 'The Sanctuary' as it seems to have had a central role in the ritual practices at the site (Al Tikriti 2011: 20-21). Our recent re-examination of this area of the site presents a clearer picture of the chronology of the settlement and the range of possible ritual practices undertaken.

Figure 4: The sanctuary directly after excavation in 1975 (Al Tikriti 2011: 29, Figure 11).

Recent archaeological investigations

In February 2021, the Department of Culture and Tourism - Abu Dhabi (DCT Abu Dhabi) started a new program of archaeological investigations at Umm an-Nar Island. Initially, the site was recorded using a range of 3D digital techniques. In addition, three seasons of archaeological excavation have been undertaken and eight trenches excavated in the settlement area of the site (Figure 2). The digital documentation of the site included digital photography, laser scanning and a photogrammetric survey of all visible archaeological features, excavations and reconstructed areas; a topographic survey of the entire site was also undertaken. This data is incorporated into the preliminary results of our excavations presented below.

Trenches 1 and 6

Trench 1 was located along Section 1014, excavated by the Danish mission in the 1960s through the highest part of the settlement (Frifelt 1995: 40-80). This sequence of deposits was the main reference for our current understanding of the site's chronology. In the first season of our work, the backfill and collapse from the trench were removed and the north-east-facing side of the section cleaned. The section through the archaeological deposits was then hand-drawn, recorded and photographed. Several samples from charcoal-rich deposits were taken for radiocarbon dating; however, the poor state of preservation meant that many did not return reliable dates. Therefore, in the second and third seasons of our excavation, Trench 6 was excavated to better understand the sequence of deposits recorded in the Danish section.

The earliest phase of activity in Trench 6 (Phase 0 in the Danish excavation of Section 1014) was found to be associated with a substantial stone wall that extended beyond the trench to the south-east. This wall was incorporated into a slightly later phase of well-built rectangular stone buildings (Phase 1 in the Danish excavation), associated occupation included a clay-lined bin that contained a large piece of bitumen. After this phase of occupation was abandoned, the site was heavily eroded by water and a thick layer of mixed deposits sealed the truncated buildings and occupation deposits. This redeposited material contained a range of finds that are likely associated with the early buildings. A later phase of occupation consisted of a more expediently constructed sub-circular building and dark midden deposits (Phase 2 in the Danish excavation). A wide range of finds were recovered from Trench 6 including stone tools, copper alloy artefacts, impressed bitumen and a significant quantity of ceramics, shells and bones.

Early occupation with walls built on bedrock

A substantial stone wall extended beyond the trench to the south-east and was built of very large stones directly on the bedrock. Abutting this wall a compact homogenous layer of sandy silt represents the deposit recorded in the Danish Section as Period 0. It is of some significance that this early phase of occupation is associated with stone architecture. This early occupation phase contained a significant amount of Mesopotamian pottery.

Well-built rectangular structures

Built on top of the earliest occupation deposits and incorporating the earlier stone wall was a substantial well-built stone building that extended beyond the limit of the excavations to the south-west and south-east; it had been truncated to the north-east by the Danish excavation of Section 1014. This structure equates to Danish Phase I and is likely contemporary with many of the reconstructed walls of the settlement directly to the north. Within Trench 6, the northern side of the building was delimited by a wall that survived to a maximum height of 1 m. This wall was recorded as Wall F in the Danish Section 1014 (Frifelt 1995: Plan 3). Abutting the internal southern face of the wall, a short internal wall created two spaces within the building, connected by a doorway. The southern wall of the building was not exposed and was located just to the south of Trench 6. To the north of this building was a narrow alleyway filled with a layer of unexcavated sandy silt. On the north side of the alley was a second well-built stone structure that extended beyond the trench

Figure 5: Trench 6. A) Later sub-circular structure; B) Rectangular structure; C) Excavation in the eastern room of the rectangular structure; D) Aerial ortho-mosaic of the earlier rectangular structure.

to the north. This wall is the same as Wall G in the Danish Section 1013 (Frifelt 1995: Plan 3). Only a small area of this building was visible in Trench 6, and it was not excavated beyond defining the top of the wall.

The earliest feature in the eastern room of the building was a firepit, located against the northern wall, which contained several in-situ burnt timbers sealed by small stones and filled with an ash-rich deposit. This pit also contained a silver metallic stone that is likely pyrite (SF184), a stone bead (SF1836) and a pierced ceramic disk (SF182), as well as fish bone and a significant amount of bird bone. This firepit may be associated with activities undertaken at the founding of the new building. Occupation in the eastern room consisted of several compact laminated floor surfaces. A shallow pit was located roughly in the centre of the space, which contained a ceramic disk (SF154). A posthole was also cut into the floor deposits (Figure 5C). The latest surviving floor surface was a black ash-rich occupation layer. In the space directly to the west, the floor layers are significantly thicker than excavated in this room. Originally there was likely a more substantial sequence of occupation, perhaps up to 0.50 m thick; however, much of this occupation was horizontally truncated by water erosion after this building was abandoned.

In the corner of the western room was a circular bin, measuring 0.9 m in diameter. The associated floor surfaces were heavily truncated to the east and west by post-abandonment water erosion, and the bin survived as it was protected by the internal wall directly to the east (Figures 5B and 5D). The bin was lined with a firm, pale grey clay, and its sandy fills contained pieces of bitumen and fragments of the clay lining. A large piece of bitumen at the base of the bin was likely part of a lid that originally sealed the feature. Surrounding the bin was a series of poorly preserved shell floors and occupation deposits.

Disturbed and redeposited material sealing buildings

The occupation of the well-built stone structure was heavily truncated by water erosion, which vertically truncated the walls and occupation deposits and cut gullies into the earlier layers, resulting in the redeposition of significant amounts of mixed material that was rich in bone and other artefacts. The Danish excavation recorded a large cut that truncated the north-east area of House Complex 1014, which was likely one of these gullies. At the southern side of the trench, a large quantity of stone collapse was within a gully that cut into the edge of the mound in this area. This stone collapse originated from one of the walls of the lower building, and the coursing of the stones could still be seen, indicating the structures were built of stone to at least 2 m higher than they survive.

Midden

Sealing the redeposited material associated with water erosion were several midden layers. These soft, ash-rich layers contained large quantities of charcoal, bone and pottery. Ceramics from these deposits included a range of local and imported wares, and the animal bone contained a significant quantity of fish and marine species including dugong, as well as terrestrial animals including sheep/goat and bird. Special finds from these layers include several stone artefacts as well as copper alloy tools. Along with the abundance of marine bone, the presence of net weights and fishhooks highlights the importance of the marine environment as a food source at the site. These midden layers represent occupation postdating the rectangular stone structures described above. It is not clear if the midden is associated with occupation in structures elsewhere on the site at this time, or if this represents a more ephemeral phase of occupation. A single C14 date from these deposits gave a calibrated date of 2274–2036 BCE (95.4%).

Sub-circular structure

At the north-east side of the trench, and partially truncated by the earlier Section 1013 collapsing, was a sub-circular structure, constructed on, and possibly partially truncating, the earlier midden layers (Figure 5A). The structure measured 8.3 m by 2.2 m internally and was constructed of unfaced beach rock and survived two courses high. A layer of sand and stone collapse was excavated from within the building, but no floors or occupation deposits inside or outside the structure were identified. It seems likely the associated occupation deposits were either very ephemeral or had been completely eroded. This building was not recorded by the Danish in Section 1014, as their section was slightly farther to the north-east; however, this phase of occupation equates to Phase II (Walls C and D in Section 1014) in the Danish excavations at the site (Frifelt 1995). Frustratingly, the lack of occupation deposits and associated finds in this phase in Trench 6 makes dating difficult. However, a very similar sub-circular structure was recorded in Trench 5 (see below), and this building is associated with extensive midden layers. The sand deposits associated with this phase of occupation are significantly different to the earlier layers, and the abundance of windblown sand in the upper levels of the site may suggest a shift to a more arid climate.

Trenches 2 and 8

Trench 2 was located directly to the west of Room 14/The Sanctuary at the northern extent of the main settlement excavation (Figure 6). Three architectural phases were identified, the earliest phase consisted of an east-west aligned stone wall that ran beneath the sanctuary wall. The second phase of architecture consisted of a large sub-circular fireplace measuring 3 m across with a low stone wall built around its edge. This feature contained a highly burnt fill suggesting repeated firings at high temperatures. The latest phase of architecture in Trench 2 consisted of the partially reconstructed wall of Room 14.

Trench 8 exposed the area excavated by the Iraqi team in Room 14, Room 10 and Room 11 (Al Tikriti 2011: 22); the trench was located directly to the north-east of Trench 2 (Figure 6). The earliest occupation in this area of the site consisted of up to 1 m of charcoal and ash-rich midden, with evidence of in-situ burning associated with fires. This may represent repeated gatherings and possibly feasting over a relatively long period of time. These midden

Figure 6: Plan of structures on Mound A including our excavations in Trenches 2, 7 and 8.

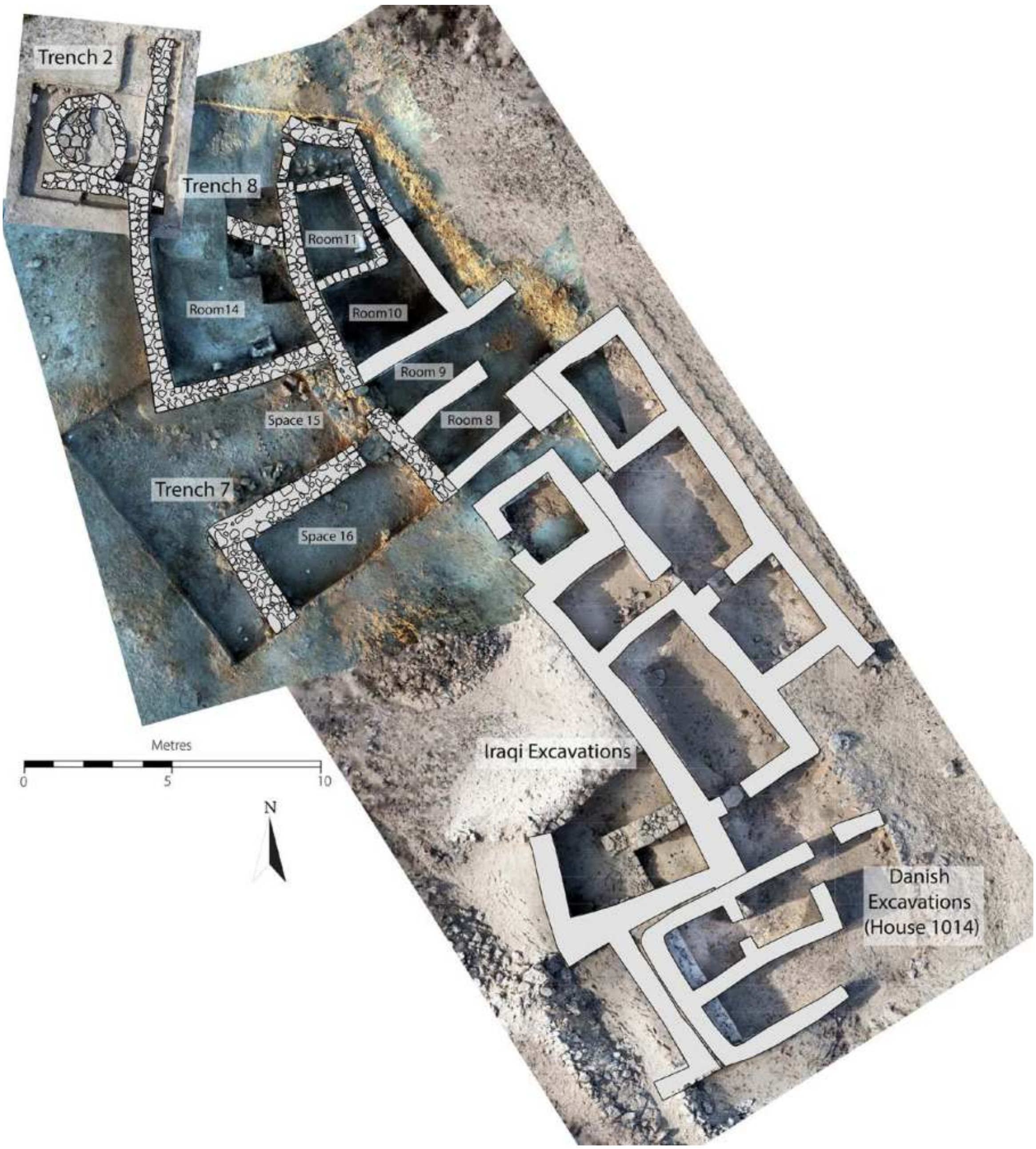

Figure 7: Trenches 2 and 8.
A) Aerial image of Trench 2 showing the circular fire instillation and associated wall below the later sanctuary wall;
B) Trench 2 showing the circular fire instillation and associated wall;
C) Trench 8 showing the earlier structure below the walls of the sanctuary, and to the left, early midden deposits;
D) Midden deposits extending to a depth of 1 m below the earliest structure in Trench 8.

deposits were sealed by a stone building, the wall of which survived only one course high. The continuation of this wall was exposed in Trench 2 and is associated with a large circular firepit. Built on top of this wall and its associated occupation deposits were the walls of Rooms 10 and 14; the occupation in these rooms was entirely removed during the excavation in the 1970s. A final phase of occupation consists of a more expediently constructed building, Room 11, with walls built only one course wide.

Charcoal and midden layers

The earliest archaeological deposits in this area of the site consisted of thick layers of ash and midden each measuring up to 1 m thick (Figures 7C and 7D). These deposits were highly laminated with multiple layers of midden, occupation, cleaner sandy accumulations and in-situ burning associated with small fires. These layers contained a great deal of animal bone and ceramics, including imported wares. These midden layers represent repeated phases of burning and possibly feasting on a large scale; the deposits extend across a significant area of the site. Similar burnt layers were identified below the structures to the south in the previous excavation (Al Tikriti 2011: Figure 18).

Early building and fire installation

Built on top of the latest layer of midden was an east-west orientated wall constructed with two parallel lines of stones and a central packed core with smaller stones (Figure 7C); this construction is typical of the Umm an-Nar period and seen across the site. To the west the wall continued in Trench 2; here a circular stone-edged fire installation was constructed against the northern face of the wall (Figure 7A). This feature measured 3 m across and was constructed of a mixture of beach stone and limestone slabs. A disk-shaped grinding stone, SF31, was incorporated into the northern side of the wall that surrounded this feature. The base of the fire installation was a compact surface that was sealed by a layer of neatly laid stone slabs. The fire installation was filled by friable red-brown burnt deposits that are associated with repeated high-temperature firing events within the structure. No parallels for this feature are known from contemporary Early Bronze Age sites in Southeast Arabia. The size of the fire-pit suggests it had a communal function, and its location adjacent to a later structure that is likely associated with ritual activity is intriguing. Possibly this unique fire installation was used in communal activities such as feasting or ritual practices in an area of the site with special significance to its inhabitants.

The Sanctuary and associated buildings (Rooms 10 and 14)

Built on top of the earlier building, the walls of Room 14 were constructed of large, roughly finished stones and measured between 0.6 and 0.7 m wide (Figures 7A and 7C). The eastern wall of Room 14 extended to the south of the trench forming a 'spine wall' against which the structures to the south were built. Abutting this wall, an L-shaped wall forms the south-east and south-west sides of Room 14. To the north-east of Room 14 a second space, Room 10, was defined by a north-south orientated wall (the southern extent of this wall has been reconstructed) and a more poorly defined east-west wall (Figure 6). These walls were in use at the same time, as a layer of pale clay wall render was visible in the corner where they met. However, the east-west wall was of more robust construction, and it is possible it represents an earlier wall reused in this structure. A threshold in the wall would have given access to this space, and a second possible threshold would have allowed access to Room 14.

Later building (Room 11)

A poorly constructed wall, which was only a single course wide, forms a small rectangular space within the earlier Room 10. This is a later phase of occupation, and the lower courses of this wall were built against rubble collapse from the walls of Rooms 10 and 14, showing that the earlier walls were at least partially ruined by the time this later space was constructed. This later, more ephemeral occupation may be associated with the latest phase of more poorly built architecture recorded in Trenches 5 and 6.

Trench 7

Trench 7 was located to the south of Room 14/Trench 8 and to the west of Rooms 8 and 9, excavated by the Iraqi mission in the 1970s (Al Tikriti 2011). Two rooms were identified in Trench 7: an internal space, Space 16, with an external space to the north, Space 15 (Figure 8A). A blocked doorway originally connected Spaces 15 and 16, a second doorway led from Space 15 into Room 9. A series of alternating occupation deposits and accumulations of sand were excavated in Spaces 15 and 16, possibly representing the seasonal use of these structures. The sequence of floors was not fully excavated and will be continued next season; below the structures in Trench 7 are thick midden deposits, visible directly to the north in Trench 8 (Figure 7C).

The eastern extent of Space 16 is defined by a continuation of the 'spine wall' that defines the eastern side of Room 14 and continues to the south of Trench 7, where it forms the western extent of several other spaces (Figure 6). Abutting this wall, an L-shaped wall defines the northern and western extent of Space 16; the southern wall of the room is just beyond the southern extent of the trench. External Space 15 is located between Space 16 and Room 14, its eastern extent is defined by the N-S aligned 'spine wall', through which a doorway gives access to Room 9 down several stone steps. At the eastern side of Space 15, there was a raised area built of two courses of large limestone blocks packed with clay. In the north-east corner of the space, built on top of the raised area, is a small circular platform of stones measuring 1.5 m by 1 m (Figure 8A).

Figure 8: Trenches 5 and 7.
A) Trench 7 looking north-east; internal Space 16 is on the right and external Space 15 on the left; Trench 8 (the sanctuary) is in the background.
B) Recording in Trench 7.
C) Sub-circular structure in Trench 5, with associated midden deposits on the far right.
D) Recording the earlier rectangular structure in Trench 5; the later sub-circular structure is visible in the background.

Internal Space 16

The surfaces within Space 16 consisted of occupation layers of compact clay with small stones, which often contain activity areas with small charcoal flecks, ceramics, shell and bone (Figure 8B). Finds were relatively common and included circular, pierced net weights, hammer stones, copper alloy objects and prills, a tooth/tusk with saw marks, fragments of bitumen, small circular beads, hammer stones, a stone pendant and a worked soft-stone object that might be a shaft straightener. Small beads from the occupation deposits are similar to those Frifelt (1991: 237, Figure 114; 120, Figure 245) describes as talcite steatite, and are the most common category in the nearby tombs. Minerals were also common, including salt or gypsum crystals, greenish stones that may be malachite, ochre and copper fragments/prills; this indicates a range of raw materials were brought to the site, and some were being worked or stored in this space.

A stone setting was constructed of two small stone blocks set upright in a trapezoid shape (Figure 8A); the function of this remains unclear, but a distinctive *Ficus* was found nearby. These were traditionally used to feed babies and are often found in contemporary tombs (Méry *et al.* 2004). The surfaces in Space 16 suggest similar activities occurring over an extended period, but with varying spatial patterns to the artefacts, indicating changing use of specific areas. It is possible that occupation was seasonal and that surfaces were exposed to the elements for some time during periods of short-term abandonment. This interpretation is supported by the presence of minor wall collapse between some of the occupation phases.

External Space 15

The external surfaces consisted of ashy, friable sand rich in ashy animal bones (including fish bones of various sizes), but also including ceramics and shell. These surfaces are of a distinctly different compaction (and lower clay content) than the interior surfaces of Space 16. The activities in the outside area included fires, possible cooking and food preparation, the handling of animal remains and the dumping of midden material. Similar to the deposits in Space 16, there appear to be periods of partial collapse between occupations, suggesting intermittent or seasonal occupations.

Collapse and abandonment

Sealing the latest clear evidence of occupation in both Spaces 15 and 16 was a major phase of collapse, associated with the erosion and collapse of the walls of the building. Mixed with this collapse was a range of artefacts, likely associated with the earlier occupation, including copper alloy objects (including a copper pin or part of a fish hook), bitumen fragments and a stone pestle. The latest phases of collapse include a red-brown, heavy burnt phase directly above Space 16. The intensity of the burning may suggest the wooden and other organic elements of the building were burnt, and this could explain why the burning did not extend into the external uncovered area to the north. However, it is also possible the burning is associated with a later phase of activity, as witnessed by Room 11 built within the collapse of Room 10 in Trench 8 and the circular structures built over the earlier collapsed buildings in Trenches 5 and 6.

Trench 5

Trench 5 measured 4 m by 11 m and was located between Warehouse 1013 and the main area of excavation of the settlement (Figure 6). Two main phases of architecture were identified; the later phase consisted of a sub-circular structure and significant quantities of associated midden; the earlier structure was rectangular in plan and can be compared to Warehouse 1013 (Figures 8c, 8d, 9).

Early rectangular building

In Trench 5 natural limestone was overlain by a layer of dirty sand that predated any structures in this area of the site and consisted of disturbed natural and occupation deposits, containing charcoal and occasional ceramics. Built on top of this was a substantial rectangular stone-built building consisting of walls that measured c. 0.7 m wide on average and survived to a maximum of six courses high (Figures 8D and 9). The walls were constructed of two parallel rows of large stones and a packed core of small stones and silty sand. A larger room in the north-west corner of the building was accessed via a doorway from a smaller space to the south. A third space extended to the north-east beyond the limit of the excavations. To the east, the building continued below the later unexcavated walls of a circular structure.

The floors of the building were not completely excavated, and therefore the full life history of the building was not recorded. In section, the southern wall of the building wall appeared to be shallower than the other walls and may have been a later addition. To the south there was evidence of extensive erosion, in the form of deep gullies cut into the archaeological deposits. The floors within the building consisted of a large number of laminated dark ashy occupation layers and cleaner floor surfaces. Several dark ashy sub-circular fire spots with evidence of in-situ burning were the result of small fires in the building and may represent cooking activities. At the western end of the trench, the external surfaces were sandier and contained more small stones and grit than the internal surfaces. These external occupation accumulations were associated with a number of larger fire spots associated with external fires. Constructed on the latest of these external deposits was a poorly preserved wall that survived to only one course high. This feature seems to be an

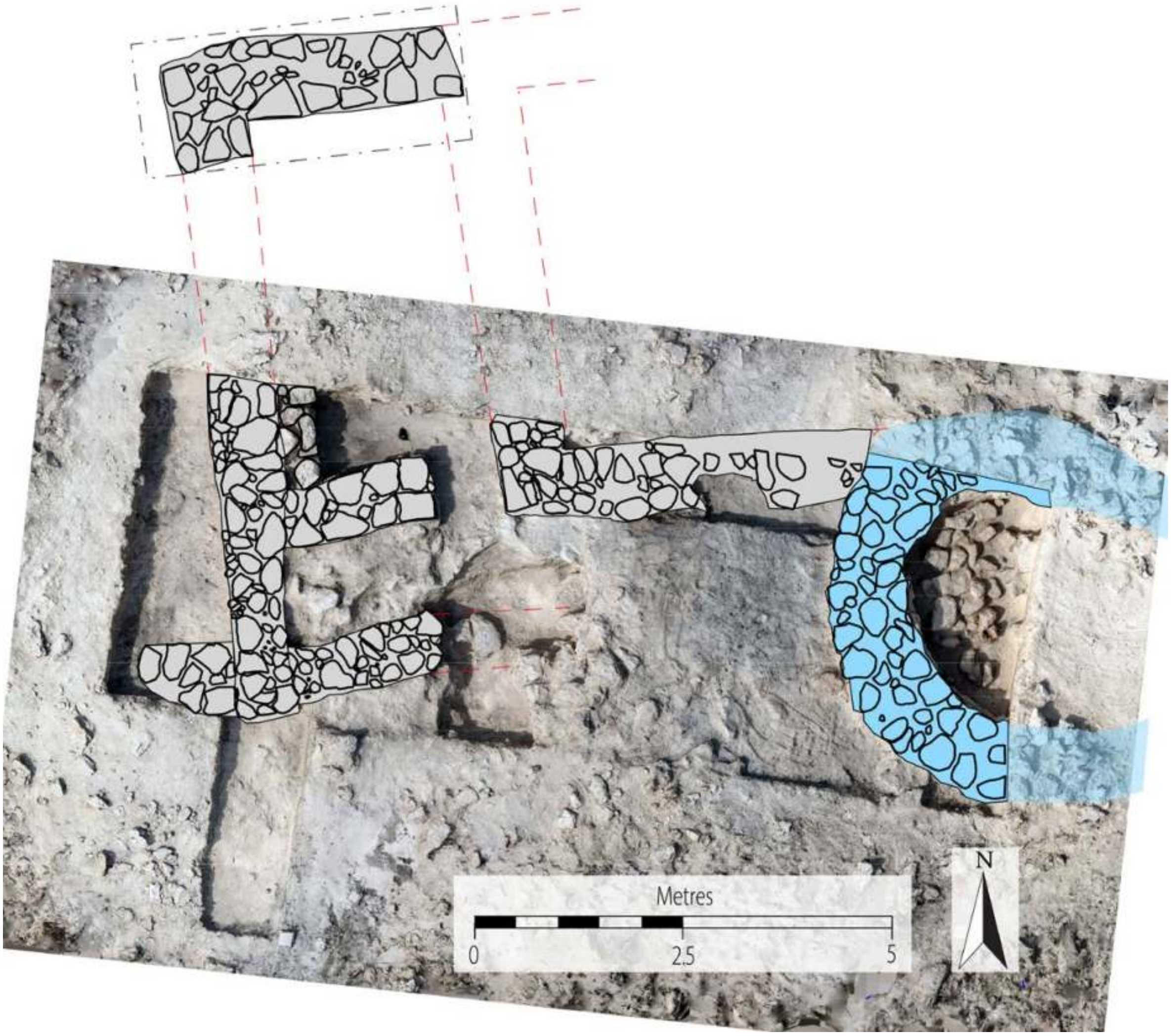

Figure 9: Plan of Trench 5 showing the later sub-rectangular structure (in blue) and associated midden directly to the left of it, sealing an earlier substantial rectangular structure (in grey).

ephemeral addition to the western side of the building late in its life, possibly intended to act as a windbreak.

Early building collapse

Sealing the occupation associated with the early building were more mixed sandy internal and external deposits. These seem to represent an interface between the occupation of the early architecture and the later use of this part of the site. These layers contained a piece of worked bone or shell with two piercings (SF9), circular, pierced net weights and ground stone objects (SF10 and SF13). A fire spot was similar to those recorded in the earlier phase within the building; however, its location within a doorway suggests it was associated with activity after the building was abandoned.

Late circular building

At the eastern end of the trench, a circular stone-built structure with an internal diameter of c. 3 m was constructed on a layer of collapse from the earlier building (Figures 8C and 9). The walls of the circular structure were built of roughly faced stone and measured up to 1.6 m thick. Inside the building, a thin occupation layer contained few finds except for bird bones and sealed a floor constructed of stone. In contrast, the external area associated with this building was covered with up to 0.3 m of dark midden deposits; these layers were rich in ash, charcoal and fish bone and had areas of burning visible that were associated with fires. After abandonment, the circular building was filled by a thick layer of sterile, windblown sand that contained no finds. This may suggest a period of climatic deterioration at the end of the settlement's occupation.

Trenches 3 and 4

Trenches 3 and 4 were located directly to the east of Warehouse 1013 (Figure 6). No archaeological remains were identified in Trench 3; this area seemed to have been used to store stone during the reconstruction of the Warehouse in the 1970s. Trench 4 contained the heavily eroded remains of a substantial building, potentially similar to the adjacent Warehouse, although only a single room of the structure survived.

In Trench 4, the natural limestone bedrock was overlain by a very compact layer of crystallised sand. Although this layer appeared to be below the building in places, it contained a range of artefacts that were associated with the overlying occupation, and extensive erosion in this area of the site had mixed the lower deposits. The walls of the structure were constructed of roughly worked limestone measuring 0.6-0.7 m across and survived to a maximum of two courses high. Within the single surviving room of the structure was a mixed and deflated layer representing the only surviving occupation deposits associated with the building. This deposit contained a relatively large amount of animal bone, shell, pottery and bronze. A metallic object (SF4) may be a piece of iron pyrite; a fragmented but complete bone utensil (SF24) was also recovered. A black polished stone is probably haematite (SF6), a grinding stone fragment (SF8) and the lower part of a flat-bottomed ceramic vessel (SF5) were also retrieved along with four circular, pierced net weights. Animal tusks/teeth were also collected and await further analysis; however, they likely are dugong tusks.

The finds

Pottery

The ceramic assemblage from Umm an-Nar Island was classified by fabric type, and a total of 14 different classes were created (Table 1). Overall, the ceramic assemblage from the site is considerably more diverse than at other Umm an-Nar sites. The ceramics display a large variation, local vessels may have been brought to the site from the Hili area and imported wares include vessels from Mesopotamia (Figure 10), the Indus, northeast Arabia, and Baluchistan. A significant number of the imported Mesopotamian vessels recovered from the site have bitumen on the inside and occasionally outside. The presence of a range of grit and quartz-tempered fabrics and unusual ceramic forms, such as cooking pots, hint at the site's role in a complex network of exchanges and interactions (Figure 11).

Table 1: Summary of the Pottery classes (fabrics) and the codes assigned to them, with reference to the fabric descriptions used in the previous Danish excavation.

<table>
<tr><th>Pottery class</th><th>Code</th><th>Origin</th><th>Danish fabric description (Frifelt 1995)</th></tr>
<tr><td>Hili Sandy Ware</td><td>HSANDY</td><td>Hili Area</td><td>Buraimi Ware</td></tr>
<tr><td>Sandy Ware</td><td>SANDY</td><td>?</td><td>Red-Pink Ware</td></tr>
<tr><td>Grey Ware</td><td>GREY</td><td>Baluchistan</td><td rowspan="3">Grave Ware</td></tr>
<tr><td>Sandy Fine Ware</td><td>SFW</td><td>Hili Area (?)</td></tr>
<tr><td>Umm an-Nar Fine Ware</td><td>UAN-FW</td><td>Hili Area (?)</td></tr>
<tr><td>Mesopotamian Type 1</td><td>MESO 1</td><td>Mesopotamia</td><td>Grey-Green Ware</td></tr>
<tr><td>Mesopotamian Type 2</td><td>MESO 2</td><td>Mesopotamia</td><td>Buff Ware</td></tr>
<tr><td>Quartz Tempered Ware</td><td>QTW</td><td>NE Arabia (?)</td><td rowspan="4">Red-Brown Ware</td></tr>
<tr><td>Large Handmade Storage Vessels</td><td>LHSV</td><td>NE Arabia (?)</td></tr>
<tr><td>Large Wheel-made Storage Vessels</td><td>LWSV</td><td>NE Arabia (?)</td></tr>
<tr><td>Black and White Gritted Ware</td><td>BWGW</td><td>NE Arabia (?)</td></tr>
<tr><td>Exploding Lime Grits</td><td>ELG</td><td>NE Arabia (?)</td><td>-</td></tr>
<tr><td>Lime Gritted Ware</td><td>LGW</td><td>NE Arabia (?)</td><td>-</td></tr>
<tr><td>Mica Rich Ware</td><td>MICA</td><td>Indus</td><td>-</td></tr>
<tr><td>-</td><td>-</td><td>?</td><td>Ridged Red Ware</td></tr>
</table>

The Exploding Lime Grits class consists of vessels with a large amount of lime inclusions, covering 10 to 20 per cent of the surface, which have 'exploded' during firing (Figure 11). This class is known from Umm an-Nar sites, and in the later Umm an-Nar period has been shown to be an import from Bahrain (Eddisford and Phillips 2009: 104-108). The ceramics in this class from Umm an-Nar Island date to the mid 3rd millennium BCE, and therefore predate the later 3rd millennium occupation on Bahrain; therefore these ceramics may originate from the northeast Arabian mainland at this time. The Mica Rich Ware consists of a fine, well-levigated fabric with mica inclusions. This type of mica-rich fabric is often indicative of vessels that originated in the Indus Valley region (e.g. Méry *et al.* 2017).

Figure 10: A selection of pottery in Mesopotamian Type 1 and Mesopotamian Type 2 fabrics.

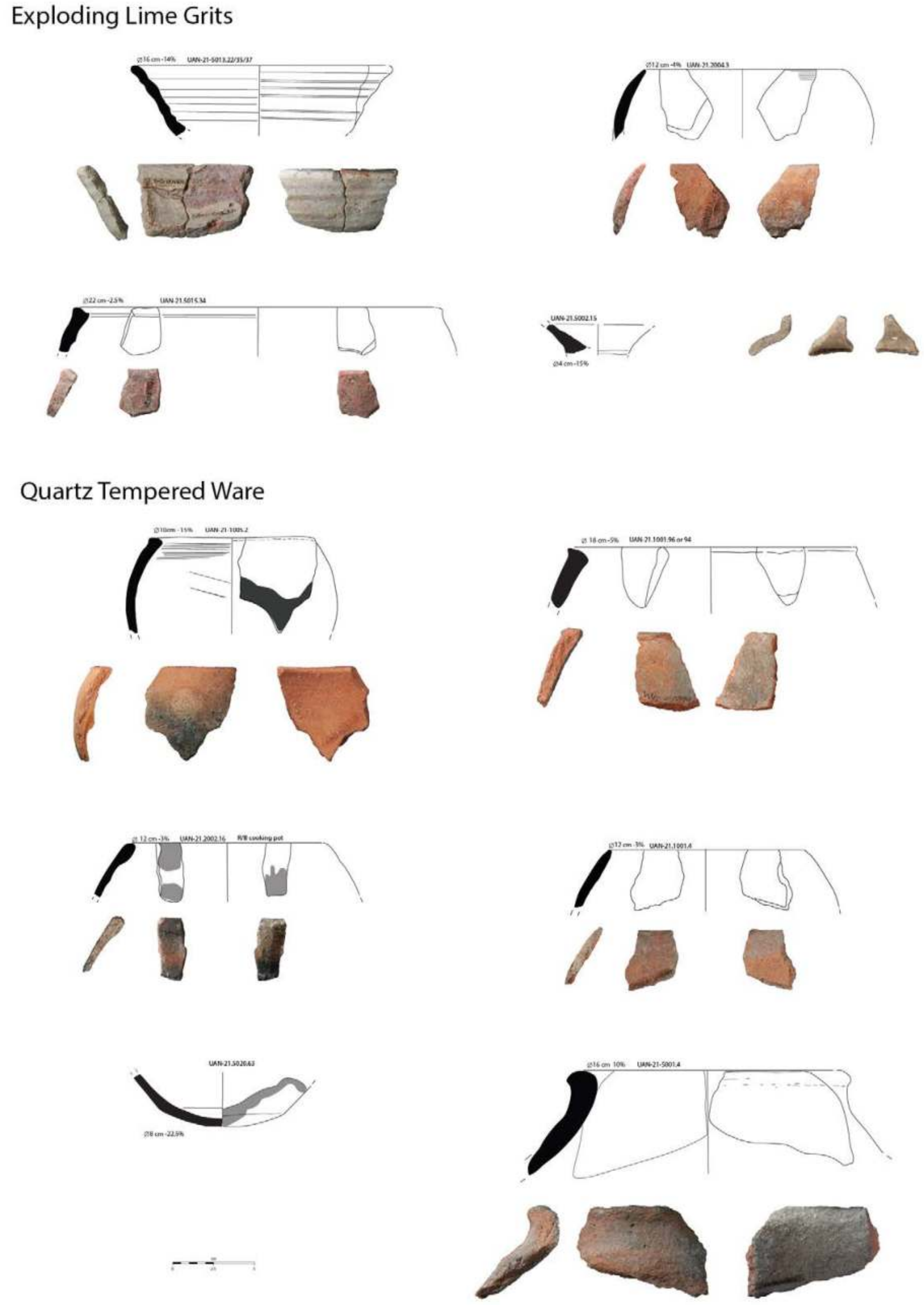

Figure 11: A selection of pottery in Exploding Lime Grits and Quartz Tempered fabrics.

Stone artefacts

Finds from the recent excavations include a large number of net weights (Figure 10); the most common type consists of roughly worked, pierced circular disks that are c. 80 mm in diameter; a less common type of weight was made by etching a groove around the circumference of a rounded pebble (Figure 12). Along with copper-alloy fish hooks (Figures 14B and 13C), these artefacts attest to the importance of fishing to the economy of the site. Other ground stone objects include grinding stones (Figure 13C), small polished stones, small axe heads or azes (Figures 13A and 13B) and stone beads (Figures 13I and 13J). A pierced stone artefact may have been used as a bead or a button (Figure 13H). Soft-stone artefacts include part of a soft-stone hemispherical bowl with a dot and circle decoration (Figure 13D) as well as a piece of a possibly undecorated stone vessel. A similar soft-stone bowl with a dot and circle decoration was recovered from the Danish excavations of House Complex 1014 (Frifelt 1995: 198, Figure 281).

A heavily worked piece of probable haematite that had been worn down on several sides (SF6; Figure 13E) was recovered from Trench 4. Weighing 68.9 g, this artefact is close to five times the Indus standard of 13.7 g. Given that the site of Umm an-Nar Island is thought to have had an important role in exchange in the early Bronze Age, the presence of weight on the Indus standard is of note.

Metal artefacts

A range of copper alloy artefacts were recovered from the site as well as copper prills that are likely associated with copper processing. Metal finds include a small adze or chisel (Figure 14A) and fish hooks (Figures 14B and 14C). Both these artefact types find parallels in the previous excavation (Frifelt 1995: 188-97). A relatively large number of pieces of corroded copper and material that may be associated with copper processing were recovered (Figures 14E–14I). Several pieces of pyrite were recovered (Figure 14J), one of which had been worked on one side.

Other artefacts

Other finds from the recent excavations included a thin bone spatula that may have been made of camel bone (Figure 13F) and is similar to tools recovered from earlier excavations (Frifelt 1995: 223, Figure 330). A small pierced, ceramic disk (Figure 13G) appears to have been made from a piece of a ceramic vessel and could represent a loom weight or a personal ornament.

Bitumen

A piece of bitumen from Trench 6 has the impression of a fibrous wood (possibly palm?) and what appears to be two pieces of rope crossing it (Figure 15). The impressed bitumen from the site is uncommon in this period and is therefore

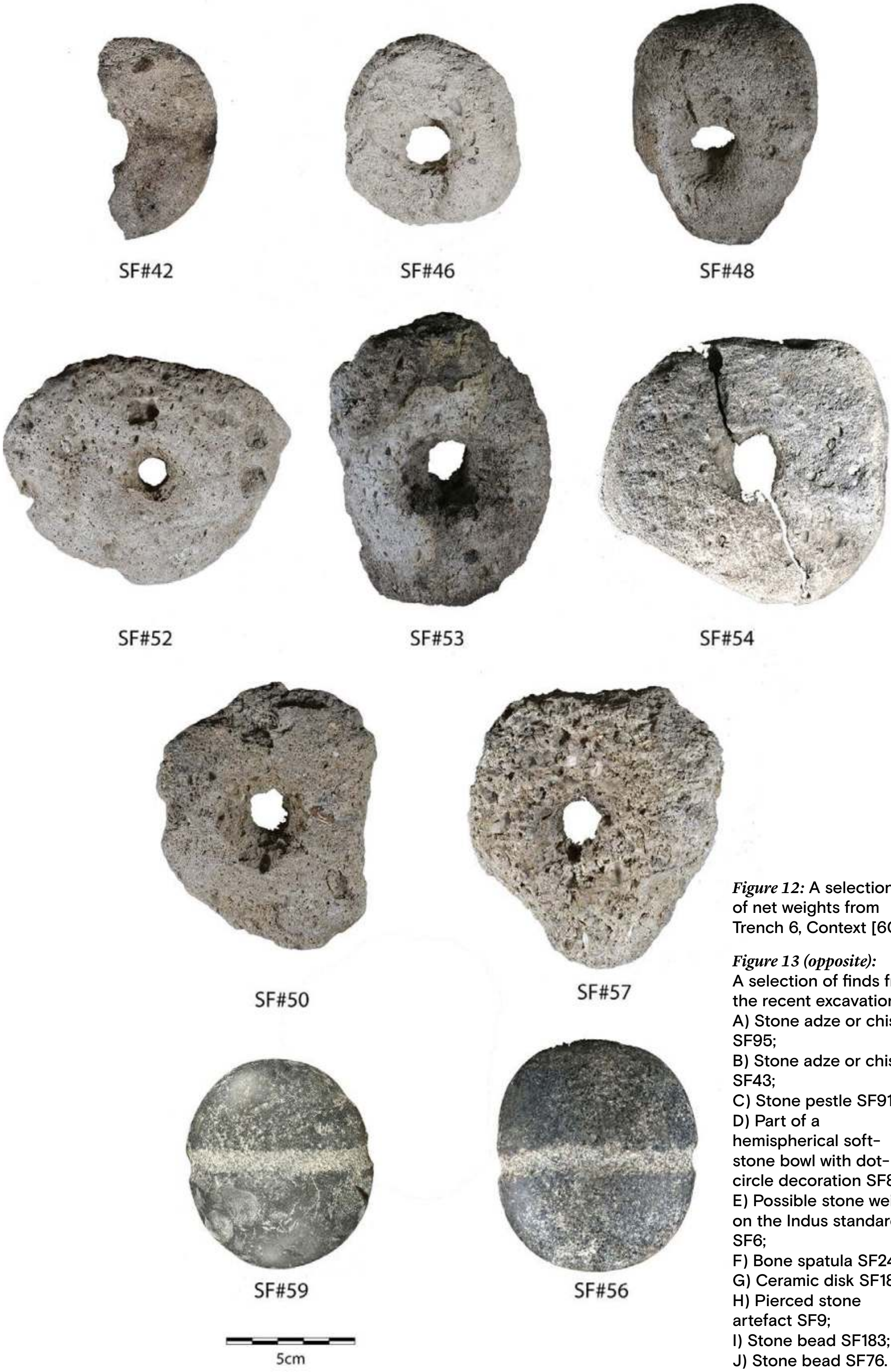

Figure 12: A selection of net weights from Trench 6, Context [6011].

Figure 13 (opposite): A selection of finds from the recent excavations.
A) Stone adze or chisel SF95;
B) Stone adze or chisel SF43;
C) Stone pestle SF91;
D) Part of a hemispherical soft-stone bowl with dot-circle decoration SF81;
E) Possible stone weight on the Indus standard SF6;
F) Bone spatula SF24;
G) Ceramic disk SF182;
H) Pierced stone artefact SF9;
I) Stone bead SF183;
J) Stone bead SF76.


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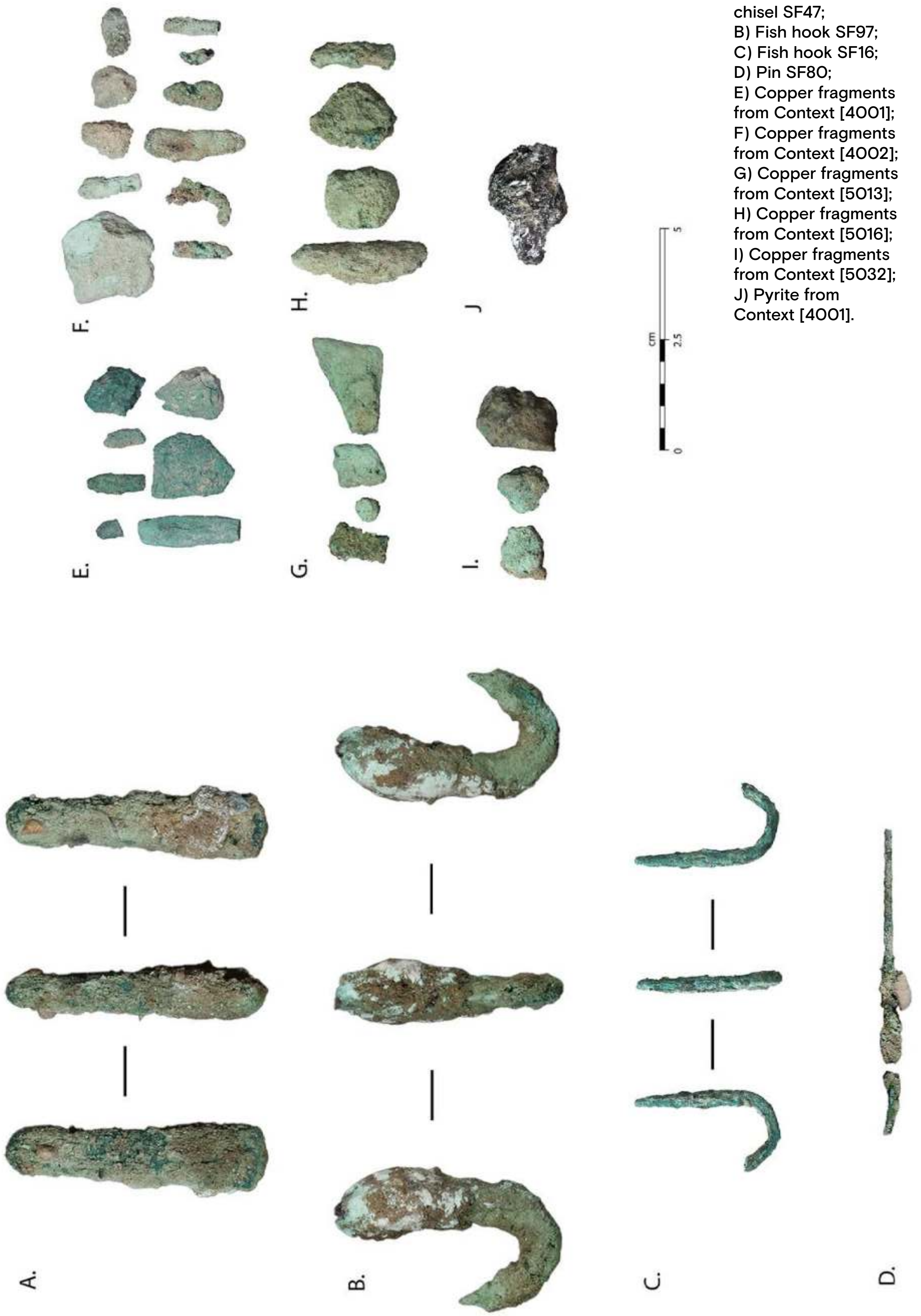

Figure 14: Copper alloy artefacts from the recent excavations.
A) Possible adze or chisel SF47;
B) Fish hook SF97;
C) Fish hook SF16;
D) Pin SF80;
E) Copper fragments from Context [4001];
F) Copper fragments from Context [4002];
G) Copper fragments from Context [5013];
H) Copper fragments from Context [5016];
I) Copper fragments from Context [5032];
J) Pyrite from Context [4001].

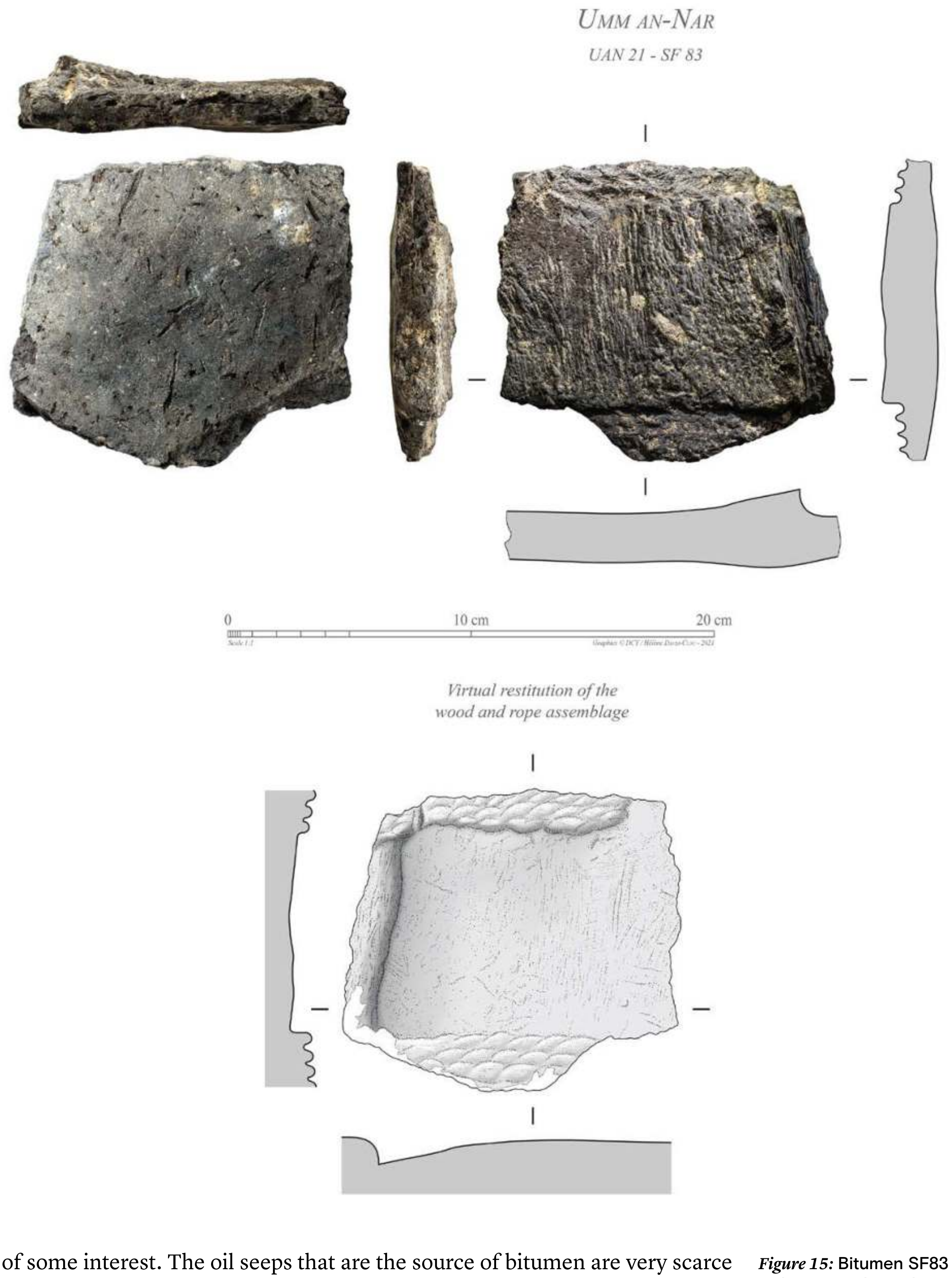

Figure 15: Bitumen SF83 with rope and wood impressions (illustration by Hélène David-Cuny).

of some interest. The oil seeps that are the source of bitumen are very scarce along the southern coast of the Gulf and are limited to Burgan Hill in Kuwait, Djebel Dukkhan in Bahrain, and the Haushi oil seep in Oman. The Omani seep is located c. 200 km from Abu Dhabi and 160 km from the Omani coast; importantly, this source has not been identified in any samples taken from archaeological materials in the region (Van de Velde 2015: 35) and therefore may have been unknown in antiquity. Bitumen in Early Bronze Age contexts is very rare, occurring only at Umm an-Nar Island (Frifelt 1995) and Ras Al Jinz RJ-2 (Cleuziou and Tosi 2000). Both these sites appear to have sourced this material from the seepages in northern Iraq (Van de Velde 2015: 122); these sources are well placed to transport bitumen south along Mesopotamia's waterways (Moorey 1994: 332-333).

The Danish excavation at Umm an-Nar Island suggests bitumen was common, but only a small sample of the material was kept by excavators. Bitumen was found in all rooms of Warehouse 1013 as well as in a number of the other structures on the site. It was applied to basketry or wickerwork, again possibly for its waterproof qualities. Impressions on bitumen fragments from Warehouse 1013 of slightly curved planks may be associated with house construction or more likely originated from a boat. Other fragments of bitumen from a cache in Warehouse 1013 are impressed with rope and palm fibres and may be associated with the sealing or unsealing of jars. Balls of chaff-tempered bitumen from the site are likely raw material used for tasks such as hafting, adhering or sealing other objects (Frifelt 1995: 226).

At Ras Al Jinz RJ-2, bitumen is again common, occurring inside, and sometimes on the outside, of a number of imported Mesopotamian jars as well in larger fragments (Cleuziou and Tosi: 2000: 53, 64-5, Figure 19; Cleuziou and Tosi: 2007: 281, 286, 289, 290-295; Connan *et al.* 2005). Larger slabs of bitumen were impressed with both wood and reeds; others had reed bundle and mat impressions. In addition, some fragments had barnacles on one side and reed impressions on the other, clearly indicating they were once part of the outer hull of a boat. Initially, it was suggested these slabs bore bulrush impressions, a species indigenous to Mesopotamia but one that does not grow in southeast Arabia (Cleuziou and Tosi 1994: 754).

In the Early Bronze Age, reed and palm wood impressed bitumen slabs are also known from Qal'at al-Bahrain Period 1b (Højlund and Andersen 1994: 409-11), although here they may be associated with non-maritime construction. At Tell F6 on Failaka Island, Ur III layers containing bitumen with wood, string and reed impressions are more likely to have been used to waterproof the hull of boats. In addition, a stone-lined pit was excavated that may have been used to heat bitumen. The bitumen from Tell F6 was analysed and found to have originated in Iran (Højlund and Abu Laban 2016: 110, 117-20).

Animal bone

A significant quantity of animal bone was collected from the excavations. The animal bone assemblage is currently being studied; however, an initial examination suggests it is dominated by marine species, with a significant quantity of fish present. Fish bones include a large number of bones from smaller fish species as well as the vertebrae of large fish species. Other maritime species represented in the assemblage include dugong, represented by a significant number of dugong tusks as well as dugong bone. Turtle and cuttlefish are also found in the assemblage. The terrestrial element of the bone assemblage includes cow scapulae, sheep/goat bones and a significant quantity of bird bones.

Shell

A range of shells was recovered from the site. A more detailed assessment of the shells will be conducted alongside the analysis of the animal bone from the site. The shell assemblage from the site includes bivalves such as *Trachycardium* and *Spondylus gaederopus* (spiny oyster). Sea snails such as cowries were present in relatively low quantities; however, in Trench 5, sea snails, probably *Turbo radiatus*, were more abundant. Shells were probably brought to the site as food, and the fact they are most common in Trench 5 is likely a reflection of the domestic deposits and midden layers excavated in this area of the site.

Discussion

The earliest occupation of Umm an-Nar Island consists of extensive burnt midden deposits, which are up to 1 m thick and are below all the structures identified in Trenches 2, 7 and 8. These layers are rich in charcoal, animal bones and other finds; they have evidence of in-situ burning associated with fires; they may represent repeated gatherings and possibly feasting over a relatively long period of time. In Trench 2, a large circular fire installation seems to represent a continuation of these communal feasting activities but with a more formal stone setting. The first stone structures in this area of the site are associated with this phase of use, in the form of a single wall abutting the southern side of the fire. To the south, the earliest phase of the Danish House Complex 1014 (Frifelt 1995: 97) may also be associated with this phase of site use.

Sealing the early walls in the main settlement area were a large number of well-built structures, consisting of the later walls of Danish House Complex 1014 (Frifelt 1995: 97), a number of structures to the north exposed by the Iraqi mission and a larger rectangular building excavated in Trench 6. At the northern extent of this building complex, a relatively large space (Room 14) contained several possible idols and altars and seems to represent a continuation of the early ritual activities in this area of the site. This phase of buildings later had a long and complicated history; in Trench 7 this appears to be associated with intermittent, possibly seasonal, occupation. This phase of occupation is followed by a period of abandonment with intense erosion and redeposition occurring, particularly on the edges of the settlement areas.

To the east of the main settlement a larger structure, Warehouse 1014, was interpreted by its excavators as having an important role in long-distance exchange based on the large quantity of imported ceramics recovered from it. It remains unclear whether the difference between this building and the more tightly packed construction to the east is chronological, functional or merely a result of the space available. However, it is clear that it was not unique, and similar larger buildings were recorded directly to the east in Trench 4 and slightly farther away in Trench 5.

The final phase of occupation at the site consists of several more expediently constructed buildings. In Trench 8, Room 11 was built on the partially collapsed walls of the earlier occupation and was more ephemeral with walls built only one course wide. In Trenches 5 and 6, earlier well-built stone structures were sealed by collapse and midden, over which were built more expediently constructed sub-circular buildings. In Trench 5, this late phase of use was associated with substantial midden deposits that contained a range of artefacts, including locally produced Umm an-Nar pottery and Mesopotamian imported wares. In Trench 6, this late phase of occupation is dated by a single C14 date to 2274–2036 BCE (95.4%).

Team Contributions

Ali Abdu Rahman Al Meqbali conceived and managed the project. Ali Abdu Rahman Al Meqbali and Daniel Eddisford designed the research. The fieldwork was carried out by Daniel Eddisford, Michel de Vreeze, Hamad Fadel, Dia Al Tawalbeh, Hager Hasan Almenhali, Dominic Tomasi and Ali Abdu Rahman Al Meqbali. Arshad Gul Meena, Wasantha Elvitigala, Rashed Ali Akram, Shahid Igbal Hussain, Furqan Abid Hussain and Alam Muhammad Firdous assisted with the archaeological excavation. The site survey and GIS were managed by Abdulla Al Yammahi. The post-excavation analysis was undertaken by Daniel Eddisford, and the pottery was analysed by Sam Botan and Michel de Vreeze. Daniel Eddisford wrote the paper with input from the other authors. Figure 15 was illustrated by Hélène David-Cuny; all other figures were prepared by Daniel Eddisford.

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Kalba: Main results of the renewed fieldwork during the campaigns of 2019–2022

Christoph Schwall and Michael Brandl

Abstract: Archaeological excavations at the coastal site of Kalba on the Gulf of Oman revealed an occupation sequence from the Early Bronze Age to the Iron Age (c. 2500–600 BCE). The renewed research at Kalba focuses especially on the settlement remains dating to the Umm an-Nar period to gain insights into the origins and development of trade networks.

In this context, the excavations concentrate on a highly promising section in the east of the settlement, including a massive Early Bronze Age retaining wall that represents the foundation of the tower constructed above. Additionally, preliminary results of material analyses illustrate the importance of lithic and ore resources for this coastal community. Besides the favourable geostrategic position, the lithic material seems to have added a significant economic factor. This indicates that the site could have functioned as a trading post connecting maritime and inland trade routes leading into the inner part of the Arabian Peninsula.

Keywords: United Arab Emirates, Gulf of Oman, emirate of Sharjah, Kalba, excavations, geo-archaeological surveys, raw material procurement, trading post

Introduction

This contribution focuses on the main results of the renewed excavations at the site of Kalba (K4), in the emirate of Sharjah (Figure 1), and the geoarchaeological surveys conducted between 2019 and 2022.[1] The research aims of this project are strongly connected with questions related to connectivity since trade and communication networks can be traced from the Aegean to the Indus region as early as the Bronze Age (i.e. Kenoyer 1998: 91-98; Şahoğlu 2005: 342-343, Figure 1; Singh 2008: 164-169; Law 2011: 462-499, Figure 13.12). The Gulf region was an especially crucial area within these broad networks between east and west.[2]

[1] For more detailed results of the work presented below see: Schwall and Jasim 2020; Schwall *et al.* 2021; 2022a; 2022b; 2023; in press a; in press b.

[2] See especially Eddisford 2022 for exchange networks in the Gulf region based on the ceramic evidence from Kalba.

Figure 1: Aerial photograph of the excavations at Kalba. (Photo: SAA/K. Kamyab)

The location of Kalba seems to be especially favourable, situated on the Gulf of Oman close to the Strait of Hormuz as well as Wadi Ham, which offers access from the eastern coast through the Hajar Mountains to the desert. Therefore, the objective of the fieldwork is to analyse the function of the settlement in the context of inter-regional maritime and land-based networks in the Gulf region. Environmental studies and extended geoarchaeological surveys are thus important to reconstruct the natural conditions and to assess the relevance of available lithic and ore resources in the direct vicinity and the wider surroundings of the site.

Fieldwork conducted at Kalba (K4)

At the beginning of the renewed excavations, different survey methods were performed to provide a basis for systematic fieldwork on-site. The setting up of a Digital Elevation Model (DEM) with the help of a drone was an important step in the creation of a 3D model, which has been taken as the basis for all Geographic Information System (GIS)-based analyses and further detailed documentation. In a second step, the results of the architectural survey were integrated, showing all visible structures (Figure 2). Additionally, geomagnetic and georadar surveys were performed inside and outside of the now fenced-off area to gain information about hidden structures below the ground and the extent of the site in general. Significant anomalies were detected up to c. 60 m around the mound, indicating a minimum size of the site with a diameter of about 110 m. Magnetic measurements outside the fenced area in the southern vicinity of the excavations produced no further indication of a continuation of the site. However, it must be assumed that, especially for the Bronze Age

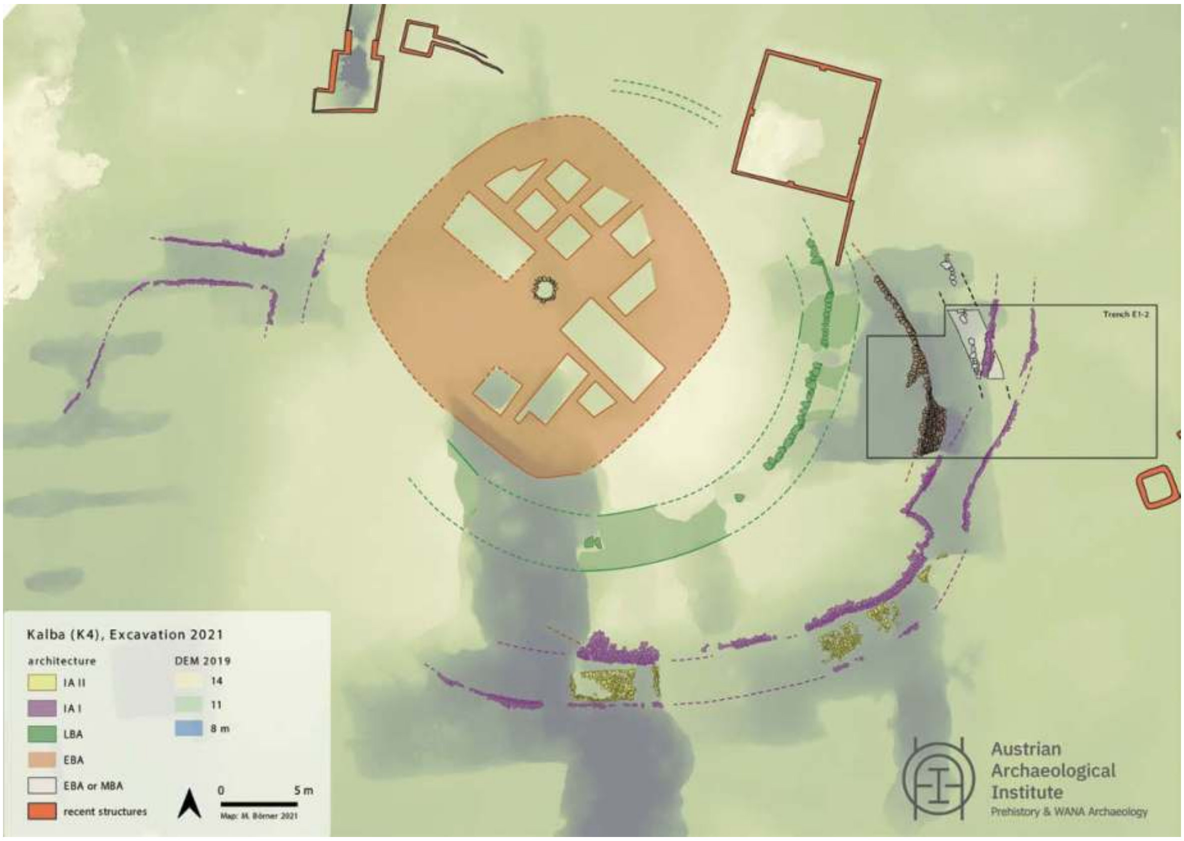


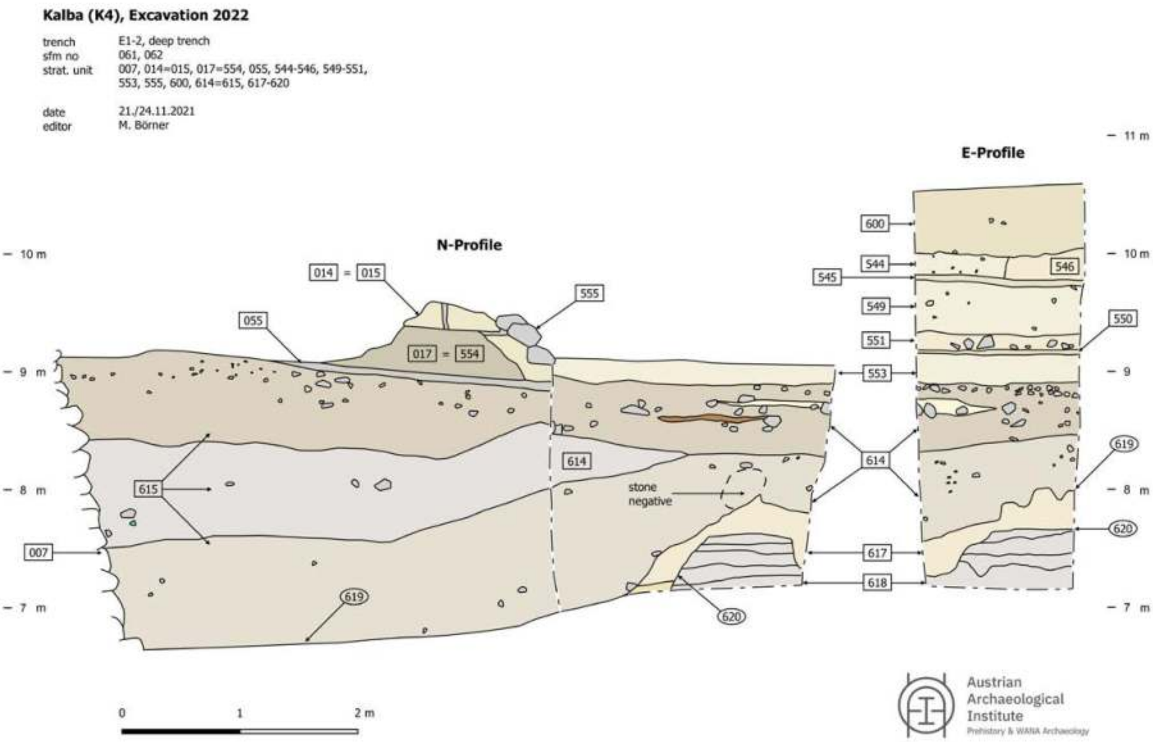
Figure 2: Overview of the architecture excavated at Kalba and the location of the trenches. (Map: OeAW-OeAI/M. Börner)

periods, structures are hidden too deep under the ground, which makes them impossible to detect by geophysical survey methods.

The excavations at Kalba concentrated on the eastern part of the mound and were focused on the stratigraphic sequence from the top down to the oldest, Early Bronze Age, occupation layers of the site, with a massive retaining wall forming the base of the Umm an-Nar tower construction (Figure 3). For this purpose, the excavations were conducted in two trenches, E1 and E2 (see Figure 2), to investigate the Early Bronze Age retaining wall and possible related domestic structures outside of the construction. During the excavation, it was revealed that the massive wall was part of a ditch, which now has a preserved depth of about 3.5 m. The filling has a thickness of up to 2.5 m and slopes from the east to the west indicated by a clayish band in the profile, representing the ditch interface (Figure 4). Interestingly, in the eastern part of the trench, an exterior retaining wall has not been detected, but the clayish band in the profile stops at an impression of a stone. Due to the shape of the interface, which runs from east to west in the profile, it can be assumed that the eastern border of the ditch has been reached. The stones of the exterior retaining wall were most probably taken and reused during the levelling process of this area in contrast to the interior wall, which has been kept in use to ensure the stability of the inner area with the tower construction situated upon it. Therefore, the Umm an-Nar period ditch construction has a preserved

Figure 3: Trenches E1–2 showing the massive Early Bronze Age retaining wall constructed of stone (back) and an Early Bronze Age mudbrick wall. (Photo: OeAW-OeAI/F. Ostmann)

Figure 4: North and east profile showing a section of the Early Bronze Age ditch construction. (Graphic: OeAW-OeAI/M. Börner)



depth of approximately 3.5 m and a width of 5.7 m. The ditch was already backfilled in Early Bronze Age times. On top of the backfill, several fireplaces were uncovered belonging to the first occupation level after the filling. The fireplaces were used for cooking activities, as indicated by numerous remains of charcoal, date stones, fish bones and molluscs, leading to the interpretation that this space was used for domestic activities. Although only a small part of the site has been excavated so far, the structures clearly show large-scale transformations of the site's inner spatial arrangement within its 300-year

Figure 5: Superposition of stone and mudbrick walls continuously enclosing the central mound of the site from the Early Bronze Age to the Iron Age I. (Photo: OeAW-OeAI/M. Börner)

occupation between 2300 and 2000 BCE. This is impressively shown by the filling of the ditch and the subsequent superposition of enclosures during later periods (Figure 5).

Radiocarbon dating and environmental studies

Absolute dates are crucial for the stratigraphy of the multi-period site of Kalba. Since no dates are currently available, within this project a radiocarbon backbone is currently being built up. Additionally, the determination of the marine reservoir effect as well as archaeobotanical studies will help to reconstruct the environmental conditions diachronically.

So far, 47 radiocarbon dates are available, spanning the Umm an-Nar to Early Iron Age II periods. Additionally, the reservoir effect of the molluscs clearly displays a change between the Early and Middle Bronze Age. The decreasing reservoir effect indicates an increasingly dry climate from c. 2500-1600 BCE.

The botanical remains provide additional information. The charcoals were strongly dominated by *Rhizophoreae* in contrast to *Avicennia marina*, which still exists at Khor Kalba. These results are interesting because *Avicennia marina* is more related to saltwater conditions, while *Rhizophora* more to fresh-water environments. Despite a trend towards an increasingly drier climate, as indicated by the marine reservoir effect from about 3000 BCE onwards, the botanical analyses revealed that at Kalba, wetter and therefore more favourable environmental conditions existed, compared to the general tendency on the south-eastern Arabian Peninsula.

The use of lithic and ore resources and geoarchaeological surveys

The evidence for and the variability of lithic and ore resources found during the excavations is astonishing. Geoarchaeological surveys were therefore started for a systematic sampling and analyses of raw materials as well as artefacts from Kalba to investigate procurement variabilities and strategies of this coastal site (Figure 6).

Evidence for on-site metal production is detectable from the Umm an-Nar period onwards. During the excavation, different stages of the chaîne opératoire are recorded in the finds assemblage. Beside a fragment of copper ore, slags, casting residues, and presumably fragments of a crucible, a pounder, and an anvil were excavated. These results were embedded in recently conducted analyses of copper objects from the Kalba excavations and ore from Wadi Al Helo, pointing to the procurement of copper ore from the nearby Hajar Mountains.

The Hajar Mountains appear to also have been a raw material extraction area for the manufacturing of stone vessels. As reported during the previous excavations (Eddisford and Phillips 2009: 109; Phillips and Simpson 2018:

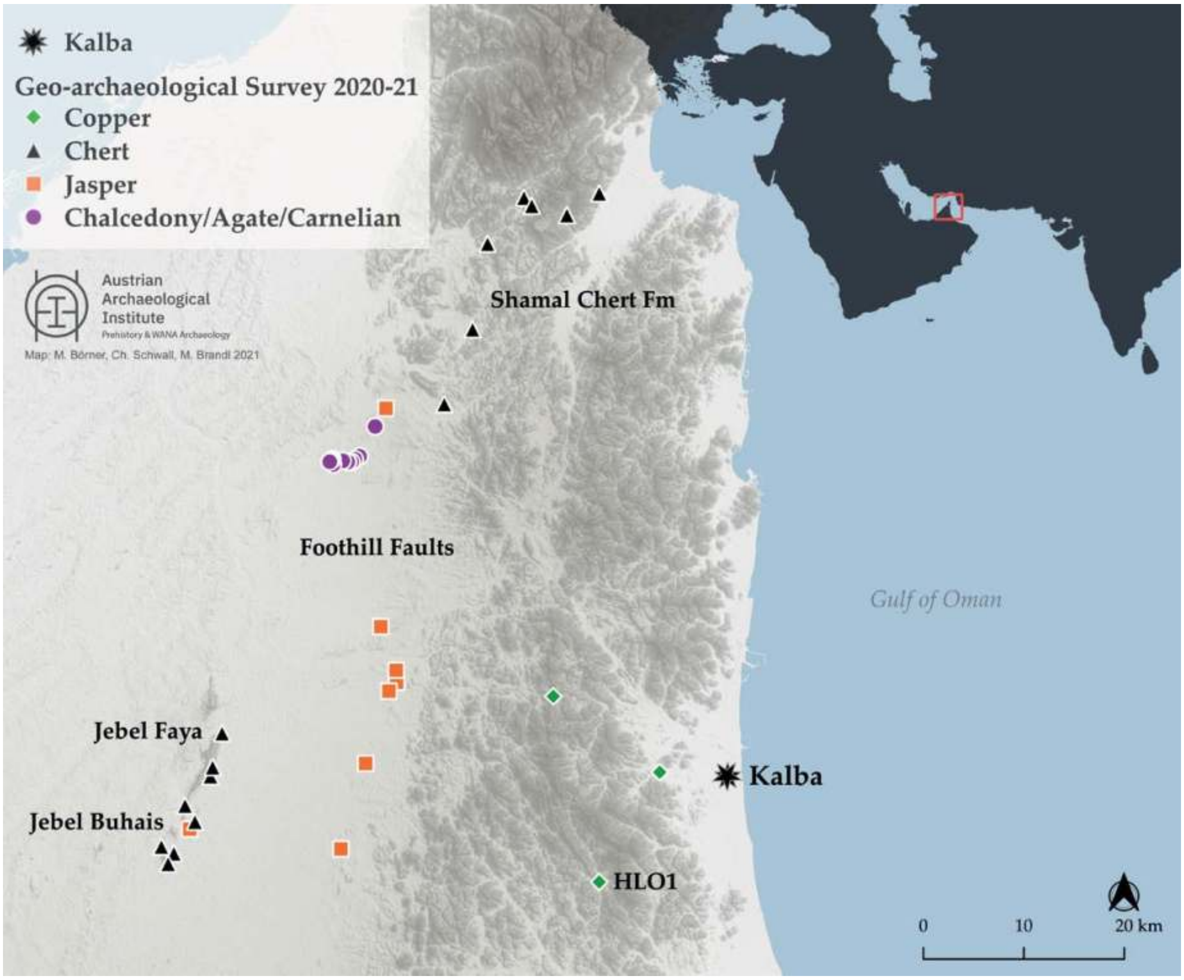


Figure 6: Map showing the sampled raw material sources during the geoarchaeological surveys 2020–2021. (Map: OeAW-OeAI/ Ch. Schwall, M. Börner).

50-51, Figure 72), on-site production is additionally evidenced by a semi-finished stone vessel fragment discovered during the current excavations in a levelling layer dating to the Iron Age I period. In particular, the manufacturing marks are similar to a published fragment from Kalba, indicating the use of similar tools to produce these vessel types.

Beside chlorite, preliminary petrographic and geochemical analyses of the stone materials point to the use of rather harder stone types, for example meta-gabbro, which is available in the Hajar Mountains. More detailed analyses regarding the stone materials are currently pending and will allow us to estimate the extent of the use of local and regional raw materials for stone vessel production.

In contrast to copper ore deposits and suitable rocks for stone vessel production, chipped chert objects found during the excavations were assigned to more remote sources eastwards in the Buhais mountain range. Based on the combination of microscopic and geochemical results, it is possible to gain a fine-grained insight into the chert resource management of the inhabitants of Kalba and beyond, indicated by one chert artefact from the site HLO1, which also chemically belongs to the Buhais area. These analyses highlight the importance of the entire Buhais range as a prehistoric lithic raw material source and the potential of this combined methodology for chert provenance analyses in the wider region.

Additionally, an incised pendant made of heavily weathered volcanic tuff, a chalcedony stone bead, and a flake of brown jasper were excavated at Kalba. Bound to igneous rocks in the north of the investigation area close to Manama, chalcedony and various multicoloured cryptocrystalline quartz modifications such as agate, carnelian and jasper can be found. In-depth chemical analyses will test the assumption that objects from the site were made from these stone resources to provide a more complete picture of Prehistoric raw material procurement strategies at Kalba.

Conclusion

As a preliminary interpretation, the site of Kalba witnessed major construction and reconstruction events over nearly 2,000 years. Especially during the Umm an-Nar period, these changes are most likely related to ecological and economic diversification and intensification attributed to the ecological niche position, resulting in the aggregation of a large number of people and consequently economic prosperity. Through this combination, Kalba seems to have developed into an important node for the entire region, established as early as the 3rd millennium BCE.

In this context, the geostrategic position between maritime and land-based routes crossing the Hajar Mountains and a possible gateway between two connection routes from north to south seem to be crucial for the diachronic occupation of the site. The combination of our interdisciplinary approaches will eventually allow us to draw a holistic picture of the site's occupational and economic history in the future.

Acknowledgements

The fieldwork at Kalba was conducted with the authorisation and in collaboration with the Sharjah Archaeology Authority (SAA) and the Ruler of Sharjah, HH Sheikh Dr Sultan bin Muhammad Al Qasimi. We would like to thank the Austrian Archaeological Institute (OeAI) and Dr Anton Oelzelt-Newin'sche Stiftung of the Austrian Academy of Sciences (AAS), the Leibniz-Zentrum für Archäologie (LEIZA) for funding and the Austrian Embassy Abu Dhabi for their continuous support during our fieldwork between 2019 and 2022. Additionally, we are grateful to Dr Aaron M. de Souza for English correction.

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Insights on the Late Bronze Age economy in south-eastern Arabia
Self-sufficiency and exchanges in Masafi-5

Maria Paola Pellegrino, Julien Charbonnier, Anne Benoist, Delphine Decruyenaere, Kevin Lidour, Michele Degli Esposti and Aurélien Hamel

Abstract: The results of recent fieldwork conducted in Masafi-5, as well as laboratory studies on the collected materials, renew our knowledge about the lifestyle and economy of the Late Bronze Age (LBA) populations in south-eastern Arabia. The interdisciplinary studies conducted by the French Archaeological Mission in the UAE over the past 10 years, indeed revealed a rich economy characterised by sedentary agriculture and animal husbandry as well as multiple craft activities (manufacture of ceramics, processing of seashells, and metallurgy) based both on the exploitation of local resources and regional exchanges. In addition, Masafi-5, thanks to a well-established stratigraphic sequence, absolute dating and a comprehensive typo-chronology of the local pottery, provides new data for a discussion of the LBA chronology.

Keywords: United Arab Emirates, Masafi-5, Late Bronze Age, economy, chronology

Introduction

Masafi-5 (Fujairah, United Arab Emirates) is one of the first sites in the interior of south-eastern Arabia where an LBA settlement associated with an oasis has been studied. The Masafi region occupies a depression located in the northern part of the Al Hajar mountain range. It benefits from exceptional water resources as it is a region of resurgence, which gives rise to three important wadis: Wadi Abadilah, which flows north-east in the direction of Dibba; Wadi Siji, which flows north-west, disappearing into the sands before reaching the coast of the Arabian Gulf; and Wadi Ham, which flows south-east towards Fujairah. Research in the Masafi area first led to the discovery of an Iron Age II occupation (1100–600 BCE) organised around the present-day palm grove (Benoist 2010; 2013; Benoist *et al.* 2012a; 2012b; Charbonnier *et al.* 2017a; 2017b; 2020). Since its discovery in 2011 (Degli Esposti and Benoist 2015), the excavation of Masafi-5, occupied from 1600 to 1200 BCE, has offered the chance to investigate the preceding phase of human occupation of the oasis and provided considerable new data on the way of life of LBA communities. An overview of these results is presented in this paper.

The Late Bronze Age: State of the art

Compared to the number of known sites for the previous periods as well as to the rich literature on the first three phases of the Bronze Age (the so-called Hafit, Umm an-Nar and Wadi Suq periods), the LBA is still a somehow neglected period of south-eastern Arabian protohistory, both due to the small number of known sites and dedicated publications.

All the LBA settlement sites in the Northern Emirates are located in areas already occupied in earlier times, either directly along the coast (Tell Abraq on the west coast, Kalba-4 and Khor Fakkan on the east coast) or along the foothills close to palm groves (as in the case of Shimal-SX and Masafi-5). The sites in question are located on hills or natural terraces, elevated positions suitable for settlement. The coastal sites are well connected to the inland areas through the wadis, which constitute natural communication routes. All these sites occupy fairly large areas, but their total surface is generally not known precisely.

Excavated architectural remains mirror a composite picture. The domestic architecture of the LBA appears to integrate elements made of perishable materials, comparable to those used in present-day *barasti*s, stone and mud bricks. It was probably a fragile architecture, threatened by erosion, easily damaged and not evident in the archaeological record, but it also had the advantage of being easily repaired or constructed. The activities that can be identified through the analyses of domestic spaces reflect a form of attachment to the territory. Despite the modest appearance of their dwellings, the inhabitants likely had access to a wide range of commodities.

Data on funerary architecture is also poor. Researchers have managed to identify elements considered to be specific to the LBA in funerary contexts. C. Velde (2003: 105, pl. 1) and P. Magee (2014: 192) state that Nizwa, Qattara, Al Qusais and Al Wasit-1 are the only tombs in the entire Oman Peninsula that can be dated to the LBA. In her PhD thesis, S. Righetti (2015: Fig. 22a) provides a more extensive map of the tombs she dates to the LBA, including several other examples such as Ghalilah-2, Asimah Grave 100, Bithnah-4, Wa'ab 4, Fashgha-1, Sharm and four tombs from the Shimal region (SH1, SH6, SH102, SH103). These tombs yielded a 'mixed' assemblage, including objects from the LBA but also artefacts datable to the Middle Bronze Age, the Iron Age (Iron II and sometimes Iron III) and sometimes to the Late Pre-Islamic period (Dibba, Bithnah-4). For this reason, we prefer to speak of 'use or reuse in the LBA' rather than considering them as proper LBA tombs, built in that period. In fact, the duality between individual and collective tombs observed for the Wadi Suq period persists in the LBA, even if collective tombs are much more widespread than individual ones, especially in the UAE. Moreover, the preferential distribution of individual and collective tombs, respectively in the Sultanate of Oman and the United Arab Emirates, persists in the LBA. Continuity at burial sites during the LBA is witnessed by the common practice of laying the deceased inside tombs already built and used during the Wadi Suq period.

The ceramic assemblage of the LBA consists mostly of coarse or semi-coarse coiled ware. Limited use of semi-fine coiled ware finished on the wheel is also attested. Orange-red to beige-brown in colour, the ceramics generally bear no slip and are sometimes decorated with red paint, often with wavy lines. Open forms dominate the assemblages: basins with straight or slightly convex walls, slightly inclined with a thinned, flat or rounded lip, are the majority; followed by medium-sized bowls, convex-walled spouted vases, sometimes with red painted decoration; and finally footed goblets with traces of string cutting at the base. These footed goblets are one of the most distinctive shapes for the LBA material culture. In addition to these vessels, closed shapes include medium-sized globular jars with rounded or thinned lips, large storage jars and small, short-necked jars with rounded lips.

A significant change in weaponry is observable from the earlier periods. Long swords with a central rib appear in the assemblages of some tombs, at Al Wasit (Al Shanfari and Weisgerber 1989: pl. 5. 2), Al Qusais, Qattara (Cleuziou 1981: Fig. 12; Yule 2001: Fig. 5.3.1 [D01], Fig. 5.15.1 [S01]) as well as at Qarn bint Saud (Cleuziou 1981: 288) and Shimal (Vogt 1998: 279). Towards the end of the LBA, one records the introduction of short swords or daggers, axes, hollow-handled daggers and, above all, bronze arrowheads. The latter represent a real innovation in LBA weaponry, being unknown in the Wadi Suq period and anticipating the Iron Age production (Velde 2003: 111-112).

In the LBA, the amount of material recovered makes it difficult to recognise the typical stone vessels of the period, which are rather rare (Velde 2003: 109). The main characteristic of the period is the disappearance of symmetrical four-handled vessels, whether globular or ovoid or truncated cone-shaped, and the introduction of a new type, the biconical vessel, along with the reappearance of rectangular boxes popular during the Early Bronze Age (Phillips and Simpson 2018). Finally, the decoration is much more complex, with series of metopes and bands of various patterns, usually oblique lines, triangles and pointed circles whose distribution seems random and overall seems to indicate a sort of horror vacui.[1]

The settlement of Masafi-5: Architecture and organisation

The settlement of Masafi-5 is located at the top of a 20m high rocky hill overlooking the Masafi palm grove from the south-west, along the road E88

[1] A relevant contribution about the possibility to identify an LBA stone vessel production was published by E. Olijdam and C. Velde (2023) after this paper was submitted but deserves to be mentioned.

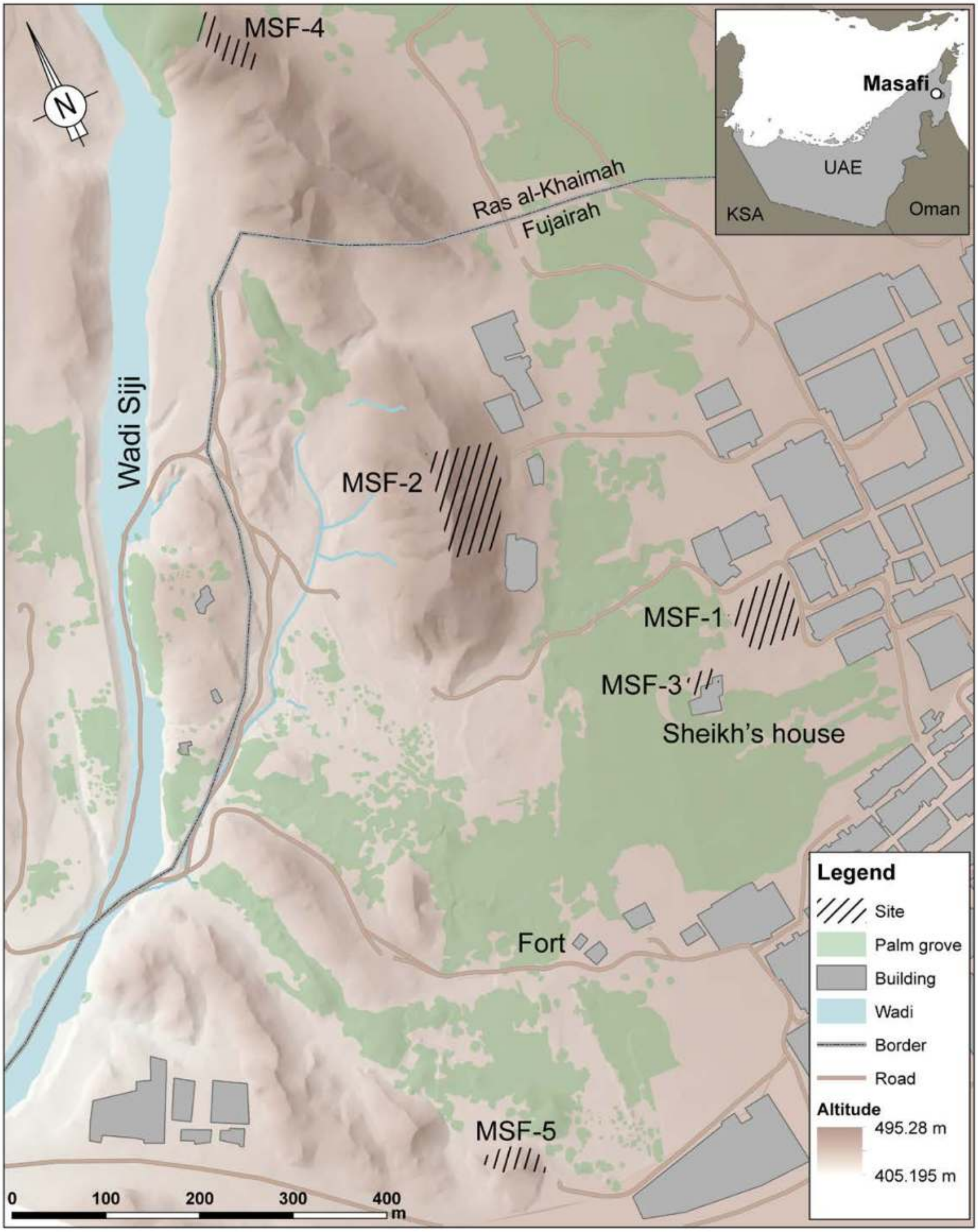


Figure 1: Location and general map of the Masafi area. (© French Archaeological Mission in the UAE. Emmanuelle Régagnon and Carine Calastrenc)

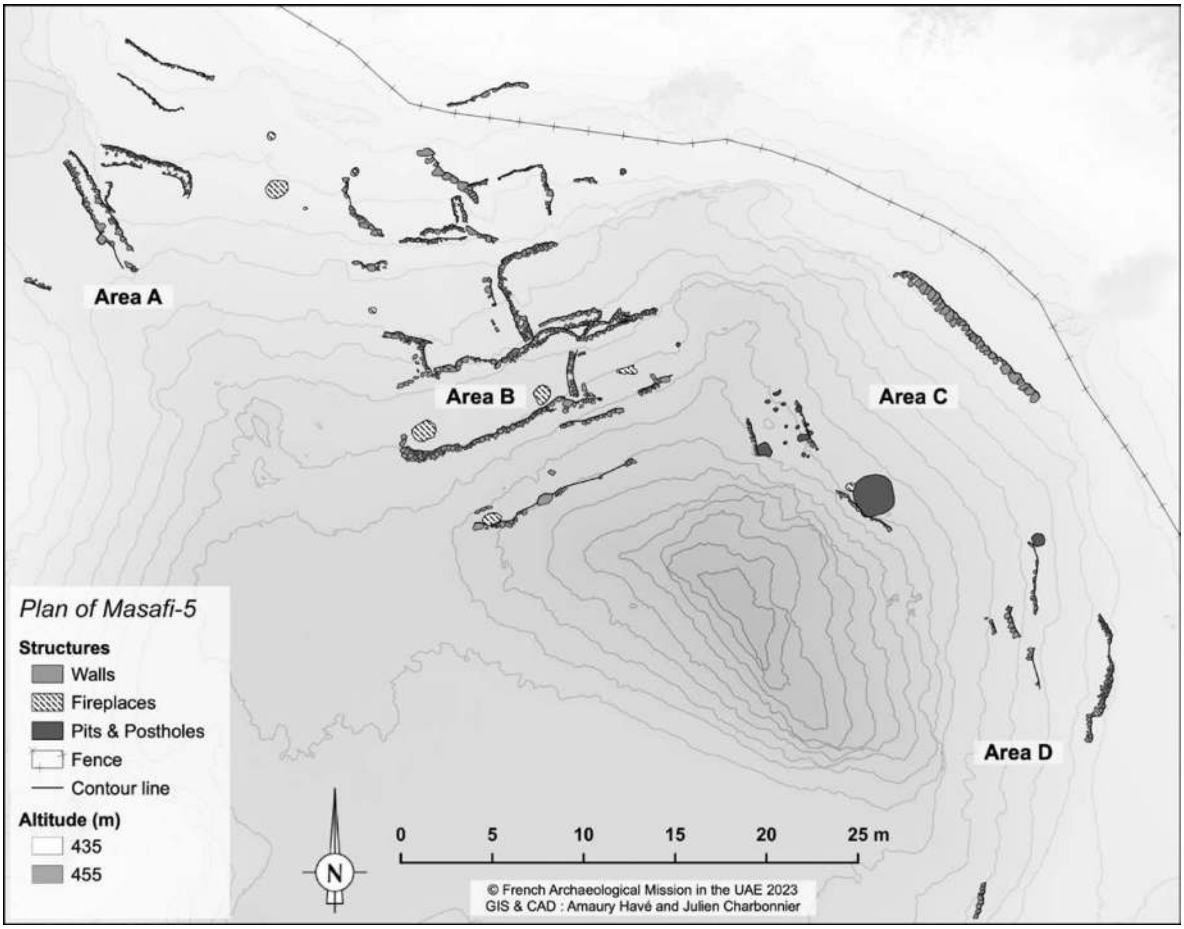


Figure 2: General map of Masafi-5. (© French Archaeological Mission in the UAE. Amaury Havé and Julien Charbonnier)

from Masafi to Sharjah, which follows Wadi Siji to the west (Figure 1). The site was rescued in 2011 from ongoing bulldozing which had already removed its south-western part. Remains of a settlement were, however, preserved on the north-eastern side of the hill, facing the palm-grove, and the northern slope of the hill.

Four areas (A, B, C and D) were distinguished during the excavations (Figure 2), as well as three main chronological phases. Phase I corresponds to the LBA (c. 1600–1200 BCE), Phase II to a limited Iron Age II reoccupation (1100–600 BCE) and Phase III to the Late Islamic period (17th–20th century CE). The LBA occupation (Phase I) could itself be subdivided into four main phases: IA IB, IC, ID.

In **Area A** to the north-west of the site, remains of an Islamic dwelling flanked by a courtyard, both delimited by double-faced walls were found at the top of the slope, and remains of two possible older terraces bordered by single-faced walls were discovered at the bottom of the slope. The material collected includes LBA and Islamic pottery sherds.

Remains exclusively dated to the LBA were preserved in the eastern part of **Area B** (Figure 3). They were arranged on five relatively narrow terraces adapted to the configuration of the slope (from Terrace I to Terrace V, bottom

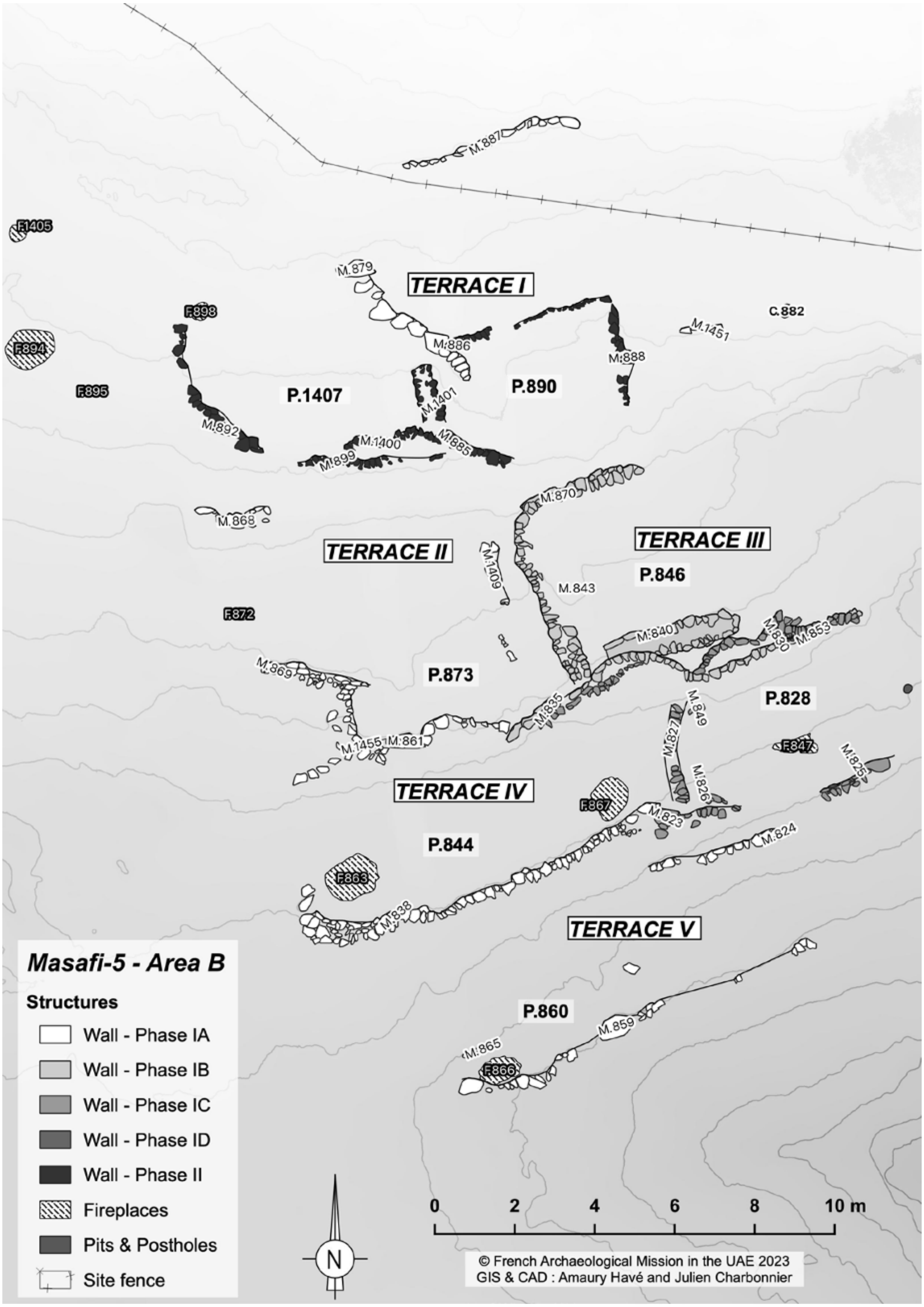


Figure 3: Map of Area B. (© French Archaeological Mission in the UAE. Amaury Havé and Julien Charbonnier)

to top of the slope and framed between two rocky spurs). Terraces were delimited by stone retaining walls, bound by a loose earthen mortar. Terraces themselves supported one or two sub-rectangular constructions delimited by low walls, which host remains of floors made of tramped earth mixed with gravel and small stones, featuring hearths and postholes. The upper part of these constructions was probably in perishable material as in modern *barasti* houses. Terrace walls showed multiple episodes of collapse and renovation, and the outline of some terraces was modified during reconstruction works. This rebuilding, as well as the stratigraphy with multiple occupation floors visible in the best-preserved areas, suggests an occupation extending over a certain span of time.

The occupation of Area B is divided into two main periods. Period I represents the LBA occupation and comprises three of its sub-phases, IA, IB, IC. Period II marks a phase of abandonment followed by a limited reoccupation in the lower part of the slope during the Iron Age II (Phase II).

Terrace I is located in the lower part of the slope. Originally (Phase IA: P.893), it was orientated north – north-west / south – south-east and was delimited by two walls, M.879 and M.892, while its northern limit is not preserved. This first terrace still hosted the badly preserved traces of a floor (S.1404).

Later (Phase II), the terrace was rebuilt and extended eastwards, and two premises were installed above it, P.890 to the east (delimited by M.1401, M.885 and M.888) and P.1407 to the west, over P.893 (delimited by M.892, M.885 and M.1401). Two successive floors were distinguished in Room P.890 (S.1402, S.1403), but none survived in Room P.1407. The pottery found in these two rooms includes residual LBA and Iron Age II potsherds mixed together.

Terrace II was built higher on the slope, during Phase IA, and was delimited to the north by wall M.868, a short wall badly preserved. It hosted a room, P.873, bordered to the south by walls M.861 and M.859. To the east, the room might have been separated from a second space by a short wall, badly preserved, found at the foot of Terrace III (M.1409). Room P.873 included two successive occupation levels (S.871, S.851). The earliest (S.871) contained a small round hearth (F.872) located in the western part of the room, from which comes a ^{14}C date between 1683 and 1509 cal. BCE (3315±35 BP, sample Poz-107055). These two occupation floors were covered to the south by the rebuilding of the retaining wall of Terrace IV after a phase of collapsing (construction of wall M.835).

Terrace III was built at a later date (Phase IB) over the eastern part of Terrace II. It was bordered to the north by a single faced wall, with a round corner (M.870) and to the west by a double faced wall (M.843). Terrace III hosted a single space, P.846, of relatively large size, with a floor including a bench (M.840), which was built along the retaining wall of Terrace IV (M.835).

Figure 4 (opposite): Map of Areas C and D. (© French Archaeological Mission in the UAE. Amaury Havé and Julien Charbonnier)

Terrace IV is the largest terrace of Area B, reaching a surface of around 40 sqm. Its construction seems contemporaneous with Terraces I and II (Phase IA), but its retaining wall (M.861) collapsed, and reconstruction works obliterated the earliest layers of Terrace II (building of M.835). Terrace IV hosted two spaces, P.844 to the west, P.828 to the east.

P.828, of smaller size, might have been covered. Inside, a first occupation layer of tramped whitish silt (S.848, Phase IA) was associated with a small hearth in the centre of the room (F.847). It was covered by a destruction layer with several stones and potsherds, above which a new floor was installed (S.839, Phase IB), as well as a new western wall erected (M.826). Over this second floor, the progressive accumulation of fine sand and anthropogenic materials (S.829, Phase IC) marks the last occupation of the room.

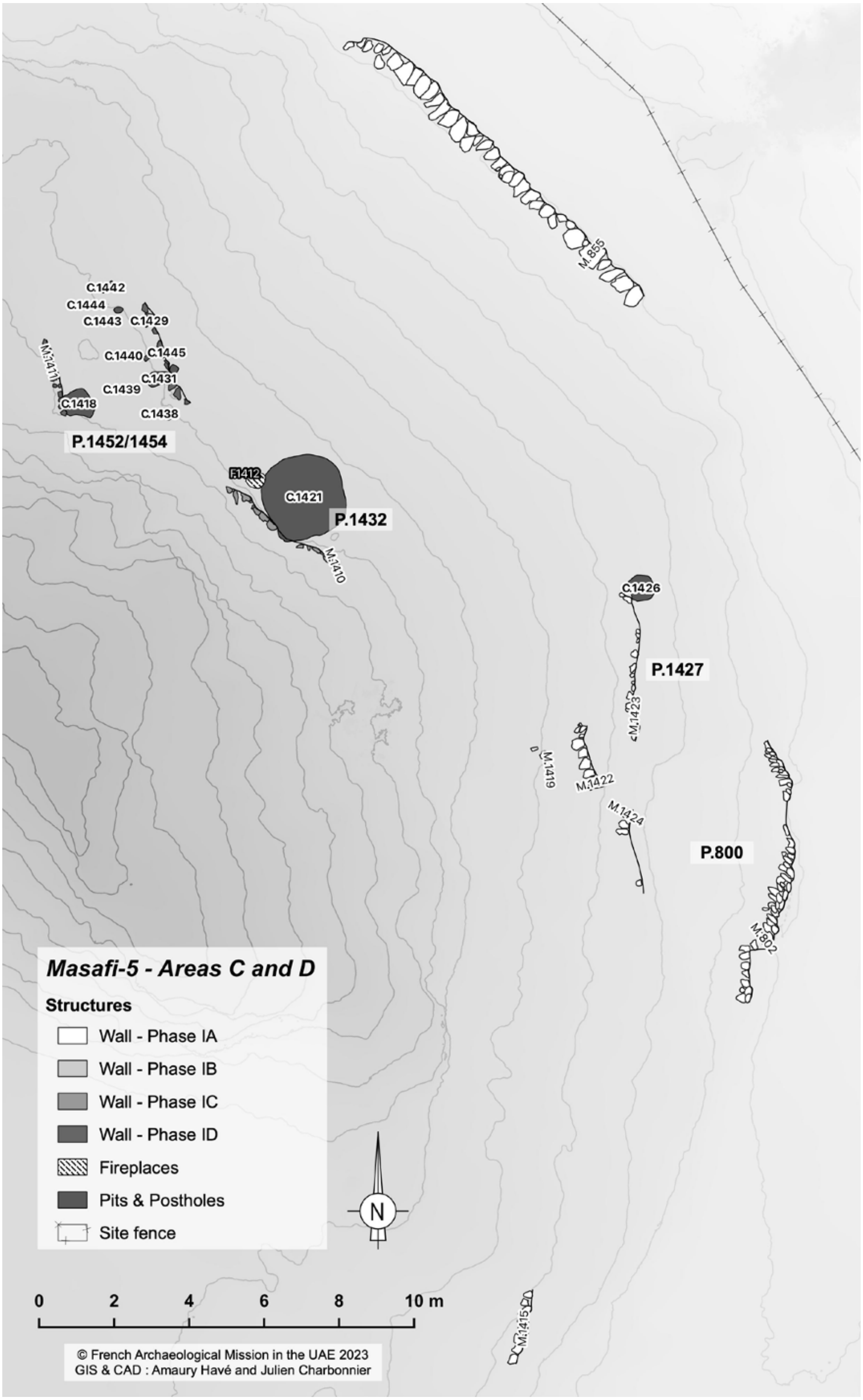
In Room P.844, in the western part of Terrace IV, two large hearths (F.862 and F.863) were set on the first occupation floor, marked by a thin level of brownish silt (S.857, Phase IA). It was followed by the installation of two other floors in yellowish clay (S.858 and later S.850). Above floor S.850 was an accumulation of dust mixed with ashes and pottery (US.435, Phase IC), which was interpreted as the remains of the last occupation of the room. On top of it, a small accumulation of ashes and charcoal provided a ^{14}C date between 1412 and 1209 cal.BCE (3045±35 BP, sample Ly 16681; dating made on Sample 407 US.433, the remains of two burnt seeds: one of a jujube tree, the other of a date stone).

Terrace V, in the upper part of the slope, was badly preserved. It included the remains of a single floor (S.864), with a hearth located in the western end of the room (F.866). A stone slab set in the middle of the room might have been used as a base for a post. A huge quantity of pottery was deposited on this floor.

The western part of Area B was less well preserved, and only yielded remains of hearths/fireplaces dug into the bedrock, which can be dated to the LBA or the Iron Age as potsherds of both periods were mixed in this area. Fireplace F.898 consists of a round pit 50 cm in diameter dug into the slope, with a small channel around the bottom and a small pit in front.

Area C is located to the east of Area B on the north-eastern slope of the hill (Figure 4). It is also framed between two rock spurs. To the north it is delimited by the terrace wall M.855. LBA remains were preserved in the south-western part of the area, in the upper part of the slope. They are grouped in two distinct spaces delimited by single-faced walls made of small to medium stones (P.1552/1554 and P.1532).

To the north-west, spaces P.1552/1554, that bear witness to two main phases of occupation, were identified. The earliest one (Phase IB/C) was delimited to the west by wall M.1411 and comprised a simple floor of tramped earth associated with postholes approximately 20-25 cm in diameter and a larger pit


Masafi-5 - Areas C and D
Structures
Wall - Phase IA
Wall - Phase IB
Wall - Phase IC
Wall - Phase ID
Fireplaces
Pits & Postholes
Site fence
N
0
2
4
6
8
10 m
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GIS & CAD : Amaury Havé and Julien Charbonnier
M.855
C.1442
C.1444
C.1443
C.1429
C.1440
C.1445
M.1411
C.1431
C.1439
C.1418
C.1438
P.1452/1454
F.1412
C.1421
P.1432
M.1410
C.1426
P.1427
M.1423
M.1419
M.1422
M.1424
P.800
M.802
M.1415

dug along wall M.1411 (C.1418, 1.10m in diameter), filled with stones. This first layer was later covered by a second occupation (Phase ID) level, linked to the construction of wall M.1420 to the east.

To the south-east of Area C, the first anthropic activity (Phase IA) was marked by a deep and large pit dug in the substratum (Pit C.1421). It was broadly round in plan, with a diameter of 2.34 m at the opening, and showed a deep conical profile, with a depth exceeding 6 metres and a diameter decreasing to less than one metre in the lowest excavated part.[2] The initial function of this deep pit is not clear, and no element has been identified to specify it. The pit was later reused as a dump, filled with a series of deposits including potsherds all dated to the LBA and two concentrations of animal bones (Phase IB). In the upper part of the pit was an accumulation of clay with mudbrick fragments.

The top of the pit was sealed by a floor of light buff clayish silt, S.1428 (Phase IB). Stone slabs were laid above this floor on top of the ancient pit. Floor S.1428 was then covered by a layer of yellowish silt, on top of which a new floor was established (S.1417; Phase IC). Over the latter was a layer of construction debris including several fragments of hewn stones, around 40 cm wide, mixed with fallen mudbricks.

During the following phase (ID), a stone wall was built to the south-west, M.1410, which marks the installation of a room in this area (P.1432). It comprised a clay floor (S.1413) and a round fireplace framed with stones, 50 cm in diameter (F.1412), in turn covered by a sediment of brown silt including small stones. This room was badly preserved since the northern part was completely eroded and the central part of this room was swept away by a gully, which created a ravine, inside which debris of mudbricks, silt, stones and gravel were mixed.

Area D is located in the eastern part of the hill, to the south of area C (Figure 4). LBA remains were mainly found in its north-eastern part, at the bottom of the slope. They include a first lower terrace, bordered to the east by the retaining wall M.802 and to the west by a badly preserved wall, M.1424. This terrace was occupied by a single space named P.800, which included two successive floors. The oldest, S.809 (Phase IA), was made up of a thin layer of brown silt with small stones. It was covered by a destruction layer with many fragments of greenish mudbricks. On top of this layer was floor S.804, in whitish silty clay (Phase IB). To the west, wall M.1424 supported the remains of the filling of a very narrow upper terrace, which might have served as a passage rather than a living space.

To the north of room P.800, another space was excavated. Its western limit is formed by wall M.1423, orientated north/south and retaining the filling of an upper terrace, while its eastern limit has been entirely eroded. Two successive floors were also found in this space. The earliest (S.1435, Phase 1A), preserved on a small surface along wall M.1423, was made of white compacted clay

2 For safety reasons, its excavation could not be carried out till the bottom.

mixed with gravel and small stones. It yielded two grindstone fragments and the fragment of a small stone mortar. It was covered by a destruction level of silt mixed with gravel, on top of which was a second floor of white compacted clay, S.1425 (Phase IB). A round pit was dug through this floor in the northern part of the terrace. It was lined with stones and filled by brown silt mixed with gravel and potsherds (C.1426).

Walls M.1423 and M.1424 were both orientated north-south and broadly aligned. Moving west there was another wall, M.1419, which probably retained another terrace built higher on the slope. The area between M.1419 and M.1423/M.1424 was relatively narrow (90 cm wide), and the surface of the rock substratum showed evidence of flattening. It probably served as a path rather than a living space.

Farther south, the hill has been partly bulldozed, but the remains of another wall (M.1415), associated with a badly preserved occupation floor, suggest that another terrace existed there. In fact, it is likely that the settlement extended over the whole hill. LBA potsherds were also found on the southern side of the hill, along the road.

The economy of Masafi-5

Agricultural practices

The geomorphological study led by M. Crépy has revealed that the oasis owed its existence to the presence of significant groundwater resources, whose local accumulation was driven by the geological context. Indeed, the oasis is in a zone of geological contact between the harzburgites of the Dibba formation, to the east, and the metamorphic rocks of the Al-Khalabiyah formation, to the west. The harzburgites are normally not permeable, but in the region of Masafi they are densely fractured, allowing water circulation (fracture porosity). The survey confirmed that most of the large cracks follow an east–west axis, i.e. from the mountains to the oasis. This circulation is blocked at the level of the metamorphic rocks as the fracturation axis of the latter is nearly vertical. Water thus accumulates in the area of the present-day oasis, and until recently, it was found at a shallow depth. The local population took advantage of it since very early times to develop cultivated areas. It is indeed at this location that all the springs and wells, of all periods, are concentrated (Charbonnier *et al.* 2020: 483-486).

For the LBA period, irrigated agriculture is attested by an abandoned and filled well discovered in one of the geoarchaeological test pits, in the center of the present-day palm grove (Figure 5). This well (WS064), not completely excavated, was probably oval or sub-rectangular in shape. No artefacts were collected during the excavation. A ^{14}C date around the 14th–13th century BCE (1415–1230 cal. BCE) was obtained on charcoal collected from one of the strata

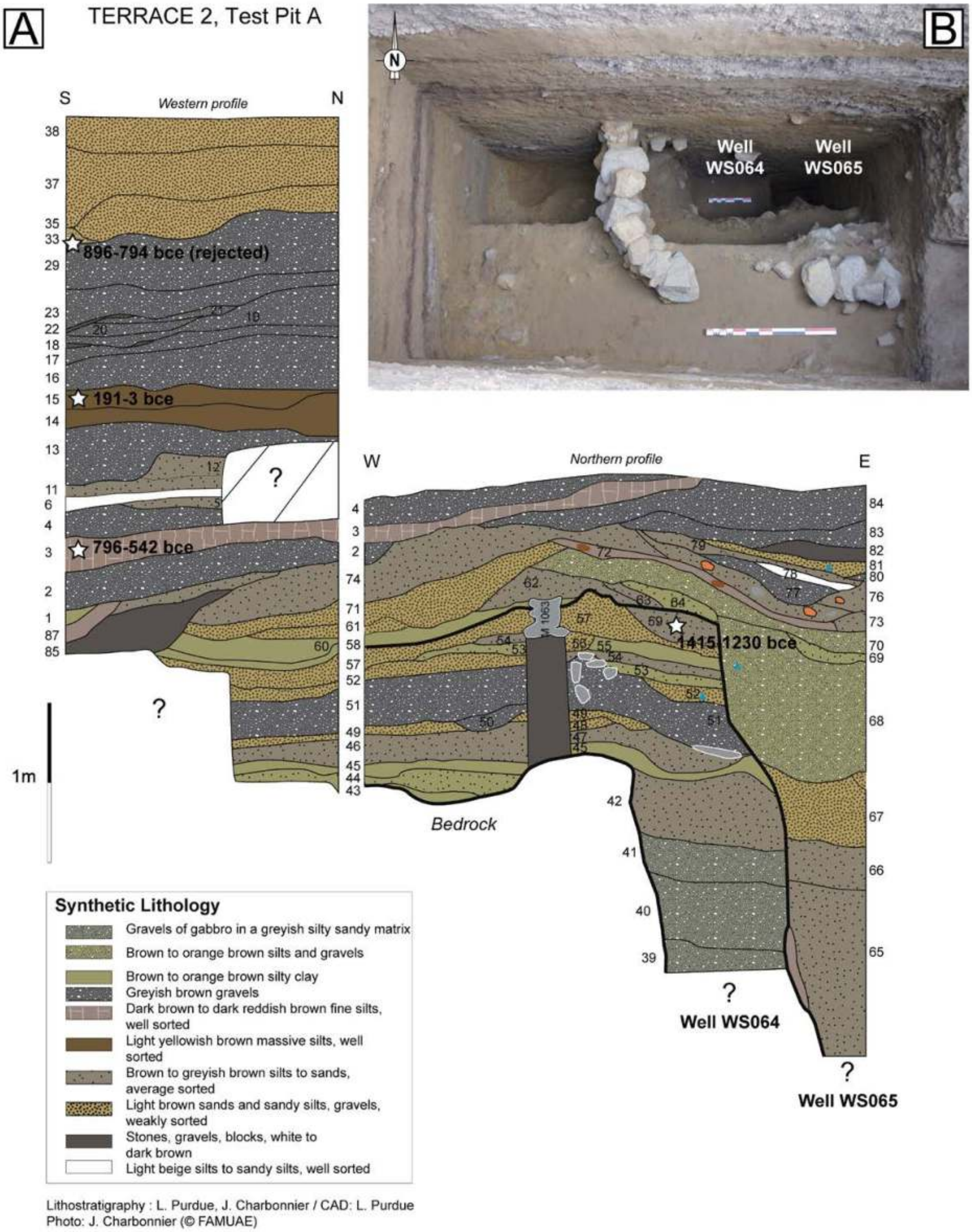

Figure 5:
Geoarchaeology in the palm-grove area: Terrace 2, Test Pit A showing the well WS064, dated from the LBA. (Louise Purdue and Julien Charbonnier)

sealing the well, suggesting that it was contemporary to Masafi-5 (Charbonnier *et al.* 2020: 486).

An agricultural economy in the LBA is further confirmed by the discoveries made during the excavation of Masafi-5. Even though archaeobotanical material was not abundant on the site, date (*Phœnix dactylifera*) and jujube (*Ziziphus spina-christi*) stones were discovered in stratum UF 433 (Area B), a context associated with Phase IC (Degli Esposti and Benoist 2015: 65). Date palm is the typical crop of Arabian and Northern African oases and has been cultivated in the Gulf since the Early Bronze Age (Tengberg 2012: 145). The jujube tree is still traditionally used in the UAE for its fruit, leaves and wood. Although it is found in the wild, it can also be cultivated. Furthermore, agriculture-related activities are indirectly witnessed by the presence of a number of ground stone tools found in several levels of Area B. This assemblage is quite varied, incorporating several types of tools (millstones, grinding stones, grinders and mortars) that likely served various functions, notably those of grinding and/or crushing. The main material used for these tools was gabbro. Millstones, which form the majority of the lithic assemblage, attest to domestic processing of cereals within the village of Masafi-5. Grinding and milling tools are present in the assemblage of other LBA settlements in the region and have also been found in some graves. At Khor Fakkan, for example, several grinding stones were found in the rooms of buildings H8 and H12 (Jasim 2000: 148-149; 151).

Animal husbandry

The mammal remains from Masafi-5 were mainly collected in the filling of cavity C.1421 (NR = 375). The bones were discovered in two distinct dump layers. The first one yielded very poorly preserved fragments: Only a bovine metatarsal could be identified. The second contained bovine and caprine bones that were relatively better preserved but still extremely brittle, which led us to plot the bones and project the scatter on a zenithal view of the cavity (Decruyenaere *et al.* 2022) (Figure 6).

This deposit includes three bovines that are at most 2 years old: one almost complete skeleton and two right lower limbs belonging to different individuals. The study of the skeletal connections and butchery marks showed that the most complete animal was dismembered and cut into anatomical segments before being thrown into the cavity, probably because of the limited space available in the bottom of C.1421. Sections of the lower limbs had been identified (radius/ulna/metacarpal or tibia/metatarsal) near areas of phalanx concentrations while the humerus and femur were isolated. Axial skeletons were also probably cut into sections as suggested by cut marks on vertebrae and ribs. Also noteworthy is the absence of the skull including the mandibles, scapulae and some phalanges. While the missing phalanges can be explained

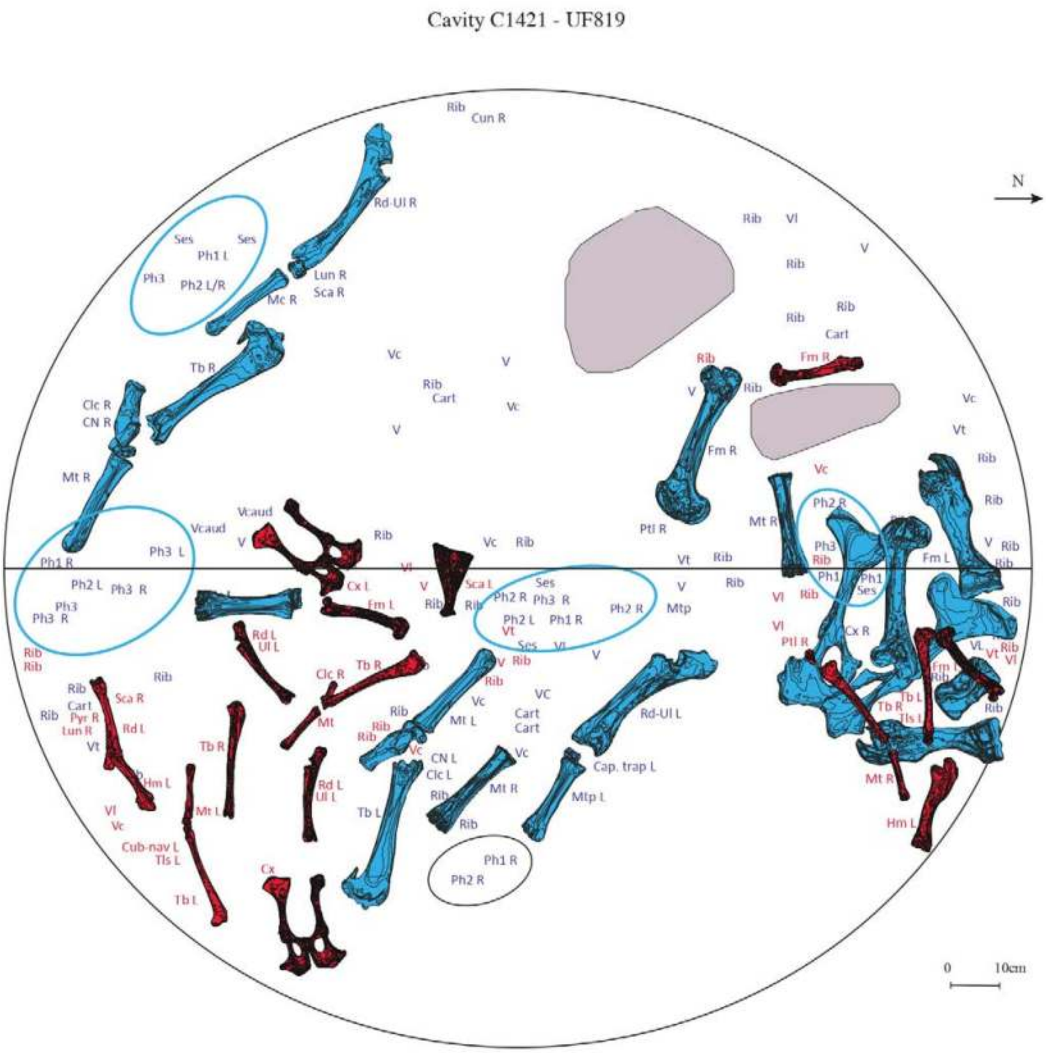

Figure 6: Zenithal view of cavity C.1421. (© Delphine Decruyenaere)

by their loss during the transporting of the carcass, the absence of the skull and scapulae seems more problematic as they are generally well preserved.

Three caprines, including two sheep (*Ovis aries*) between 4 and 6 years old, were also recorded. Here again, anatomical segments were detected, even if they differ from those of the bovine. There are still lower limb connections (radius/ulna-metacarpal and tibia-metatarsal) but also upper limb connections such as a femur-tibia and humerus-radius/ulna. The unorganised distribution of the remains suggests that the carcass parts have also been discarded rather than deposited. As with the bovines, a certain pattern of selection can be detected since the skull and phalanges are missing.

It is difficult to speculate on the consumption of these animals since there are little traces of anthropogenic activity. Obviously, this does not mean they were not consumed, since the processing of the animal may leave no trace. For example, it is possible that the meaty parts were deboned without marking the bones. The absence of burning traces can be explained by the fact that the meat was boiled. However, in the case of bovines, it seems unlikely that segments as large as the metatarsals/tibia/phalanges were cooked together.

The first hypothesis to explain this deposit might be the rendering of carcasses following natural death. Disease may explain why the meat does not seem to have been eaten, at least for the cattle. On the other hand, the absence of some skeletal elements from both species, notably skulls/mandibles, raises the hypothesis of a ritual deposit. The possibility of Masafi-5 being symbolically significant during the Iron Age is discussed in Benoist *et al.* (2015). It is worth mentioning that the nearby Iron Age sites of Bithnah-44 (Fujairah) and Al Madam 1-Tuqeibah (Sharjah) both yielded ritual contexts where remains of domestic caprines and cattle were buried in pits or cenotaphs (Skorupka *et al.* 2013; Del Cerro 2013). In the case of Al Madam, only specific parts of animals were found. The species and the absence of some bones, notably skulls and mandibles, echoes with our assemblage.

Based on these observations, it is legitimate to question whether one is witnessing here a specific manifestation of a ritual tradition (banqueting?) involving domestic animals that will continue until the Iron Age. Was it a rendering to get rid of sick animals or just the remains from a meal? The little data do not allow firm conclusions, but whichever hypothesis, it must be kept in mind that this assemblage was unearthed in a closed context and corresponds to a specific event. As such, it probably does not reflect the subsistence economy of Masafi-5 in its totality, but it provides a starting point for discussion, since only nine poorly preserved remains were discovered in the settlement. All of these remains have been identified as belonging to small ruminants, probably caprines, but the presence of gazelles cannot be ruled out.

Studies conducted on nearby contemporary sites almost all show the same trend: a subsistence economy based on caprines and, to a lesser extent, on bovines (Uerpmann and Uerpmann 2017; Roberts *et al.* 2019). Caprines (with sheep — *Ovis aries* — positively identified) and bovines that compose our restricted faunal spectrum could also have played an important economic role in Masafi-5, not only for the production of meat and dairy but also for the exploitation of other resources such as wool, leather, etc. Bovines were certainly also used as draught animals. Two species are present in the region: *Bos taurus* (the taurine domestic cattle) and *Bos indicus* (the zebu). The cattle remains from Masafi-5 have been identified as belonging to taurine cattle on the basis that there is no bifid spine on the thoracic vertebra, which is the main diagnostic feature between common cattle and zebu (Clutton-Brock 1989).

Except for the possible gazelle bones found in the settlement, the absence of wild animals is the major difference from most contemporaneous sites in the UAE, where they can be economically and socially important along with domestic animals (Stephan 1995; Uerpmann 2001; Roberts *et al.* 2018, 2019; 2020). This divergence should be highlighted and brings Masafi-5 closer to the cultic sites of Bithnah-44 and Al Madam.

Processing of mollusc shells

In addition to mammals, molluscs have been recovered in large quantities and contributed substantially to the human diet (Decruyenaere *et al.* 2022; Lidour *et al.* 2023).

Excavations at Masafi-5 provided a non-negligible amount of mollusc shells (N=250). Most of this malacological assemblage belongs to marine taxa — with only three specimens identified as small freshwater gastropods (two *Melanoides tuberculata* and one *Hydrobia* sp.). The taxa diversity is relatively high for a site located 30km from the nearest coast. Indeed, the assemblage comprises 23 species distributed among 22 genera and 16 families. According to the MNI calculation, the main taxa represented include the giant mangrove whelk (*Terebralia palustris*) (29.6%), the black-lip pearl oyster (*Pinctada persica*) (13.2%), venus clams (*Veneridae*) (11.8%), ark shells (*Arcidae*) (11.2%) and the violet asaphis (*Asaphis violascens*) (6.6%). A recent study (Lidour *et al.* 2023) highlighted that marine shells retrieved from Masafi-5 not only result from the local consumption of seafood but are also associated with the production of personal adornments and tools.

Mostly giant mangrove whelks and, potentially, some ark shells are expected to have been consumed as seafood at the site. The giant mangrove whelk represents a remarkable source of protein (up to 28%) — thus equalling mammal meat and tuna — for people living inland and potentially seeking diversification and sophistication of their diet. This mollusc is also suitable for trade, since it can be kept alive for several weeks in a cool container (with seawater). It has been suggested that fresh molluscs contained in large jars could have been exchanged between coastal and inland sites during the LBA (Pellegrino *et al.* 2020).

Specimens associated with the local production of personal adornments include polished plaques of mother-of-pearl (identified as belonging to large black-lip pearl oyster valves) and fragments of large *Conus* shells that witness various stages in the manufacture of shell rings at the site. The presence of a few fragments of giant frog shells (*Tutufa bardeyi*) also suggests the presence of a small-scale workshop producing other forms of adornments despite the absence of finished products (e.g. pendants, bracelet plates, columella beads, or discs/medallions). Marine shells had other non-dietary purposes at Masafi-5, including being used as small containers for pigments and cosmetics: bittersweet clams (*Glycymeris* sp.) and small ark shells sometimes show traces of coloured residues in their inner valves — composition analyses are currently ongoing (Figure 7).

Another significant result of the study of the shells from Masafi-5 is the identification of shell tools and their functional analysis using high-power magnification. Specimens of Venus clams and violet asaphis show scalar-like retouches along their ventral margin. This modification provides an

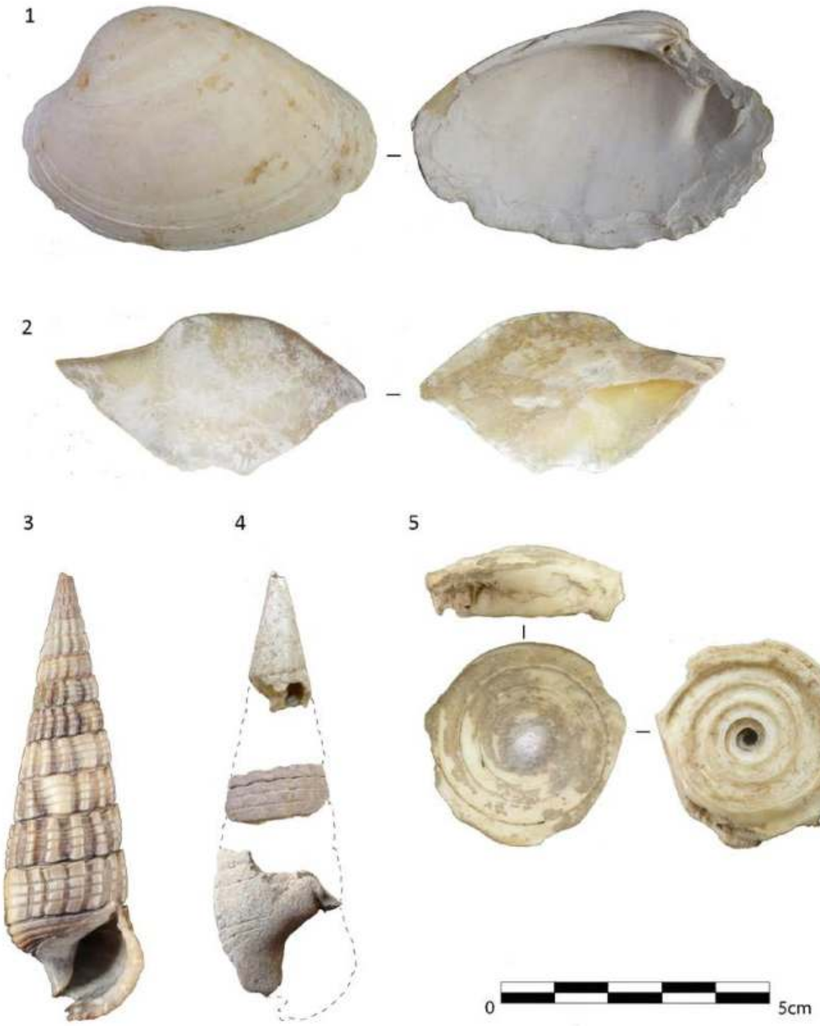

Figure 7: Sample of archaeological marine shells recovered during the excavations conducted at Masafi-5. 1) Left valve of a red venus clam (*Callista erycina*) showing scalar-like retouches along its ventral margin; 2) Polished fragment of a black-lip pearl oyster valve (*Pinctada persica*); 3) Reference specimen of a giant mangrove whelk (*Terebralia palustris*) shell (MNHN-IM-2000-36221); 4) Fragments of a giant mangrove whelk (*Terebralia palustris*) shell with their approximate locations on a complete specimen; 5) *Conus* sp. shell spire showing the ongoing drilling through its apex. (Images K. Lidour).

efficient cutting edge for cutting or scraping activities (Lidour and Cuenca Solana, in press). Use-wear analyses conducted on shell tools from Masafi-5 have allowed the documentation of the transversal process (cutting and/or stretching) of vegetal fibres at the site. Although it remains to be confirmed and discussed in more detail, the vegetal fibres could have consisted of date-palm leaflets and leaf sheath, known as raw materials in traditional basketry and in rope manufacture in the UAE. If confirmed, the ancient exploitation of date palm fibres is coherent within the context of the long-term development of an oasis-agriculture-based economy from the Bronze Age onwards and the diversified integration of the date-palm culture (*Phoenix dactylifera*) in socio-economic activities. One can question why shell tools continued to be used during the Bronze Age despite the development of copper metallurgy and the subsequent availability of metal tools. It is also evident that marine shells do not represent an obvious choice as raw material for tools in the Masafi area, where the nearest coast is located 30km across the mountains. We believe that, as opposed to metal tools manufactured by specialised craftsmen, shell tools could be easily made by anyone needing them. Experiments showed that scalar-like retouches like those observed on shell tools from Masafi-5 can be made with a series of small direct percussions using a hard hammerstone (or even a resting hammer). Furthermore, the use of shell tools at Masafi-5 could have been stimulated by the high frequency of exchanges between the hinterlands and the coast (including the movement of people). It could have resulted in cultural connectivity, facilitating the exchange of artefacts and tools and influencing technological behaviours.

A copper melting furnace on the site?

Evidence of metallurgy on the site is provided by the small structure F.898 located in the western part of Area B down the slope. Its form, a pit c. 50 cm in diameter with a small channel dug around the bottom and a small pit in front, resembles examples of copper-smelting furnaces discovered on several other sites in the region (Hauptmann 1985). This possible furnace was surrounded by a small number of copper slags found scattered on the slope (Figure 8). These slags are of relatively small size, compact, with few porosities on the surface. The size of the furnace and the small quantity of slag would speak for a small copper-melting workshop rather than for a copper-smelting site, but this needs to be confirmed by further palaeo-metallurgical study. Although its precise date is still uncertain, several LBA potsherds were collected around this small feature.

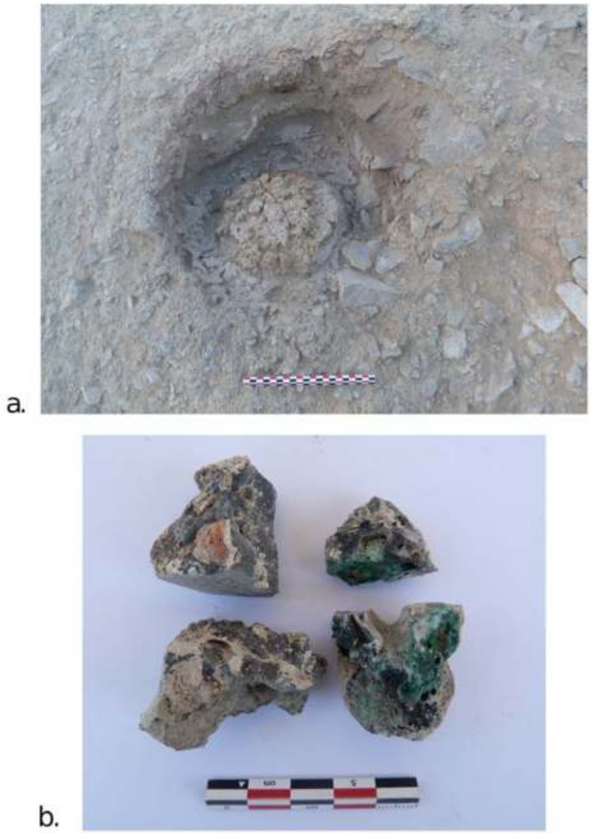

Figure 8: a) Possible furnace F.898; b) samples of slag collected in the vicinity. (© French Archaeological Mission in the UAE. Photos Aurélien Hamel)

Pottery production

A total of 32,614 potsherds comprise the Masafi-5 pottery assemblage. Most of them were collected in Area B. The pottery was analysed using different methods: morphological study, macroscopic and microscopic studies of fabrics, petrographic analysis (carried out by S. Méry) — with the results compared with geological data (with the contribution of S. Costa) — and finally a first technological study.

The macroscopic study showed that the large majority of the pottery collected on the site belongs to a single pottery group named Group 1, characterised by the presence of grey-greenish shining inclusions and by a clay with a soapy texture. Macroscopic Group 1 constitutes the bulk of the ceramic assemblage at Masafi-5 during the entire occupation of the site, representing more than 80 per cent of the pottery collected. It comprises a large majority of open vessels (basins, bowls, dishes, spouted bowls), generally with a straight or slightly convex body and a simple rim — rounded, pointed or flat). Short-neck jars, storage jars and pots also appear in smaller quantities (Figure 9).

Petrographic analyses have demonstrated that these ceramics form a homogeneous assemblage and were most likely made in the Masafi area (Pellegrino 2022; Pellegrino *et al.* 2020). These grey-greenish inclusions are fragments of sericite schist, which is abundant in the Masafi geological background (Costa 2022; British Geological Survey 2006). Although the LBA pottery workshop was not identified yet, one can assume Group 1 pottery was made in the Masafi region itself exploiting local sericite schist deposits, and it could well represent the local pottery production.

Samples of pottery belonging to Masafi Group 1 were also collected in small quantities on other LBA sites (Shimal SX, Tell Abraq and Kalba 4). Their petrographic analysis confirmed their similarity with Masafi pottery samples. It can be stated that pottery made in the Masafi area was transported as far as Shimal SX and Tell Abraq in the north, and Kalba 4 in the south-east, confirming the integration, from the LBA onwards, of Masafi-5 and its valley in the intra-regional exchanges of the northern United Arab Emirates. This pottery group appears to extend to the Al Ain region, where it is found in small quantities at the Bayt Bin Ati site (Power *et al.* 2019).

A technological study made on samples from Group 1 has shown that this pottery was shaped by hand, using exclusively the coiling technique. Microscopic study of the joints of coils and clay slabs shows several types of joints typical of a non-standardised pottery production in which the potters express a variety of skills and technical habits that are specific to them (Figure 10).

Other groups found in small quantities at Masafi-5 were also studied (Groups 2, 3, 4). The study demonstrated the importation at Masafi of productions originating from other regions in the UAE, notably Group 2, which

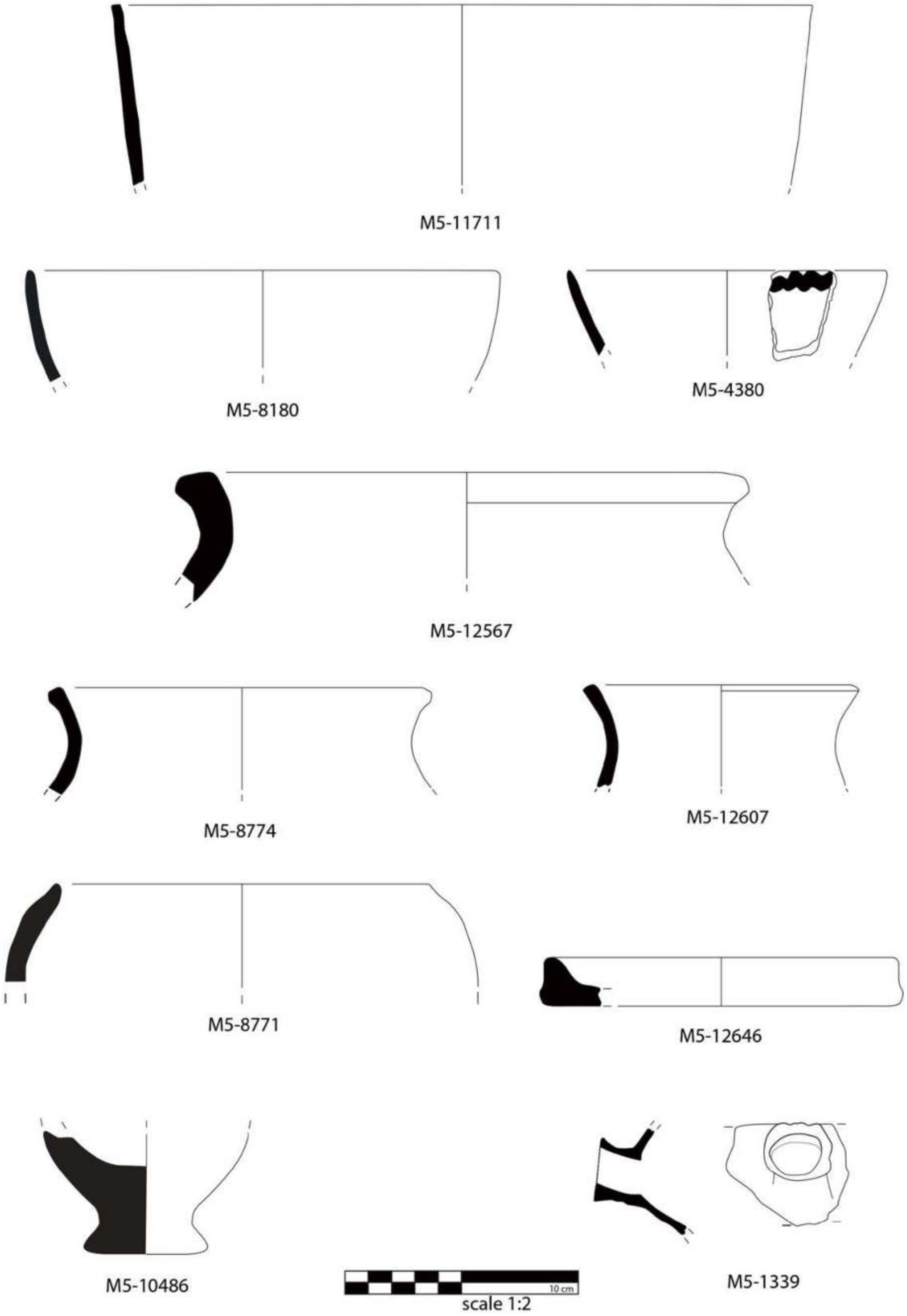

Figure 9: LBA pottery from Masafi-5: typical LBA shapes. (© French Archaeological Mission in the UAE. Drawings Marilisa Buta)

Figure 10: LBA pottery from Masafi-5: Group 1. (© French Archaeological Mission in the UAE. Photos Maria Paola Pellegrino).

Figure 11: LBA pottery from Masafi-5: Group 2. (© French Archaeological Mission in the UAE. Photos Maria Paola Pellegrino)

is characterised by inclusions of hard white calcareous minerals, probably coming from northern Ras Al Khaimah. This group is frequent at Shimal SX (Velde 1992) and seems also well represented at Tell Abraq as well as in tombs located in the Fujairah region (Dibba 76/1, Mereshid, Daba LCG-1, Qidfa 1) (Pellegrino, pers. comm.). Shimal pottery identified at Masafi notably includes fragments of necked jars with a thickened rounded rim and footed goblets. To the difference of Masafi-5 Group 1, vessels from Group 2 were finished on a rotating base (Figure 11).

Our study of the ceramics from Masafi-5 allowed us to trace certain aspects of exchange (materials and know-how) and to characterise cultural, economic and technological traits that differentiate human groups. The self-reliant, autonomous character of Masafi-5 can be seen in its ceramic assemblage: It is composed almost entirely of ceramics made on-site or in the vicinity of the village. The production of pottery seems fully integrated into the local economy and has an original and relatively intensive character, undoubtedly showcasing the importance of pottery making for the village community. The pottery seems to have been produced primarily for the domestic use of the local population but was also used in exchanges with sites sometimes several dozen kilometres away. The study of local and imported ceramics thus serves as a privileged 'window' for understanding cultural and economic interaction in the LBA.

Conclusion

Until now, our knowledge of the economy of LBA societies in south-eastern Arabia has remained quite limited. Nevertheless, the various and complementary studies conducted at Masafi-5 expand and specify the existing general picture. It results from these studies that the Masafi-5 society was much more diversified and better organised than was previously thought.

Indeed, these new data notably suggest that Masafi-5 can be considered a 'village' in the proper sense of the word, a community in its own right, with a desire for self-sufficiency in daily life; self-sufficiency essentially made possible by the site's favourable environment, with both easily accessible mineral resources and a regular water supply.

The inhabitants subsisted on both local agriculture and animal husbandry, and the village was the centre of various types of handicrafts (pottery, seashells and possibly metallurgy).

The self-sufficient nature of Masafi-5's economy can mainly be seen in its ceramic assemblage, which is composed almost entirely of ceramics produced on-site or in the vicinity of the village. At the same time, the site was well integrated into regional trade networks due to its strategic position, at the crossroads of several routes and close to three wadis, making it a place of transit and exchange for allochthonous products.

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Another side to the story Preliminary results from the renewed excavations on the eastern flank of Tell Abraq (2021-2022)

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with Camille Abric and Francesca Barchiesi

Abstract: Excavations on the eastern flank of Tell Abraq, within the territory of the emirate of Umm Al Quwain, during the 2021 and 2022 field seasons, yielded remarkable results that help to better understand how the site was occupied in the second half of the 2nd and throughout the 1st millennium BCE. Evidence for several phases in the site's occupation is connected with buildings and features characterised by largely differing architecture, dimensions and associated materials, before a final switch (in the Late Pre-Islamic period) to the funerary use of the area, with several burials that were likely the target of later robbing. Scattered artefacts, comprising exceptional items unique in the UAE, might be referred to the original inventory of these graves, as contemporary architecture has not been discovered so far. Some of these artefacts illustrate the strong influence of foreign productions conveyed both overland from South Arabia and oversea, via Characene, during the first centuries CE.

Keywords: Umm Al Quwain, Bronze Age architecture, Early Iron Age, Late Pre-Islamic Arabia, geomorphology, archaeology of Southeast Arabia

Introduction

In 2019, the Italian Archaeological Mission in Umm Al Quwain (IAMUQ), in cooperation with the Department of Tourism and Archaeology Department of Umm Al Quwain (TAD), began a new programme of stratigraphic excavation in the eastern part of the multi-period, pluri-stratified site of Tell Abraq, the western part of which conversely lies in the emirate of Sharjah (Figure 1) as the major component of the Abraq Research Project.

While the results of the first two seasons (2019 and 2020) have been summarised elsewhere (Degli Esposti *et al.* 2022), this contribution aims at presenting some highlights from the 2021 and 2022 field seasons, especially as they provide some perspective on the site's life, which comes partially unexpected, considering the results of previous excavations at the site by other teams.

The first archaeological investigations at Tell Abraq belong to a period that can be placed at the beginnings of the archaeology of Southeast Arabia,

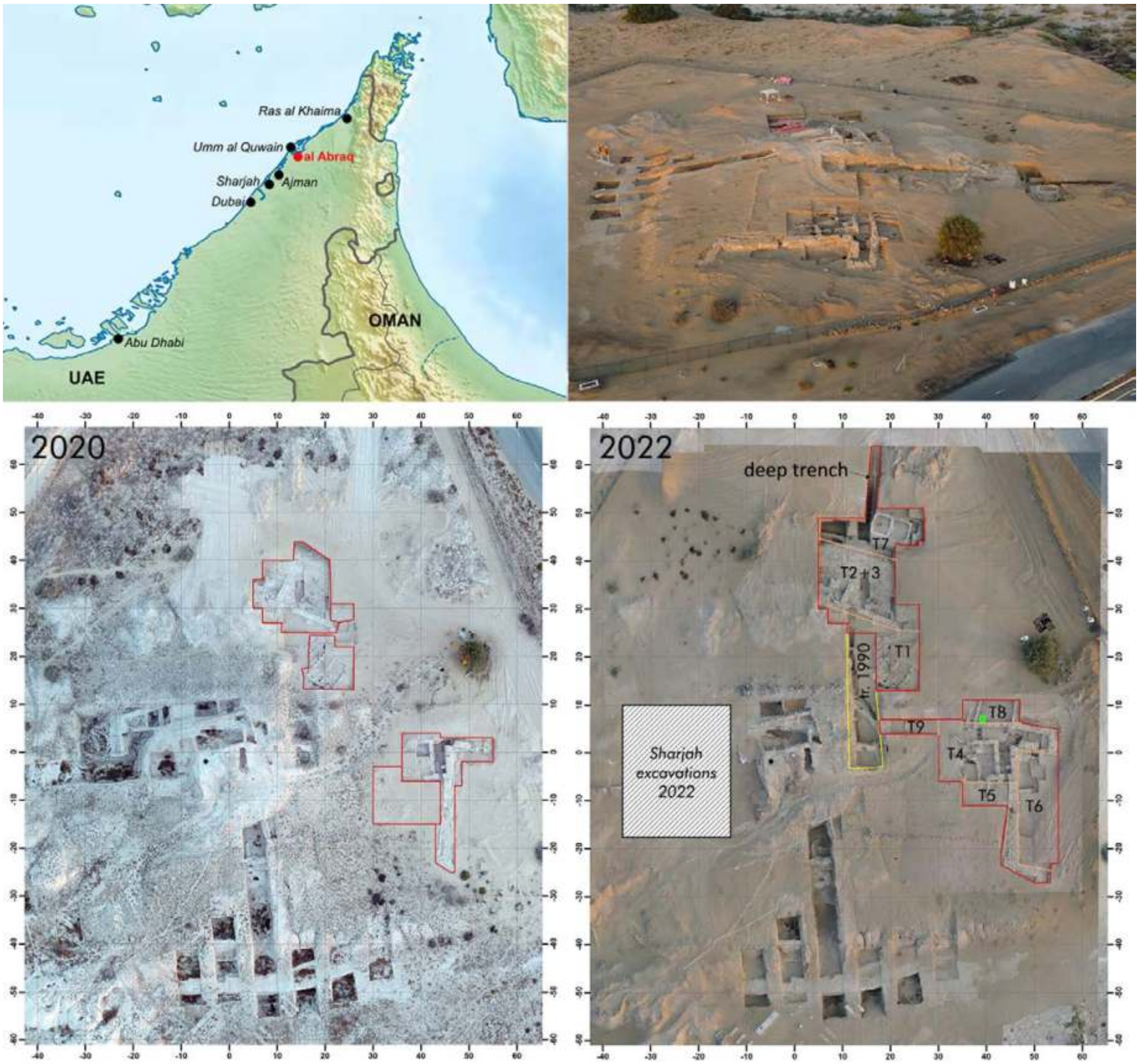

Figure 1: Top, the location of Tell Abraq along the western coast of the UAE and a bird's-eye view of the site, November 2022, looking west. Bottom, work progress from 2020 to 2022 and indication of the trench layout. The green dot indicates the position of Grave 5. North on top. (Photos F. Borgi)

a field of research that is still quite new within the broader discipline of Near Eastern Archaeology. While early, very limited trenching by an Iraqi expedition in 1973 left almost no record (Salman 1974), the results of the multi-year project directed by Daniel T. Potts (e.g. Potts 1990; 1991; 1993a and 2000) were essential in building up a first broad chronological sequence for the region, spanning the period from the second half of the third millennium to the first millennium BCE and extending to the early centuries CE, especially when combined with the information being collected at nearby Ed-Dur (Boucharlat *et al.* 1989; Haerinck 2001 and 2011). Later, a new multi-year project directed by Peter Magee focused on the excavation of several long trenches in the western (Sharjah) side of the mound, as well as re-documenting earlier exposed sections and providing archaeological surveillance during the placement of a water pipe near the mound by the Sharjah Municipality (Magee *et al.* 2015; 2017 and 2018). In 2022, the Sharjah Archaeology Authority restarted excavations on the western side of the mound, opening a large squared trench just south of the Umm an-Nar tomb excavated in the 1990s (Potts and Weeks 1999). The results of this new project will surely be of great relevance to the reconstruction of the site's evolution.

The works of the IAMUQ started in 2019 with a three-week season carried out with a small team, essentially intended to evaluate the condition of the stepped trench excavated by D. Potts in 1990, as well as to select the main areas of excavation for the new project (Degli Esposti and Borgi 2020). In the following years (2020 to 2022), the team was enlarged, and a five-week field season took place between October and November of each year (Hussein Kannouma, Degli Esposti and Borgi 2021). Throughout the project, the IAMUQ could rely on the invaluable support of the TAD for both logistics and fieldwork.

Nine trenches were established at the site and these comprise two main areas, one to the north/north-east of the mound, in physical continuity with the 1990s stepped trench, the other on the eastern side of the mound. The first area comprises Trench 1, Trench 2/3 and Trench 7, while the second area comprises Trenches 4, 5, 6, 8 and 9, with only the uppermost, windblown and reworked deposits having been so far removed from Trenches 5 and 9.[1]

Not all of these trenches bear witness to the same phases within the long-lasting occupation of the site that spans c. 2500 BCE to 300 CE. Indeed, the IAMUQ excavation did not, so far, hit contexts dated earlier than c. the mid-2nd millennium BCE, with the exception of a very small, deep sounding excavated in Trench 2 (Degli Esposti *et al.* 2022: 144-145 and Figure 5). In this account, therefore, the new data will be presented in chronological order rather than as a report of the results for each individual trench, as it is considered to be clearer for the reader.

The second half of the second millennium BCE

In Trench 1, an L-shaped room (Room A) was discovered, dated to the mid/third quarter of the 2nd millennium BCE (Degli Esposti *et al.* 2022: 142–144) interestingly associated with the grit grey ware that is now being more and more recognised as characteristic of a period extending much earlier than the so-called Iron Age I (1300-1100 BCE) and reaching at least the mid-2nd millennium (Magee *et al.* 2017: 226–227; Karacic *et al.* 2018: 25; Degli Esposti *et al.* 2022: 151). Work was not continued in this trench after 2020 and, therefore, it will not be discussed further here.

Downslope of this room, work in Trench 2/3 brought to light a large portion of what is apparently a substantial terrace, on top of which a stone wall (Stratigraphic Unit [SU] 12) was erected that framed an upper, smaller terrace or at least an open area, accessible through a single-flight, stone staircase

[1] These deposits can, however, be quite substantial and range from c. 30 cm in Trench 5 to almost 1 m in the upper (westernmost) part of Trench 9.

Figure 2: View of Trenches 7, 2/3 and 1, with the massive wall SU173 in the foreground. In the left inset, a detail of wall SU173; right inset, the flight of stairs providing access to the terrace delimited by the stone wall SU12. (Photos F. Borgi, M. Degli Esposti)

discovered in 2019 (Figure 2). Previous excavation south of wall SU12 had revealed the presence of several floors, some of which were associated with postholes (Potts 1991: 36 and Figure 36) suggesting the presence of *barasti*-like dwellings in this area, as it was the case further upslope and in our Trench 1 as well (Potts 1991: Figures 27, 37; Degli Esposti *et al.* 2022: 142 and Figure 2a).

Already in 2020, it was evident that this huge terrace was contained by a remarkably thick wall, comprising several "skins" built one against the other and with different techniques, involving the combined use of stone and mud-bricks (but notably not eolianite slabs). During the last two seasons, it has been finally possible to reveal a 15 m stretch of its outer face, setting it free from its own massive collapse. It survives to a height of more than 2 m.

This wall, listed in the IAMUQ's archives as SU173 (Figure 2), can be recognised to be the same exposed in several trenches by the international mission working in the Sharjah portion of the site, named as wall Set 52 and dated to the final quarter of the 2nd millennium (Magee *et al.* 2017). From the start, the stratigraphic data from IAMUQ's excavation indicated a relative chronology for SU173 in broad agreement with this date, as it covered Wadi Suq deposits and was buried under Early Iron Age ones, the latter including its own massive collapse.

Most recent excavation provided further dating evidence for its construction. Once the base of this wall was reached, Trench 7 (see Figure 1 bottom right) was extended north and another structure built with remarkably hard bricks and mortar (SU361) was discovered below the terrace wall, the nature of which still has to be understood (Figure 3). At this stage, two interpretations of this wall can be considered. The first sees it as the retaining wall of an earlier terrace or open area; the second option is that it could be the lining of the outer

Figure 3: Wall SU361 discovered in Trench 7, which predates wall SU173. The dumped burnt matter layer SU429, running under wall SU173, provided a *terminus post quem* for its construction and *ante quem* for the construction of wall SU361. (Original photos F. Borgi)

side of a ditch (of which one would thus be seeing the outer face intended to stand against the sand and not the one towards the inside of the ditch), possibly the so-called ditch Set 10 discovered in the southwestern portion of the site, on top of which the huge wall Set 52 was built (Magee *et al.* 2017: 220). Indeed, the lining wall of ditch Set 10 is made with a different technique than SU361, implying the use of aeolianite slabs, but it would not be surprising if

Table 1: New radiocarbon dates for different contexts at Tell Abraq

LAB CODE	Sample	Trench	Context (Stratigraphic Unit)	^{14}C Date (BP)	Calibrated date (2σ) *
LTL22008	SMP 100	4	267, deposit above the threshold between Building Ia - Room 1 and Room 2	3143 ± 45	1503BC (73.1%) 1366BC 1360BC (22.3%) 1290BC
LTL22009	SMP 104	4	274(=SU204), anthropogenic deposit above the earliest floor in Building Ia - Room 2, SU281	3165 ± 45	1516BC (85.2%) 1374BC 1349BC (10.2%) 1302BC
LTL22015	SMP 114	2	309 Lens with abundant burnt matter and charcoal, sloping down inside the backfilled ditch north of huge wall SU 173.	2381 ± 45	749BC (10.0%) 686BC 665BC (4.4%) 639BC 569BC (80.9%) 382BC
LTL22016	SMP 115	2	310 Layer with abundant pulverised charcoal and ash, visible in the section above Room B, associated with postholes. Occupational level.	2124 ± 35	349BC (10.4%) 309BC 206BC (85.0%) 44BC
LTL22665	SMP 62	4	204, anthropogenic deposit above the earliest floor in Building Ia - Room 3 (SU170) - INTRUSIVE	2925 ± 45	1264BC (95.4%) 969BC
LTL31044	SMP 178	4	252, burnt lens in Building Ia - Room 1 north	3064 ± 35	1415BC (90.0%) 1254BC 1249BC (5.4%) 1224BC
LTL31045	SMP 182	4	261, anthropogenic deposit in Building Ia - Room 1 north	3028 ± 35	1401BC (92.4%) 1195BC 1172BC (1.3%) 1162BC 1142BC (1.6%) 1131BC
LTL31046	SMP 204	7	429, dumped burnt matter below wall SU173	3022 ± 35	1397BC (89.5%) 1191BC 1178BC (3.0%) 1158BC 1145BC (3.0%) 1127BC
LTL31047	SMP 209	4	204, anthropogenic deposit above the earliest floor in Building Ia - Room 3 (SU170) with smashed pot	3163 ± 35	1505BC (90.3%) 1385BC 1339BC (5.1%) 1317BC

* Calibrated using OxCal v4.4.4 (Bronk Ramsey 2009) and the INTCAL20 atmospheric curve (Reimer *et al.* 2020).

different construction methods were used for the different parts of such a large structure, as is the case with the huge surrounding wall SU173=set 52 itself. Possibly more significant, the wall discovered in our trench would be too low to be lining a ditch unless one envisages that it was razed to provide a flat area for the later construction of wall SU173 or that only the upper part of the ditch had been lined.

Whatever the case, this lower wall constitutes the north boundary of a thick charcoal-rich lens — SU429 — which runs below wall SU173.[2] This context was sampled and the radiocarbon determination provides a *terminus post quem* for the construction of SU 173 between 1397-1127 BCE (2σ), thus in agreement with previous hypotheses (Table 1, lab code LTL31046).[3]

2 The layout of this lens would be consistent with the presence of a backfilled depression (the ditch?) delimited by wall SU361 and covered by wall SU173.

3 This, however, means that the late Wadi Suq date for wall SU12 proposed by Potts, and meant to be framed between 1600-1300 BCE (1991: 36), has to be rejected.

Figure 4: Rectified orthophoto of Building I (a and b) at the end of the 2022 season (N to the right), and a view looking south. The walls in the foreground (in Trench 8) belong to later structures. (Photos F. Borgi).

To the second millennium is also dated what is arguably the most unexpected discovery made so far during our renewed excavations, located in Trench 4. That some substantial structure should be present in this area was rather clearly indicated by its flat morphology (Degli Esposti *et al.* 2022: 145, 147 Figure 6 top), which could only be explained by the presence of structures creating a sort of "box" which prevented the erosion of the archeological deposits along the mound's slope.

Here, the remains of an impressive building, currently identified as Building I, were discovered, to our knowledge an *unicum* in the whole South East Arabia and also remarkable for its preservation, with walls reaching 1.8 m in height (Figure 4). The building surely underwent numerous modifications during several construction phases, many of which will need further excavation to be understood. Building techniques also changed significantly from one phase to the other, and walls comprising segments made with different

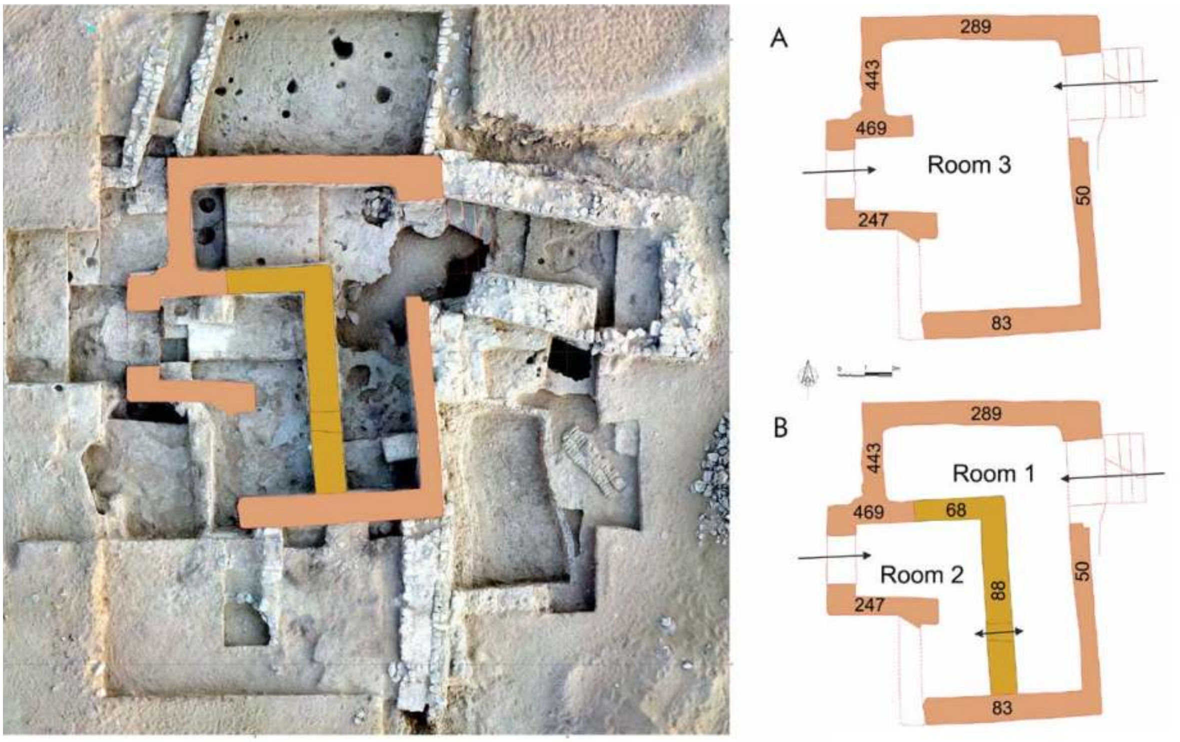

Figure 5: The plan of Building Ia outlined on the rectified orthophoto and a detail of its two construction phases. (Elaboration M. Degli Esposti)

techniques are not uncommon, which makes reconstructing the building's evolution even more complicated.

Nevertheless, during the 2022 campaign, the original plan of the earlier portion of this building was revealed (Figure 5). It actually represents an independent building in itself that will be henceforth referred to as Building Ia, as opposed to Building Ib meant to indicate the larger structure comprising the later modifications and additions.

Building Ia originally comprised a single large hall with two entrances, named as Room 3, later subdivided into two rooms (1 and 2). This first construction made use of a peculiar building technique, especially for what concerns the cement-hard mortar used to bind the beachrock blocks of the wall (Figure 6a). This kind of mortar is not found in the later walls erected against this original building, nor in the walls built to separate Room 1 and Room 2. At the same time, it is witnessed in a few other walls at the site, including the later extension of the 2nd millennium platform that occupied the top of the mound (Potts 1993a: 118), part of which sits within UAQ territory. If the presence of this peculiar mortar has a chronological value will have to be verified but it seems plausible at this stage.

Characteristic of Building Ia is also the presence, on all the surviving perimeter walls, of triangular ventilation slits that recall those still visible today in traditional houses (Figure 6b).

Building Ia could be accessed both from the east and the west. The eastern door was unfortunately largely dismantled by a late, huge pit that removed

Figure 6: Building Ia: a) Detail of the wall masonry (wall SU50); b) Triangular ventilation slits in the northern perimeter wall (wall SU289); c) The east entrance, with detail of the door socket; d) The west entrance. (Photos M. Degli Esposti)

its southern side and part of the wall forming the northeast "tower" of later Building Ib. This entrance, which is tempting to describe as a gate, was accessed via a flight of shallow steps made in the same hard mortar used to bind the walls and create the original floor surfaces (Figure 6c). Noteworthy is the presence of a door socket still in situ, just inside the threshold (Figure 6c inset). A second door socket was discovered near it, slightly displaced. Interestingly, it showed the traces (and actually was still associated with the extremely decayed remains) of a bronze item that was likely applied to the bottom of the doorpost to facilitate its rotation on the socket.

The western entrance appears to be less monumental, although framed by two half pilasters tied to the side walls (Figure 6d).

The whole building was paved with the stone-hard plaster floor mentioned above, SU170, which showed traces of burning at least in its south-eastern portion, where the walls' plaster is also blackened.

When it comes to establishing a date for Building Ia, recently obtained radiocarbon dates have changed the picture originally proposed. In fact, the first radiocarbon date that we had available came from a sample collected right above the original floor SU170 (Deposit SU204) in the area of Room 3 later modified into Room 1 (eastern part), and provided a date between 1200 and 950 BCE (Degli Esposti *et al.* 2022: Table 3, lab code LTL20649), confirmed by a second sample from the same context (Table 1, lab code LTL22665).

However, dates from contexts that are stratigraphically later than SU204 were not consistent with these two. An example is provided by SU267, a deposit covering the threshold of the passage connecting Rooms 1 and 2 through wall SU88 (therefore, surely later than SU204, see Figure 5) for which the radiocarbon determination indicates a date into the third quarter of the 2nd millennium (Table 1, lab code LTL22008).

Given this incongruity, it was deemed useful to obtain another date from SU204. During the 2022 field season, one further portion of this deposit was excavated, undoubtedly framed between the original floor SU170 and the later plaster floor SU99 that replaced it when rooms 1 and 2 were realised. Here, a vessel smashed on the floor (F497) was associated with some charcoal. This was sampled to get an additional date (Table 1, lab code LTL31047) that turned out to be in agreement with those from the adjacent area but not with the more recent ones previously obtained for SU204. Further confirmation comes from another sample collected from deposit SU274 inside Room 2. This anthropogenic accumulation lies directly above the original stone-hard floor of the early Room 3, here identified as SU281 but equal to SU170 (Figure 7), so that SU274 itself can be equated with SU204. The obtained date (Table 1, lab code LTL22009) is consistent with the new one from context SU204 and with the one from SU267.

This strongly indicates that the samples previously collected and associated with SU204 have actually to be correlated with some of the later pits, dumps and reworked deposits that buried the eastern part of Room 1.

Figure 7: The original, stone-hard plaster floor of Room 3, as exposed in the area of later Room 1, top left, and Room 2, top and bottom right. Bottom left, the smashed pot F497 above SU170. (Original photos F. Borgi, F. Barchiesi, M. Degli Esposti)

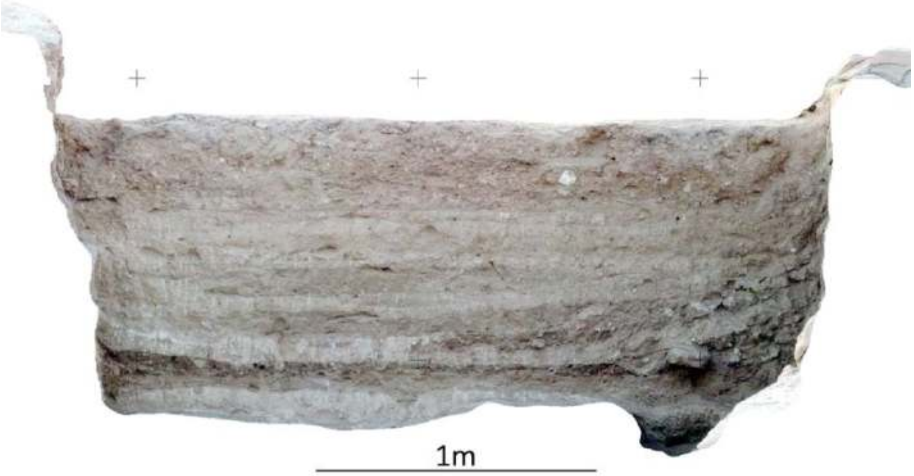

Figure 8: The stratigraphic sequence in the northern part of Room 2, with a succession of hard-packed floors and thin anthropogenic deposits. (Elaboration F. Borgi)

Furthermore, excavation during the 2022 field season showed that the stratigraphy in the eastern part of Room 1 is completely different from that in its northern part. The latter comprises a sequence of floors and thin anthropogenic accumulations arranged in an orderly succession (Figure 8). From this sequence, a series of samples were collected, two of which have already been dated, others pending. Unfortunately, the archaeological material associated with these layers is quite scarce, as the surfaces were likely to have been clean, but one can underline here the presence, again, of vessels made in the gritty grey ware discussed above. The two dates cover the period between the late 15th century and the 12th century BCE (Table 1, lab codes LTL31044, LTL31045) and are consistently slightly later than those obtained for the earliest deposits on top of Room 3's floor. Despite other ASM analyses pending, the available data now rather convincingly indicate a date for the construction of Building Ia between 1500-1300 BCE. This also means that this impressive structure could have coexisted, at least partially, with the significantly humbler Room A discovered in Trench 1 (see above), and calls for further excavation aimed at investigating the stratigraphic correlation between the two areas.

Incidentally, this revised chronology better fits the presence, in a dump layer associated with the decommissioning of Building I, of several large, so-called trumpet base jars, two of which bore the impression of two different cylinder seals. These were discussed elsewhere (Majchrzak and Degli Esposti 2022), primarily focusing on the seals' iconography and more generally on the diffusion of similar jars, pointing out their probable provenance from south-eastern Iran or southern Mesopotamia. More work is needed, hopefully including archaeometric studies that could support the proposed provenance. When discussing their possible date, morphological parallels and the available radiocarbon dates — which are now known to be too recent — were used to balance the indication obtained from iconographic comparisons. It is now clear that the narrower chronological frame indicated by the iconography, that is, the third quarter of the 2nd millennium, has to be favoured against the broader range or actually even a later date previously suggested and mainly based on the absolute dates and morphological comparisons (Majchrzak and Degli Esposti 2022: 166).

Parallels for the plan of Building Ia will have to be sought for, to trace possible external influences. It is again the iconography of the mentioned seal impressions that might guide the search. In fact, it indicates a possible provenance from southern Mesopotamia or the Elamite area (Majchrzak and Degli Esposti 2022: 165). The latter would be consistent with the discovery of a faience seal from Tell Abraq with parallels in the Middle Elamite (1500-1100 BCE) glyptic of the 14th/13th century BCE (Potts 1990: 122-123 and Figures 150–15). At the same time, it has been speculated that this side of the Arabian Gulf was under the Kassite sphere of influence, respected by the Elamites, who were consolidating their control over the opposite coast, within the context of an inter-dynastic alliance (Potts 2006).

Early Iron Age (Iron Age II)

Apart from investigating the huge surrounding wall SU173, the deep trench excavated to the north-east of the mound (in the area of Trench 7) had another aim, namely to verify the possible presence of a second, later ditch, previously discovered in the south-western part of the site and considered coeval with wall Set 52 (Magee *et al.* 2017).

Indeed, a possible ditch (SU465) was identified, although its bottom was not reached and the lower infill remains to be excavated (Figure 9). From what can

Figure 9: View of the possible ditch SU465 at the bottom of the deep trench in Trench 7, opposite views. (Photos F. Borgi)

Figure 10: The setting of the small bridge-spouted jar F372, nested inside different potsherds in a small pit in Trench 7, and the gold wire it contained. (Photos M. Degli Esposti, drawing N. Gilbert)

be seen at this stage, its lower part could have also been lined with stones (at least on one side), which would be consistent with the fact that it was cut through clean sand. In fact, in this place, there is no evidence of the aeolianite formations reported from other areas of the site (Magee *et al.* 2017: 222, Figure 18).

All the materials so far collected from the upper fills of this possible ditch can be dated to the 1st millennium BCE with the occasional occurrence of Iron Age III material. Radiocarbon dates support such a chronology (e.g., Table 1, lab code LTL22015). No built structure belonging to the Iron Age II period was discovered.

From a context buried beneath the massive collapse of the huge wall SU173 (that contains the large terrace surrounding the site), inside which Early Iron Age material was exclusively collected, another interesting find was that of a small bridge-spouted vessel, rather crudely made, that contained gold wire and was hidden in a small pit, further nested inside the large sherds of a few different pots (Figure 10). The gold wire immediately brings to mind connection with Saruq al Hadid (Weeks *et al.* 2017: Figure 22/SF 28523 and SF22231), further supported by the shape of the small vessel itself, which finds parallels at the same site (Weeks *et al.* 2017: Figure 3/SF 30192), including some specimens used to store copper scrap (Valente *et al.*: Figure 10).

Structures dated — again by means of the associated materials as well as by radiocarbon dating — to the first half of the 1st millennium were discovered in Trenches 4 and 5, above the buried remains of Building I. While the presence

Figure 11: Zenithal view of Trench 5 (N at the bottom) with wall SU272, pillar SU465 (and detail), and a picture of the smashed storage jar F344 before removal. (Photos F. Borgi, M. Degli Esposti)

of a use-surface associated with a hearth and a *tannour* jar in Trench 4 was reported elsewhere (Degli Esposti *et al.* 2022), the extension of the excavated area to the south by means of Trench 5 revealed other features connected to this phase of occupation (Figure 11). These include the stretch of a straight N/S stone wall (SU272), a large storage jar smashed in situ near it (F344), and a particular square pillar base (SU465). Wall SU272, with a preserved height of three courses of stones, abuts the surviving crest of wall SU83, that is, the southern perimeter wall of the earlier Building Ia. It seems conversely to have no actual correlation with the pillar base as they have inconsistent orientations. At this stage of the work, the outline of the building to which wall SU272 could pertain cannot be identified, nor the context of pillar SU465 specified.

Iron Age III

Above the backfilled ditch in Trench 7, another structure was discovered that represents an addition to the rich site's history. This two-room building, named Building II, can be dated to the Iron Age III period, for which no other structure was reported from the site as far as we are aware (Figure 12). Its presence is all the more remarkable in the general paucity of remains of this period in the region, with the notable exception of Al Madam. The peculiar whitish mudbricks, in all likelihood made by mixing clay with the gypsum-rich

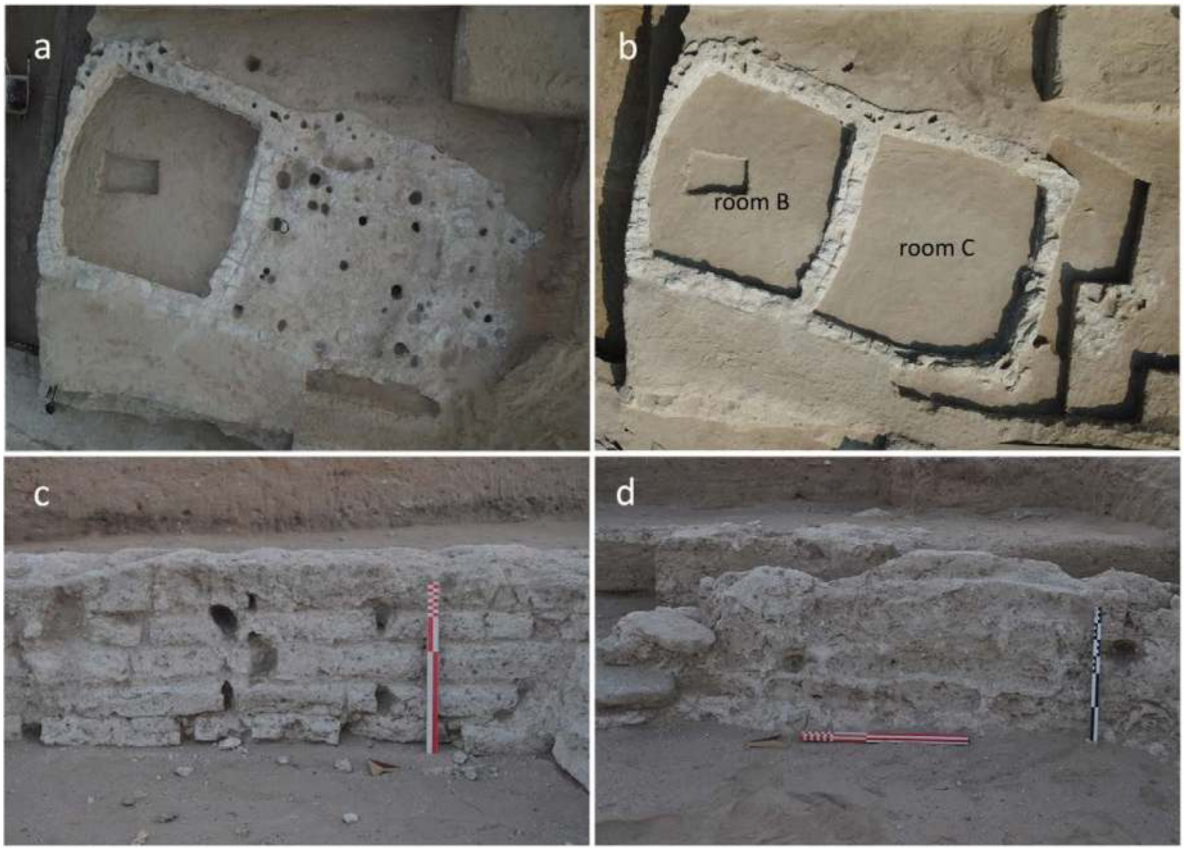

Figure 12: Building II in Trench 7, with an image of later postholes cutting through it and connected to later occupational surfaces (N on top). Bottom left and right, detail of the different masonry in Room B and Room C respectively. (Photos F. Borgi, M. Degli Esposti)

substratum typical of the coastal sabkha environments (Evans *et al.* 1969), are also worth mentioning and recall the technique witnessed in the Mud Working Area at Al Madam 1 / Thuqeibah, dated to the Iron Age II/III (Córdoba 2013: 144-147). Although the two rooms of the building seem to have been erected at the same time, one has to point out their different masonry. While for the western room the whitish mudbricks just described were used, the eastern room was built with softer, brown mudbricks with a sandy fabric. However, the same white, gypsum-base mortar was used as a binder in both rooms.

Two radiocarbon dates help frame the construction of this two-room building. One was obtained from SU309, a charcoal lens filling the ditch SU465 that runs below Building II, the other from SU310, one of several occupation surfaces associated with postholes developed above the abandoned structure (Table 1, lab code LTL22015, LTL22016).

The Late Pre-Islamic period

With the possible exception of a new grave discovered during the 2022 season (see below), which adds to the extremely ruined features brought to light previously by the IAMUQ and only tentatively interpreted as burials (Degli Esposti *et al.* 2022: 144-145 and Figure 6a–c), no structure has so far been discovered in the IAMUQ's excavation that can be dated to this period. At the same time,

Figure 13: Camel figurines, copper-alloy figurines and stone statues from the reworked deposit SU43 in Trench 4. (Photos F. Borgi, M. Degli Esposti, C. Abric)

however, a surprisingly rich assemblage of artefacts was discovered scattered through the topmost 50 cm of loose sand accumulation on top of Trench 4 (SU43), stratigraphically unrelated, therefore, to any safe context.

A few camel figurines had already been discovered in this area during the 2020 season (Degli Esposti *et al.* 2022: 153 and Figure 10/2), but the remarkable number of new specimens found mainly in 2021 actually came as a surprise.

All the figurines coming from this area can be dated to the Late Pre-Islamic (LPI) period. A first discussion of these figurines, using a pottery-technology approach that also helps in attributing a date to the loose fragments, has recently been presented at a conference in Mainz and will be published in the related proceedings (Abric, Pellegrino and Degli Esposti 2022).

Among the LPI examples, a figurine (F72), which could be largely reconstructed from detached fragments, stands out (Figure 13a). Its peculiarity is the saddle (F244), shaped separately and then fixed on the hump with a thin patch of clay, above which the rider was also represented. Unfortunately, the rider's body is lost and only the hips and legs survive together with the saddle.

The neck displays an incised decoration, likely to be representing the harness, comprising straight lines and tiny dots. Similar figurines are known from several sites over the whole Arabian Peninsula, such as Tayma (Al Hashash 2006: pl. 3.10/c), Dadan (Al Saeed *et al.* 2011: pl. 2.8/c) and Thaj (Eskoubi and al-Alaa 1985: plate 35.A-B) among others, all with the same dots and line decoration.

Another fragmentary figurine (F1) discovered in Trench 2 provides a perfect example of the difference between the fabric used to shape the LPI figurines and that used for Early Iron Age (Iron Age II) examples (Figure 13b).[4] F1 lacks the neck, head and tail, and only the upper part of the legs survives. However, it still comprises a squarish, flat saddle decorated with dark red-brownish strokes, the latter also visible along the body. The best parallel surely is the almost-complete, painted figurine discovered at Muweilah together with other fragments including a detached square saddle (Magee 1996a: 207 and Figure 28; Magee 2007: Figure 30), but these figurines are also widespread and other painted examples are known, for example, from Rumeilah (Boucharlat and Lombard 1985: plate 65/4–6) and farther afield, Salut in central Oman (Degli Esposti 2021: Figure 27). The preference for painted decoration over an incised one seems another potential chronological indicator in addition to the material used.

From the same disturbed context also come a few bronze figurines. The most interesting two, a standing naked man and an ibex, illustrate the reception and re-elaboration of external motifs and iconographies (Figure 13e-f). While the ibex immediately recalls South Arabian productions, for the human figure the interpretation as a crudely and partially misunderstood representation of the motif of the resting Heracles can be suggested (Pavan and Degli Esposti 2023).

If these figurines were actually not much expected, the most remarkable finds from this surprisingly rich context are two fragmentary human statues made in bio-calcarenite (Figure 13g-h). While in one way they recall the eagle statues discovered in the large fortified building in Chantier F (Lecomte 1993: Figure 2; Boucharlat *et al.* 1989: 38-39, Figures AE, AF) and less so the ruined example from the Shamash temple (Haerinck 2011: 10 and pl. 54/1) at Ed-Dur, they are, however, unique in the region as they portray human figures.[5] On the one hand, the raw material can be found along the emirates' coast; on the other, at first sight, they recall the statuary from Hatra or Palmira, the influence of which reached Southeast Arabia in the period when the kingdom of Characene prospered and exerted its control over the sea routes through the Gulf (Gregoratti 2011). In this perspective, the discovery of coins from Characene at the nearby site of Ed-Dur can be mentioned here, underlining the fact that they constitute the larger group among the foreign issues (Haerinck 1998).[6]

[4] See also the difference between the LPI example in Figure 13c and the Iron Age one in Figure 13d.

[5] Only a fragmented figurine of much smaller dimension from Mleiha is known to the authors (Méry and Mouton 2018/2013: 53).

[6] A detailed iconographic analysis of these statues is currently being carried out and its publication is in preparation by I. Bucci and M. Degli Esposti.

Figure 14: Grave 5. Note the bunch of iron arrowheads to the left of the body, below the LPI grey ware potsherd. (Photo M. Degli Esposti)

A new Late Pre-Islamic (or Sasanian?) grave

A new grave was discovered in November 2022 in Trench 8, that is, the explored area to the north of Building I. The burial, identified as Grave 5, was placed in a simple pit right against its northern wall, suggesting the latter was still visible (Figure 14). The body is west-east oriented, with the head turned to the right and thus facing south. The individual lies mainly on its back but is slightly turned on the right shoulder. The left arm is flexed at 90 degrees with the forearm on the abdomen. The right forearm is largely missing due to late disturbance, but it was probably flexed with the hand almost in front of

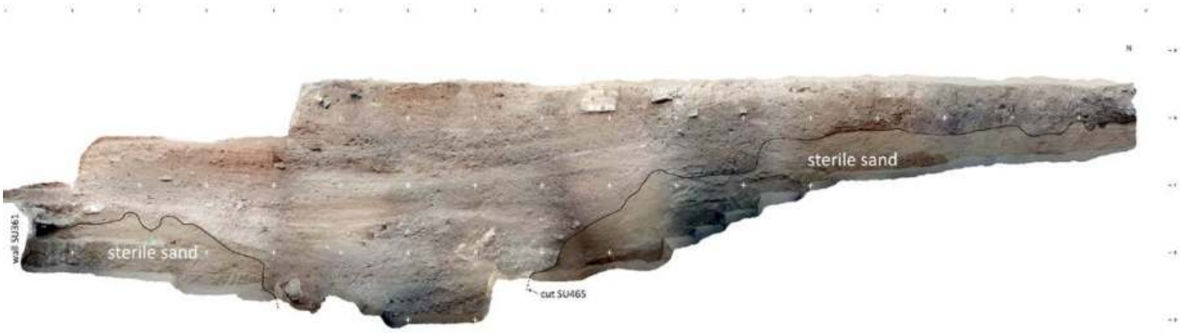

Figure 15: The western profile of the deep trench in Trench 7, showing the layout of the possible natural dune that was cut to realise ditch SU465. (Elaboration F. Borgi, M. Degli Esposti)

the mouth. The lower limbs are flexed in a semi-crouched position.[7] The grave contained no funerary goods except for a bunch of five iron arrowheads fused together by corrosion, probably originally contained in a quiver or small bag.

The dating of this burial remains hypothetical. Several graves dated to the LPI period were identified by the team of D. Potts on this same slope of the mound (Potts 1991: 105–119), and it is tempting to add Grave 5 to that group. At the same time, a date later into the Sasanian period cannot be ruled out, especially considering the discovery of a drachm of Shapur II near the surface of the site not far from Trench 8 (Potts 2000: 115). A possible indication of such a date for the burial might come from the retrieval, inside the pit, of the sherd of a large storage jar in the thick grey ware typical of the LPI at Ed-Dur, possibly providing a *terminus post quem* for the excavation of the pit.

A window on past climate change

The excavation of the deep trench targeting the possible outer ditch in Trench 7 not only exposed the structures discussed above but also provided a view of the stratigraphic record spanning the end of the second millennium to the current surface. Of great interest, and currently under study by our geomorphologists,[8] is the sand formation exposed by the deep trench (Figure 15). This seems to pertain, at least in its upper portion, to a natural dune, the bottom of which was possibly deepened artificially to realise the actual ditch (cut SU465). It is clear that, if confirmed, the existence of an episode of dune formation during the lifetime of the site would be of great interest for the reconstruction of past climate changes at a discrete scale. To establish the chronology of this possible event, however, understanding the nature of wall SU361 (see above) will be essential. In case it is proved to constitute the lining of an earlier ditch, the presence of at least the lower part of the dune would

[7] The anthropological study of the remains has already been completed by T. Nicolosi (University of Bologna) and samples were collected for isotopic and proteomic study. It is hoped that radiocarbon dating will also be possible.

[8] The geomorphological investigation at Tell Abraq is part of the collaboration between the IAMUQ and the Department of Earth Sciences "A. Desio" of the University of Milan and is carried out by L. Forti, M. Cremaschi and A. Zerboni.

predate it; conversely, should SU361 be the containing wall of an ancient terrace, the dune would have accumulated against it at some point between the 14th/12th centuries BCE (when final activity on the possible terrace is witnessed by the radiocarbon-dated dumped material of SU429, see Table 1, lab code LTL31046) and broadly the beginning of the 1st millennium BCE (as indicated by the Iron Age II material collected from the fills of cut SU465, the possible ditch).

Discussion and final remarks

Tell Abraq is arguably one of the most extensively investigated sites of Southeast Arabia, with a history of research beginning almost 50 years ago. Due to their massive quantity, only part of the collected data has found its way to publication (e.g., Potts 1990, 1991, 2000; Magee *et al.* 2017), yet it sufficed to make the site a key reference for the archaeology of the region thanks to the comprehensive stratigraphic sequence and the evidence for long-distance connections with surrounding regions (Potts 1993b and 2000).

Although imbalanced towards the south and eastern sides of the site, located in Sharjah's territory, previous excavations provided the basis for the reconstruction of the general evolution of the site, outlining the original existence of an impressive Early Bronze Age tower and associated grave(s) and the later development of a large terrace system over the buried remains of the tower, topped during the 2nd millennium by the construction of a massive mudbrick platform and surrounded by two ditches excavated at different moments and not simultaneously active (Potts 1993a; Magee *et al.* 2017). Occupation extended beyond the limits of the lowermost terrace, where evidence for light-material structures was collected, mainly dated to the late 2nd millennium BCE, and the site is likely to have represented a landmark in a vast and sparse anthropic landscape developing along the coast (Magee *et al.* 2017: 210-211).

The new excavation project started by the IAMUQ along the east/north-eastern slope of the mound was originally set to verify this general model and to proceed to the swift publication of the results. Admittedly, however, the results are characterised by adding previously unreported aspects to the site's history rather than merely confirming the proposed reconstruction, even though our excavation has not reached so far the levels predating c. the mid-2nd millennium BCE.

In the north-eastern part of the mound, remains of the terrace system were actually documented, although remarkably truncated by erosion in the upper slope. Notwithstanding this, an L-shaped room with mudbrick and stone walls (Room A), datable to the third quarter of the 2nd millennium BCE, was brought to light, which should have occupied one of the terraces (the layout of which is currently not identifiable). This structure already represented an unprecedented discovery at least in its scale and completeness, although it can be compared with loci 16 and 17, two structures partially revealed in the 1989's stepped trench and dated by the excavator to the Iron Age (Potts 1990: 96-98). Such a date was based on the collected pottery, which notably included several sherds in the gritty grey ware that was later isolated as a possible leit-fossil for the Iron Age I (1300-1100 BCE) period (Magee 1996b) but is now reckoned to span a longer chronology going back at least to the mid-2nd millennium BCE (see above). As such, we cannot exclude the possibility that Room A could have coexisted with loci 16 and 17 on the opposite slope of the mound.

Also consistent with previous results, a new stretch of the massive wall surrounding the site (SU173 in the IAMUQ's archive) and containing the widest terrace was exposed to the north of the mound, and one or two possible ditches were located, which could correspond to those identified by the team lead by P. Magee (Magee *et al.* 2017). These cut features have been only exposed over a very limited extent, and further excavation is needed to assess their nature, possibly alongside a thorough geomorphological study of their fills aimed at the reconstruction of ancient climate.

Unprecedented, conversely, is the discovery of Building II, dated to the Iron Age III period but unfortunately associated with a very limited pottery assemblage that is, moreover, extremely mixed due to the continuous reworking of the sediments linked to the repeated occupation of the area. In the paucity of coeval structures in Southeast Arabia in general, and in the absence of them at Tell Abraq, this discovery will open the way to a discussion of this period at the site and more broadly in the Umm Al Quwain coastal area, where it has not been previously documented.

The most astonishing discovery was, however, that of the impressive remains of Building I, here meaning both the original, self-standing Building Ia and the later, composite structure of Building Ib. Not only does the presence of this building compel an investigation of the possible influences behind its construction, as outlined above, but its scale also calls into question the general layout of the whole eastern/south-eastern part of the mound. Its dimensions, in fact, imply that to provide space for its construction, a large swathe of the earlier deposits had to be removed. Our first assumption was that the building replaced part of the mentioned terrace system of the 2nd millennium BCE, including the possibility that the impressive building enterprise represented by the erection of the surrounding wall SU173 might have been functional to the creation of a large flat area where Building I could be accommodated. The new radiocarbon dates presented here, however, indicate this was an oversimplified reconstruction. Building I appears, in fact, to be more ancient than wall SU173 and to have been first erected in a period when several terraces with numerous floors and light-material structures were in use (Magee *et al.* 2017), including Room A in our Trench 1. On the one hand, this provides a first hint of a possible hierarchy among the built structures at the site in the second half of the 2nd millennium BCE (possibly linked to a different provenance of the builders?); on the other, it underlines the need for further excavation aimed at clarifying the stratigraphic connections between Building I and the surrounding terraced areas.

In this paper, only brief mentions have been made of a few particular artefacts from the site.[9] By way of a general point, one can say that pottery is not as abundant as one would expect, largely due to the situation in the area of Building I. There, in fact, the stratigraphy is heavily disturbed by large pits, inside which little ancient materials were re-dumped. Moreover, there are areas where successions of ancient floors were preserved, but the interlaying deposits are very poor in artefacts, likely mirroring the fact the surfaces were kept clean. The discovery of the rich LPI assemblage from the topsoil in Trench 4 represents an exceptional finding for the area but raises the impelling question of which structure(s) they could be associated with. As discussed elsewhere, two options present themselves: graves or a cultic building (Pavan and Degli Esposti 2023). In the absence of structural remains of this date, the grave goods interpretation has been favoured (*ibid.*), but a more extensive investigation of the upper eastern slope is necessary to exclude the presence of buried structures. Indeed, in Trench 9, the small portion of what seems to be a platform made with unhewn beach-rock blocks, was discovered at the end of the 2022 season. Its stratigraphically late collocation and its appearance are reminiscent of the structures currently visible at Ed-Dur and demands for a complete excavation to try and ascertain its nature, although it would surely be nothing comparable with the unique temple of Shamash discovered there (Haerinck 2011).

One final point deserves mention, even if it goes beyond the subject of archaeological investigation. In fact, the continuation of our work at Tell Abraq is aimed not only at answering the archaeological questions we have (and raising new ones as shown above) but also at enhancing the 'usability' of the site for the wider public, a paramount goal for the Tourism and Archaeology Department. Surely, the discovery of outstanding structures such as wall SU173 and Building I will strongly contribute to making the site a new pole of attraction for the interested local community and for international tourists, integrated into the broader network of sites of primary importance that constitute the ancient heritage of Umm Al Quwain. Moreover, the completion of the new national museum, currently under construction, will enrich the offer and will provide a perfect display for the findings from Tell Abraq.

9 A thorough discussion of the Late Bronze Age and Early Iron Age pottery is in preparation by M.P. Pellegrino and M. Degli Esposti.

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‘We should build with the stones we have’
An assessment of the Al Ain Oasis during the Iron Age based on the soft-stone vessels from the Oman Border Fence

Eric Olijdam

Abstract: Soft-stone vessels are rapidly establishing prominence as one of the principal chronological markers for the 2nd millennium BCE. For some periods, they provide unprecedented detail not encountered in other artefact categories, particularly the largely elusive Iron Age I (c. 1300–1000 BCE). The extensive collection of 449 individual vessels retrieved during the Oman Border Fence excavations (2021–2022) in Al Ain presents an extraordinary opportunity to study soft-stone vessels from a range of secure and well-developed contexts. This collection, consisting almost exclusively of fragmented remains, is examined using the latest insights on soft-stone seriation and offers a unique perspective on the diachronic development of the cemetery and the Iron Age agricultural and hydraulic systems encountered within the circumscribed limits of the excavations. It is also an important tool to assess the Al Ain Oasis in light of the ongoing debate about the nature and extent of the Iron Age I horizon in Southeast Arabia.

Keywords: Al Ain, Iron Age, Iron Age I period, soft stone (chlorite/steatite/soapstone) vessels, *falaj*

Preamble

One of the first things an archaeologist wants to determine when dealing with a site is how old it is. For most periods, the answer is to be found first and foremost in the pottery. It was believed for a long time that this also applied to sites dating to the Iron Age. A tripartite chronological framework has long been proposed, corresponding to three distinct ceramic assemblages, that is well-established and widely accepted (Magee 1996; Magee and Carter 1999).[1]

[1] However, the transitions from Late Bronze Age to Iron Age I and from Iron Age I to Iron Age II are poorly defined. Cessation of the Iron Age I period at c. 1100 BCE requires review in light of the current complexity and apparent fluidity in the ceramic record as well as the results of robust radiocarbon-dating programmes at Saruq al-Hadid and Salut (Weeks *et al.* 2019; Condoluci, Degli Esposti and Phillips 2018; Degli Esposti 2021). A date of c. 1000 BCE is consistent with the overall trend emerging from the radiocarbon samples of other sites in Southeast Arabia (Magee 2003; 2007; Magee *et al.* 2017; Karacic *et al.* 2020; De Vreeze *et al.* 2022; Majchrzak and Degli Esposti 2022; Schwall *et al.* 2023).

For decades, the Iron Age I horizon (c. 1300–1000 BCE) was identified solely on the basis of simple, crudely made ceramics. This narrow definition worked for the UAE and Northern Oman, where two traditions have been identified (Magee and Carter 1999).[2] It is, however, inapplicable for the rest of Oman as no such handmade pottery has been attested there. The result is a strict division of Southeast Arabia into a northern part with handmade pottery and a southern part without it (Schreiber 2010). Excavations at Husn Salut in Central Oman confirmed this long-held perception in a rather surprising manner. In well-defined stratigraphic contexts that are dated by a robust radiocarbon-dating programme, a clear Iron Age I horizon has been identified that is by all definitions ceramically Iron Age II in nature (Phillips 2010; Condoluci, Degli Esposti and Philips 2018; Degli Esposti *et al.* 2018). The validity of these results is now confirmed by similar findings from the associated settlement at Qaryat Salut (Degli Esposti 2021). This unexpected conclusion challenges the automatic inferences that Iron Age II pottery equals an Iron Age II date and that the absence of handmade Iron Age I pottery implies an Iron Age II date, at least for Central Oman (Phillips 2010: 72; Degli Esposti *et al.* 2018: 379).

However, the restricted distribution of handmade Iron Age I pottery supports the hypothesis that even within the north it presents a local phenomenon linked to only a select number of well-established communities (Schreiber 2010: 87-88; Magee 2011: 214-215). To underscore this point, the ceramic evidence from several settlements, primarily located in the interior, reveals a more complex picture. A limited range of Iron Age II ceramics has been attested in Iron Age I contexts in the SHARP (Saruq al-Hadid Australian Research Project) excavations at Saruq al-Hadid. Due to the nature of the Level III deposit, these could be dismissed as intrusive — like they have been for Tell Abraq (Magee 2011: 215) — if it were not for the fact that it only concerns a rather specific category of Iron Age II ceramics, namely 'ritual' vessels (Weeks *et al.* 2019: 1062). Irrespective of whether they were imports or local imitations, this shows that a select range of Iron Age II vessels circulated in the north during the Iron Age I period and that the two ceramic regions were in contact. Concomitantly, in the north, at least one of the Iron Age I wares appears to have remained in use during the Iron Age II period (Power, Benoist and Sheehan 2019: 85): it forms a substantial minority in the Iron Age II assemblages of Tell Abraq and Saruq al-Hadid (Magee 2011: 215, 217; Weeks *et al.* 2019: 1062-1064). Minute amounts have been reported from the Iron Age II inland settlement sites at Muweilah, Al Thuqeibah, Hili 2, and Hili 17 (Magee and Carter 1999: 176; Schreiber 2010: 84; Magee 2011: 216),

[2] In contexts without a reliable stratigraphically defined chronology, it has proved challenging to differentiate between Late Bronze Age handmade pottery and its Iron Age I counterpart, which is clearly a continuation of the former (Magee 2014: 189-195; Magee *et al.* 2017: 226-231; Degli Esposti *et al.* 2022: 151).

indicating they almost certainly represent intra-regional imports.[3] Handmade Iron Age I pottery has also been attested in Rumeilah, the most extensive Iron Age settlement site in the Al Ain Oasis (Schreiber 2010: 84 n.18). It is regretfully unspecified how much and in/from which contexts, so it is unclear if this was found in Iron Age II contexts — similar to Tell Abraq, Saruq al-Hadid, Muweilah, Al Thuqeibah, Hili 2 and Hili 17 — or whether it may indicate the presence of an Iron Age I horizon somewhere at the site — which would be supported by a series of radiocarbon dates from different parts of the site and a fair portion of its soft-stone collection (Boucharlat and Lombard 1985; 1991). Questions regarding the stratigraphic security of radiocarbon samples and the potential reuse of material culture add another dimension to the uncertainty (*pers. comm.* Anne Benoist).

For the latter half of the 2nd millennium BCE, our understanding of the diachronic and geographical complexities and their reflections in the ceramic record needs to improve. Until then, independent verification is required in much of Southeast Arabia and for most archaeological contexts to ascertain whether surveyed or excavated materials date to the Iron Age I and/or Iron Age II periods. This may have far-reaching consequences if it were to be strictly applied to the available data, as the Iron Age I 'Dark Age' and the sudden Iron Age II boom are based to a very large extent on a rigorous attribution of ceramics to a specific time frame. Their sharp contrast heavily influences our understanding of the socio-economic and political dynamics of the Iron Age in Southeast Arabia (Magee 2007; 2014: 214-240).

Beyond ceramics

In order to increase our knowledge of what Iron Age I material culture entails, Christian Velde and I recently focused on a much-neglected category: soft-stone vessels. By combining a multitude of evidence, we defined a coherent assemblage that can be attributed to the Iron Age I period (c. 1300–1000 BCE) (Olijdam and Velde 2023). By doing so, we established something that the pottery evidence cannot do in the current state of understanding: identify an independent, unambiguous and easily verifiable parameter for the Iron Age I period. So far, Iron Age I soft-stone vessels have been attested at 42 sites in Southeast Arabia, from Shimal in the north to Bilad Bani Bu Hasan in the

[3] A small amount and a limited range of handmade Iron Age I pottery (congruent in ware and shape) have also been found in central Oman at Husn Salut in contexts dating to the Iron Age II period (Phillips 2010: 72 n.3; Degli Esposti *et al.* 2018: 377 n.38). This material is notably absent from the Iron Age I levels of that site.

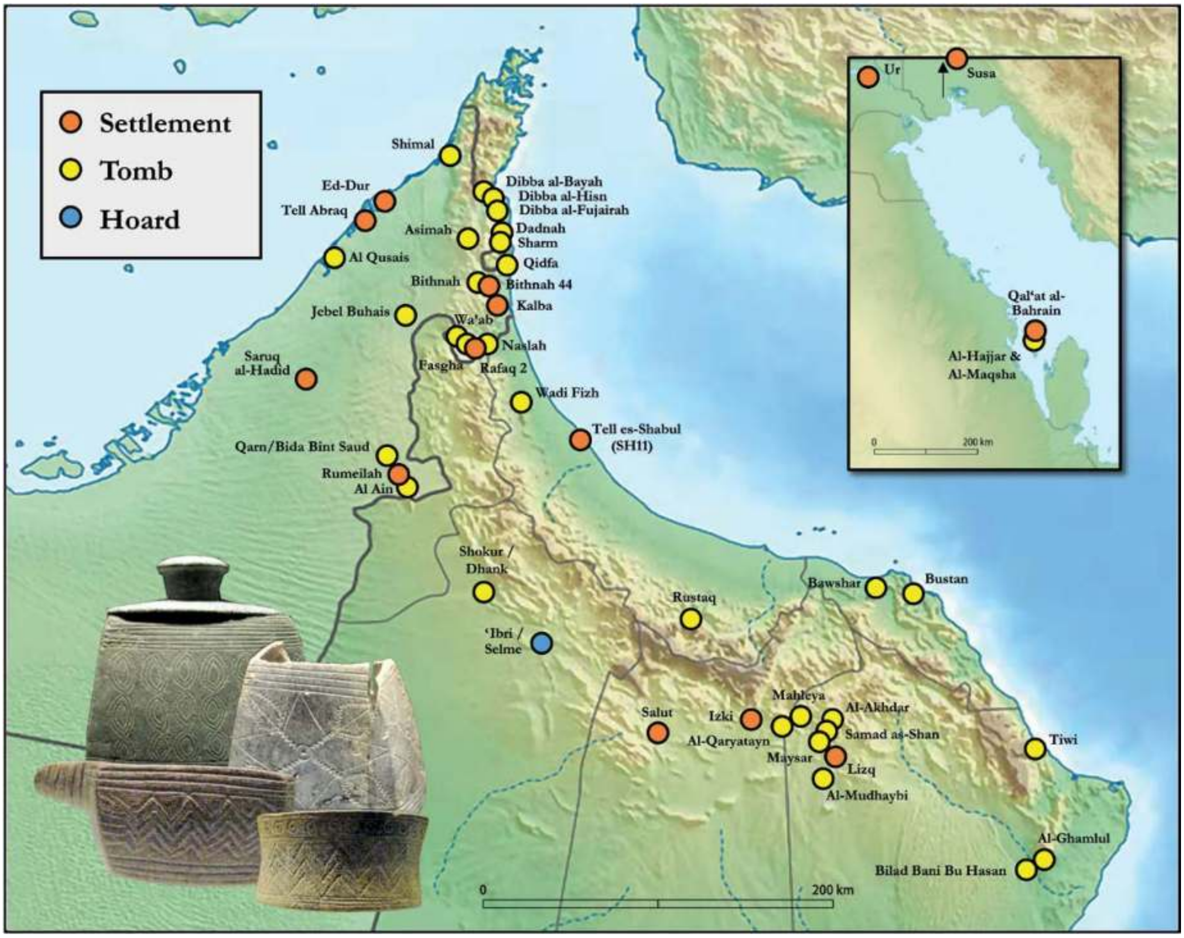


Figure 1: Distribution map of Iron Age I soft-stone vessels.

south (Figure 1).[4] The fact that it has been attested in well-defined Iron Age I contexts in the north in association with exclusively handmade Iron Age I pottery (at Shimal 102, Asimah 100, and Dibba LCG-1) as well as with a mixture of handmade Iron Age I pottery and Iron Age II pottery (at Saruq al-Hadid), and in well-defined Iron Age I contexts in the South with exclusively Iron Age II pottery (at Husn Salut and Qaryat Salut) strengthens its position rather than weakens it. Soft stone is the only reliable chronological Iron Age I marker that is valid for the whole of Southeast Arabia. An additional bonus is that retroactively examining collected soft-stone materials is relatively easy and inexpensive.[5]

Furthermore, we proposed a chronological refinement of the Iron Age I assemblage by identifying two chronologically disparate stylistic groups, provisionally labelled 'early' and 'late' (Olijdam and Velde 2023: 257-264) (Figures 2a and 2b). The relative positioning of the two groups in relation to the

[4] An Iron Age I vessel has been reportedly found in a settlement context at Gharfah (Taha 2009: Pl. 66/C). It is unclear how accurate this attribution is and how this find relates to other discoveries in the Dibba area. Pending additional information, its inclusion in the distribution map is therefore withheld.

[5] An accurate result requires an in-person examination of all the materials rather than revisiting old drawings and/or photographs (Olijdam and Velde 2023: 256-257).

Figure 2a: Iron Age I 'early' group. Legenda: (1) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/08, (2) Bithnah 4: Corboud *et al.* 1996: Pl. 19/01; (3) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/05; (4) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/06; (5) Dibba LCG-1: Genchi and Tursi 2022: Figure 15/15; (6) Dibba LCG-1: Genchi and Tursi 2022: Figure 15/16; (7) Dibba LCG-1: Genchi and Tursi 2022: Figure 15/13; (8) Dibba LCG-1: Genchi and Tursi 2022: Figure 15/17; (9) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/10; (10) Dibba LCG-1: Genchi and Tursi 2022: Figure 10/14; (11) Dibba LCG-1: Genchi and Tursi 2022: Figure 10/09; (12) Dibba LCG-1: Genchi and Tursi 2022: Figure 7/15; (13) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/08; (14) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/03; (15) Dibba LCG-1: Genchi and Tursi 2022: Figure 10/11; (16) Dibba LCG-1: Genchi and Tursi 2022: Figure 7/13; (17) Dibba LCG-1: Genchi and Tursi 2022: Figure 19; (18) Naslah 1: Phillips 1997: Figure 7; (19) Fashgha 1: Display National Museum of Ras Al Khaimah.

Figure 2b: Iron Age I 'late' group. Legenda: (1) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/09; (2) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/10; (3) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/11; (4) Mahleya G10: Eric Olijdam (DA 20744); (5) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/12; (6) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/03; (7) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/04; (8) Dibba LCG-1: Genchi and Tursi 2022: Figure 16/01; (9) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/14; (10) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/16; (11) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/20; (12) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/19; (13) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/18; (14) Dibba LCG-1: Genchi and Tursi 2022: Figure 07/17; (15) Dibba LCG-1: Genchi and Tursi 2022: Figure 10/10; (16) Dibba LCG-1: Genchi and Tursi 2022: Figure 10/13; (17) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/12; (18) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/15; (19) Wa'ab 4: Eric Olijdam (RAK 5213); (20) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/14; (21) Dibba LCG-1: Genchi and Tursi 2022: Figure 13/13; (22) Dibba LCG-1: Genchi and Tursi 2022: Figure 20/03; (23) Dibba LCG-1: Genchi and Tursi 2022: Figure 18/right.

Late Bronze Age and Iron Age II soft-stone corpora, respectively, is clear, as is their internal placement within the Iron Age I assemblage. What is missing at the moment is independent dating evidence that anchors the 'early' and 'late' groups and determines their longevity and possible overlap.[6]

This puts soft-stone vessels at the forefront of the discussion on the nature and extent of the Iron Age I horizon in Southeast Arabia.

The Oman Border Fence Project

The presence of a specific range of Iron Age II pottery in Level III contexts at Saruq al-Hadid, the southernmost site in the northern part of Southeast Arabia with a demonstrable Iron Age I horizon, clearly indicates that some form of interaction existed between the north and the south during the c. 1300–1000 BCE time frame.[7] The most logical route of communication is via the Al Ain Oasis in the interior of the emirate of Abu Dhabi. It lies at the crossroads of two historical routes connecting the north with the south: one runs east and follows the natural corridor of the Wadi al-Jizzi through the Hajar Mountains towards the Batinah Coast, and the other runs south all along the western flank of the Hajar Mountains. Besides a logistical linchpin, Al Ain is part of a large portion of Southeast Arabia devoid of assemblages made up of handmade Iron Age I pottery. It lies strategically between the southernmost attestation of Iron Age I ceramics in an independently verified Iron Age I context (at Saruq al-Hadid) and the northernmost attestation of an Iron Age II ceramic assemblage in an independently verified Iron Age I context (at Husn Salut and Qaryat Salut).

The Oman Border Fence Project, linked to an 11.5-kilometre-long upgrade of the UAE-Oman Border Fence, provides an extremely valuable, uninterrupted cross-section through the historic Al Ain Oasis to beyond the Hili-Qattarah area, where many Iron Age settlement sites are located. In 2021, in close collaboration with the UAE Armed Forces, the Historic Buildings and Landscapes team from the Department of Culture and Tourism - Abu Dhabi, led by Peter Sheehan, carefully documented and excavated every feature encountered in the dynamic trench as it slowly moved northwards (Sheehan *et al.* 2023; this volume).[8] Moreover, by combining evidence from previous research on both sides of the

[6] So far, only vessels from the 'late' group have been attested in secure stratigraphical contexts that are radiocarbon-dated to the Iron Age I period (at Saruq al-Hadid and Husn Salut). The illustration of a vessel with an organic decoration (Degli Esposti 2021: Figure 22/A) and the reference to decorations with the dotted-circle motif (Degli Esposti 2021: 145) indicate that the 'early' and 'late' groups are both found at Qaryat Salut in Iron Age I contexts; information about specific find contexts are, however, not provided.

[7] That regular contact was maintained between soft-stone production areas, individual workshops and communities throughout Southeast Arabia has already been established based on the distribution of Iron Age I soft-stone vessels and the uniformity of their stylistic and morphological developments (Olijdam and Velde 2023: 267-269).

[8] In Zone Ab cleaning operations and some minor work continued in 2022.

border (Power *et al.* 2015; 2016; 2017; Sheehan *et al.* 2015; 2022; Sheehan, Power and Al Kaabi 2018; Power, Benoist and Sheehan 2019), it allows a comprehensive synthesis of the development of the Al Ain Oasis.

The most consequential result of the Oman Border Fence is the discovery of a largely pristine Iron Age landscape, consisting of a cemetery and a vast agricultural area comprised of field systems and a wide range of hydraulic installations. Based on the associated pottery, this agricultural area and the complex water-management infrastructure that facilitated it is firmly attributed to the Iron Age, which agrees with prior research into the *falaj* systems at Hili 15 and Bida Bint Saud (Al Tikriti 2002; 2011). It has been estimated that the irrigation-fed cultivated area in the Al Ain Oasis could have extended to almost 500 hectares during the Iron Age (Sheehan *et al.* 2023: 333). This extensive and elaborate system was abandoned before the Iron Age III period (i.e. c. 600 BCE), probably because of dramatically fallen water tables resulting from deteriorating climatic conditions. The cemetery, located south of the agricultural area, displays a longer lifespan. It originated in the Bronze Age and reached its zenith during the Iron Age before being abandoned shortly afterwards. The sizeable portion of Iron Age III ceramics in the two collective graves indicates that this abandonment may have been less abrupt and probably more prolonged than evidenced by the agricultural area.

Pending the roll-out of a robust OSL- and radiocarbon-dating programme targeting the various feature groups, individual features and find contexts encountered in the Oman Border Fence transect, the current chronological framework — based almost exclusively on the ceramic evidence — can be improved by including the examination of the extensive soft-stone collection from the cemetery and agricultural area. Soft-stone vessels are rapidly establishing prominence as one of the principal chronological markers for the 2nd and 1st millennia BCE as chronological refinement is not only limited to the Iron Age I period. The Wadi Suq period can be subdivided into three phases (Velde 2018), the Iron Age into Iron Age I 'early', Iron Age I 'late', and Iron Age II, i.e. 'classic' Iron Age (Olijdam and Velde 2023). The possibility of an Iron Age III soft-stone assemblage has been proposed based on materials from Husn Salut and the associated settlement at Qaryat Salut (Tagliamonte 2018: 286-287; Degli Esposti *et al.* 2019: 102-104; Degli Esposti 2021: 145), although evaluation is necessary, particularly about its status as an independent entity and its relation to the Late Pre-Islamic assemblage, for which four phases have been identified (Mouton 2018).

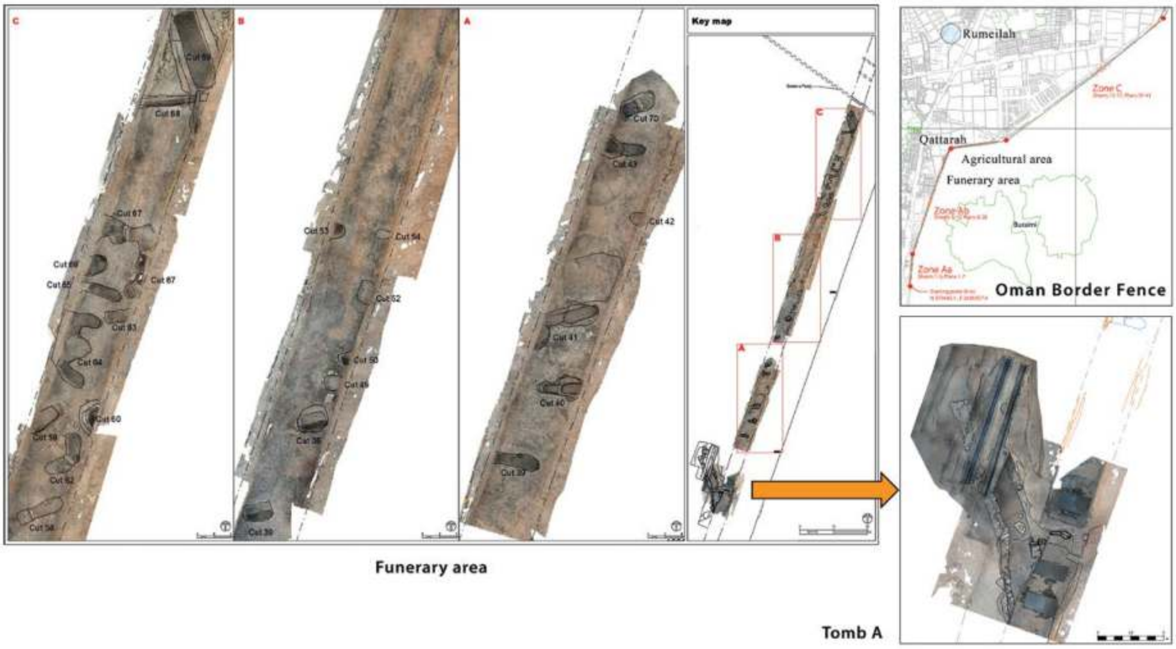
With 478 fragments from 449 vessels, the bulk of which date to the Iron Age, it can be determined unequivocally whether or not an Iron Age I horizon is present in the Oman Border Fence transect and, if so, how robust it is. Moreover, the identification of Iron Age I 'early' and 'late' groups provides a degree of temporal control unparalleled in other artefact groups.

Concomitantly, the extensive soft-stone collection has excellent provenance. The vessels derive from a wide range of secure and well-developed contexts, allowing analysis of feature groups as well as individual features.

Feature groups

Over an 11.5-kilometre-long transect, a trench was dug about 3.5 m wide and 3-4 m deep. This trench was created using a mechanical digger that proceeded at a pace of c. 80 m per day. In Zone Ab, where almost all of the soft-stone

Figure 3: Zones Ab and B of the Oman Border Fence, the cemetery encountered in the funerary area and the overall make-up of the soft-stone collection.



Funerary area		Fragments	Vessels
Tomb A	035, 072, 076, 077, 078, 080, 081, 082, 086, 088, 1001, 1005, 1007, 1008, 1009, 1011, 1012, 1014, 1015	209	198
Grave 069	069	151	141
Shaft graves	033, 039, 041, 043, 044, 047, 048, 053, 056, 059, 061, 062, 063, 064, 064A, 064B, 064C, 067, 067A, 070, 074	78	77
	Subtotal	438	416
Agricultural area		**Fragments**	**Vessels**
Wells	060, 553	3	3
Aflaj	068, 101, 103A	11	11
Basins	144, 383, 399, 500, 525, 701	7	7
Pits	596, 735	2	2
Modern	504, 515	3	3
Late Pre-Islamic tombs	132, 400, 402	6	6
	Subtotal	32	32
Unknown		1	1
	Total	471	449

material was recovered, excavations occurred in two stages. First, the digger removed the compact sand deposits down to the bedrock. Each newly exposed area was then cleaned by hand, and individual features that appeared in the bedrock were carefully excavated. An exception to this excavation strategy was made for the collective Tomb A. After the digger had demolished and removed its south-eastern extent in the trench, the rest of Tomb A on the western side of the border was excavated manually.

In Zone Ab, an Iron Age cemetery was unearthed, consisting of two communal graves and two clusters of shaft burials. The northern limit of this cemetery, as attested in the excavation trench, is delineated by a long-used collective grave. An extensive Iron Age agricultural area lies to the north, physically separated from the cemetery by a roughly 50-metre-wide barren strip of wasteland (Figure 3).

Tomb A

Tomb A is a stone-built, semi-subterranean long-chamber tomb. The long-axis walls have been almost completely dismantled, except for the lower section of the south-western wall and the opposing area near the entrance in the north-eastern wall. Several well-dressed ashlar slabs were incorporated into the wall and placed upright beside the tomb's entrance; one of the slabs formed the actual door jamb. These slabs are repurposed from a substantial Umm an-Nar tomb and hint at an earlier phase in the cemetery that is not physically attested in the narrow Oman Border Fence transect.[9] Excavations were extended beyond the limits of the trench in order to identify the western side wall of Tomb A. The eastern half of the tomb is located on Omani territory and remains unexcavated. Dimensions of the exposed portion are c. 25 × 3 × 1 m. In semi-subterranean long-chamber tombs, the doorway is typically located midway along the long axis (Pellegrino *et al.* 2019: 3). This would suggest that Tomb A may be about 40 m long, making it the largest of its kind. The walls comprised of small-sized boulders placed against the cut in the natural were lined with mortar. The south-western wall showed the beginnings of a corbelled roof that was probably closed off with a series of large slabs. The floor of the burial chamber is set well below the base of the wall, making a powerful case that the original floor level was lowered at some point. Alterations like this are not uncommon in long-used collective tombs in Southeast Arabia.

Based on the combined inventories of similar-type examples, semi-subterranean long-chamber tombs can be safely attributed to the late Wadi Suq

[9] Another Umm an-Nar ashlar slab was retrieved from Tomb C, a Late Pre-Islamic period tomb excavated at the northern limit of Zone Ab (Sheehan *et al.* 2023: 329). A significant number of Umm an-Nar 'sugar lumps', which are chrono-typologically earlier than the slabs retrieved from Tombs A and C, feature prominently in the interior walls and door sides of the famous tomb at Qattarah (Cleuziou 1981: 284), located only several metres west of the Oman Border Fence transect in the northern limit of Zone Ab.

period (Carter 1997: 37-38; Pellegrino *et al.* 2019; Genchi and Tursi 2022). The grave furnishings from Tomb A demonstrate that it continued to be used during the Late Bronze Age and Iron Age periods. Materials from the Late Pre-Islamic period (*Pré-Islamique Récent* = PIR) indicate intermittent reuse following the Iron Age.

Despite the near-complete removal of the two long-axis walls and roofing stones, Tomb A's sandy fill was retrieved almost intact. Except for the section that was machined away, a series of discrete deposits was recognised and excavated accordingly. Two major robbing events have been documented. The first represents a traditional, somewhat hastily executed looting job to obtain precious and/or valuable grave goods and materials. The most recent grave goods from the deposit associated with the looting event date to the Late Pre-Islamic period (phase PIR.D), thus providing a solid chronological benchmark for the looting. The second event, aimed at retrieving building materials and represented by parallel robber trenches, occurred during the Late Islamic period and is probably linked to the construction of the nearby Qattarah *falaj* (Sheehan *et al.* 2023: 328).

In addition to the eastern half of the tomb on Omani territory, some of the fill on the UAE side remains unexcavated (*pers. comm.* Peter Sheehan).

Grave 069

The northern collective burial, Grave 069, is placed along a similar alignment as Tomb A. The two funerary structures, however, are quite different. The burial chamber of Grave 069 is a deep rectangular pit carved into the natural. It measures 5 × 2 × 1.4 m and was originally covered by large capstones resting on the bedrock. The trench profile shows a 1.2-metre-wide cut above the burial chamber. This is a robber trench that probably masks the shaft of the original structure. The capstones that had sealed the burial chamber were not found in situ; several large fragments were retrieved inside the chamber. According to the ceramic evidence, this looting event occurred after the Iron Age III period. The burial chamber was manually excavated in six horizontal spits (each 20-30 cm thick), and the fill was sieved; all grave goods were recovered.

Shaft graves

Between Tomb A and Grave 069, a cluster of 32 shaft graves, several accessing multiple burial chambers, were exposed in the trench. None of the graves intersect, indicating some grave marker must have been visible on the surface, especially as the shafts had been dug into the generally loose sand and gravel that characterises this area. The burial chambers and lower part of the shafts were carved into the bedrock. Some 70 m south of Tomb A, three additional shaft graves have been partially preserved in the western trench profile, probably indicating the location of another cluster of this type of grave

(Sheehan *et al.* 2023: 327). Each grave was accessed via a (narrow) shaft dug through the sand deposits overlying the bedrock; the maximum depth is 1.7 m. Entrance to the burial chambers was blocked by limestone or gypsum blocks. Sometimes a small annexe was added to the burial chamber to store grave goods. The shaft graves encountered in the Oman Border Fence transect are reminiscent of similar-type graves excavated in Al Qusais (Taha 2009).

The burial chambers and annexes were manually excavated, and the fill was sieved; all grave goods were recovered. Parts of the graves that lie beyond the trench have not been excavated. Almost all graves showed signs of being plundered and/or disturbed in the past, indicating that only a palimpsest of the original grave inventory was retrieved.[10] Notwithstanding, the shaft graves display an extensive array of finds, including gold jewellery. This also closely matches the situation at Al Qusais.

Agricultural and hydraulic contexts

An extensive agricultural area was encountered slightly north of the cemetery. In Zones Ab and B, it manifests as a regularly laid out Iron Age field system characterised by rows of individual rock-cut tree pits linked by open-air irrigation channels. Excellent parallels for this particular type of horticulture are known elsewhere in the Al Ain Oasis (Power and Sheehan 2011; Power, Benoist and Sheehan 2019) and Al Madam (Del Cerro Linares 2017a; 2017b). In the Oman Border Fence transect, two distinct phases are represented. The earliest arrangement is preserved only in certain pockets of bedrock; in some areas, it is consistently cut and obliterated by a system with deeper basins and V-shaped channels representing a more recent phase. The associated pottery unequivocally demonstrates that this new phase was abandoned before the start of the Iron Age III period.[11] Intriguingly, it is reported that some elements of the ceramic corpus display subtle changes between the two agricultural phases (Sheehan *et al.* 2023: 331). The latter should be viewed as an encouraging development towards understanding diachronic developments within the Iron Age ceramic corpus.

A vast and intricate network of hydraulic installations was instrumental in the unprecedented scale of exploitation of the Al Ain Oasis. During the Iron Age, it consisted of a combination of surface-running *ghayls* and *aflaj* with subterranean galleries (many with regularly spaced access shafts). How the different hydraulic systems relate to the two agricultural phases requires

[10] One shaft grave was found intact; three others may possibly also hold their original content.

[11] A similar sequence and time frame have been reported from the Bayt Bin Ati site in the Al Ain Oasis (Power, Benoist and Sheehan 2019: 100). Two phases have also been attested at Al Madam (AM-2), whereby deep basins — referred to as ponds — cut and partially destroy an earlier (unspecified) system. Both phases unequivocally date to the Iron Age. The new phase, which yielded exclusively Iron Age II pottery, is linked to the deepening of the subterranean gallery system (Dell Cerro Linares 2017a; 2017b).

additional analysis. One of the *aflaj* encountered in the Oman Border Fence transect is believed to be the upstream extension of the one explored at Hili 15 (Sheehan *et al.* 2023: 332).

The soft-stone collection

This contribution presents the preliminary results of my examination of the soft-stone fragments collected during the rescue excavations and subsequent cleaning operations of the Oman Border Fence in 2021 and 2022. Additional research on the collection is necessary, as is a constant evaluation of the data in light of the latest insights into Iron Age soft-stone vessels. However, while details may change, the patterns, overall trends and conclusions will remain unaffected.

With some notable exceptions, the soft-stone vessels from the Oman Border Fence consist of fragments; complete or near-complete vessels are scarce. They are, nearly all, the result of ancient breakage, as indicated by discoloration and patination of the breaks. Moreover, most fractures are smoothed, revealing that the fragments had moved around since their initial breaking. Few fractures are fresh, i.e. created during construction related to the Oman Border Fence or other modern activities. In most cases where recent damage can be identified, it was inflicted on already broken vessels.

The highly fragmented nature of the collection matches many funerary sites in Southeast Arabia. Damage and fragmentation are caused primarily by the extensive reuse of the grave, whereby ancient interments and associated grave goods are constantly pushed aside and moved around to create space for fresh burials. This accounts for much of the observed damage and the rounding-off of breaks, especially in the two collective graves. As most graves have also been subjected to looting, the other major contributor responsible for the fragmented state of the vessels is the actions of grave robbers, irrespective if they were targeting stones or grave goods.

Because of the excellent contextual provenance, it was decided to determine the number of soft-stone vessels per feature by combining data on find context, decoration, vessel morphology, metric data, surface treatment, and stone characteristics. This approach, which proved very successful for this collection, revealed an excellent overall correspondence between fragments and vessels: 563 individual entries correspond to 471 fragments from 449 individual vessels.[12]

[12] Entries – joining sherds = fragments; fragments – non-joining sherds = vessels. Joining pieces are counted as one; non-joining fragments are counted as separate fragments.

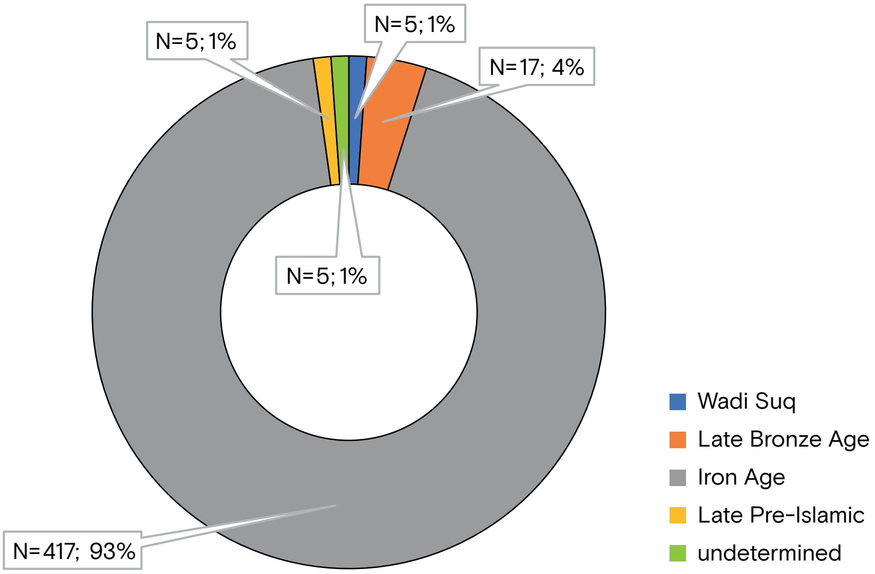


Figure 4: Composition of the Oman Border Fence soft-stone collection (N=449 vessels).

Chronological determinations

Based on the latest insights on soft-stone chronology and seriation, specimens from the Wadi Suq, Late Bronze Age, Iron Age, and Late Pre-Islamic periods have been identified (Figure 4). Vessels initially identified as Umm an-Nar have been reattributed to the Wadi Suq, Late Bronze Age and Iron Age.

The earliest specimens date to the Wadi Suq period. The fragments from Tomb A and Grave 069 can be attributed to the first and third phases of the Wadi Suq period. The fourth, badly degraded and probably belonging to the second Wadi Suq phase, is found in one of the basins from the agricultural zone. This fragment is a genuine outlier because the rest of the soft-stone vessels from that area are Iron Age, except for a single Late Pre-Islamic vessel found in an ashy dump inside an abandoned basin.[13]

An Iranian import, found in Tomb A, has a close parallel in Susa (De Miroschedji 1973: Figure 9/1). Regretfully, precise stratigraphic contexts of the vessels from Susa are unknown. Stylistic analysis of that corpus suggests a likely date in the late 3rd or early 2nd millennium BCE.[14] The contextual information from Tomb A favours an early 2nd-millennium date, if not for the vessel production, then certainly for its deposition in the tomb.

The Late Bronze Age is represented by 17 soft-stone vessels. These also derive exclusively from the collective burials, i.e. Tomb A (11x) and Grave 069

[13] The Wadi Suq period collective tomb at Qattarah, which was reused up until the Late Bronze Age, indicates earlier activity in the area just beyond the narrow Oman Border Fence transect. Limited Late Pre-Islamic activity is reported for Zone Ab in the form of middens (with large quantities of pottery) in abandoned deep wells and basins and two elite burials overlying the abandoned Iron Age field system.

[14] Interestingly, the Susa corpus holds an Iron Age I import from Southeast Arabia (De Miroschedji 1973: Pl. VII/b).

(6x). Even though this number seems insignificant on a total of 449 vessels, it means an increase in known Late Bronze Age soft-stone vessels in Southeast Arabia by nearly a third.

Iron Age materials completely dominate the Oman Border Fence collection, representing 93 per cent of the vessels.

Most of the 417 Iron Age vessels can be subdivided according to the latest insights (Olijdam and Velde 2023): 49 per cent date to the Iron Age I period, and 38 per cent to Iron Age II. The remainder cannot be ascribed beyond the level of the Iron Age. Iron Age I thus outnumbers Iron Age II — even when nearly all undifferentiable Iron Age fragments are to be attributed to Iron Age II, which is highly improbable.

While the ubiquity of Iron Age soft-stone vessels is no surprise given the results of the pottery analysis, the primacy of the Iron Age I horizon over Iron Age II is unanticipated, as only a small amount of Late Bronze Age/Iron Age I handmade sherds is attested. The bulk of the ceramics consists of Iron Age II pottery, with a fair amount of Iron Age III (Sheehan *et al.* 2023). This mirrors the composition of the long Iron Age sequence unearthed at the Bayt Bin Ati site in the Al Ain Oasis (Power, Benoist and Sheehan 2019). Although still somewhat tentative in the absence of independent corroborative dating evidence, the aggregate data strongly suggest that in the Al Ain Oasis, the Iron Age I and Iron Age II horizons feature (almost exclusively) Iron Age II ceramics — especially as this may also be the case for Rumeilah (see Karacic *et al.* 2020: 19). I will return to this matter in more detail when discussing the soft-stone assemblages from the various feature groups.

Based on the decoration scheme and secondary characteristics, it is possible to differentiate Iron Age I into an 'early' and a 'late' group (Olijdam and Velde 2023: 257-264). The dotted-circle or dotted-double-circle motif is the defining criterion to assign an Iron Age vessel to the Iron Age I 'early' group. No matter how little of a circle is preserved, it can be confidently attributed when attested. The 'late' group is defined by the absence of this characteristic trait of the 'early' group. Dotted circles can feature in various parts of the design. Enough of the vessel, therefore, has to be preserved to ascertain its absence from the design. Due to their fragmented nature, this is often not the case, which explains why a large portion cannot be assigned to a specific subgroup. Despite this limitation, the prevalence of 'late' Iron Age I over 'early' Iron Age I genuinely reflects the overall composition of the Iron Age I corpus. Given the structural under-representation of the 'late' group in the pool of assignable fragments, this definitely cannot be said about the ratio of 'early' versus 'late', and the disparity is likely to be even more pronounced.

One large body sherd, OBFS.0027, does not fit any known assemblage (Figure 5). This fragment comes from Tomb A. While the vessel shape and decoration — the two most-diagnostic features of soft-stone vessels — would

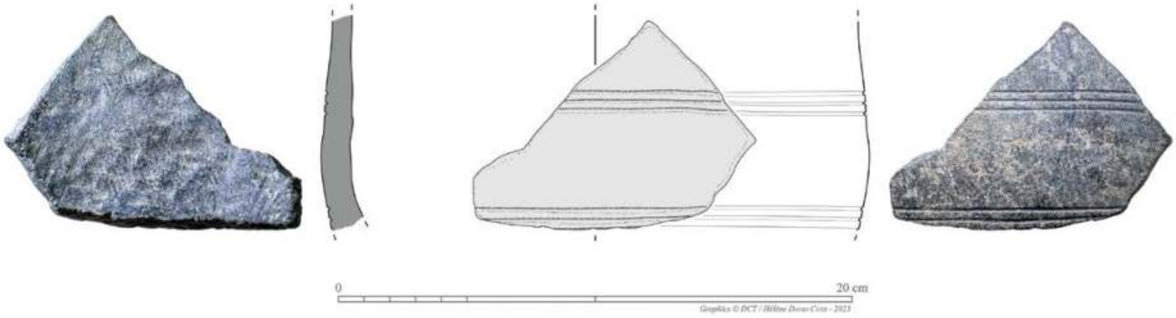


Figure 5: Possible Iron Age III vessel from Tomb A (OBFS.0027).

be a-typical, the stone, carving techniques, overall quality, and surface treatment favour an Iron Age date. As it does not concur with the well-known Iron Age II corpus, an Iron Age III date (c. 600–300 BCE) seems a plausible option, especially as Iron Age III pottery has been identified from Tomb A (Sheehan *et al.* 2023: 328). An Iron Age III date has been tentatively proposed for a group of small, lathe-turned, open vessels from Husn Salut (Tagliamonte 2018: Nos 57-69). However, this group is definitely later than Iron Age III and is to be attributed to the Late Pre-Islamic period. In a recent publication dealing with the associated settlement at Qaryat Salut, Iron Age II and III soft-stone vessels have suddenly been lumped into one coherent assemblage without any explanation or justification (Degli Esposti 2021: 145). OBFS.0027 combines characteristics of 'classic' Iron Age II vessels (i.e. stone, tool marks and surface finishing) and Late Pre-Islamic vessels (i.e. general shape and decoration). It would therefore be a good candidate for an Iron Age III specimen. What is often overlooked, however, is that Late Pre-Islamic vessels — like those in previous periods — are primarily shaped and carved using chisels before they are finished using a lathe. The lathe reduces the wall thickness, smooths the inner and outer surfaces, and produces the diagnostic regular profile, glossy surface and incised decoration. So the fact that this bulky fragment bears tool marks of chisels and does not have a symmetrical profile is insufficient to dismiss a possible Late Pre-Islamic date.[15] However, besides not being made of the dark-coloured, fine-grained stone characteristic of Late Pre-Islamic vessels, OBFS.0027 lacks the hallmarks of a semi-finished product that is one step away from being finished and decorated using a lathe (cf. Mouton 2018: 128, Figure 8/1-2). The presence of a possible Iron Age III vessel in the Oman Border Fence collection warrants further examination and research.

The most recent vessels date to the Late Pre-Islamic period and derive primarily from funerary contexts: Tomb A (3x) and Late Pre-Islamic Tomb B (1x). One specimen belongs to phase PIR.A (3rd century BCE to mid-2nd century

[15] A possible parallel comes from Qaryat Salut (Degli Esposti *et al.* 2019: Figure 4/6). This fragment is lathe-turned and carved from the characteristic dark-coloured stone used for Late Pre-Islamic vessels. The find context is not specified, but it is stated that contexts in the northern sector are "nearly always mixed, but Iron Age material widely outnumbers later items" (Degli Esposti *et al.* 2019: 104).

BCE), one to phase PIR.B (mid-2nd century BCE to 1st century BCE), one to phase PIR.C (1st century BCE to mid-2nd century CE), and one to phase PIR.D (mid-2nd century CE to mid-4th century CE). Two vessels from Tomb A (from phases PIR.A and PIR.B) are not made of the characteristic dark-coloured, fine-grained stone but rather a semi-translucent soapy stone predominantly used for Late Bronze Age and Iron Age I vessels. As far as I know, these are the first Late Pre-Islamic vessels executed in this material. The use of an a-typical stone for these two vessels throws some doubt on the possible Iron Age III identification of OBFS.0027, whose shape and decoration may point towards a phase PIR.C or PIR.D date. A fifth vessel comes from the agricultural area, where it was found in an ashy dump deposited in an abandoned basin. This piece shows compelling evidence that it was burnt as a fragment.

Contextual determinations

About 93 per cent of the soft-stone vessels from the Oman Border Fence derive from the cemetery; only a tiny portion comes from the agricultural area (Figure 3).

Tomb A

Tomb A generated the most extensive set of soft-stone materials: 209 fragments from 198 vessels (Figure 6). Based on the extant soft-stone material, its main phase of use appears evident: the overwhelming majority dates to the Iron Age. Early specimens consist of a Wadi Suq vessel, an imported Iranian box and 11 Late Bronze Age vessels. The paucity of Wadi Suq and Late Bronze Age materials, including ceramics, can best be explained by inferring that the content of the tomb had been removed at a time near the start of the Iron Age I period, either just before or early in the period.[16] Ergo, the materials encountered in Tomb A represent the remnants of grave goods associated with interments made after this clean-out, with only some residual remains from the earlier phase. This pattern is typical of most long-used communal tombs in Southeast Arabia. What sets the collective graves from the Oman Border Fence apart from others is the early date of their respective clean-outs. Based on the composition of the published inventories, most communal tombs appear to have been stripped of their content (at least for the last time) at the start of the Iron Age II period — with residual Wadi Suq, Late Bronze Age, and Iron Age I materials. Such a scenario makes much more sense than the implicit characterisation that these tombs were used only sparingly and intermittently during the first five centuries after their construction, reaching the scale of interments for which

[16] It is highly likely that the floor level inside the tomb was lowered. This excavation would have required the tomb's surface to be (mostly) devoid of human remains and grave goods. The two events may thus have coincided.

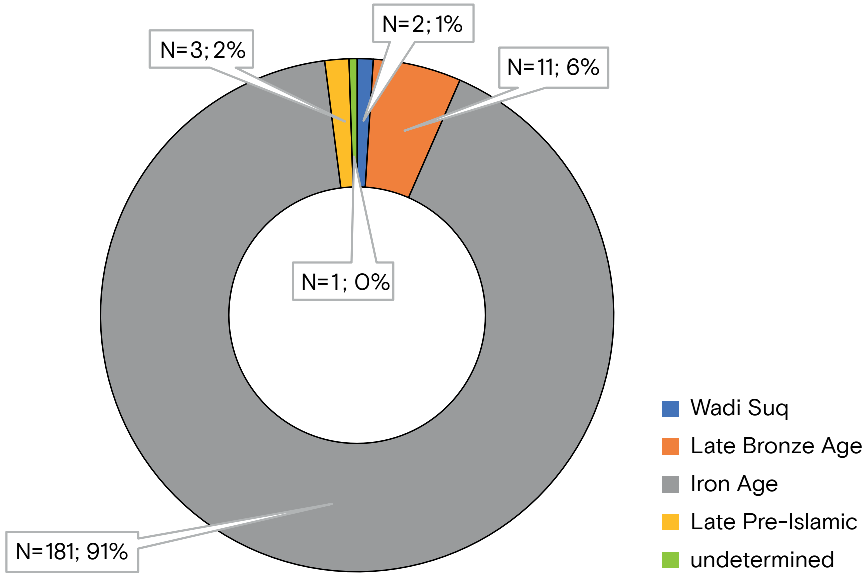


Figure 6: Composition of the soft-stone assemblage from Tomb A (N=198 vessels).

they were initially designed only during the Iron Age II period. This popular interpretation — mistakenly, in my opinion — takes the extant record as a direct reflection of the tomb's use, whereby the quantity of retrieved materials equals the level of intensity. There are strong clues that former content of several long-used collective tombs, including skeletal remains, was ritually redeposited in pits.[17] For Tomb A, this would mean it must have had a substantial Wadi Suq and Late Bronze Age occupation and probably an even more robust Iron Age I presence, given the fact that Iron Age I soft-stone vessels are already the most common in the extent inventory, with more than twice the amount of Iron Age II (Table 1). The limited number of materials dating to the Late Pre-Islamic period indicates Tomb A was reused intermittently after the Iron Age. This, too, follows a well-established pattern in the funerary landscape of Southeast Arabia.

The Iron Age I soft-stone corpus can be differentiated into an 'early' and a 'late' group. 'Early' Iron Age I is clearly the most prevalent. However, a more forceful interpretation is difficult due to the large amount of Iron Age I fragments that cannot be attributed to either group and the strong bias in favour of 'early' specimens due to the fragmented nature of the materials. Concomitantly, if Tomb A was cleaned out early in the Iron Age I period rather than at the close of the Late Bronze Age, the overall total of 'early' vessels would have been even higher.

[17] At Dibba Murba, a large pit has been excavated. The fill reportedly represents several episodes, each consisting of chronologically discrete deposits, indicating several clean-outs of the nearby collective tomb (Pfeiffer *et al.* 2020). A large pit has been partially excavated at Shokur/Dhank, adjacent to a Wadi Suq-type collective tomb (David-Cuny, Frenez and Williams 2016; *pers. comm.* Kimberly Williams). Small pits are attested next to the semi-subterranean long-chamber tomb at Dibba LCG-1 (Genchi and Tursi 2022). Reburial of tomb material is also reported for the Wadi Suq period, sometimes in pits in the vicinity of the collective tombs (Carter 1997: 49-50).

Table 1: Iron Age soft-stone vessels from Tomb A

Composition of Iron Age	Fragments	Vessels
Iron Age I	118	108
Iron Age II	53	51
Iron Age III	1	1
Iron Age (unspecified)	21	21
Total	193	181
Composition of Iron Age I	**Fragments**	**Vessels**
Iron Age I 'early'	47	44
Iron Age I 'late'	33	27
Iron Age I (unspecified)	38	37
Subtotal	118	108

Since soft-stone vessels attest to a robust Iron Age I horizon, the other issue that needs to be tackled is how this is reflected in the ceramic assemblage. Even though the two presumably performed different roles in the funerary ritual, a comparison of the relative proportions of soft-stone vessels and the associated pottery (data derived from Sheehan *et al.* 2023) highlights several inescapable conclusions, especially as they hold up in the context of other feature groups. For Tomb A, the best numerical fit is between Late Bronze Age soft-stone vessels and handmade Late Bronze Age/Iron Age I pottery, while Iron Age soft-stone vessels and Iron Age II ceramics are the most prevalent in their respective artefact category (Table 2). The combination of Iron Age I representing at minimum 55 per cent of the soft-stone vessels and handmade

Table 2: Comparison of the ceramic and soft-stone assemblages from Tomb A

Diagnostic pottery sherds	
Late Bronze Age/Iron Age I	6%
Iron Age II	65%
Iron Age III/Late Pre-Islamic	20%
Soft-stone vessels	
Wadi Suq	1%
Late Bronze Age	6%
Iron Age	91%
Iron Age III/Late Pre-Islamic	2%
Soft-stone vessels (Iron Age differentiated)	
Wadi Suq	1%
Late Bronze Age	6%
Iron Age I	55%
Iron Age II	26%
Iron Age (unspecified)	11%
Iron Age III/Late Pre-Islamic	2%

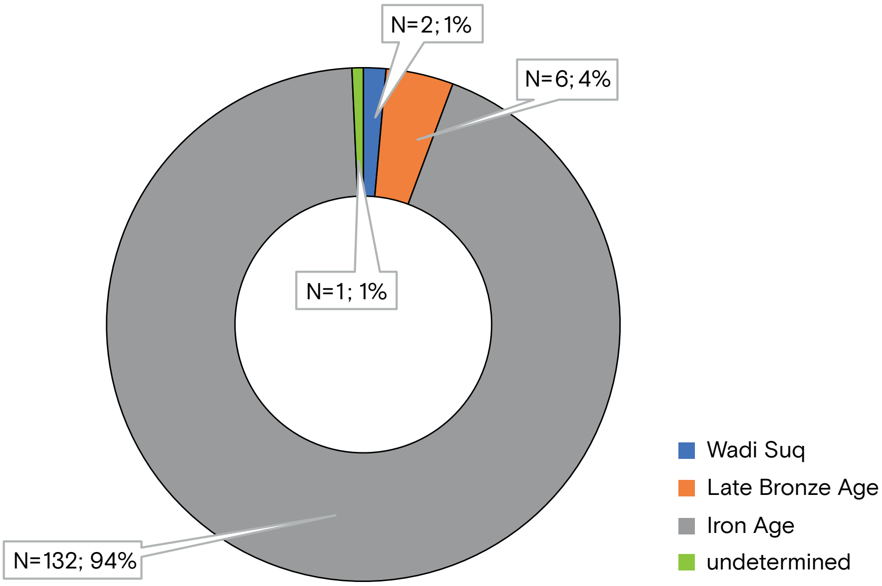


Figure 7: Composition of the soft-stone assemblage from Grave 069 (N=141 vessels).

Late Bronze Age/Iron Age I pottery accounting for a mere 6 per cent of the ceramic assemblage, automatically implies that Iron Age II pottery is the main ceramic component for both Iron Age I and Iron Age II horizons. The Late Bronze Age/Iron Age I pottery can, at best, only be a minor component in the Iron Age I and/or Iron Age II assemblages. It is, however, much more plausible that this material relates to the Late Bronze Age (c. 1600–1300 BCE).

Grave 069

From this unusual and more modest communal grave, 151 soft-stone fragments from 141 vessels have been retrieved (Figure 7). The pre-Iron Age component is smaller than in Tomb A. Another notable difference is the complete absence of Late Pre-Islamic vessels. Based on the extant inventory, the Iron Age represents the dominant horizon in Grave 069.

Table 3: Iron Age soft-stone vessels from Grave 069

Composition of Iron Age	**Fragments**	**Vessels**
Iron Age I	73	68
Iron Age II	46	44
Iron Age III	0	0
Iron Age (unspecified)	23	20
Total	142	132
Composition of Iron Age I	**Fragments**	**Vessels**
Iron Age I 'early'	7	6
Iron Age I 'late'	36	32
Iron Age I (unspecified)	30	30
Subtotal	73	68

Table 4: Comparison of the ceramic and soft-stone assemblages from Grave 069

Diagnostic pottery sherds	
Late Bronze Age/Iron Age I	3%
Iron Age II	74%
Iron Age III/Late Pre-Islamic	9%
Soft-stone vessels	
Wadi Suq	1%
Late Bronze Age	4%
Iron Age	94%
Iron Age III/Late Pre-Islamic	0%
Soft-stone vessels (Iron Age differentiated)	
Wadi Suq	1%
Late Bronze Age	4%
Iron Age I	48%
Iron Age II	31%
Iron Age (unspecified)	14%
Iron Age III/Late Pre-Islamic	0%

Iron Age I also significantly outperforms Iron Age II (Table 3). However, the differences are less profound than for Tomb A, not in the least because of the much larger pool of undifferentiable Iron Age fragments.

Only a minority of Iron Age I soft-stone vessels can be attributed to the 'early' group. This, together with the small quantities of Wadi Suq and Late Bronze Age vessels, the complete absence of Wadi Suq pottery and the paucity of Late Bronze Age/Iron Age I handmade pottery, suggest that Grave 069 was emptied during the first part of the Iron Age I period, i.e. (slightly) later than Tomb A. The retrieved materials would thus represent the grave goods associated with interments following this clean-out, with some residual remains from the earlier phase.

When the results of the soft-stone analysis are compared with that of the pottery, a similar picture emerges as for Tomb A: a strong numerical fit between the Late Bronze Age soft-stone vessels and the handmade Late Bronze Age/Iron Age I pottery and an even more prominent dominance of Iron Age soft-stone vessels and Iron Age II ceramics (Table 4).

Shaft graves

Eighteen graves (equalling 20 burial chambers) yielded soft-stone vessels, i.e. 56 per cent of the shaft graves exposed in the area between the two communal graves. In total, 78 fragments from 77 vessels have been found. This amounts to an astonishing four vessels per grave or burial chamber containing soft-stone vessels. Even more remarkable is that not all graves have been completely excavated, only what was located within the limits of the trench.

Table 5: Soft-stone vessels from shaft graves

Composition of Iron Age	Fragments	Vessels
Iron Age I	19	18
Iron Age II	53	52
Iron Age III	0	0
Iron Age (unspecified)	15	7
Total	87	77
Composition of Iron Age I	**Fragments**	**Vessels**
Iron Age I 'early'	2	2
Iron Age I 'late'	11	11
Iron Age I (unspecified)	6	5
Subtotal	19	18

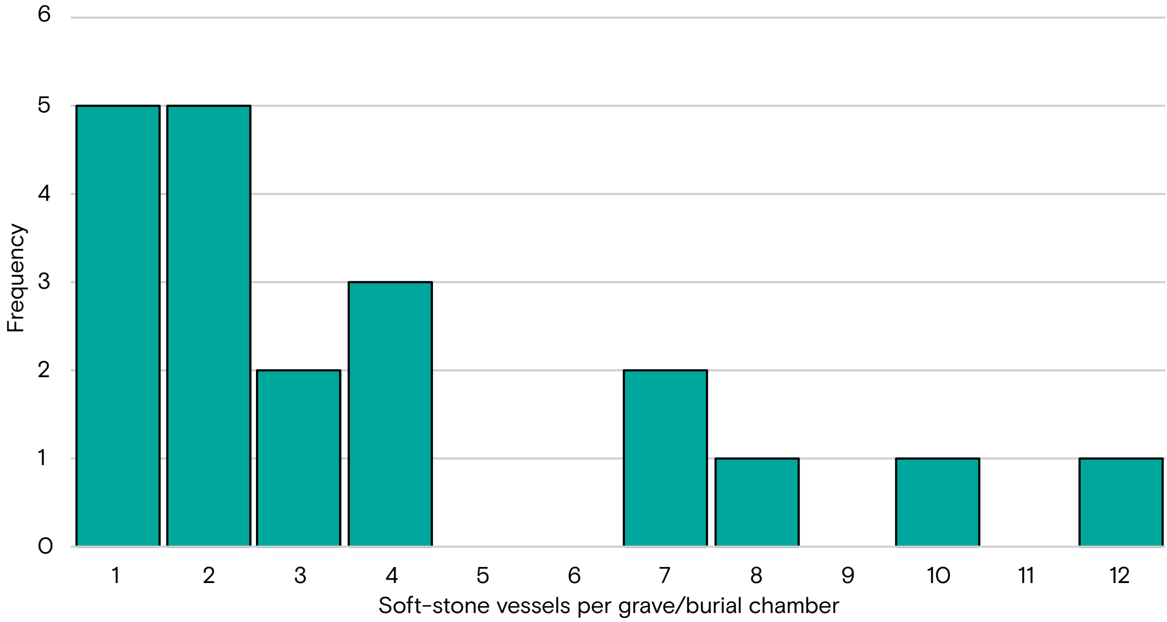
Unlike the inventories from Tomb A and Grave 069, which display a long history of use, every soft-stone vessel from shaft graves dates to the Iron Age period (Table 5). Iron Age II represents 68 per cent of the total corpus, more than thrice the number of Iron Age I vessels. This is a radically different pattern than observed for the two collective graves. Since only two fragments can be assigned to Iron Age I 'early', it strongly suggests shaft burials were introduced somewhat later in the Iron Age I period, quite possibly around the time Tomb A and Grave 069 were cleaned out. They became popular in the Iron Age II period, after which they ceased being used.[18]

Shaft graves have been designated single burials. The large quantity of soft-stone vessels per grave or burial chamber allows for the possibility that these specific graves were elite burials with an extensive and rich funerary inventory (Figure 13). However, as they regularly show a mixture of Iron Age I and Iron Age II soft-stone vessels, at least a significant portion appears to contain grave goods associated with multiple interments.

Despite this complicating factor, shaft graves allow relatively straightforward correlations between soft-stone vessels and ceramics because they yielded only Iron Age II pottery (Sheehan *et al.* 2023: 328). While nearly a quarter of the soft-stone assemblage comprises Iron Age I vessels, they are found in 45 per cent of the graves/burial chambers with soft-stone vessels. This proves the Iron Age I and Iron Age II horizons are ceramically Iron Age II in nature. The complete absence of handmade Late Bronze Age/Iron Age I pottery, even in shaft graves with Iron Age I 'early' vessels, makes attributing most — if not all — handmade ceramics to the Late Bronze Age extremely likely.

[18] The published soft-stone evidence from similar-type graves at Al Qusais indicates an even bigger dominance of Iron Age II materials (Taha 2009). However, as bases and small fragments are suspiciously absent from that publication, there are legitimate questions regarding the representativeness of the presented data.

Figure 8: A histogram of the amount of soft-stone vessels recovered per shaft grave/burial chamber and the composition for each individual grave/burial chamber. These clearly indicate that a significant portion of the shaft graves contain grave goods from multiple interments. A tentative construction date is provided based on the extant soft-stone inventory.



Grave	Iron Age I 'Early'	Iron Age I 'Late'	Iron Age I Unspecified	Iron Age II	Iron Age unspecified	Tentative construction date
O33	1	2		3	1	Iron Age I period (c. 1300–1000 BCE)
O70	1	1	1	6	1	
O53		1				
O44		2	1	1		
O74		2	1	4		
O47		1		7		
O67A			2	1		
O61			1	1		
O67		1				
O39				12		Iron Age II period (c. 1000–600 BCE)
O41				4		
O43				3	1	
O64				3		
O48				2		
O59				1	1	
O63				1	1	
O56				1		
O64A				1		
O64C				1		
O64B					2	

Table 6: Soft-stone vessels from the agricultural area

Composition	Wells	*Aflaj*	Basins	Pits	Modern
Wadi Suq			1		
Late Bronze Age					
Iron Age I	1	3	3	1	
Iron Age II	2	2	2	1	2
Iron Age (unspecified)		4			
Iron Age III					
Late Pre-Islamic					1
Undetermined		2	1		

Agricultural and hydraulic contexts

The number of soft-stone vessels found in agricultural and hydraulic contexts is only a fraction of the quantity encountered in the funerary contexts. Nevertheless, the fact that 26 soft-stone fragments were found in these contexts is surprising. Many represent unique attestations in Southeast Arabia, including pieces found in *aflaj*. Given their relative paucity at settlement sites, their alleged status as 'ritual' items and their primary deposit in funerary contexts, it is highly improbable that soft-stone vessels were lost by farmers working the fields and/or maintaining the subterranean tunnels. These vessels were probably already broken when discarded and made their way to these contexts as part of settlement refuse used to fertilise the fields.

Although only a tiny portion of the soft-stone vessels have been found in agricultural and hydraulic contexts, the results are remarkably consistent (Table 6). They are all Iron Age, apart from a badly degraded Wadi Suq fragment and a Late Pre-Islamic fragment that post-dates the use of this field system as it was found in a Late Pre-Islamic ashy dump layer inside an abandoned basin. This homogeneity matches the assessment of the associated ceramics, indicating that soft-stone vessels can be used as a reliable chronological indicator even in these 'open' contexts.

Iron Age I and Iron Age II soft-stone vessels are attested equally. At least 38 per cent of this area's Iron Age soft-stone vessels can be attributed to the Iron Age I period (c. 1300–1000 BCE). This is even more remarkable when one realises that only a fraction of the earlier field system has survived, being almost entirely obliterated by the creation of the new system, which unquestionably dates to the Iron Age II period (c. 1000–600 BCE). Seven of the 15 agricultural and hydraulic contexts that generated soft-stone vessels, including two *aflaj*, have an Iron Age I presence. Two contexts yielded 'early' Iron Age I vessels, four have 'late' vessels, and one has an unspecified Iron Age I vessel.

Comparison with the ceramic assemblage confirms the evidence and conclusions from the other feature groups, as the Iron Age agricultural and hydraulic contexts feature only Iron Age II pottery, apart from a single Iron Age III sherd (Sheehan *et al.* 2023: 331). The absence of handmade Late Bronze Age/Iron Age I pottery from any of these contexts confirms that this pottery is indeed Late Bronze Age in date.

Conclusions

The Oman Border Fence soft-stone collection is important for four reasons.

First, the Oman Border Fence provides a vital case study that has the potential to improve our understanding of Iron Age material culture fundamentally. Due to excellent provenance, it is possible to link and compare the ceramic and soft-stone analyses. The soft-stone vessels come from the same contexts and show that an Iron Age I horizon (c. 1300–1000 BCE) is well-attested and even more substantial than Iron Age II (c. 1000–600 BCE). Moreover, this Iron Age I horizon is attested in every feature group, even in those that yielded exclusively Iron Age II pottery. It is, therefore, beyond doubt that the Iron Age I and Iron Age II contexts encountered in the Oman Border Fence transect identify ceramically as Iron Age II. I sincerely hope that the fine-grained soft-stone seriation, which not only distinguishes between Late Bronze Age, Iron Age I and Iron Age II vessels but also allows the identification of an Iron Age I 'early' and 'late' group, will provide a significant — and necessary — impetus to study the Iron Age pottery assemblage in greater detail. Some contexts from the agricultural area have already provided some intriguing clues about potential chronological developments within Iron Age ceramics. Based so far only on internal arguments within the pottery assemblage, these observations can now be evaluated and expanded by direct comparison with the soft-stone assemblage from the same contexts. The upcoming roll-out of a robust OSL- and radiocarbon-dating programme will help clarify the age of many individual features and contexts in the Oman Border Fence, thereby providing crucial independent dating evidence that can be used to further our understanding of the Late Bronze Age and Iron Age material cultures.

Second, it represents a major collection of predominantly Iron Age vessels. It harbours several important specimens, particularly vessels that illustrate the transition between the Late Bronze Age and the Iron Age I 'early' group and between the Iron Age I 'late' group and Iron Age II. These pieces form indisputable evidence that the chronological subdivision of the Iron Age I assemblage is correct. They also illustrate the gradual nature of developments. An intriguing vessel that combines characteristics of the Iron Age II and Late Pre-Islamic corpora may be attributed to the Iron Age III period

(c. 600–300 BCE), which is at present terra incognita in terms of soft-stone vessels and likely to mark a transition between the well-established Iron Age II and Late Pre-Islamic corpora (more specifically phase PIR.A). Doing so would establish a continuous development of the indigenous soft-stone tradition from the Umm an-Nar period to the Late Pre-Islamic period. Finally, the Oman Border Fence collection holds two atypical Late Pre-Islamic vessels whose relation to the traditional Late Pre-Islamic corpus also requires further examination.

Third, the latest insights on 2nd-millennium-BCE soft-stone seriation, which provides a remarkable level of chronological refinement, can be used to explore temporal trends and dynamics within the cemetery area to a much higher resolution than before. This opens up exciting inquiries into the social dynamics within the cemetery area, especially given the variability in tomb architecture and funerary practices. The soft-stone vessels derive from two long-used communal graves constructed during the Wadi Suq period and a cluster of Iron Age shaft graves. These three feature groups, all attested within a 3.5-metre-wide transect over 120 m, show slightly different trajectories but reached their zenith simultaneously. Another cluster of shaft graves appears to have been situated c. 70 m south of Tomb A. The implication is that the Wadi Suq, Late Bronze Age and Iron Age populations that used this cemetery for over 1,500 years did not form a homogeneous unit but consisted of a mix of disparate groups who not only shared a historically anchored focal point in the landscape for their corporate mortuary practices but also acknowledged and respected the other groups' claims and traditions through time.

Four, a limited yet significant set of soft-stone vessels come from agricultural and hydraulic contexts. This is the first time a substantial amount of soft-stone vessels is attested in such contexts. The vessels underscore the Iron Age date for the intricate *falaj* system in the Al Ain Oasis. Until now, the introduction of the *falaj* has been ascribed to the early stage of the Iron Age II period (Al Tikriti 2002; 2011; Magee 2007: 7-8; 2014: 215-222). This is based on Iron Age II pottery recovered from water-management installations, field systems and buildings from associated settlement sites and on a series of radiocarbon dates, all at present limited to these settlement sites. The soft-stone vessels from the Oman Border Fence transect provide the first tangible evidence that the development of the *falaj* and the intensive irrigation-fed agriculture may be pushed back to the Iron Age I period (c. 1300–1000 BCE). The origins of this system and the subsequent movement of peoples and technologies deemed instrumental to the Iron Age II boom are likely to have their roots in the Iron Age I period. If true, this would support the hypothesis tentatively posited by Christian Velde and myself, based on the distribution pattern of Iron Age I 'early' versus 'late' vessels, of a much more gradual development into the Iron Age II period (Olijdam and Velde 2023: 267). The roll-out of a robust OSL- and radiocarbon-dating programme by the Oman Border Fence Project will hopefully also provide independent dating evidence on the inception of this crucial technology, this time from the field systems and hydraulic installations themselves.

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Iron Age copper production and the 'ritual economy' of Saruq al-Hadid (Dubai, UAE)

Lloyd Weeks, Tatiana Valente, Kristina Franke, Fernando Contreras, Mansour Boraik Radwan and Hassan Zein

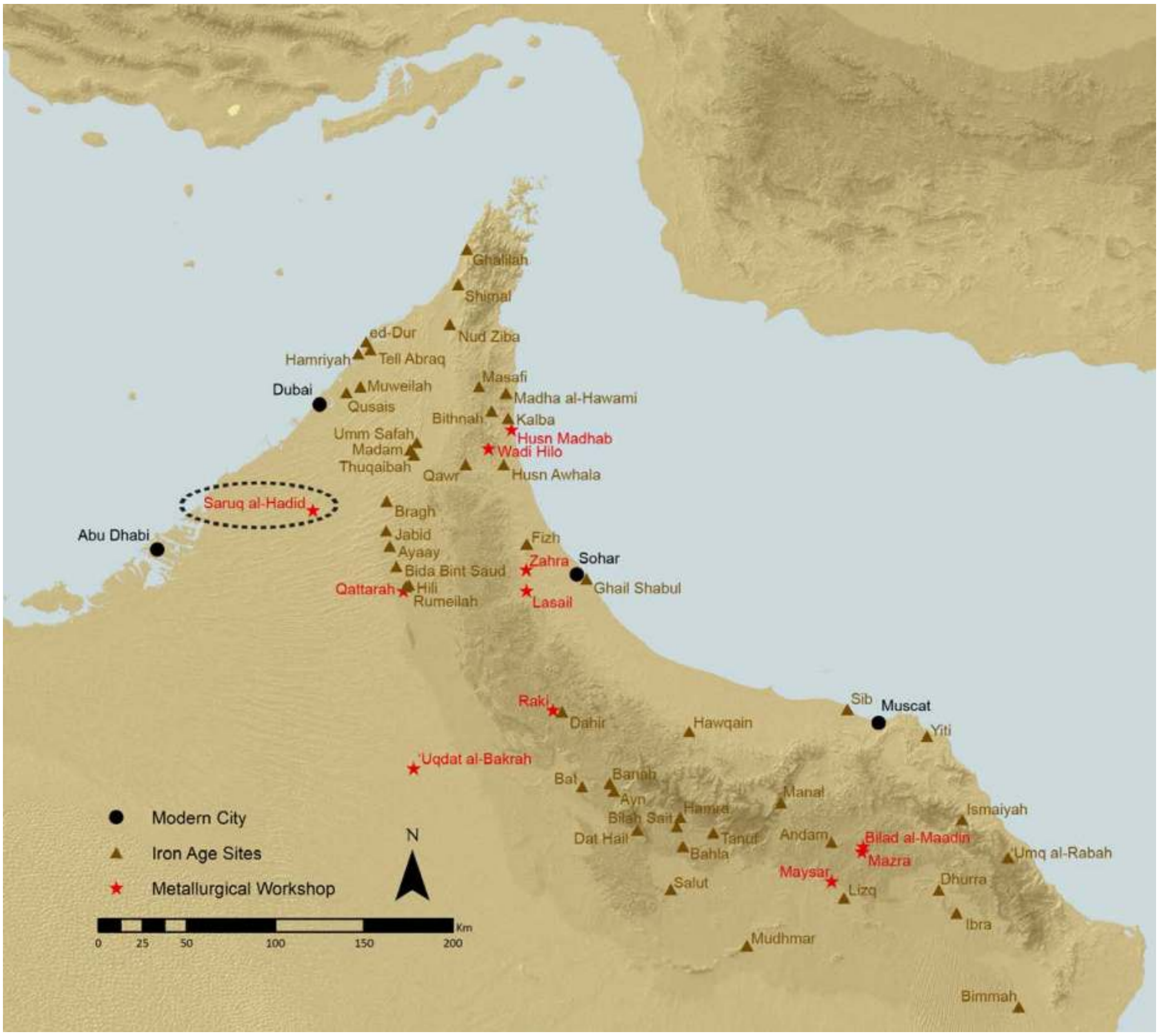
Abstract: The site of Saruq al-Hadid has significant potential to enhance our understanding of copper metallurgy and its social role in the Iron Age societies of Southeastern Arabia. The metallurgical evidence from the site indicates Iron Age copper production activities that included metal smelting and refining, alongside the fabrication of finished artefacts from local and imported materials through casting and working. Many of the products of this metallurgical activity were recovered from contexts that likely represent cultic activity, in particular the deposition of votives to a 'snake deity'. Alongside these acts, copper artefacts were also a component of ritual performances of social cohesion that would likely have worked to legitimise the authority of those who controlled the production and deposition of such materials. The broader organisation and significance of copper production at the site can be effectively interpreted through the theoretical lens of a 'ritual economy', which situates this technology within the socially constructed knowledge, beliefs and practices of Early Iron Age society in Southeastern Arabia.

Keywords: Iron Age, Southeastern Arabia, copper metallurgy, social cohesion, ritual economy, snake cult

Introduction

Saruq al-Hadid is a site of long-term, persistent, seasonal human activities stretching from the Neolithic period into the Early Islamic period. Situated on the southern border of Dubai, on the fringes of the Rub' al-Khali desert (Figure 1), the site has been explored by a number of archaeological teams since its first discovery in 2002 (Valente *et al.* 2020; Weeks *et al.* 2019b). This research has served to clarify the nature and extent of human activities at the site and their changing nature through time, although a coherent and nuanced understanding of this complex and enigmatic site remains a focus of research.

Here, we present a summary of ongoing research into the nature of practices related to copper metallurgy at the site — a key component of the activities undertaken there in the Iron Age and later periods — and explore the social factors that contoured metallurgy and craft production at the site


Ghalilah
Shimal
Nud Ziba
ed-Dur
Tell Abraq
Hamriyah
Muweilah
Qusais
Dubai
Masafi
Madha al-Hawami
Bithnah
Kalba
Husn Madhab
Wadi Hilo
Umm Safah
Madam
Thuqaibah
Qawr
Husn Awhala
Saruq al-Hadid
Bragh
Abu Dhabi
Jabid
Ayaay
Bida Bint Saud
Fizh
Zahra
Sohar
Ghail Shabul
Qattarah
Hili
Rumeilah
Lasail
Raki
Dahir
Hawqain
Sib
Muscat
Yiti
'Uqdat al-Bakrah
Bat
Banah
Ayn
Manal
Ismaiyah
Bilah Sait
Hamra
Dat Hail
Tanuf
Andam
Bilad al-Maadin
Mazra
'Umq al-Rabah
Bahla
Salut
Maysar
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and shaped the deposition of its material remains. In doing so, we draw on excavations undertaken principally by the Dubai Municipality, the Sanisera Archaeological Institute (SAI) and the Saruq al-Hadid Archaeological Research Project (SHARP) in two areas of the site: Area F/G and Area 2A, which sit approximately 100 metres apart (Figure 2), and on archaeometric analyses of metallurgical residues and copper-base artefacts from Area F/G undertaken by SHARP. The paper begins with a summary of the development of the archaeological sequence of the site, followed by a review of the variety of metallurgical materials and practices undertaken there, as reconstructed from macroscopic and archaeometric analyses. Subsequently, the 'ritualisation' of copper production and deposition at Saruq al-Hadid is considered, and the nature of craft activities at the site is conceptualised within the framework of a 'ritual economy'.

The archaeological deposits of Saruq al-Hadid

Saruq al-Hadid sits in a desert environment, amidst aeolian sand dunes, at the north-eastern limits of the Rub' al-Khali desert. Throughout its long history, the site does not exhibit evidence of permanent settlement but rather of seasonal occupation. This aspect is evidenced in the immediate vicinity of Saruq al-Hadid from the Neolithic period, when (semi-)mobile communities moved seasonally to the area to graze and water their domestic animals, exploiting the improved vegetation cover caused by the Early Holocene humid period.

As climate deteriorated from the Late Neolithic into the Bronze Age, seasonal hunting activities took place at the site (Roberts *et al.* 2018). Postholes, hearths, potsherds and a large bone midden in Area F/G are testimony of the occupation at this time. Palaeoenvironmental data suggest the site may have looked somewhat different from today, with a less dense and deep coverage of sand dunes and with a denser vegetation of shrubs, acacia and *ghaf* trees (Valente *et al.* 2020: 171-177; Weeks *et al.* 2017: 38-40). Water, which still flows abundantly in underground aquifers (Rizk and Alsharhan 2003), could be reached through wells. Several were found on-site, although only one could be dated securely to the Umm an-Nar period, remaining in use until the Iron I period (Valente *et al.* 2020: 172).

Similar environmental conditions continue throughout the Iron Age. However, it is evident from the archaeological record that dune accretion accelerated and further transformed the landscape during this period, with vegetation progressively diminishing (Valente *et al.* 2020: 173), perhaps due to deforestation actions for charcoal production, although this is not yet proved (Parker and Goudie 2008: 468). At this time, the site becomes a focus for metallurgical production, alongside other craft, cultic and community activities (Weeks *et al.* 2019a; Weeks *et al.* 2019b; Valente *et al.* 2020). In the Saruq-53

Figure 1 (opposite, top): The location of Saruq al-Hadid and other early Iron Age sites in Southeastern Arabia. (© Tatiana Valente)

Figure 2 (opposite, bottom): Drone image of Saruq al-Hadid, looking south-west, showing Area 2A (foreground) and Area F/G (background). (© Qutaiba Al Dasouqi)

Figure 3: Examples of ceremonial deposits from Areas 2A and G. (© Tatiana Valente and Fernando Contreras)

area, about 500 m to the east of Areas F/G and 2A, dense deposits of charcoal have been recovered from excavation; these are dated to the Iron II period and may represent the remains of charcoal production at the site. Although the site appears to have possessed several fundamental resources necessary to support a metal industry, most importantly water and wood for charcoal, the copper ore had to be brought in from at least 100 km away, where the nearest sources are located in the Hajar Mountains. Transport of ore over such long distances is rarely documented in the archaeological record, and where practised it typically characterises the very earliest periods of extractive metallurgy (Hauptmann 2007: 14).

From the stratigraphic sequences identified in Area F/G of the site, the first ritualistic deposits appear during the Iron I period, c. 1250–1000 BCE (Horizon III [Weeks *et al.* 2019b: Fig. 8; cf. Valente *et al.* 2020: 172]). They are marked by the presence of 'incense' burners decorated with snake appliqués, comparable to those observed in Masafi, for example (Benoist *et al.* 2015: 25, Fig. 4, 1-3). Subsequently, an intensive occupation throughout most of the Iron II period is observed (Weeks *et al.* 2019a; Contreras *et al.* 2017), both in the shape of 'ritualised' deposits in Areas F/G and 2A (Figure 3), and of metal production in Area 2A, where multiple combustion structures, raw metal lumps, metallurgical residues and scrap have been identified.

In Area F/G, activities involving the deposition of copper-base artefacts and other materials within possible ritual contexts are observed in the shape of relatively thin depositional lenses with rich material remains, separated by dune deposition indicating periods of abandonment, the duration of which is difficult to determine. In Area 2A, in contrast, ritualised deposition appears to have occurred more consistently, occupying a single deposit of c. 50 cm in depth, suggesting continuous (albeit seasonal) deposition of objects within a relatively circumscribed time period. It is important to note that in Area 2A these ritual deposits are stratified above deposits with abundant metallurgical debris, although mostly concentrated in a central zone with no combustion structures below (Valente *et al.* 2019: Fig. 2). Despite the sandy stratigraphy, and the prevalence of complex and deflated deposits, it is apparent that social activities characterised by ritual deposition tended to occur in raised areas of the site, where substantial dunes had already accumulated by the Early Iron Age. This is seen in both Area 2A and Area F/G, where the existing high point of the Bronze Age midden appears to have been a focal point for ritual activities.

Finally, the top horizon (or 'slag layer' as it is alternatively known) contains discarded materials datable from the Iron II period all the way to the Pre-Islamic and Early Islamic periods (Weeks *et al.* 2019a; Contreras *et al.* 2017). The chronological development of this archaeological horizon is challenging to disentangle due to its complex natural and cultural formation processes. Based on the available radiocarbon evidence, the site appears to have been progressively abandoned before the beginning of the Iron III period, possibly due to worsening environmental conditions of continued dune accretion and reduced vegetation cover. After this period, the site was visited sporadically for metal scavenging and recycling, thus creating the top horizon of accumulated discarded material and metallurgical debris, before the resumption of more substantial copper smelting activities in the Early Islamic period (Stepanov *et al.* 2019; Weeks *et al.* 2019a: 7; Valente *et al.* 2020: 177). Much of the metallurgical assemblage discussed in this paper derives from this uppermost horizon at Saruq al-Hadid. Despite absence of clear chronostratigraphic sequencing in Area F/G, the well-stratified remains from Area 2A and a range of additional archaeological and archaeometric data allow the identification of the major metallurgical production activities undertaken at the site during the Iron Age, as discussed in more detail below.

As a final point of consideration, we note that Saruq al-Hadid is distant from major contemporary settlements of the Iron Age (Figure 1). Although significant surface scatters of Iron Age pottery are known from c. 28 km to the east, at Al-Sooq (Qandil 2005), the nearest sedentary Iron Age settlements comprise a string of sites about 40 km to the east, stretching northwards from the Al Ain Oasis along the piedmont towards Al Madam (Al-Tikriti 2010). The oasis of Al Ain, with its concentration of Iron Age sites, is c. 70 km distant, as are the major sites of Al Qusais and Muweilah closer to the coast. Saruq al-Hadid is spatially separate from any of these sites, although they share similar assemblages of cultural material (Karacic *et al.* 2018; Lombard 1985; Taha 1981; Valente *et al.* 2023; Córdoba 2016).

Thus, Saruq al-Hadid's location is liminal both in terms of the wider Iron Age settlement system and in relation to the metallurgical resources that were exploited there. Here, we argue that its social role in the Iron Age society of the region is key to understanding the existence, location and activities undertaken at this enigmatic site. Saruq al-Hadid's important material and metallurgical assemblages, discussed in this paper, provide further insight into this matter.

Copper production at Saruq al-Hadid: A brief summary

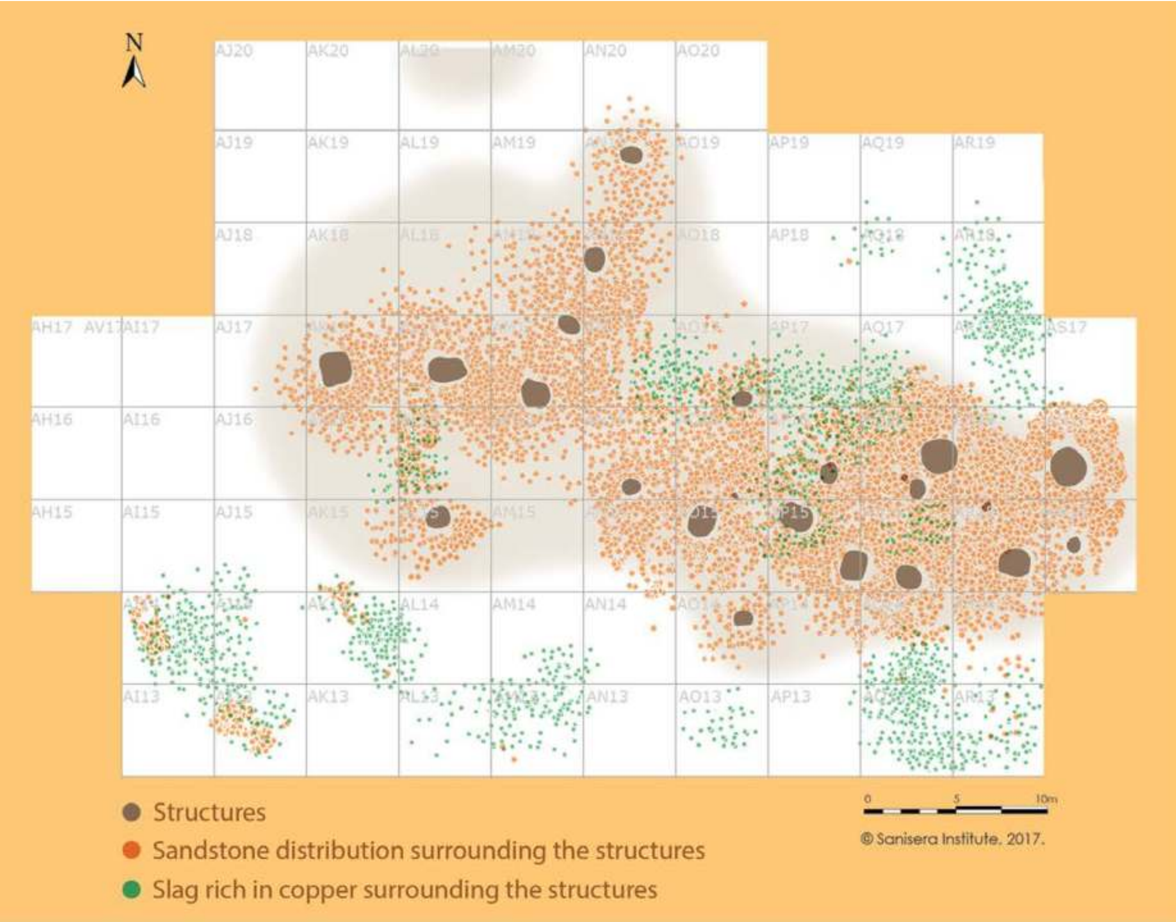
The range of evidence

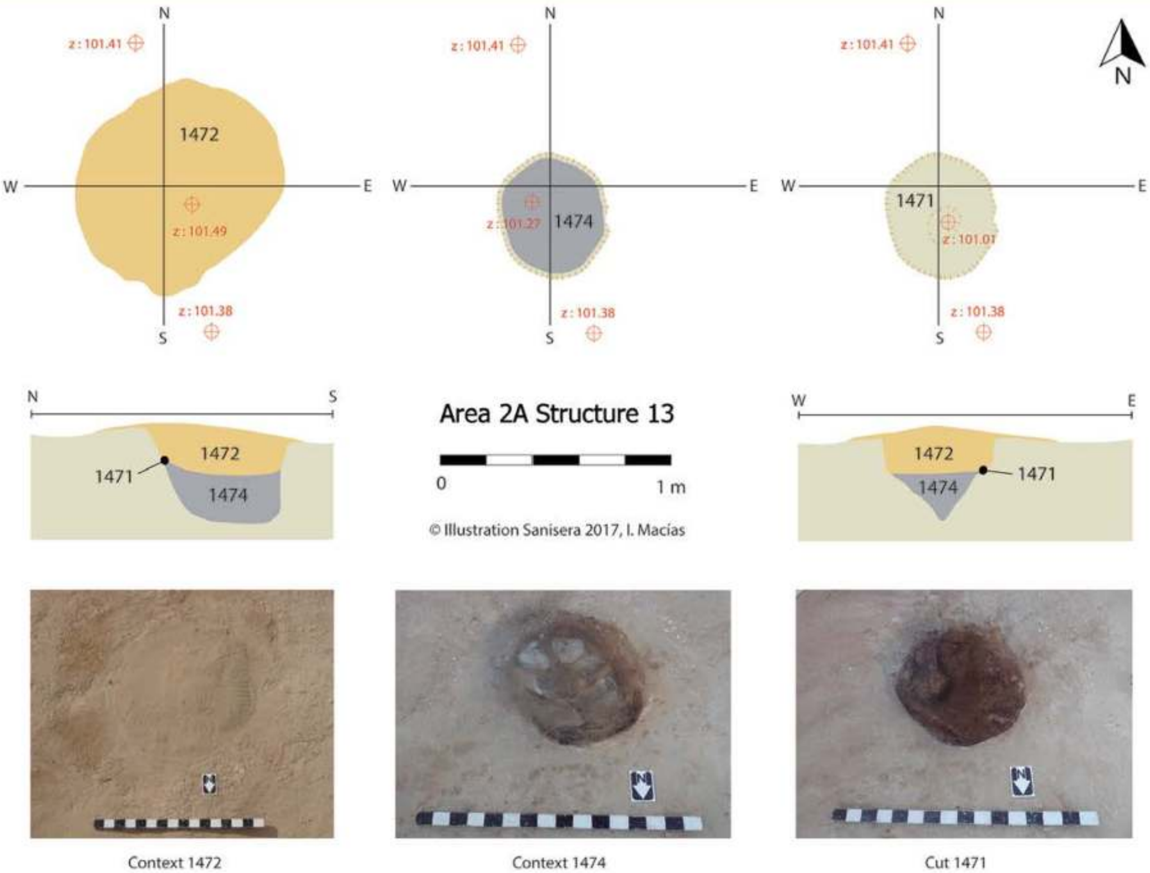
Saruq al-Hadid has produced an abundance of material remains related to metals and metallurgy, including hundreds of kilograms of ferrous remains, many hundreds of gold and silver artefacts, and smaller quantities of artefacts in lead and antimony (Boraik Radwan 2018; Weeks *et al.* 2017). Most abundant among the metal remains from the site, however, are those related to the extraction and refining of copper and the production of copper-base artefacts. As described above, copper smelting slags, showing a variety of morphologies and technologies, are a dominant component of the upper deposits of the site, concentrated by natural and human action into dense deposits that allowed the first identification of the site and its archaeological significance. Residues from subsequent stages of the production process, including the refining of the raw copper and the production of ingots, have also been recovered in substantial numbers, alongside evidence that this metal was melted, possibly alloyed, cast and worked to produce a wide range of finished artefacts. Such artefacts are known in their thousands from the site, and many appear to have been produced there.

As discussed above, the chronology of these activities can be difficult to reconstruct with certainty due to the complex formation processes that characterise the site (Weeks *et al.* 2019a; Valente *et al.* 2020). Based on the stratigraphic position of metal artefacts and residues, it seems clear that high-temperature metallurgical activities did not begin there before the Early Iron Age, although copper-base metal artefacts (principally arrowheads) are reported in modest numbers from the Wadi Suq period to Late Bronze Age deposits of Horizon IV in Area F/G (Weeks *et al.* 2017). A broader range of metal artefacts characterises Iron I period deposits in Area F/G, dated to c. 1300–1000 BCE, when copper artefact numbers and types expand and diversify to include production residues, alongside the earliest evidence for ferrous remains and precious metal artefacts, as well as cultic paraphernalia (Weeks *et al.* 2019b: Fig. 8). By the Iron II period in Area F/G, consistently radiocarbon dated between c. 1000–800 BCE, copper production residues and artefacts are abundant, and include smelting slags and fragmentary furnace remains, raw copper and refining debris, ingots and apparent casting spills. The sequence in Area F/G is capped by dense, deflated deposits (Weeks *et al.* 2019b: Fig. 11 and above), within which copper slags are the major artefactual component, alongside other semi-products, production residues and copper-base artefacts. Direct radiocarbon dating of charcoal from copper slag and thermoluminescence dating of technical ceramics (the lining of copper smelting furnace walls) suggest that these remains span a huge time period from the Early Iron Age, c. 1000–800 BCE, through the Late Pre-Islamic period and into the Early Islamic period in the 9th to 10th centuries CE (Weeks *et al.* 2019a: Fig. 11).

However, many of the metallurgical remains from Area F/G are in secondary or higher-order contexts affected by human action and the complex taphonomy of the burial environment at the site; coherent collections of metallurgical debris and pyrotechnological installations have not been recovered from this area of the site. Although the chronology of finished artefacts can be reasonably well defined through typological studies, allowing the florescence of metal production and deposition in the Early Iron Age to emerge clearly from the archaeological evidence, the metallurgical debris is typically not as amenable to such studies. Some well-preserved slags from Horizons I and II can be typologically dated by comparison to material known from other smelting sites in the region and thus positioned within the long history of metallurgical developments across the Oman Peninsula (e.g. Weisgerber 1980; 1981; Hauptmann 1985; Goy 2019), but many of the material remains are highly fragmentary and chronologically undiagnostic according to either their morphology or production technology. Thus, the development of an overarching *chaîne opératoire* for Iron Age metallurgical production in Area F/G is challenging due to the possibility that exemplars of particular metallurgical residues and technologies might be erroneously drawn from multiple, technologically divergent production periods. Also to be factored into the discussion is the possibility that many materials from the site, very likely metal artefacts but possibly also metallurgical debris, may have been brought to the site from elsewhere, and may thus represent off-site craft practices.

A better interpretation of the metallurgical assemblage from Area F/G, and the isolation of the Early Iron Age technological corpus, thus depends heavily on the excavated evidence from Area 2A, 100 m to the north-east, which provides the clearest evidence for in-situ metallurgical activities that has so far been documented at Saruq al-Hadid (Valente *et al.* 2020: Figs. 5-8; Contreras *et al.* 2017). Numerous absolute dates indicate that this area was in use between c. 1200–800 BCE, with rare dates extending into the 8th or 7th centuries BCE. As shown in Figure 4, Area 2A contains multiple pits dug


N
Structures
Sandstone distribution surrounding the structures
Slag rich in copper surrounding the structures
0 5 10m
© Sanisera Institute, 2017.


z: 101.41
1472
z: 101.49
z: 101.38
1474
z: 101.27
1471
z: 101.07
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S
W
E
1471
1472
1474
Area 2A Structure 13
0
1 m
© Illustration Sanisera 2017, I. Macías
Context 1472
Context 1474
Cut 1471

into the ground surface. Although they are themselves free of metallurgical debris, and some seem too large to have been effective for metallurgical operations, these combustion structures and the site area in general can be linked to metallurgical activities through the identification of abundant charcoal, and thousands of copper-rich refining and production residues and scrap metal pieces in the immediate vicinity (Figure 5). They also bear close comparison to pits recorded at the Early Iron Age copper processing site of ʻUqdat al-Bakrah in Oman (Genchi and Giardino 2018: 17-23, Figs 3.9-3.18).

Figure 4 (opposite): Upper: Pits in Area 2A and their spatial association with abundant copper production residues. Lower: An example of the small pit and deposits recorded as Structure 13. (© Manuel González, Ismael Macias and Anna Zuber)

Figure 5 (above): Examples of metallurgical residues from Area 2A. (© Anna Zuber and Tatiana Valente)

Analytical approaches

The metallurgical remains from Saruq al-Hadid are the subject of an ongoing programme of archaeometric research. This research aims to provide a clearer understanding of the nature of the extractive metallurgical processes that were undertaken at the site, the technology of metal refining, alloying and artefact fabrication, the provenance of raw materials, and the social, political and economic systems that supported these activities.

Field recording of the metallurgical assemblage employed traditional approaches to typological classification and quantification of different categories of remains, supplemented by the use of portable X-Ray Fluorescence (pXRF) analyses for non-invasive qualitative assessments of artefact composition and the selection of materials for further analyses. A subset of the examined metal-related materials was exported for an integrated suite of materials analyses. This included quantification of bulk major, minor and trace element composition, optical metallography of mounted specimens to determine fabrication techniques, and measurement of lead isotope ratios for provenance determinations. The preliminary results of these studies are drawn on in the following discussion, although it is noted that material from Area 2A has not yet been incorporated into the analytical programme.

Primary copper extraction during the Iron Age: smelting slags and furnace fragments

Macroscopic examination of the slag from Saruq al-Hadid indicates a diversity of types, but with a dominance of furnace slag (i.e. those that solidified within the furnace) over tap slag (i.e. those that solidified outside the furnace). The best-preserved example of a furnace slag recovered from the site is SF21468, from a Horizon II context in Area G (Weeks *et al.* 2019a: Fig. 9). This fragmentary piece has a surviving diameter of c. 20-25 cm, and is characterised by a rough upper surface, convex sides and a flat lower surface that represents the original interface between the slag and the matte (concentrated copper-(iron)-sulphides) and raw metal that formed towards the base of the smelting furnace. With a diameter of c. 15 cm, this interface has dimensions similar to the 'ingot-shaped raw material' (SF21467) found in direct association with it in Area G, which consisted of a large layer of matte with a thin layer of black copper (see below) at its base. This particular find may have been the result of an unsuccessful smelting operation, but the existence of several other likely raw metal ingots known from excavation that could weigh up to c. 6 kg supports the evidence for smelting operations on the site.

Although surviving fragments of furnace lining are commonplace at the site — typically displaying slag-encrusted inner surfaces and highly eroded outer surfaces — clearly identifiable components of smelting furnace superstructures are comparatively rare. A good example is SF27901, a slightly inverted rim fragment of mineral-tempered clay, with an outer rim diameter of c. 24 cm increasing to 26 cm at its lower end (Weeks *et al.* 2017: Fig. 20); in its diameter, it is comparable to other diagnostic furnace wall fragments. Although the height of the furnaces used at the site cannot be reconstructed from currently available evidence, it appears that cylindrical clay furnaces that narrowed towards their top with a rim diameter of c. 18-30 cm were used to smelt copper at the site during the Early Iron Age, sitting atop a pit in the ground where the bulk of the furnace slag formed above the primary metallurgical product of the smelt — comprising copper matte and raw metal. The nature of the air supply to these furnaces remains somewhat unclear. No tuyères have been recovered from the site, but many furnace wall fragments exhibit holes of c. 2 cm diameter that allowed for the inflow of air into the smelting chamber (Weeks *et al.* 2017: Fig. 20; Boraik Radwan 2018: 44). These may have facilitated a natural draught into the furnace, as known for example from prehistoric metallurgical production in other regions of the Old World (Hauptmann 2007: 229-232).

The Iron Age date of this extraction technology is supported by the stratigraphic position of key remains (Area F/G, Horizon II), as well as several typological parallels with excavated EIA metallurgical remains from Masafi-1 (e.g. Benoist *et al.* 2015: 28–30, Fig. 7). This dating is further confirmed by the recent discovery of typologically comparable smelting remains within the Early Iron Age settlement at Hili-14 in Al Ain, Abu Dhabi (D. Eddisford, *pers. comm.*) and by a broader typological resemblance to smelting slags from the EIA site of Raki in Oman (e.g. Goy 2019: 202-203, Fig. 115).

A second copper extraction method is evidenced by two conical slag blocks from the site with tapped upper surface textures, gravel or sand burned into their outer/lower surfaces, and a diameter of c. 30-40 cm. These slag blocks can be associated with a fair amount of tap slag and so-called dense slag found in Areas F/G and 2A. Here, the produced copper was separated from the slag by tapping it out of the furnace into a separated pit. The shapes and sizes of the furnaces remain unknown, since no diagnostic furnace-lining fragments have been clearly associated with this method so far. This smelting method is known from later periods in the region (Weisgerber 1981; Hauptmann 1985) and analysed associated slag showed on average significantly lower amounts of trapped copper than the furnace slag, confirming an improved technology in copper extraction during later periods of copper smelting at Saruq al-Hadid.

Analyses of polished sections of primary smelting slags (Figure 6) display mineralogical associations typical for ancient primary copper smelting slags, including abundant Fe-rich olivines (principally fayalite) alongside iron oxides in a glassy matrix. Inclusions within the slag matrix are primarily of copper(-iron)-sulphides, alongside larger matte phases, metallic copper prills and often also unreacted and semi-reacted fragments of the original sulphidic copper ore charge. The inclusions thus demonstrate that smelting activities were focused on the reduction of sulphidic copper ores, a technology that, in Southeastern Arabia, is first documented as the dominant metallurgical extraction technology in the Early Iron Age.

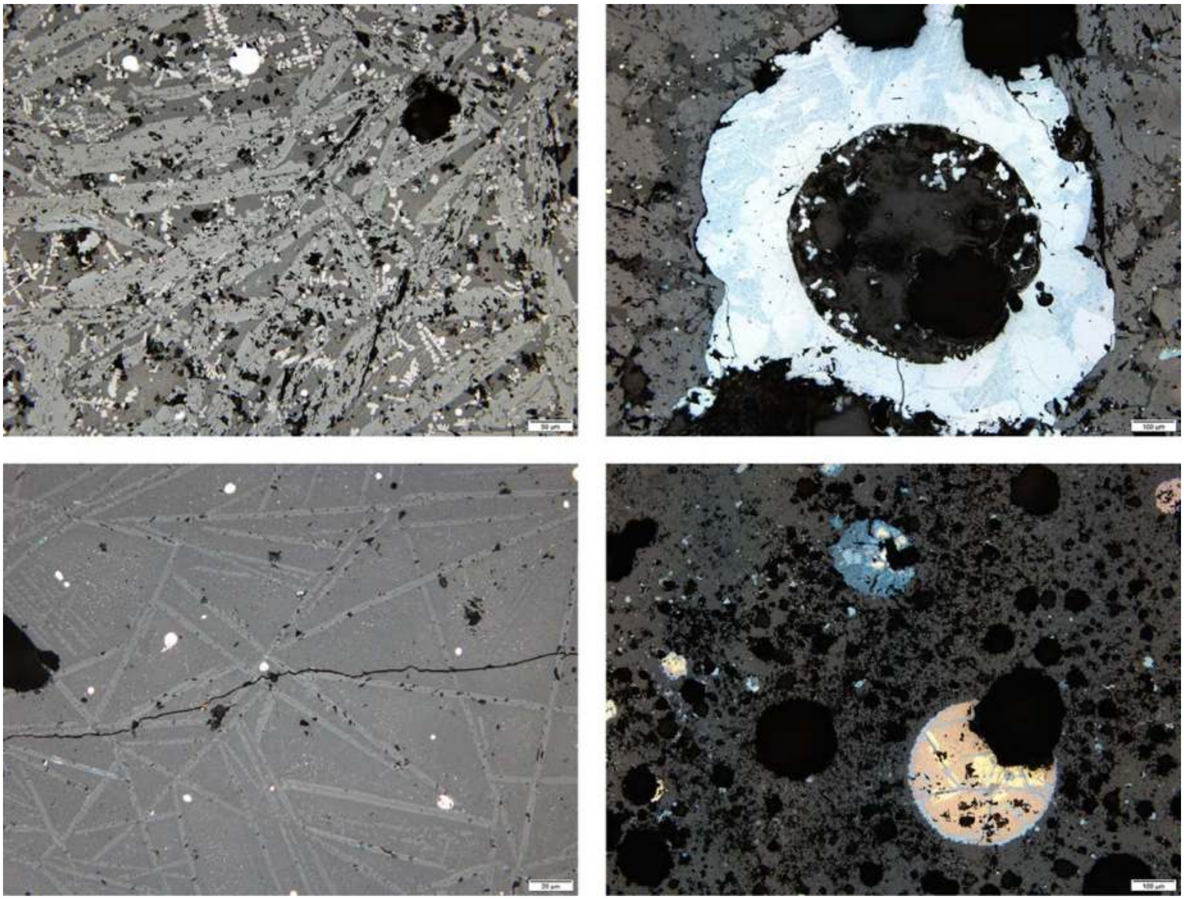
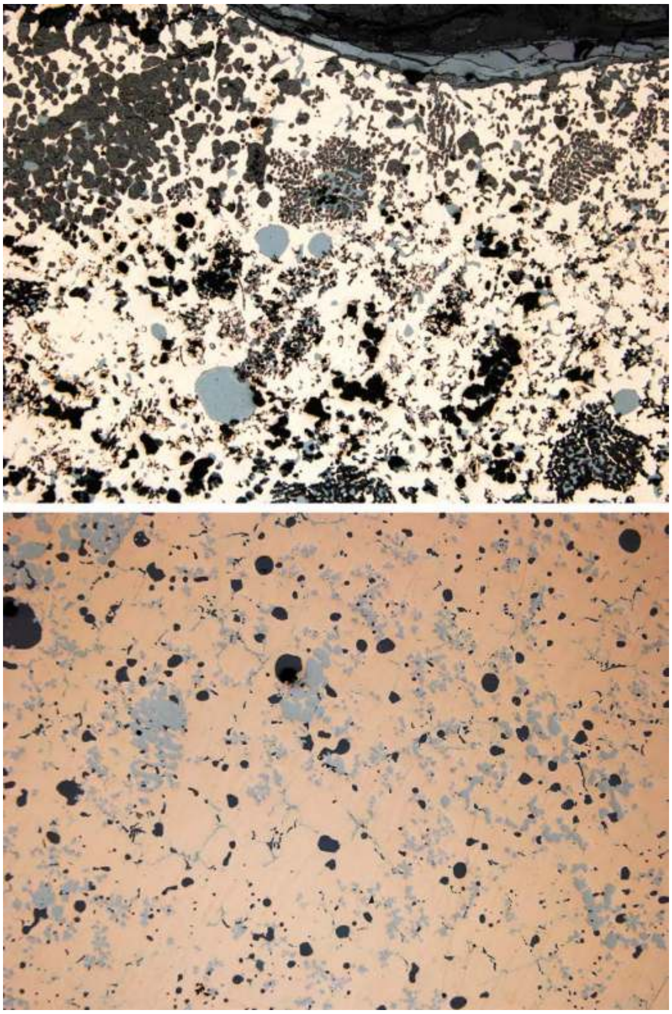


Figure 6: Microstructures of slags from Saruq al-Hadid. Top left: SF22481 showing skeletal fayalite of different sizes (mid grey) with dendrites of iron oxide (light grey) and prills of copper sulphide (pale blue-grey) and copper (white) in a glassy matrix (dark grey) (scale bar 50 μm). Bottom left: SF22449 showing long skeletal fayalite laths (mid grey) in a glassy matrix (dark grey) with copper prills (yellow-white) (scalebar 20 μm). Top right: SF22776 showing matte (copper-iron-sulphide) forming in the slag (scalebar 100 μm). Bottom right: SF22432 showing fragments of partially reduced ore (bright orange-blue) in a lath to massive fayalite slag with rare copper prills (scale bar 100 μm). (Micrographs: T. Eley)

Raw copper, matte and refining in the Iron Age

The archaeological evidence from Saruq al-Hadid for the primary and intermediate products of smelting operations — matte, raw copper, refining debris and ingots — is abundant. The exploitation of sulphidic copper ores (see above) is reflected in the presence of numerous pieces of matte that were produced in the primary smelt alongside, and sometimes inter-mixed with, raw copper. A good example of this is provided by specimen SF38149 (Figure 7), which shows a section through a large, disc-shaped 'ingot' of matte and raw copper produced during a (primary) smelting operation. The artefact has a rough exterior with areas of typical green corrosion products but also abundant rusty-red areas indicative of its high iron content. The polished section reveals an upper area with a shiny dark-grey metallic appearance, representing a layer comprised predominantly of matte. Below this, but intermixed with it, is a layer rich in reddish metallic copper (and some metallic iron), which has separated from the matte during the smelt due to its greater density. The separation is imperfect, and the raw copper metal includes matte as well as pieces of smelting slag (dark areas within the metal), alongside large pores.

Microscopic examination of the raw copper from Saruq al-Hadid indicates the presence of abundant inclusions of (corroded) metallic iron and copper(-iron)-sulphides, sometimes amounting to 30-40 wt% of the specimen



(Figure 8). This material can be classified as 'black copper', a primary smelting product that is well known from other LBA/EIA smelting sites in Southwest Asia (Moorey *et al.* 1988; Roman 1990). This raw metal was subsequently re-melted and thereby refined for the stepwise removal of metallic iron content, and then cast into copper ingots (Merkel 1990), numerous examples of which are known from the site (e.g. Weeks *et al.* 2017: Fig. 21; Boraik Radwan 2018: 42-43). The copper ingots, typically of rough plano-convex shape with diameters of c. 10 cm and weights of c. 1 kg (although 'miniature' versions are also reported), commonly have sulphur concentrations of less than 1 wt% and iron concentrations of c. 4 wt% or less. Residues from these secondary re-melting and refining processes, comprising amorphous lumps of metallurgical waste (refining slag), are well attested in Horizons II-I in Area F/G. The evidence of pyrometallurgical installations from Area 2A is critical in documenting the on-site processing and refining of raw copper rich in iron impurities, as attested by the rusty corroded appearance of many metalworking residues from this area (Figure 5). Based on an experimental study by Merkel (1990), refining may have been undertaken in only three to four steps to reduce the metallic iron content dramatically. During

Figure 7 (left): The raw copper 'ingot' SF38149, showing its rough, disc-like shape, surface corrosion indicating a high iron content, and (in section, centre) the presence of poorly separated layers of matte (upper) and raw copper, iron and slag (lower). (Photographs: L. Weeks)

Figure 8 (right): The microstructure and composition of raw 'black copper' smelted at Saruq al-Hadid. Top: SA23156 showing abundant corroded iron inclusions and copper-sulphides. Bottom: SA22772 showing abundant metallic iron (light blue) and copper sulphides (grey). (Micrographs: K. Franke)

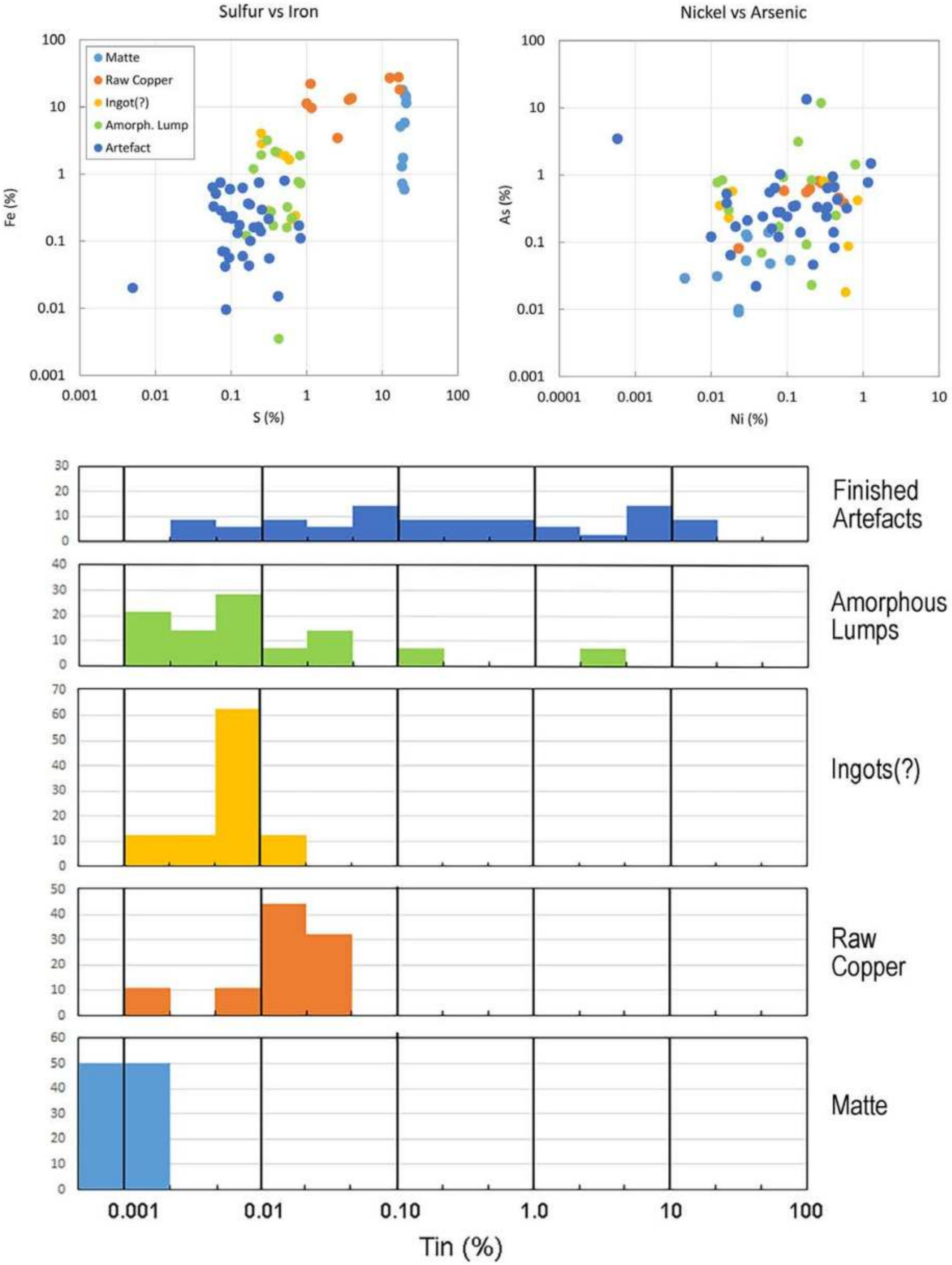


Figure 9: Compositional data for metallurgical remains (n=76) from Saruq al-Hadid, showing scatterplots of iron (Fe) and sulphur (S) concentrations (upper left), arsenic (As) and nickel (Ni) concentrations (upper right), and histograms of tin (Sn) concentrations (lower). (Images: L. Weeks)

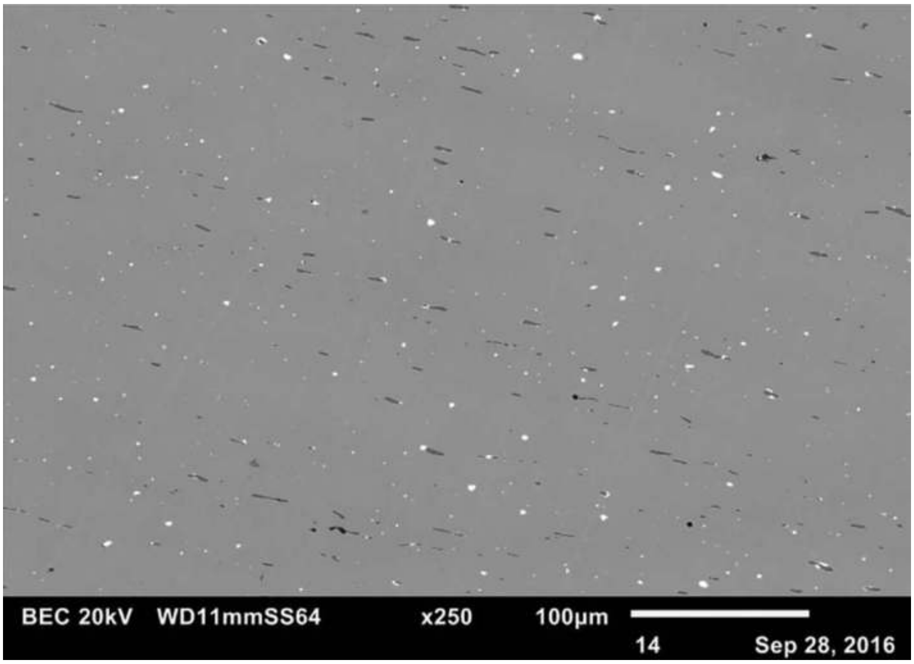


Figure 10: SEM image (backscattered mode) of sample BF27644, a bronze artefact with c. 11% Sn and minor concentrations of As and Ni. The sample contains c. 0.47% Pb, which can be clearly seen in the image as abundant small, white dots. (Image: K. Franke)

melting of the copper metal for casting, additional iron content may have been removed which is evident by the on-average lower iron (and sulphur) content within finished artefacts in comparison to ingots from Saruq al-Hadid (Figure 9).

Final products: Iron Age artefacts, production residues and recycling

The record of finished copper-base artefacts from Iron Age Saruq al-Hadid is superabundant, incorporating many thousands of individual items including arrowheads, daggers, bracelets/anklets, vessels, braziers, fishhooks, anthropomorphic and animal figurines and many other artefact categories (Boraik Radwan 2018: 51-85; Weeks *et al.* 2017: Fig. 19; Contreras *et al.* 2017: Fig. 7). These assemblages come from Horizons I and II in Area F/G, and from Area 2A, and are securely dated to the Early Iron Age by consideration of their stratigraphic position, a large number of radiocarbon dates and many typological parallels to EIA sites across Southeastern Arabia.

At least some of these artefacts were manufactured at Saruq al-Hadid, although it is difficult to know what proportion of the entire artefactual assemblage was produced on site. Artefact production at the site is indicated incontrovertibly by the pyrometallurgical installations and production residues found in situ in Area 2A and is strongly suggested by the recovery of unfinished cast artefacts from the site, including arrowheads and an elaborate socketed axe or halberd (e.g. Boraik Radwan 2018: 45). In addition, compositional analyses of artefacts and production residues from Area F/G indicate similarities between ingots, amorphous lumps and spills, and finished artefacts from Saruq in terms of their arsenic and nickel concentrations (amongst other trace and minor elements), while also documenting the presence in finished artefacts and production debris of alloying elements such as tin and occasionally zinc, antimony and lead (Figures 9, 10). In contrast to the increased concentrations of these elements within production debris, they occur only at trace concentrations in the raw copper produced at the site. Tin and lead, in particular, are likely to indicate the use of alloying material from outside the region. It is clear that at Saruq al-Hadid, similarly to other Early Iron Age sites in Southeastern Arabia (Goy 2019), a wide range of tin concentrations was employed in the production of finished artefacts, no doubt in part a reflection of widespread recycling of copper-base artefacts. Lead isotope analysis indicate that a large proportion of the analysed ingots, production debris, and finished and semi-finished artefacts derived from copper sources from the Semail Ophiolite in Oman. However, several outliers suggest the import of particular copper-base artefacts or raw materials.

The evidence of 'scrap' copper-base metal pieces from Area F/G (Weeks *et al.* 2017: Fig. 20), usually identified by the fact that they are broken and/or folded, and the inclusion of finished artefacts alongside raw metal in a vessel from Area 2A (Valente *et al.* 2020: Fig. 10), indicates that the recycling of metal was a common practice at the site. This evidence matches the compositional data from the wider region indicating the prevalence of recycling in Early Iron Age metallurgy in Southeastern Arabia (Goy 2019), as well as ancient written sources from Mesopotamia in which the recycling of metal is repeatedly mentioned (e.g. Moorey 1994: 254).

In exploring the nature of copper-base artefact production at Saruq al-Hadid, it must be acknowledged that some (perhaps a considerable proportion) of the excavated artefacts were imported to the site as finished artefacts, perhaps even from outside Southeastern Arabia. Despite typological parallels to copper-base artefacts from the UAE and Oman (e.g. 'Uqdat al-Bakrah, Jabal Mudhmar, Adam, Daba, Ibri, Masafi, Salut), many of the most elaborate artefacts from the site, including for example the bimetallic bronze-iron daggers with strong Iranian parallels (Weeks and Petrie, in press), or braziers with bulls' hooves with parallels in Urartu (Potts 2009), are candidates for such imports. Such artefacts remain largely unstudied in archaeometric terms.

Copper and ritual deposition at Saruq al-Hadid

The contexts in which copper-base artefacts and residues were recovered at Saruq al-Hadid encourage their interpretation as not simply the remains of mundane craft activities, but as the material manifestation of ritual activities of considerable social and/or political significance. As Hull (2014: 165) has stated: "… all ancient societies lacking writing systems probably depended upon ritual – and especially the performative aspects of ritual — as one means within a relatively limited repertoire of media through which values, meaning and identity could be created, expressed, reinforced and negotiated." Budd and Taylor (1995: 139) likewise highlight the importance of ritual for ancient metallurgical practice in non-literate societies, where complex procedures might be committed to memory as 'spells'.

As described in detail elsewhere (Valente *et al.* 2020; Weeks *et al.* 2019b), ritual activities at Saruq al-Hadid include the careful placement of raw copper (including ingots and amorphous lumps) alongside arrowheads, axe heads, daggers, swords, jewellery (bead necklaces, earrings, rings and bracelets) and copper-base snake figurines. Next to these agglomerations, the presence of alabaster, soft stone and ceramic ware (snake-decorated, Grey Ware and spouted vessels) is also common. Miniaturised weaponry, such as axe heads and daggers, is also a component of several of these ritual deposits, including near a group in Area 2A that included multiple anthropomorphic and snake figurines (Valente *et al.* 2019). The constellations of materials deposited at Saruq al-Hadid demonstrate ritual activities characterised by a complex intersection of symbols and beliefs and likely cross-cutting any simple division between sacred and profane. This complexity is now beginning to emerge at a regional scale, as witnessed in a variety of manifestations at cultic sites across Early Iron Age Southeastern Arabia (e.g. Benoist *et al.* 2015), which seem to have been a fundamental aspect of the reproduction of Iron Age society.

To better understand the 'ritualisation' of copper production and deposition at Saruq al-Hadid, it is necessary to explore the co-mingling of artefacts of different materials, functions and provenance at the site. As noted above, ritualised deposits appear either in the shape of small agglomerations in Area F/G, in between sterile deposits, or in successive, concentrated accumulations as observed in Area 2A. In addition to their different intensities and/or periodicities of deposition, however, Areas F/G and 2A also display some differences in the types of objects incorporated into ritual activities, which seem to reflect different types of rituals.

In Area F/G (Figure 11), we observe mostly copper-base weaponry dispersed through small, ritualised deposits, which also include copper-base snakes and 'incense' burners in both copper and pottery, many snake-decorated (Karacic *et al.* 2017). Alongside these materials, the Area F/G assemblage is also characterised by the presence of alabaster, soft stone, iron and precious metal artefacts, finely crafted products in shell and bone, and pottery vessels (the majority in bowl form). Although these deposits are among the richest and most varied examples of their kind from the wider region, they nevertheless compare closely with deposits found at several other Early Iron Age sites in Southeastern Arabia, including Bithnah (Benoist 2005; 2007; Benoist *et al.* 2012), Masafi (Benoist *et al.* 2015), the 'mound of serpents' at Al Qusais (Taha 2009), Jabal Mudhmar (Gernez *et al.* 2017; Gernez and Jean 2020) and Salut (Avanzini and Degli Esposti 2018). Collectively, these sites document a region-wide tradition of cultic or ritual activities related to a 'snake deity'

Figures 11a and 11b: Some typical artefacts from ceremonial deposits in Area F/G (© Hélène David-Cuny, Anna Zuber, Edurne Fernández and Julia Coso)


JM 2592
GR 15358
Saruq al-Hadid
GR 15380
GR 12216
GR 9628
SF 30880
SF 30701
SF 30705
SF 36265
SF 31814
SF 30707
SF 30703

(Mouton *et al.* 2011; Cian 2015; Karacic *et al.* 2017), with numerous examples of snake-decorated pottery and small copper-base figurines depicting this animal. The evidence for the burning of aromatics (probably incense) at each of these sites indicates its importance in cultic events in general.

Furthermore, it is clear that the by-products of metallurgical activity at Saruq al-Hadid were incorporated into these 'ritualised' deposits. The variety of copper-base metallurgical residues found in such contexts include small amorphous copper lumps, larger pieces of slag, raw copper 'ingots' and plano-convex ingots produced after refining. In both areas of Saruq al-Hadid, these are observed as small piles or collections of material placed with or next to other deposited materials. This practice parallels contemporary sites, for example Masafi and Bithnah (Benoist *et al.* 2015), where metallurgical residues including 'furnace bottoms' and ingots were also found inside pottery vessels decorated with snakes or in pits. Similar collections were also identified in Salut (Avanzini *et al.* 2007) and at 'Uqdat al-Bakrah, where a small number of snake figurines is known (Yule and Gernez 2018: cat. nos. 399, 400).

Together, this evidence supports the theory that such materials are votive offerings to propitiate a snake deity who is associated with metallurgical knowledge and production (Benoist 2010; Benoist *et al.* 2015). The symbolism of the snake as a transformative and creative force, intertwined with fire and the craft of metalworking, can be found in various cultures across different regions. In ancient Southwest Asia, the snake had multiple aspects and associations, including healing, water and fertility. As a symbol of renewal and regeneration, in several cultural traditions the snake represented the transformative powers involved in the creation and manipulation of metals (Rothenberg 1972; Miroschedji 1981; Bollhagen 1983; Golan 2003; Münnich 2008; Zych 2019).

Nevertheless, alongside the presence and significance of production residues and raw copper, the social importance of *finished* copper-base artefacts in these rituals must also be considered. At Saruq al-Hadid, the variety of such finished objects is extraordinary — from simple tools such as pins/needles, hooks and hoes to decorative items such as bracelets and rings, and vessels of different forms (e.g. Boraik Radwan 2018). However, by far the greatest proportion of the finished objects comprises weapons, including axes, daggers and especially arrowheads; many thousands of the latter have been recovered from the site. Elsewhere in Iron Age Southeastern Arabia, copper-based weaponry is particularly abundant in the cultic assemblages from Al Qusaism (Taha 2009) and Jabal Mudhmar (e.g. Gernez *et al.* 2017: 111).

Miniaturised versions of weapons (and occasionally other object categories) are also common at these sites. Saruq al-Hadid has produced miniature bows, quivers, arrows, daggers and axes, often made as skeuomorphs in copper-base or precious metal. At 'Uqdat al-Bakrah, miniature axes and daggers are recorded (Yule and Gernez 2018: cat. nos. 86-87, 223-226, 360-368), and Jabal Mudhmar has a wide range of such objects, including miniature skeuomorphs of axes, arrows, arrowheads, bows and quivers (Gernez *et al.* 2017; Gernez and Jean 2020). Each of these sites is known, moreover, for the presence of unfinished castings of copper-base weapons. These include both full-sized and miniature examples of socketed axe heads still with attached casting cup/sprues and flashing (e.g. Gernez *et al.* 2017; Yule and Gernez 2018: cat. nos. 82, 111-114).

The prevalence of weaponry in cultic contexts is undoubtedly of cultural significance, although identifying the specific nature and meaning of this practice for Early Iron Age societies in Southeastern Arabia is very challenging. At Jabal Mudhmar, the abundance of weaponry (especially archery-related artefacts) in votive contexts has been tentatively linked to their offering to a "warrior deity… as key elements of specific social practices" (Gernez *et al.* 2017: 111). Beyond the religious realm, one can consider the possibility that the deposition of weaponry to a deity with a martial aspect mirrored the existence of a 'warrior' ideology in contemporary society. Cross-culturally, such practices and beliefs have been linked to the emergence of warrior leaders or chieftains, who manipulated the materialised ideology of warriorhood to gain and maintain power, often through the control of relevant natural resources and/or industries, such as metallurgical production, and the exchange of these products and others considered 'prestigious' (Earle 1997).

Other material categories from cultic sites/deposits emphasise this aspect. In particular, the presence at Saruq al-Hadid of iron swords (in Area F/G only) alongside numerous bimetallic daggers (Boraik Radwan 2018: 48-53) is significant, as is the presence of rare examples of bimetallic artefacts in votive contexts at other sites, including Jabal Mudhmar, Al Qusais and 'Uqdat al-Bakrah (Stepanov *et al.* 2020; Weeks and Petrie, in press). Noting that there is no evidence of local iron smelting at any Iron Age site in the region, as well as the strong typological, technological and compositional parallels with contemporary material from Iran (Stepanov *et al.* 2020), it is highly likely that such artefacts were obtained through long-distance trading circuits. These votives are, therefore, profound exemplars of exotic and rare raw materials and craft skills. Not only symbols of a warrior identity, these weapons were also material manifestations of the power to participate in and control the long-distance movement of exotic materials, likely the prerogative of a highly circumscribed, elite segment of society, as proposed above. In Area F/G, their deposition simultaneously served purposes both sacred and profane: propitiating a deity that was responsible for knowledge of fire and metallurgy, while also demonstrating and legitimising the power of Iron Age community leaders.

To better understand this complex dynamic of belief, politics and economics, however, we must also consider the assemblage found in Area 2A which, as noted above, is somewhat different from the one identified in Area F/G. The

Figure 12: Some typical artefacts from ceremonial deposits in Area 2A. (© Anna Zuber, Edurne Fernández and Julia Coso)

assemblage from the ritual contexts in Area 2A (Figure 12) also contains offerings of copper-base snakes, weapons (miniaturised and regular), raw copper, and jewellery as described above. But, unlike Area F/G, incense burners have not been found there. As these seem to be a fundamental and pervasive component of cultic rituals at Iron Age sites in Southeastern Arabia, their absence in Area 2A suggests that more mundane 'political ceremonies', in the shape of gift exchange and convivial festivity (Benoist 2010), characterised activities in this area of Saruq al-Hadid. Although votive offerings to a snake deity were still a component of the material remains from Area 2A, here only agreements and exchanges between those who visited the site seem to have been celebrated. Similar actions have been observed in other societies, where celebrations and ceremonies reinforced and legitimised ties between individuals and groups, providing recognition of authority, legitimacy and mutual obligations, particularly between actors at threat of conflict or simply between political entities within the same region, who relied on each other economically or politically (Levy 1995; Swenson 2015; Swenson and Berquist 2022).

The ceramic assemblage found in Area 2A adds to our consideration of this hypothesis. Area 2A is dominated by Grey Ware jars and spouted vessels (Benoist and Valente 2017) which parallel examples found in Rumeilah, Dadna, Bithnah, Wadi Al Qawr, and Muweilah (Benoist 1999; Benoist and Ali Hassan 2010; Corboud *et al.* 1996; Phillips 1987; Magee 1998a; Benoist and Méry 2012). As likely products of the extra-regional exchange circuits noted above, these vessels also had an enhanced material significance. Such vessels are comparatively rare in Area F/G, which is instead dominated by Sandy Ware bowls and snake-decorated vessels of local production (Karacic *et al.* 2017). Steatite and copper vessels (many spouted), although produced locally (David 2002), also occur frequently in the Saruq al-Hadid assemblage and parallel those of Iron Age contexts in the region (Lombard 1985; Ziolkowski 2001; Genchi and Tursi 2022; Taha 1981; Valente *et al.* 2023). Finally, the presence of ladles is also attested on-site, paralleling those found at Muweilah (Magee 1998a). Collectively, such objects suggest a pervasive commensality at Saruq al-Hadid; in this respect, they resemble the assemblages found in meeting and administrative buildings across the region, including the columned halls of Muweilah (Magee 2002; 2007), Bida bint Saud (al-Tikriti 2002) and Rumeilah (Boucharlat and Lombard 2001), for example.

Together, this evidence suggests that activities in Area 2A, while redolent with cultic imagery and characterised by the performance of offerings, took place within a context where people would banquet and celebrate. This celebration likely encompassed not only the craft production undertaken there, but also the gathering itself and the social connections that came from it.

Copper and the 'ritual economy' of Early Iron Age Southeastern Arabia

Above, we have argued that copper technology was 'ritualised' at Saruq al-Hadid, as manifested through votive offerings to a snake deity who controlled metallurgical knowledge and production, and who was venerated by the deposition of metal production residues and finished artefacts, especially weapons. However, it can be argued that ritualisation characterises not only the technology of copper production at Saruq al-Hadid, but also its economic organisation.

Over the last two decades, archaeologists have worked to break down the pervasive, Western, dualistic conception of a (rational) sphere of economic action that can be contrasted with an (irrational) sphere of ritual action, in particular by deploying the concept of the 'ritual economy'. Such an approach explores the ways in which rituals can structure craft practices and the production, distribution and consumption of craft goods (e.g. Miller 2015; McAnany and Wells 2008). Archaeological and ethnographic studies of ritual economies have highlighted, for example, societies in which the ritual cycle "structures production and consumption… in a manner outside of the political control of any one group or individual. In this case economic interactions became embedded in the ritual cycle as a means to ensure peace and reciprocity while uniting groups outside of the bonds of kinship" (Miller 2015: 125).

Although ritual economies have been explored as engines for the intensification of production in small scale, non-centralised societies (e.g. Miller 2015; Everhart and Ruby 2020), the mutually constitutive realms of ritual and economy nevertheless provide many opportunities for ritual production to be co-opted in the exercise of power and the negotiation of (uneven) social relationships. In a particularly relevant case study from the Late Moche site of Huaca Colorada in Peru, Swenson and Warner (2012) identify the gathering together at the site of people from spatially separated communities for the purposes of copper production — smelting, refining and object fabrication — that was associated with feasting and ritual activities. In their assessment, "copper metallurgy was intimately associated with ritual transformation complicit in the forging of political identities and dependencies" (Swenson and Warner 2012: 314). Critically, however, they note that the contexts in which metallurgical production was undertaken indicate that "participation in the metallurgical artisanry was not one of coercive or top-down subjugation. Instead, metallurgy, feasting, sacrifice, and the exchange of finished products… contributed to a sense of community integration and interdependency" (Swenson and Warner 2012: 315). Here, we argue that a perspective derived from the concept of ritual economies is valuable in understanding the organisation of copper production in Early Iron Age Southeastern Arabia and its specific materialisation at sites such as Saruq al-Hadid.

Benoist (2010) has discussed authority and religion in the Southeastern Arabian Iron Age, correlating data from several cultic sites and meeting places. Her review highlights the evidence for cultic activities, gatherings and festivity, but also the close association and importance of these activities for the management and sharing of resources, in a way that aligns well with the workings of a ritual economy. Although numerous sites evidence either one or another aspect of authority and religion, Saruq al-Hadid's rich material assemblage, despite not yet providing any evidence for columned halls or cultic structures, shows it to be a place where members from communities across the region could gather for the purposes of craft production, and while doing so, enact religious, social and political events that were fundamental to social reproduction and cohesion, as well as the negotiation of relations of power and prestige. Here, the liminal desert locations of sites such as Saruq al-Hadid and ʻUqdat al-Bakrah (Yule and Gernez 2018) are not anomalous, but rather a key criterion of their function: They represent a space *for* many communities but not *of* any specific community and outside the control of any one group or individual. If we consider the Iron Age population of Southeastern Arabia as experiencing an increased likelihood or threat of conflict — a suggestion supported by the fortification of many sites in the region during this period (e.g. Benoist 2010) and also the abundance of weaponry produced at this time — the need for places and rituals of social cohesion becomes clear.

If conflicts were occurring between the Iron Age communities of the region, or simply if every settlement had its own elite controlling and defending specific territories and resources, sites like Saruq al-Hadid and ʻUqdat al-Bakrah may have been crucial to formalise and consolidate extra-community ties, and a sense of interdependency, as well as the authority of the elites who gathered there periodically (e.g. see Swenson and Berquist 2022). Magee (1998a; 2002; 2007) has repeatedly stressed this idea and refers to the evidence supporting the existence of such elites. The referred characteristic assemblage found in columned halls – and at Saruq al-Hadid – comprises objects such as spouted vessels and ladles, which seem to symbolise the power of those who possess them. Similar claims can be made regarding the control of foreign resources such as iron (Magee 1998b) or tin for copper alloying (Weeks and Petrie, in press), or the Grey Ware vessels found at Saruq al-Hadid (Benoist and Valente 2017), noting that some could be local imitations. Many of these materials may be of Iranian origin or obtained via Iran (Weeks and Petrie, in press), suggesting economic connections between elites in these areas who were responsible for the control and distribution of such products. Furthermore, the production of decorated shells buttons and beads of various materials is also attested at the Saruq al-Hadid (Weeks *et al.* 2019c; Rempel *et al.* 2021), thus stressing the idea that many forms of 'prestigious' production took place at the site and were incorporated into its ritual economy. Trading evidence found at Saruq al-Hadid also supports the idea of numerous groups of people coming together at the site to engage in exchange. This includes scale pans (Boraik Radwan 2018: 47), which indicate the weighing of items such as metal ingots, objects and scrap for exchange, as well as an extensive and diverse collection of stamp 'seals' found at the site (Karim *et al.* 2017). In fact, the entire paraphernalia observed in cultic and administrative or communal meeting structures in Iron Age Southeastern Arabia, always charged with ritualised symbolic practices, appears to have been produced, offered and exchanged at Saruq al-Hadid.

Conclusions

This study has summarised the evidence for copper production and use at Saruq al-Hadid, alongside other craft activities focused on elite or prestige good manufacture, and has outlined the details of an elaborate set of associated ritual practices directed towards a snake deity. It has been argued that this copper production – typically envisaged as a leading 'industrial' technology of its time that provided a major raw material for exchange – cannot be properly explored in purely technological and economic terms. As Budd and Taylor (1995: 138-139) suggested many years ago: "metal-making was a non-scientific business, highly varied and variable, in which the various activities for which we have archaeological evidence were carried on alongside social activities which we cannot easily infer. Those activities may be better described as 'ritual' or 'symbolic' rather than 'economic'." Here, we have argued that the production and deposition of copper at Saruq al-Hadid can only be properly understood within complex, culturally specific beliefs and practices, and with the recognition that aspects of a 'ritual economy' shaped the nature of the Iron Age copper industry in Southeastern Arabia.

Previously, Saruq al-Hadid has been conceptualised within the framework of 'Arabian pilgrimage' (Magee 2014: 239-240; Weeks *et al.* 2019b: 173), a social practice that has been described as "a constellation of gathering, sacrifice, and feasting at a sacred place to assemble and reify communities that are not coresident" (McCorriston 2013: 608). While this model maintains its fundamental interpretive relevance for understanding a site such as Saruq al-Hadid, its explanatory power is enhanced when broadened to include the insights of studies of ritual economy; specifically, that such gatherings mobilised, and were mobilised by, ritualised craft production of copper and other materials.

Much work remains to be completed on the metallurgical remains from Saruq al-Hadid. This includes, but is not limited to: a fuller catalogue of metal artefacts from the site; comprehensive archaeometric studies of metal extraction, composition, fabrication, use and provenance; and an exploration of interactions and technological transfers between the various high-temperature crafts attested at the site. Critical to the success of these endeavours will be the continued parallel development of interpretive frameworks that capture the full complexity of the social contexts in which metallurgy developed in Early Iron Age Southeastern Arabia.

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Cultures, technologies and environment on the Oman Peninsula
Recent discoveries and some hypotheses about the *falaj* system in Al Madam, Sharjah, UAE

Carlos Fernández and Carmen del Cerro

Abstract: The Al Madam 2 *falaj* (Sharjah, UAE) is one of the best-known examples from the region. From 2002 to the present, it has been the object of excavations by the Spanish Archaeological Mission, allowing us to discover its underground route, the shafts that give access to it and the ancient cultivation area, among others. The investigations have continued during the latest excavation campaigns, focused on following the path of the *falaj* (pl. *aflaj*), with its respective secondary channels and the ponds and tree pits to which they give access. However, the main objective currently is the search for the end of the *falaj* and to understand its relationship with the structures of the village of Al Madam 1. In this paper, we will explore the different possibilities according to the hypotheses that our team handles and the parallels with other excavated *aflaj* in the United Arab Emirates.

Keywords: Al Madam, *falaj*, Iron Age, agriculture in antiquity, United Arab Emirates

Introduction

The site of Al Madam is located in the central region of Sharjah, a savannah steppe-like plain covering an area of about 10 × 5 kilometres, bounded on the east by the Hajar Mountains and on the west by the *jibal* (mountains) Buhais, Emalah and Faya (see Figure 1). The location of the Al Madam oasis provided its inhabitants with the conditions to guarantee agricultural productivity despite being in such an arid and unstable environment (see Figure 2).

The aforementioned *jibal* protect the area from the sands of the Rub al Khali, the great desert of Arabia. Sometimes, however, this sand manages to pass over these hills, thus reaching the habitable plain. In these cases, the nearby Wadi Yudayyah manages to carry during its floodings the accumulated sand. To these elements, we must add the proximity of the Hajar Mountains, which allow seasonal rains, that in antiquity were essential to recharge an aquifer close to the surface.

The studies of the Spanish Archaeological Mission, which has been working in the field since 1994 (in cooperation with the French CNRS team for the

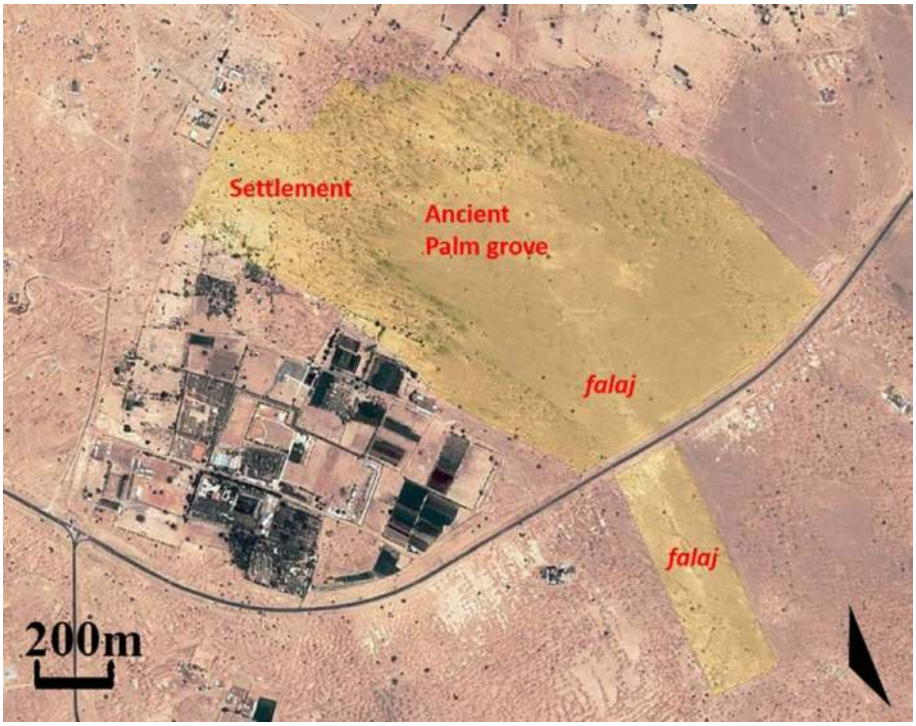

Figure 1: Map of the Oman Peninsula with location of Al Madam archaeological site (base image: NASA, edited by C. Fernández).

Figure 2: Plan of Al Madam archaeological site showing the location of the settlement (AM1), the *falaj* and the ancient palm grove (AM2) (base image: Google Maps, edited by C. del Cerro).

first two campaigns and afterwards alone), have concentrated mainly on two sectors of the vast region: Al Madam 1 (AM1) and Al Madam 2 (AM2). AM1 (also known as Al Thuqeibah) is an Iron Age II–III settlement that is in an excellent state of preservation thanks to the protection afforded by the surrounding dunes. On the other hand, in AM2, one of the oldest *aflaj* on the peninsula has been excavated. In addition, during surveys by the French team led by M. Mouton, carried out in the Al Madam-Mleiha region in the early 1990s, at least four other *aflaj*, visible on the surface, were identified in sectors AM7, AM8, AM21 and AM31 (Córdoba 2010: 147).

Archaeological research in the Al Madam area offers us a vivid picture of the ways of life of an Iron Age village, which was peacefully abandoned without any sign of violence due to lack of water at the end of said period. Many of the materials found in the AM1 village, such as hand mills, highlight the link between its population and agriculture. For this reason, from the first excavation campaigns in AM1, agriculture and cultivation modes were foremost in our minds.

The gallery and the cultivation area of the *falaj* of Al Madam 2

In 2002, we decided to confirm the presence of a *falaj* in AM2, as suggested by the French archaeological team, by carrying out a survey that cut through one of the hills which, from the surface, suggested the presence of an access shaft to a *falaj* on the plain of Al Madam. Thus, the first of the wells (*thuqba*, pl. *thuqab*) that gave access to the *falaj* gallery in antiquity were dug (see Figure 3). The Al Madam *thuqab* were carved directly into the bedrock, through layers of sand and gravel. The results indicated that the *thuqab* were intentionally blocked, probably as a security measure after the structure was abandoned.

As the campaigns progressed, six additional *thuqab* were excavated. Our understanding of this *falaj*'s gallery grew as a total of 35 metres of a subterranean layout that followed a zigzag path was excavated. Our work on this part of the structure allowed us to conclude that it was a water collection gallery, rather than a *falaj* in the strict sense.

Figure 3: Thuqba
Tqb 1 of the *falaj*, after excavation (Spanish Archaeological Mission).

On the Oman Peninsula, there are three types of *aflaj* depending on the source of water they have access to (Benoist *et al.* 2020: 170): *dawudi falaj*, which takes water from deep underground aquifers; *ghayl falaj*, which exploits the shallow groundwater tables of alluvial basins or the base of seasonal rivers; and *ʿayni falaj*, whose waters are derived directly from springs. In any case, it is always a matter of finding layers that are well fed by continuous seepage or a spring that does not show symptoms of water scarcity.

The mother well, or *umm al falaj*, of the AM2 intake gallery has not yet been found, so we still do not understand exactly where the section of the underground gallery began, but possibly its origin was close to the current border with the Sultanate of Oman, near the Hajar Mountains, a few meters from the archaeological area of Al Madam.

One of the most relevant peculiarities of the AM2 *falaj* is the re-excavation process carried out in a second phase of its history due to the drop in the level of the water table, possibly caused by the overexploitation of the aquifer together with the increase in aridity of the environment. The total height of the gallery increased, in this second phase, from 1.5 m to 4.8 m. Its width, on the other hand, remained between 0.50 and 0.55 cm (see Figure 4). The re-excavation

Figure 4: Underground gallery of the Al Madam 2 *falaj* (Spanish Archaeological Mission).

Figure 5: Drone view of the Irrigation Channel Network Area (Spanish Archaeological Mission).

of the structures to reach the water table is also visible in the structures of the village located in Sector 1 of Al Madam. The well in the central area of settlement, called We1, was extended from a depth of 4.5 m to 7 m.

In 2009, two surveys, one geomagnetic and one with georadar, helped us to identify the course of the *falaj* from the previously excavated *thuqab*. Following the results obtained, 17 surveys were carried out to follow the trajectory of the main channel between 2011 and 2014. Thanks to this, it was possible to locate the exact point where the *falaj* changed from being an underground gallery to an open-cast channel that would run about 200 m before reaching the area destined for crops in antiquity.

Determining the extension of this area of cultivation was made possible due to the observation of a series of mounds that seemed to frame an area of approximately 600 × 300 m. At first, these hills seemed to be the result of an artificial flattening of the surface that housed the crops. In February 2015, this hypothesis was confirmed, owing to the fact that one of these hills had been transversally cut through the enlargement P, confirming that it was actually an artificially created mound whose strata clearly indicated that earth had been intentionally accumulated there. We find ourselves before what on the Oman Peninsula is known as *nadd* (palm grove mounds) (Costa 1983: 249 and Figure 2), i.e. the result of the re-excavation of an area prepared to guarantee the transfer of water to the entire facility (see Figure 5).

In the 2015 campaign, excavations also continued in the central area that housed the Al Madam crops (i.e. the Irrigation Channel Network Area, ICNA

Figure 6 (right): Artificial hill cut through the enlargement P, after excavation (Spanish Archaeological Mission).

Figure 7 (below): Molluscs (*Truncatella marginata*) found in the Irrigation Channel Network Area (Spanish Archaeological Mission).

hereafter). The ICNA of Al Madam is a well-defined and articulated network very similar to those of other regions, such as southern Iraq and other parts of the emirates (see Figure 6). It is made up of lines of trees (usually palm trees) that provide shade to protect more sensitive crops from the sun. The Bedouins who currently inhabit the region revealed to us that their ancestors farmed directly on the sand, thus suggesting that harvesting was possible (Del Cerro and Córdoba 2018a: 95). From an archaeological point of view, it is impossible to know if the inhabitants of Al Madam in the Iron Age farmed on the sand, but fortunately the entire network of canals, tree pits and ponds has been preserved because it was excavated directly into the bedrock.

In addition, large quantities of small snails belonging to the Thiaridae family (*Melanoides tuberculata* and *Truncatella marginata*) were found in the channels, which undoubtedly indicates the presence of clean, fresh, flowing water (Morales and Llorente 2016: 141-142) (see Figure 7). These molluscs appear for the first time in the ICNA Eastern Limit, but they are much more numerous in the central and north-western area of the system. In other words, they increased as the force of the flow decreases and as the gallery loses height, and we could collect them at all points of the main channel and of its junctions with the secondary channels.

The chronology of the structure was confirmed thanks to the presence of potsherds from the Iron Age II in the secondary channels of the ICNA, which is clearly related to the pieces found in the nearby town of AM1. Likewise, another dating was possible using a marine calibration curve[1] from shell fragments of the snail *Terebralia palustris*, found in an archaeological context in the structure itself, which provided a date between 1065 and 808 BCE (95 per cent probability).

Recent excavations in the Al Madam 2 *falaj*: 2017–2021

Since 2017, we have tried to follow the *falaj* along its main channel (Ch 6) to get as close as possible to its end. That is why the enlargements that have been carried out throughout the last campaigns are mostly limited to allow us to see the path of the channel without opening it as wide as in previous campaigns..

In the 2017 campaign, two enlargements (R and S) were excavated, which increased the surface of the known *falaj* and the crop area in a north-west direction, with a total surface area of 60 × 5.5 m. In addition to following the route of the main channel, it was possible to identify additional secondary channels (30 in that campaign), which emerged from both sides of the *falaj* and also flow into tree pits and ponds (22 and three in that campaign, respectively).

The ponds, which were used as water reservoirs and/or crop fields, were an unexpected find for us during that campaign. One of them (Po 11), was impossible to study as it lay under the profile of the SW archaeological trench. However, Po 12 and Po 14 showed a surprising width (5.5 and 7 m, respectively) (see Figure 8).

In the 2017 campaign, we also excavated at the ICNA Eastern Limit. Its discovery in 2015 allowed us to understand where the old palm grove began, but the lack of time made it impossible to fully understand the structures. For this reason, in 2017, we resumed work in this sector by opening a survey (nº 15) that cut through the *falaj*, with an area of 14 × 11 m. Bad weather forced us to postpone its excavation until 2018, when we completed the excavation of the main channel section included in this area. At this point, the main channel was 2.30 m deep and 0.90 m wide at its crest and 0.46 m at its bottom.

In the 2013 campaign, the AM2 *falaj* was sampled with the objective of carrying out mite analyses, which are excellent paleoenvironmental bioindicators. The results obtained allowed us to affirm that the climate of the region during the Iron Age had very similar characteristics to the current climate, although it was possibly somewhat more humid (Del Cerro and Córdoba 2018b: 87-88).

Once the channel was emptied, the tool marks present on its bottom and walls (i.e. in the geological substrate) were studied, which allowed us to understand better the construction process of the second phase of the *falaj*. The

[1] "marino9.14c". We thank the University of Tübingen for this data, especially H.P. Ürpmann and B. Kromer.

Figure 8: General view of the excavated area after the 2017 season of work (Spanish Archaeological Mission).

Figure 9: Toolmarks in the *falaj*, Eastern Limit Area (Spanish Archaeological Mission).

marks observed were produced, mostly, by the tip of a metal pick, although there are also others that would correspond to an axe or an adze, also metal, used to improve the initial work of opening the channel (see Figure 9). Thanks to the distribution of these marks, it was possible to observe that, at intervals of 3.5 m, the peak marks alternately changed direction. From this it can be deduced that the canal was deepened during its second construction stage by duly coordinating crews of workers distributed approximately every 7 m.

Two ponds (Po 9 and Po 10) and the channels that supplied them (Ch 35 and Ch 36, respectively) were excavated within the excavated area in the ICNA Eastern Limit. Ch 35 had a length of 1.86 m, a width of between 0.44 and 0.30 cm and a maximum depth of 0.74 cm. Thus, Ch 35 allowed water access from the main channel to Po 9, whose precise measurements are unknown to us as it was partially hidden under a large mass of compact sand (*vide infra*). However, it does have a maximum depth of between 1.34 and 1.20 m. Within it, a total of four tree pits (Tp 82, Tp 83 and Tp 85) were identified for planting palm trees or other large trees.

On the other hand, Po 10 was supplied from water by the secondary channel, Ch 36, which is 1.80 m long and 0.22 to 0.26 cm wide, with a maximum depth of 0.68 cm. The complete measurements of the raft itself are impossible to know now since it has not been fully excavated. On the other hand, we do know its maximum depth, between 0.34 and 0.54 cm (except for the tree pits and interior channels). In its interior, it houses a small irrigation system made up of three tree pits (Tp 81, Tp 84 and Tp 87) and two intermediate channels connected in a line (Ch 73 and Ch 90).

All these elements are fully carved into the geological substrate. Some of them (Tp 81 and Tp 84) have preserved remains of arable land inside, made up, as in the case of basins Po 9A and Po 9B of pond Po 9, of compacted gravel mixed with a small proportion of sand. The Tp 81 tree pit also had remains of the decomposition in situ of the root ball of the plant that it housed. After the first abandonment of the system, the interior of Po 10 and all the associated structures were naturally clogged by successive sand sediments introduced by wind processes.

In 2018, the mass of compact sand that occupied part of the open-cast route already identified during the 2017 campaign was also excavated to better understand it. This sand mass, crossing the excavated area in an east-west direction, came to lie on the clogged-up fillings that resulted from the abandonment of the first phase of the system, both of Po 9 and Ch 68. However, this mass of sand appears to be cut transversely by the main channel, which shows that the aforementioned channel has two construction phases: an initial one and another one of reactivation through its re-excavation after the first abandonment of the system. The Po 9 and Po 10 ponds, and all associated structures, remained in disuse despite the said reactivation attempt since they show no signs of re-excavation. As a result, their supply channels were clearly out of reach of the water flow, and because they appeared partially buried under the mass of compact sand preserved in situ.

To clarify the nature of this compact mass, during the 2018 campaign, an exhaustive cleaning of its southern and northern fronts was carried out, the excavation of its southern side was completed, and its northern front was excavated. Finally, no evidence was found to prove the constructive nature of said mass, since it is not made up of differentiated blocks nor does it show batches of tamping in its internal structure. It is made up of veins of loose gravel on its northern and southern fronts, and the verticality of these aforementioned fronts is a consequence of the profiling of the same during the excavation work carried out in its surroundings during previous campaigns. Everything indicates that it is a deposit of sedimentary origin that could have been compacted as a consequence of natural processes (i.e. a fossil dune). In any case, its position within the stratigraphic sequence of the excavated area has been decisive in identifying the existence of two different construction stages in the irrigation system, followed by an equal number of periods of abandonment.

Lastly, during the 2018 campaign, we expanded the ICNA core area excavated in 2017 (enlargements R and S) with a new 11 × 9 m enlargement (named T), where the continuation of the *falaj* was documented. This stretch is about 10 cm deep with a variable width between 0.25 to 0.30 m. Parallel to

Figure 10: General view of the excavated area after the 2018 season of work (Spanish Archaeological Mission).

the channel we found a large, 10.30-m-wide pond (Po 13). We do not know its length for it was not completely excavated as it penetrated the W profile of the trench. The filling of Po 13 was mostly windblown sand mixed with gravel at the mouth of Ch 79. This channel presents a drop of 1 m from its mouth to the bottom of the pond, something that was solved by placing a tubular ceramic vessel on the channel that would have two functions: one as a flood stone (something very common throughout the ICNA) and another as a pipe to reinforce the structure of the channel at that point (see Figure 10).

Six secondary channels were also found: Four of them flow into the great pond Po 13 (Ch 69, Ch 70, Ch 71 and Ch 80) and only one, Ch 72, connects the main channel with a line of tree pits (of which only one can be seen, Tp 79, as the others are below the profile line), a typical system of the irrigation area.

Because the *falaj* veers slightly to the east and was lost in profile, the following enlargement U had to be adapted. This enlargement allowed us to follow once again the *falaj* along its entire length, documenting a complex system of channels and pools.

Subsequently, during the 2018 campaign, we also proceeded to open a new excavation area, enlargement V. As in previous sections, the main channel in enlargement V maintains a width between 0.25 and 0.30 m, and 0.10 m in depth. Its trajectory gradually veers towards the north-east of the trench area. The secondary channels in this enlargement derive from the main channel on both sides of it, although a greater complexity could be documented in its western part, with three large ponds (Po 18, Po 19 and Po 20).

From this campaign, it became clear that the regular structure presented by the irrigation zone in the first excavated sectors (A-Q) was not repeated as the archaeological work progressed. This pattern consisted of parallel and elongated ponds, irrigated by a single channel and with parallel secondary channels. Since 2017, we have noticed that the ponds of these enlargements began to be much wider and received water from several secondary channels.

Fieldwork for the 2021 campaign at AM2 ICNA enlargements W and X was carried out with the intention of once again following the line of the *falaj* from enlargement V. The enlargement W (24 m north-south and 8.3 m east-west) has allowed us to follow the section of the *falaj* for 24 m farther downstream, in a north/north-west direction. The channel enters the enlargement 2 m from the west profile and turns slightly in both directions along the trench, finally entering the north profile 2 m farther east, in the centre of the excavation area, 4 m from the west profile. In other words, it has deviated 2 m in its path along the enlargement. On both sides of the channel, channels and ponds are distributed in a composition very similar to that found in the 2017 and 2018 enlargements. In total, 14 channels and five ponds have been found.

With enlargement X (24 m north-south and 8.3 m east-west) we followed the *falaj* section for 24 m farther downstream, in a north-northwest direction. In total, during this campaign, a distance of 48 m has been advanced to document the final drainage of the *falaj*. The channel enters the extension 3 m from the east profile and turns slightly in both directions along the trench, finally entering the north profile 1 m farther east, near the north-east corner of the extension. In other words, this shows that it has deviated 1 m in its path along enlargement X.

Channels and possible ponds are distributed on both sides of the channel, but the structures are few and far between as we move downstream from the *falaj*, so that in the 24-m-long extension we only find a pond and a tree pit or pit to the west of the *falaj* and three channels to the east, two of which appear to flow into ponds that start just below the eastern profile of the enlargement X.

The pattern presented by the ICNA in the 2021 campaign seems to continue with respect to the excavations of previous years in the first 30 m of the 48 m excavated (see Figure 11). Ponds of various sizes on both sides of the main channel or *falaj*, interspersed with small- or medium-sized ponds that are fed by a single channel, such as the Po 24 pond, the narrowest at 1.5 m wide, along large ponds, such as Po 25 (12 m wide and with five channels that carry water from the *falaj*). It is the widest pond documented in the irrigation area and the one with the largest number of channels. Several partitions regulate the flow of water in a system typical of the area; stone slabs and large broken ceramics cut off the entrance of water to the ponds.

But the last 18 m of the 2021 excavation indicate a change in the pattern. The structures are greatly reduced, with only a single well with no connection

Figure 11: General view of the excavated area after the 2021 season of work (Photo: 2023, Spanish Archaeological Mission).

to the *falaj*. It is documented to the west of it, as we have only managed to document three channels to the east of the main channel with at least 6 m of separation between them. The diverse patterns of the channels, wells and pond ends (for the moment at least) give way to an area featuring fewer structures on either side of a main channel, and which no longer exceeds 0.10 m in depth.

In summary, up until the 2021 campaign, a total of 115 secondary channels, 89 tree pits, 28 ponds and two basins have been documented throughout the *falaj* system. Likewise, in total, between the 2017 and 2021 campaigns, we were able to follow the route of the *falaj* for 150 m, in addition to the 55 m already excavated in line with the ICNA core.

The AM2 ceramics: a preliminary analysis

Most of the ICNA ceramics correspond to Phase I of AM1-Al Thuqeibah, confirming an Iron II chronology but also, to a lesser extent, the presence of an Iron III. The ceramics act as flood stones, in most cases, to regulate the flow of water to the different secondary channels although, on occasions, there are

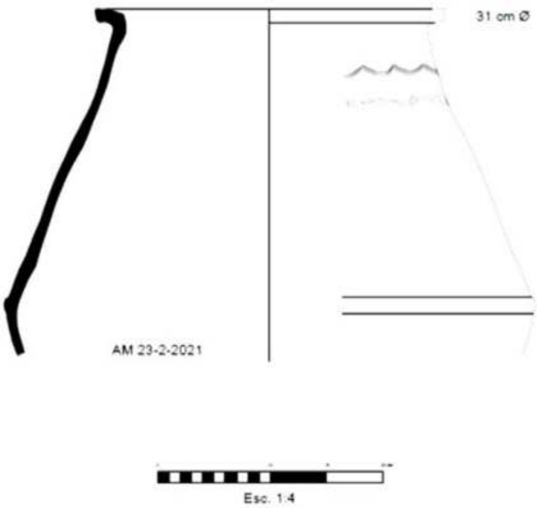

Figure 12: Iron Age II pottery used as flood stone, in situ (Spanish Archaeological Mission).

Figure 13: Iron Age II pottery used as flood stone (O. de Diego, Spanish Archaeological Mission).

stone slabs that perform the same function (see Figure 12). Some ceramics, in turn, are also arranged in the channels as pipes to bridge the slope between the channel and the bottom of the corresponding pond.

The wares are the same as in Al Madam 1: common Red, Brown and Buff ware with mineral temper in all cases. To a lesser extent we find Buff and Grey Sandy Ware, typical of Iron II in Oman. Iron III is exemplified by an open bowl with rounded rim, fine and hardware, identical to those found in the AM 1 settlement (see Figure 13).

The shapes are typical of a place where water is the protagonist, as well as small-scale crops: small, medium and large bowls, only one carinated;

medium- and large-size jars with and without neck, with cordon decoration; and especially, hole mouth jars with an overhanging rim, the same as those of the town of AM1; a form also linked to the rest of the Iron Age settlements such as Rumeilah, Muweilah or Bida bint Saud. Curiously, the only complete item we have in this sector is a large bowl, very open, which once broken in half, was used as a flood stone, inserting it into one of the channels.

This analysis is, however, preliminary. The pottery found in the AM2 *falaj* is still under study and will be the subject of future publications.

5. The search for the end of the *falaj*: Hypotheses and theories

However, in the 2021 campaign, archaeological work was also carried out in the theoretical western end of the Iron Age irrigated area at Al Thuqeibah, identified as the ICNA Western Limit within Sector AM2 of the deposit: Survey 20. Our aim was to locate the end of the *falaj* at its north-western end, and, therefore, the north-western limit of the irrigated area of the Iron Age (ICNA), as well as to determine how the mouth of the *falaj* was laid out, and its possible parallels with the *aflaj* found in Hili and Qarn bint Saud.

The Hili and Qarn bint Saud *aflaj* were excavated prior to the Al Madam intake gallery and have always served as our reference. The Iron Age villages of the Oman Peninsula were located and were distributed depending on the end of the *aflaj* that supplied water to their crops, and despite the fact that the water was not always collected at the same point during the time in which these hydraulic systems were in use. If the water table drops, in a gallery you must intervene directly in the aquifer that feeds the *falaj* and re-excavate until you find it. When lowering the gallery, the old slope is no longer useful; it must be corrected, so the outlet of the channel is displaced. If the water that feeds the crops is far from the oasis, the population is faced with a problem that they were able to solve in various ways and that we have verified archaeologically: (i) transfer of the population to the new exit of the *falaj* (i.e. Hili); (ii) lower the channel and the orchards until meeting the new channel, accumulating around the palm grove mounds called *nadd* (Costa 1983: 249, Figure 2), (i.e. Al Madam); and (iii) the opening of a cistern in the ground, into which the water flows (i.e. Qarn bint Saud) (Al Tikriti 2011: 99-100, Figures 66, 71-72 and 76).

At Hili, at least two intake galleries related to Iron Age structures have been excavated (i.e. Hili 2, 14 and 17, among others). Thus, in Sectors 5-6 of Hili (Cleuziou *et al.* 1978; Lombard 1985: 134), 200 m west of the Hili Archaeological Park, a *falaj* dated to Iron II was prospected in 1978 and dug in 1984, where a single sounding revealed the remains of an irrigation system. Associated with the village of Hili 2, Sector 15 of Hili (Al Tikriti and Haddou 2001; Boucharlat 2001; Al Tikriti 2002) shows a *falaj* whose route is undoubtedly associated with the town of Hili 17 and the structure known as Hili 14, to the north of the Hili Archaeological Park. It was excavated between 1983 and 1987 and allowed us to see the layout of a *falaj* at the point where it rises to the surface. The open-cast channel was delimited in a silty-clay substrate that today remains buried in sand, as is the beginning of the excavation of the channel in the earth and some of the first ventilation shafts. The pottery belongs to Iron II, so it is contemporary in use with the Hili Iron Age sectors already excavated.

In Bida bint Saud, the solution was different (Cleuziou 1978: 10; Al Tikriti 1998; Benoist 1999; Al Tikriti *et al.* 2001). The site is located 13 km north-west of Hili and 1 km west of the Qarn bint Saud necropolis and shows a large building and a *falaj* (Al Tikriti 2002: 349-351), only 150 m south of the main gate of the building, dated to Iron Age II. *Falaj* and building were prospected in the 1970s and excavated between 1998 and 2000. The team of archaeologists first located a *thuqba*. Afterwards, they dug a trench to locate the gallery to verify that the well was part of a *falaj*. The gallery was 3.96 m from the surface. In two excavation campaigns, 11 *thuqab* built with sandstone were found (called A-H and J-L) forming two parallel lines, and a small part of the gallery that, cut into the bedrock, which was about to end in the *shariʿah* (the point at which water first appears on the surface of the earth) excavated between Wells H and K. The interesting thing about this *shariʿah* is that the channel does not rise to the surface from where the water is distributed, but lay below surface level, at a depth of 3.80 m. The gallery (Al Tikriti 2002: 95) ends in a 4 m long channel, roofed with flagstones that reach a large cistern of about 7 × 15 m in which water accumulated. This *shariʿah* is accessible by means of a staircase in the northern part, a staircase made with large *wadi* pebbles. The cistern was also reinforced with this type of stone. Archaeologists cannot be sure if this cistern was made so that the water would be retained and when levelling up, it would be easier to move it. Nor do they specify whether it was excavated after the drop in the water table that fed the *falaj*. Several artificial hills near the *shariʿah* could have resulted from the emptying of sand to build the *falaj* (Al Tikriti 2002: 96).

Returning to the Al Madam region, some 200 m to the north-east of the houses that constitute the AM1 settlement, we found a structure called House H4, although it was not a domestic space as was the cases of the other houses in AM1. With a surface area of 213 m², H4 is a truly peculiar structure that presents two construction phases and was built on a mudbrick platform that served to level the ground. Phase 1 is a building with four pillars and two clearly differentiated areas (see Figure 14). The pottery found inside is typical of Iron Age II. In Phase 2, on the other hand, the dimensions of the structure, although an exterior pavement, made up of a thick layer of mortar that served

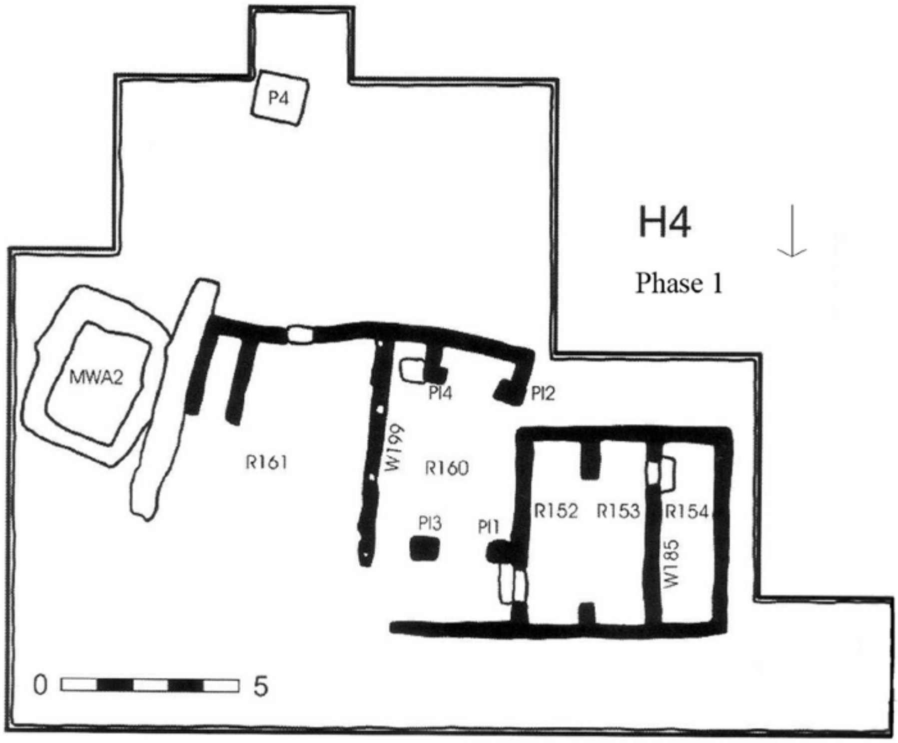

Figure 14: Plan of House H4, Phase 1 (M.A. Nuñez, Spanish Archaeological Mission).

to cover the bases where the pillars rested, were extended. The ceramics of this phase belong, in contrast, to Iron III.

In addition to the bases on which the pillars would support the roof, H4 also presents a higher quality of construction materials than those seen in the rest of the AM1 houses. This includes a very good quality pinkish plaster and more elaborate thresholds. The pottery found there was also different, although Common Ware is the most numerous, there are also significant amounts of Fine Painted Ware, Painted Common Ware and Incised Common Ware, mostly present as open bowls and medium jars. In the same manner, small jars and fragments of spout vessels, very rare in the houses of the town, were also found, as well as the upper part of an incense burner (*Vid.* Mañé 2005: 253-269).

The construction characteristics of House H4 distinguish it from the rest of the structures in the nucleus of the settlement, together with the presence of bases for pillars and certainly different archaeological material. All of this suggests that H4 could have been a building for collective use. Following the theories of scholars such as P. Magee, these constructions could serve as meeting places to hold banquets where the elite discussed strategies to maintain and legitimise their political and/or military authority (Magee 2003: 186), as well as making decisions, reaching agreements and establishing contacts between different population groups (Benoist 2010: 132). On the other hand, R. Boucharlat and P. Lombard, based on the example of Rumeilah, proposed that the meetings in this building would be related to the community management of water and its distribution, due to the symbolism of the serpentiform representations (Boucharlat and Lombard 2001: 224).

Our theory links the proximity of the end of the *falaj* to this building, since it is currently the AM1 structure closest to the *falaj* and, therefore, to the crop area. The constructive characteristics of the building, as well as its plan, suggest a collective use for it, which could have served as a *beit al falaj*. However, our hypothesis required further proof. To do this, Survey 20 was set up about 200 m from House H4 and 260 m to the north-west of the 2021 ICNA core excavation area, on the right bank of an old natural run-off channel, like a stream, whose trace was visible on the surface before the start of work. The structure of the land made us think that this run-off could be the drainage point of the structure, hence the choice of the place.

The stream, which runs in an east-west direction, sloping to the east, seems to delimit the irrigated area from the Iron Age towards the north-west, since the two large alignments of mounds generated by the creation of the irrigation area are interrupted precisely at this point, without either of them going beyond the course of the channel to the north-west. Therefore, we can assume that the *falaj* that supplied the area emptied into this stream on its right bank. Consequently, and given that the main objective of the 2021 campaign was to identify the mouth of the *falaj* and, therefore, the north-western limit of the irrigated area, it was decided to carry out Survey 20 on the right bank of said channel, in the stretch included between the two alignments of mounds that delimit it.

Despite all this, we did not have sufficiently reliable references to determine at what height of that section of the channel the mouth of the *falaj* was most likely to appear. Finally, since the general layout of the main irrigation chaneel is fairly straight for most of its known route, we decided to work with the hypothesis that this would also happen in its final stretch.

In the selected area, three small run-off channels were identified on the surface that flow into the right bank of the main channel from the south, included in a section of the stream about 15 m long. Given the possibility that any of these three small surface run-offs was induced by the presence of the mouth of the *falaj* at lower levels, we decided to carry out Survey 20 on that section, in such a way that it included the three depressions.

Previously, we verified by means of topographical levelling techniques, that the height of the *falaj* bed in the area excavated in 2021 (at a distance of 260 m) is about 70 cm higher than that of the channel bed at this point, which places the slope between both points in an average of around 2.7 per cent, therefore lower than the 3 per cent that is considered the limit from which the water erosion can destroy the surface of the channel. This demonstrates that the registered unevenness was coherent with our initial hypothesis.

In the ICNA Western Limit, four natural structures were found: the main channel of the stream and three lateral runoffs that flow into its right bank in the excavated section as well as four artificial structures that include two tree pits (Tp 88 and Tp 89), two pits (P 16 and P 17), which probably belonged to the AM2 irrigation system in the Iron Age.

Despite the complete absence of archaeological materials in the fillings within all these structures — with the sole exception of the small fragment of copper slag found inside Tp 89 — we have dated these structures to the Iron Age due to their evident formal and stratigraphic analogy with others already documented in the irrigation system that was implemented in Al Thuqeibah at that time. It is surprising, however, that all of them appear isolated from one another, completely unrelated to any network of supply channels, unconnected to irrigation ponds and devoid of their own water supply.

The stratigraphic sequence documented in the area excavated in 2021 and 2023 at the ICNA Western Limit has allowed us to document some construction activity related to Iron Age farms at Al Madam-Al Thuqeibah, which manifests itself by the presence of four isolated underground structures, some of which, however, are difficult to interpret.

The nature and characteristics of the surface anomaly that delimited the irrigated area to the north-west have also been documented, confirming that it is an old natural stream that seasonally evacuates rainwater to the east. Finally, it was not possible to detect the mouth of the *falaj* in the said stream, so it will be necessary to carry out new archaeological surveys in this area in future campaigns, already scheduled for 2024.

Conclusions

The discovery of the end of the *falaj* will allow us to have more reliable information on the different sections of the entire hydraulic system, including its underground route, the open-cast channel, its first derivation into a secondary channel and a complete overview of the cultivation area itself. The possibilities that exist regarding the mouth of the *falaj* are diverse and force us to formulate a series of approaches to which, however, we still cannot find a definitive solution.

The existence of a seasonal stream, visible even today as soon as the earth is soaked by rain, located where the lines of the artificial hills that delimit the old palm grove end, allows us to suppose that the *falaj* would drain into it once it had completed its journey. Perhaps in times of greater aridity, the amount of water that reached the stream was residual. In such cases, any litre of this precious element that reached the stream could be considered a loss (especially considering the environmental conditions of this environment), since it was not stored or used for irrigation. At times of greater abundance,

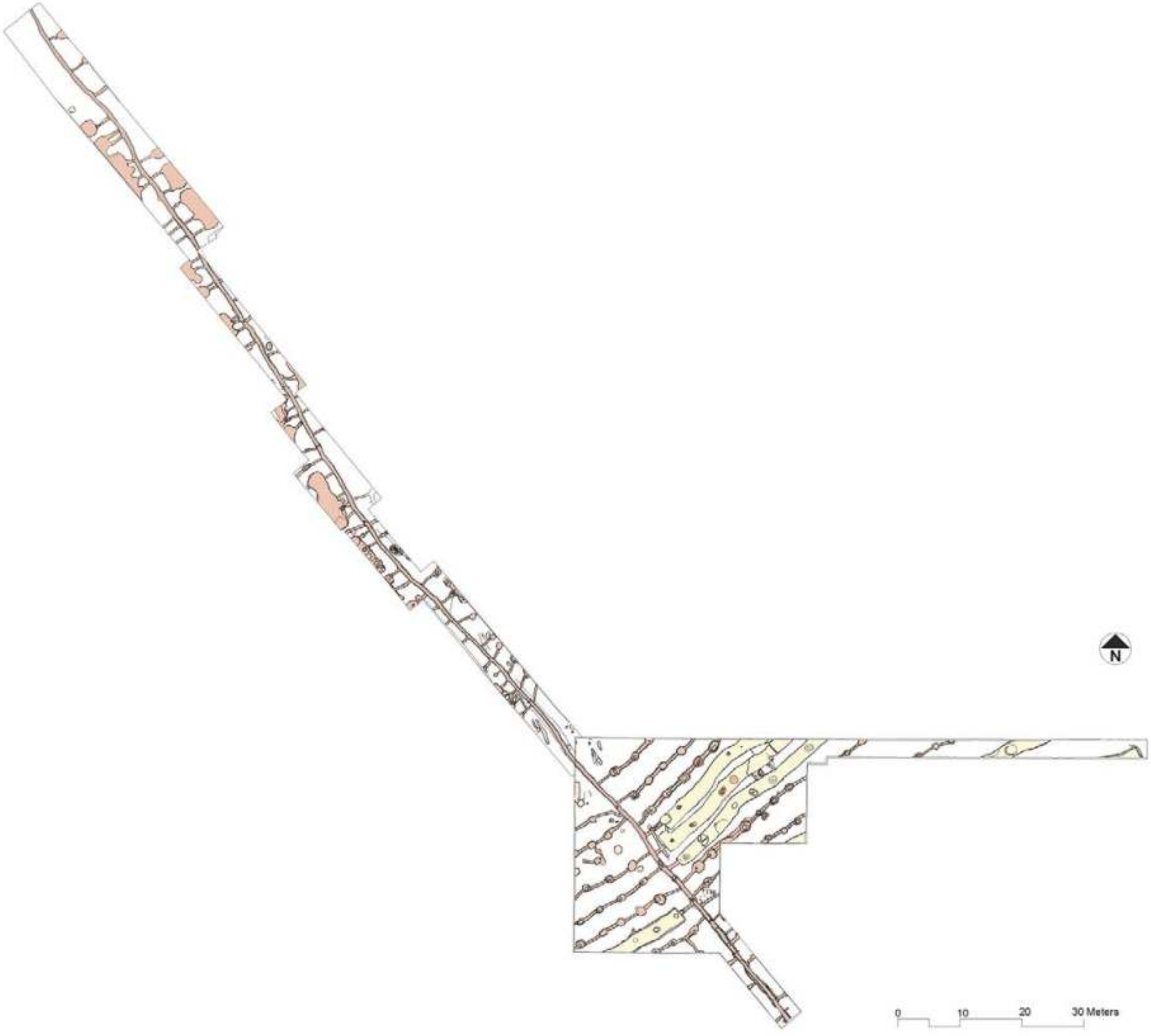

Figure 15: Vectorised plan of the *falaj* of AM2 till the date (O. de Diego, Spanish Archaeological Mission).

surely, the mechanism of flood stones (very abundant in the last excavated enlargements) would allow the redistribution of water to the different ponds, where it would accumulate, and, as such, optimise its use; but part of the water could end up in the stream, where several pits would guarantee a last attempt to retain the excess water (see Figure 15).

The connection between where the *falaj* ends with the H4 house (possibly *beit al falaj*) seems a perfectly plausible hypothesis, although at this moment we cannot be sure. If, as we suggested, the *falaj* ends at the level of the last hills, the distance between the stream and House H4 is 200 m (a similar distance to that recorded between the *beit al falaj* of Hili 14 and the *falaj* of Hili 15) (*Vid.* Al Tikriti 2002: Figure 29). Could the H4 house have been a public meeting place where the inhabitants of the village of Al Madam managed the water that the *falaj* provided for them? Perhaps the location of this structure, halfway between the village and the cultivation area, allowed it to perform this function.

In short, work on the Al Madam *falaj* should continue in forthcoming campaigns. After two decades working at various points in the irrigation system, we consider this *falaj* to be one of the best-known examples in the entire region. However, the *umm al falaj* remains to be discovered, as does understanding of how the ancient inhabitants of the village determined the end of the system. The resolution of this issue is crucial, since it will allow us to establish parallels with other known *aflaj* as well as to better understand the relationship between the settlement and the cultivated area. We might also be able to give House H4 a more concrete role as a distribution and community water management point.

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Secrets of the shaabiyat
Recent developments in the archaeology of the (urban) oasis landscape of Al Ain

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Abstract: This paper will provide a brief overview of ongoing archaeological investigations being undertaken by the Department of Culture and Tourism – Abu Dhabi's Historic Environment Department during infrastructure and construction projects in the historic *shaabiyat* housing areas of Al Ain. It will outline the scope of these works, the opportunities they present and the archaeological response. The paper will conclude with some recent examples from two areas, Falaj Al Mazmi and Kuwaitat, of the important new insights this work is providing, both for our understanding of the development of the oasis landscape of Al Ain and its future management within a modern urban context.

Keywords: *shaabiyat*, Al Ain, oasis landscape, Iron Age agriculture, *aflaj*, PIR cemetery

Archaeology in the *shaabiyat*

Since 2019, our understanding of the ancient landscape of Al Ain has been significantly advanced by archaeological discoveries, first at Al Ain Museum and then during archaeological monitoring of a major project to renew the border fence between the UAE and Oman. Over the same period, another project has been going on more or less continuously, and this has also provided large quantities of significant new information.

Archaeological monitoring of the Al Ain Municipality project 'Upgrading of Roads and Infrastructure Work in Old Shabia's in Al Ain Region Part 1' began at the end of 2019 and has continued since then, at times simultaneously with archaeological work at Al Ain Museum, along the line of the border fence, and in response to various housing and construction projects.

The *shaabiyat* are government housing projects initiated in Al Ain from the late 1960s onwards. Some of them lie in or are adjacent to the buffer zones of the Cultural Sites of Al Ain World Heritage Site, and many are close to the oases and the historic earthen villages that they effectively replaced. These areas form an integral part of not only the historic oasis landscape but also the shifting palimpsest of earlier settlement and land use that characterises the wider cultural

Figure 1: The Al Ain Municipality project to upgrade roads and infrastructure in the old *shaabiyat* of Al Ain has produced a great deal of new archaeological information.

landscape of Al Ain. Many of the names of the *shaabiyat* — Falaj Al Mazmi, for example — reflect the memories of these earlier 'lives' of the landscape and the activities that were associated with them in various locations.

A more tangible factor for the purposes of landscape archaeology is that the *shaabiyat* buildings generally have shallow foundations with no basements and until now have not been impacted by major modern infrastructure. On the other hand, the construction of these new housing areas appears generally to have been preceded by a clearing and levelling that truncated archaeological and natural deposits without destroying them. This levelled surface was then covered with a layer (usually around 400 millimetres) of compacted material, on which the houses were built.

In most cases, the initial Emirati character of the *shaabiyat* has been eroded over time, as the local population moved out and the housing was given over to rental use, often subdivided into multiple units. Partly in consequence of this, they retain a strong character and identity as the 'popular' districts of Al Ain. Change, however, is afoot, mostly connected with the rapid growth of the city and its population. The infrastructure improvements brought by the Municipality project are already being followed by a wave of demolitions and new construction in these areas, aimed at both the residential and the investment villa rental market.

From an archaeological point of view, this work provides a range of challenges and opportunities. The network of 1 m wide and up to 4 m deep stormwater trenches running through the street grid of the *shaabiyat* represents a series of archaeological evaluation trenches with which to inform our response to future construction works in adjacent plots. Each road or plot is considered

Figure 2: The shallow foundations of the old *shaabiyat* of Al Ain have not impacted heavily on buried archaeology in these areas.

Figure 3: One of the old street signs in Falaj Al Mazmi. The site codes for each archaeological intervention in the *shaabiyat* use the system — area/year street number, for example FAM20 R1.

as a separate archaeological site with a unique site code showing the area, year and location (the latter being usually the street name). FAM20 R1, for example, refers to a site located at Road 1 in Falaj Al Mazmi recorded during 2020. We were perhaps fortunate in the naming of sites that most of the project took place before this old system of street numbers was replaced by the new one of street names.

The archaeological response begins with continual monitoring of every trench, checking for evidence of deep cut features that have survived the truncation associated with the construction of the *shaabiyat*. Once these cut features have been identified, work proceeds with careful cleaning of the sides and the base of the trench, numbering and recording features, production of a 3D model with either digital photogrammetry or full 3D laser scanning (or both), sampling of deposits and registering of finds. In general, finds from the archaeological monitoring are few, due both to earlier truncations and the nature of the largely linear agricultural features encountered. There have, however, occasionally been quite spectacular exceptions, some of which are discussed below.

Wherever space and time allow it, features noted in a section can be explored more intensively by extending archaeological works outside the limits of the trench. These extended areas, along with individual building plots that are investigated after demolition of the old houses and before construction of the new, give a wider context to the essentially 2D nature of the trench sections, and they are particularly important in showing the alignment of long linear features like *aflaj* (underground water channels, sing. *falaj*.)

Once recording is complete, the archaeological works conclude with various protection measures. These can include conservation interventions if required, as well as sandbagging and backfilling of features. For the *aflaj* and other significant negative cut features, we usually request that the Municipality arrange with the contractor to provide either precast or cast *in situ* slabs to protect the *aflaj* and avoid future subsidence. Protecting the archaeology within

Figure 4: 3-D laser scanning in progress. Recording at all the sites involves production of a 3-D model using either digital photogrammetry or (as here) full 3-D laser scanning.

Figure 5: After documentation is complete, precast or cast in-situ slabs are used both to protect the *aflaj* and other significant archaeological features and to avoid future subsidence.

building plots is achieved through the No Objection Certificate (NOC) system, which allows us to give conditional approval for projects based on the receipt of an undertaking from the owner that they will allow us access for archaeological monitoring and that they will change their design if necessary.

To summarise the results briefly, in the last three years we have identified and recorded more than 50 separate *aflaj* in more than 150 different locations at depths of up to 15 m below modern street level. These *aflaj* discoveries have been made in three main areas of the city — around Hili Oasis in the north of the city, Qattara and Jimi Oases, and the Central District of the downtown area to the east of Al Ain Oasis. The second part of the paper will focus briefly on recent discoveries in two *shaabiyat*; Falaj Al Mazmi, located to the south of Hili Oasis, and Hai Al Murabba/Kuwaitat to the east of Al Ain Oasis. It is worth noting that both of these areas currently lie outside the World Heritage Site buffer zones of the two oases, an omission that reflects the fact the major archaeological significance of these areas was largely unknown until our recent works.

Falaj Al Mazmi

The name Falaj Al Mazmi (FAM) relates to a *falaj* that oral histories relate crossed the southern part of the area in historic times. In addition, the name Thuqbat Maazami ('Mazmi falaj shafts') appears on the Municipality mapping of the area to the south-east of the *shaabiya* in a location where we recorded two very deep shafts and related tunnels during work on the Oman border fence project in 2021 (Sheehan *et al.* 2023). The *shaabiya* itself dates to the 1980s and is locally known as *shaabiya al hamra*, from the red colour of the

Figure 6: Archival aerial image of the *shaabiya* of Falaj Al Mazmi, taken shortly after its construction in the 1980s.

brick used in its houses. Falaj Al Mazmi and the adjoining Eidan Al Mahabba (EM) were the first *shaabiyat* we worked in and also the most recent, which reflects the way that archaeological monitoring responds to construction schedules outside our control. It was here in December 2019 that the east side of the first stormwater trench we monitored (site code EM19 R1) opened into an empty winding tunnel with a number of intact covered shafts or *thuqab* (sing. *thuqba*), which we were able to enter and document for more than 25 m. In the three years since then, we have been able to trace the downstream course of this same *falaj* at seven separate locations over a distance of more than 800 m to the west.

The broad direction indicated by the initial tunnel allowed us first to tentatively link its course to a *falaj* noted farther to the west in two parallel streets, first FAM20 R11 and then FAM20 R1. The setting of the latter near an open area allowed us to extend the excavation to the west and document the alignment of this *falaj* going west, provided by five closely spaced *thuqab*. In 2021, the demolition of a house on Plot 15 in Road 6 (FAM21 R6/P15) allowed us to record another 30 m-plus of the *falaj* in plan (see Figure 2). Later in the same year, the *falaj* was noted during the installation of a sewer line (FAM21 R6). In 2022, 12 more *thuqab* covering a distance of 30 m were recorded after the demolition of another villa (FAM 22 R1). The exact direction of the *falaj* going east is less certain, but it is likely to be one of a group of closely spaced *aflaj* noted in the Oman Border Fence (OBF) project 1.5 kilometres away in 2021.

The westernmost extent of this *falaj*, the seventh location to the west, brings us to two remarkable and adjacent plots fronting on to Road 6 to the north and Road 12 to the south. The two plots are significant not just for the high level of preservation but also since they appear to represent the junction between the water transport sections of several *aflaj* and the agricultural areas they were intended to water.

The basis of the outline chronology proposed here is a comparison of pottery from the sites discussed here with published Iron Age, Late Pre-Islamic and Early Islamic ceramic assemblages from other sites in Al Ain and the region (Magee 1996; Benoist 2000; Power *et al.* 2019; Sheehan *et al.* 2022).

The Road 6 plot provides evidence of a sequence of six *aflaj*, of which the *falaj* described above appears to be the first. This channel runs from east to west across the plot and is cut by a broader and deeper channel of which one branch runs to the north-east corner of the site while another runs perpendicularly to the south-east. In turn, these two channels appear to have been deliberately blocked and become blocked respectively, with the remaining upstream part diverted to supplement the flow provided by a new underground *falaj* coming from the north-east, which in turn was supplemented by another branch tunnel coming from the south-east.

These first three *aflaj* appear to be Iron Age in date and appear to consist of successively more complex phases of remodelling involving the abandonment or addition of channels, with the final phase *falaj* related to the excavation of large rectangular rock-cut basins containing deep square rock-cut tree pits linked by channels, with beyond these a deep rock-cut cistern. The south-east corner of another rectangular rock-cut basin was noted in the north-west corner of the Road 12 plot.

The last and most complex of the Iron Age phases is sealed by deep waterborne deposits, indicative of violent flooding and abandonment, which filled the basins and cistern. Three later *aflaj* cut through these flood deposits and the Iron Age features, and where they cross the open space of the former

Figure 7: Falaj Al Mazmi Road 6 — a view of the excavation, showing the deep waterborne deposits, indicative of violent flooding and abandonment, that filled the basins and cistern after the *aflaj* were abandoned.

basins they have been built up with stone and plastered. Significantly, given the oral histories that refer to a Falaj Al Mergab in this area, these three later *aflaj* appear to be heading in the direction of the area of Al Mergab farther to the north and west.

The fill of the basins and channels from Road 6 produced more than 4,000 sherds; 85 per cent of this assemblage was identifiable as Iron Age (1100–600 BCE) , with 1 per cent Late Bronze Age or Early Iron Age, and 7 per cent PIR (Late Pre-Islamic) common wares with no type fossils, which means that they could be transitional from the Late Iron Age. Six per cent of the assemblage was either too small, eroded or burnt to be identified. Eighteen out of 44 of the Bronze Age sherds came from a single tree pit, while the PIR sherds derive either from the upper part of these fill deposits (where some mixing may have occurred during the construction of the earlier house on this plot) or from areas where the three later *aflaj* have been cut through the flood deposits.

In the adjacent plot in Road 12, the carefully arranged array of deep square tree pits linked by surface channels appears to link this with the similar features in the final IA phase of Road 6. It is interesting to note that in the north-west corner of the Road 12 plot, there is a less regular arrangement of pits and channels set within a basin and on quite a distinct alignment. Its water supply

Figure 8: Falaj Al Mazmi Road 12 — the array of deep square tree pits linked by surface channels appears connected to similar features in the final Iron Age phase of the adjacent plot in Falaj Al Mazmi Road 6.

and the relationship to the array of square tree pits is unclear, and it may be related to the second phase noted in Road 6. Although the quantity of pottery recovered from Road 12 was small, it similarly supports an Iron Age date for both groups of features. Excavation and sampling of the fill of the individual square tree pits suggests they represent an early type of 'container gardening', with a deep circular cut in the base to allow water to drain into the underlying gravel layer, similar to those noted during the OBF project in 2021. The various locations we have now recorded with similar rock-cut square tree pits suggest the area under intensive cultivation in the Iron Age could have been as much as 500 hectares, stretching from the border fence tree pits in the east to those at the Bin ʻAti House at the western edge of Qattara Oasis, and from the junction of the Iron Age fields with the contemporary cemetery in the south to the tree pits at FAM Road 6 and Road 12 in the north.

Hai Al Murabba and Kuwaitat

To the east and north-east of Al Ain Museum lie the *shaabiyat* of Kuwaitat and Hai Al Murabba, both outside the World Heritage Site buffer zones. The discovery of a deep open 'well' during excavation for a new villa in Hai Al Murabba alerted our team to the potential significance of the site, and cleaning at the level to which excavation had reached revealed this was in fact one of an array of multiple shafts belonging to at least five *aflaj* crossing the plot limits. Differences in the typology and depth of these shafts and most importantly their orientation suggest they can be divided into three groups, with the two earliest (and shallowest) on the same broad orientation as those identified as Iron Age *aflaj* at the Al Ain Museum in 2020. 3-D laser scanning of the shafts and tunnels allowed us to model the processes of excavation, collapse and re-excavation of these shafts as well as establishing the depth and direction of the different channels, including an open tunnel 15 m deep that we were actually able to access for some distance under the adjacent plot.

The Hai Al Murabba site alerted us to the archaeological possibilities of the area and coincided with the commencement of the Municipality upgrading project in the densely populated area of Kuwaitat immediately to the south. Here a number of deep *aflaj* shafts were noted below the level truncated for the construction of the *shaabiya*, with the typology of the shafts and the orientation of the linear features to which they belong comparable with those recorded both in the Murabba site and at Al Ain Museum.

In general, finds from this area were quite limited, consisting mostly of small quantities of PIR sherds. In the east-west Road 5, however, excavation of

Figure 9: The building plot in Hai Al Murabba with a number of *thuqab* revealed after construction was stopped, and initial cleaning had taken place.

Figure 10: Road 5 in Kuwaitat following extension of the stormwater trench to the north. Excavation of several of the graves forming part of the Late Pre-Islamic cemetery discovered here in progress.

the stormwater trench first revealed fragments of a PIR glazed amphora lying within the distinctive form of one of several graves revealed in the section. Plans by the Municipality project to excavate for a new road base to the north of this trench led us to carry out an archaeological excavation in this area to establish the nature and extent of these graves. We recorded around 20 graves, most displaying a similar truncated typology with a shaft leading to the actual burial niche carved into the sandy clay natural and sealed with a mudbrick wall.

Finds from these graves included well-preserved iron weaponry including swords (one 70 centimetre-long example preserved intact), spearheads and quivers of arrows, in several cases found in association with intact amphorae. Other graves appeared to present a more 'female' assemblage, including bronze and alabaster bowls and in one grave a single glass vessel. There is

Figure 11: An intact glazed looped amphora recovered along with iron weaponry from one of the graves in Road 5, Kuwaitat.

Figure 12: Intact iron sword, 70 cm long, recovered from one of the graves in Road 5, Kuwaitat.

almost no evidence of human remains, but several show postholes just outside the actual burial, perhaps for grave markers. Going east, the graves appear to end after a certain point, suggesting the eastern edge of a PIR cemetery that perhaps extends as far as 500 m to the west, to the high-status PIR tomb noted at Al Ain Museum in 2019. This is of course significant in suggesting the likely presence of a settlement associated with this substantial cemetery.

Conclusion

To conclude, the *shaabiyat* of Al Ain are yielding up their secrets as a direct result of the control offered by the NOC system and a conservation cycle in which new information is added to the GIS and informs our response to further development. From a landscape archaeology point of view, the sheer numbers of *aflaj*, forming a network of tunnels below the streets of the modern city, represent a major step forward. There is important new evidence from FAM not just for the water transport section of the *aflaj* but also for their interface with cultivated areas and the complex agricultural techniques in use in the Iron Age, as well as the later use and adaption of this system in an inherited landscape. Similarly, the latest discoveries in Kuwaitat continue to fill another significant lacuna in our understanding of the PIR in Al Ain, its relation to the Al Ain Oasis and its role in the development of the historic landscape.

Finally, it goes without saying that this is a teamwork *par excellence*, so acknowledgements are due to Al Ain Municipality and their consultants and

contractors for their continued cooperation, to the Historic Environment NOC team for their awareness, to our field team and our survey partners Geotech 3D for their dedication and skill and to the rest of the DCT Abu Dhabi family for their ongoing support.

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The discovery of a Late Antique and Early Islamic monastery on Siniya Island, Umm Al Quwain

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Abstract: The proposed development on Siniya Island in the lagoon of Umm Al Quwain prompted an archaeological survey and excavation that brought to light a previously unknown Christian monastery. Radiocarbon and ceramic dates suggest that the Siniya Monastery flourished between the late 6th/early 7th and mid 8th centuries CE. The monastery consists of a (i) church and communal complex (refectory, cistern, baptismal font, kitchen, storeroom, etc.) with a (ii) neighbouring large double-courtyard building, interpreted as the 'abbot's house'/bishop's palace, surrounded by (iii) outlying single- and double-roomed rectangular buildings, where the monks most likely lived, to which can possibly be added (iv) isolated anchoritic retreats including the possibly reuse of ruins. This pattern is consistent with the East Arabian monastic sites of al-Qusur and Sir Bani Yas, which conform to the *cenobia* or *laura* model developed in Egypt and the Fertile Crescent between the 4th and 6th centuries CE. The present paper will outline the discovery of the monastery and provide an overview of its constituent architectural units together with a discussion of the phasing and dating.

Keywords: Late Antiquity, Early Islam, Arabian Gulf, Christianity, monasticism

Introduction

Siniya Island is located on the northern side of Khor Al Beida, the historic lagoon of Umm Al Quwain, facing the mainland to the south (Figure 1). The historic environment of the lagoon has an important occupational sequence reaching back to the Neolithic period, including some of the most famous archaeological sites in the United Arab Emirates (Power *et al.* 2022). Archaeological work on Siniya Island was part of the strategy of the Department of Tourism and Antiquities to discover new archaeological sites. A survey of the island was carried out by the local team in 2019, in which more than 60 archaeological sites were recorded, and the first season of excavation began in 2021. The discovery of a Late Antique to early Islamic monastery led to a collaboration with the Ministry of Culture and Youth, UAE University, the Italian Archaeological Mission, and New York University beginning in 2022 (Power *et al.* 2022; 2023).

Figure 1: Siniya Island, showing the location of the monastery and important local sites.

Discovery and identification

Oral tradition tells that the Al Ali — the dominant tribe in the emirate of Umm Al Quwain — first settled on Siniya Island under the leadership of Sheikh Rashid bin Majid Al Mualla (1768–1820). He is said to have built a fort and mosque around which the town grew. A prominent pile of stone rubble on the north-east of the island was rumoured to be the site of that building, for which reason it was targeted by the Umm Al Quwain Tourism and Archaeology Department (UAQ-TAD) in early 2021. The excavations were both part of a programme of archaeological mitigation prompted by forthcoming development and a personal quest by Sheikh Majid bin Saud bin Rashid Al Mualla, the Chairman of UAQ-TAD, to unearth his family's deep roots on Siniya Island.

The end of the first season's excavation afforded a moment of reflection, and the drone photographs were re-examined and shared with the Ministry of Culture and Youth. Clearly, the partially exposed architectural plan did not resemble that of a fort or mosque. The department excavations had revealed two parallel corridors divided into shorter and longer rectangular units, holding out the tantalising possibility that a third remained to be unearthed beneath the baulk, which would have created a tripartite plan strongly recalling the basilicas of al-Qusur on Failaka Island in Kuwait (Bernard and Salles 1991; Bonnéric 2020; 2021) and Sir Bani Yas in Abu Dhabi (King 1997; Elders 2001; 2003). A preliminary examination of the surface ceramics, meanwhile, revealed common wares of the Late Antique and Early Islamic period. This quickly led to a new and exciting interpretation of the site, not as a Late Islamic fort or mosque but as a Late Antique church.

Figure 2: Oblique drone shot of the Siniya Monastery taken at the end of the 2022 season.

The outstanding cultural significance of the site required a change in strategy. Sheikh Majid, working closely with the Ministry of Culture and Youth, invited the present authors to set up a research project. This collaboration, dubbed the Siniya Island Archaeological Project, was tasked with the excavation and publication of the newly identified church and other sites on the island. The first season's excavation in 2022 completed the excavation of the putative church and established that we were indeed dealing with a monastic complex, further proposing a chronology based on radiocarbon dating and a ceramic study (Figure 2). The second season of fieldwork in 2023 shifted the focus to the monastic buildings surrounding the church, discovering in the process a Late Antique–Early Islamic cemetery and Late Islamic Sufi shrine, and began excavation of a contemporary settlement that was found a little way to the south.

The occupational sequence

The monastery consists of a (i) church and communal complex (refectory, cistern, baptismal font, kitchen, storeroom, etc.) with a (ii) neighbouring large double-courtyard structure dubbed Building A and interpreted as an abbot's house or even bishop's palace, surrounded by (iii) outlying single- and

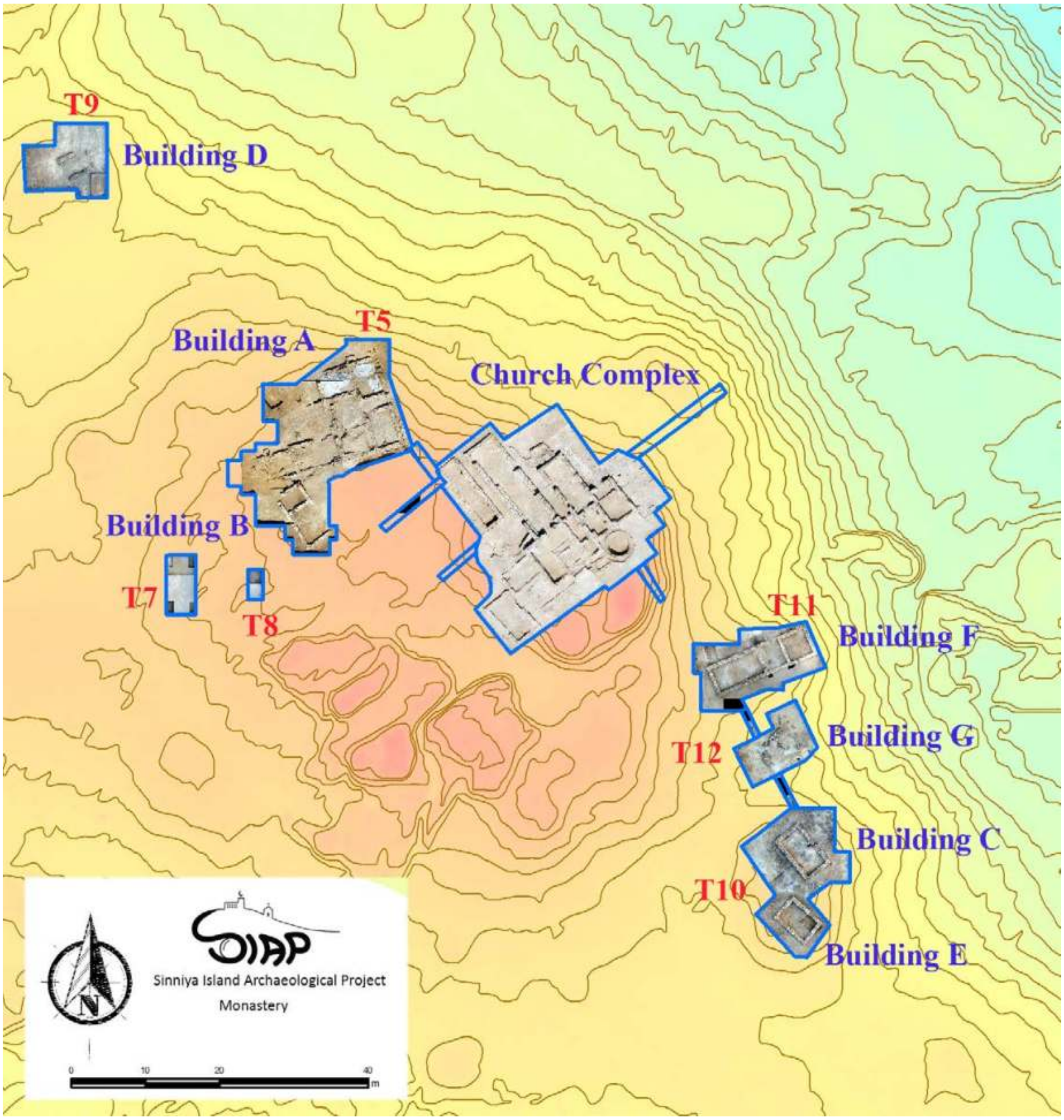


Figure 3: Plan of the monastery excavations at the end of the 2023 season.

Figure 4 (opposite): Drone photograph showing the communal complex and abbot's house at the end of the 2023 season.

double-roomed rectangular buildings, where the monks most likely lived (Figures 3 and 4), to which can possibly be added (iv) isolated anchoritic retreats including the reuse of ruins. This pattern is consistent with the East Arabian monastic sites of al-Qusur and, to a lesser extent, Sir Bani Yas, which conform to the *cenobia* or *laura* model developed in Egypt and the Fertile Crescent between the 4th and 6th centuries CE. It is, however, quite different to the barrack-like arrangement of monks' cells at the monastery of Kharg on the Iranian littoral, which clearly postdates the reforms of Abraham of Kashkar (d. 586) and Babai the Great (d. 628), the founding fathers of East Syriac monasticism (Jullien 2010; 2019).

These three or four elements that together constitute the Siniya Monastery presently appear to be spread across four main occupational phases (Table 1).

Table 1: Phasing of the core monastery buildings with associated dating evidence. The 1σ probability is reported. Refer to Table 3 for the full radiocarbon date range.

Phase	Communal complex		Abbot's house		Dating evidence
1.1	Sanctuary (R2)		Construction of Building A (R1-6)		TURQ Type 64
1.2	Nave (R1)				
2	Lower dump	Prothesis (R3) Diaconicon (R8 & 12) Refectory (R7) Cistern (R10)	First expansion of Building A (R7)		TURQ Type 72 #35 564–640 CE #09 574–641 CE > Justin II (d. 578)
3	Upper dump	Rooms 11, 14, 16 Building I	Second expansion of Building A (R8)		TURQ Type 72 #10 605–662 CE
4	Demolition R16		Demolition Building A		#19 670–772 CE #04 673–772 CE
	Font (R15) & R17-18		Cemetery	Building B constructed nearby (R1-2)	
5	Abandonment and partial collapse				≠ *TURQ Applique*
6	Posthole structures		Windblown sand		YBTIN #22 774–890 CE
7	Abandonment and complete collapse				≠ *Samārrāʾ Horizon*
8	Islamic graves				JULFAR 16th century C14

However, given that occupational activity is spread horizontally over a large area and not vertically in a small area, and that the finds assemblage derives either from dumps near but not abutting buildings, or else abandonment deposits of windblown sand and architectural tumble filling rooms, it is not possible to confidently establish a single stratigraphic sequence for the whole site. For that reason, we have dealt with each element separately below. We can, however, attempt an interpretation of the overarching sequence drawing together the constituent elements. This remains a work in progress and has already changed since the earliest publication of the site, and will no doubt be further revised as excavations and post-excavation analysis continue. There appear to be four main phases of activity at the site:

- **Phase 1** is associated with the construction of first the sanctuary and then the nave that together make up a simple single-aisle church or chapel; we place the construction of Building A (the abbot's house) in this first phase, perhaps contemporary with the first enlargement of the church, though there is no clear stratigraphic relationship between the two.
- **Phase 2** witnessed the addition of the prothesis, diaconicon and refectory, representing a significant enlargement of the church and its transformation into a monastery proper; probably the abbot's house was also enlarged in this phase of expansion; this phase also likely witnessed the construction of the first outlying scattered monks' cells, though their stratigraphic position remains ambiguous.
- **Phase 3** is characterised by a second expansion of the monastery, associated with the construction of additional monks' cells around the communal complex and putative abbot's house. Arguably, the quality of construction of the later monks' cells is poorer than earlier buildings, though this may be a functional phenomenon.
- **Phase 4** is associated with the demolition of Building A (the abbot's house) to make way for a cemetery, the demolition of Room 16 to the north-east of the church and the construction of a baptismal font behind the sanctuary. This is the last activity prior to the abandonment of the site, bringing the occupation of the Siniya Monastery to a close.

The church and communal complex

The church and communal complex are built of beach rock covered by lime plaster. Rooms tend to abut each other, allowing us to place them into a sequence of construction. It remains somewhat ambiguous as to whether this simply reflects building methods used within a single short episode of activity or whether this should be interpreted as the long-term development of the monastery over several phases of occupation. Yet the repeated modification of the entrances to the church would seem to suggest that we are dealing with

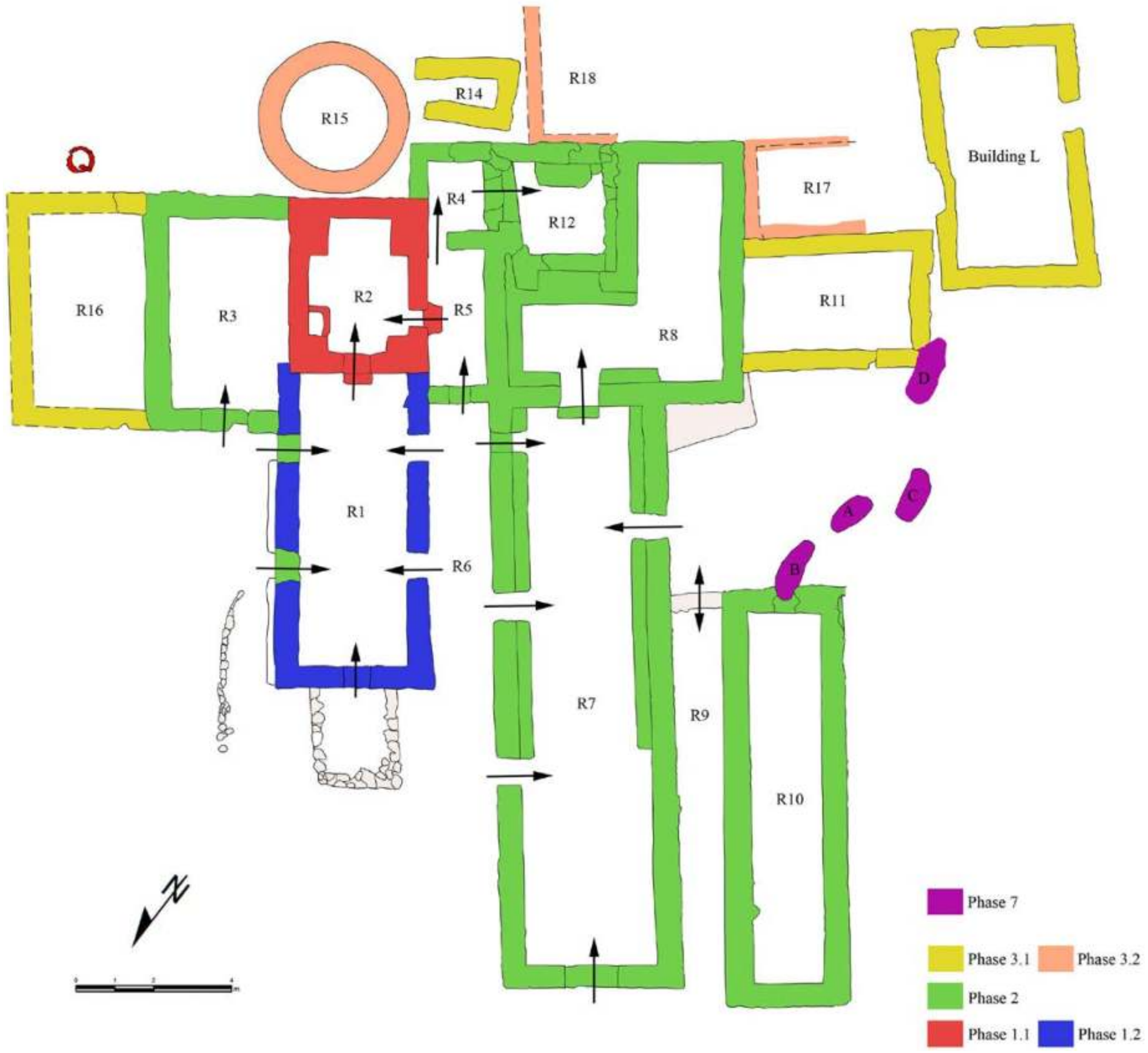


Figure 5: Phasing of the communal complex based largely on abutting wall relationships.

at least three phases of construction over a longer period of use (Figure 5). This has important ramifications for the chronology of the Siniya Monastery, which we will return to shortly.

Phase 1.1

The earliest architectural element is the sanctuary (R2). It consists of a rectangle, c. 5 × 5 m, with a cruciform internal space. A socket for the altar was situated in the south-eastern end, with the main entrance in the facing north-western wall; a smaller secondary entrance was situated in the south-western wall. The plastered floor of the sanctuary was higher than the surrounding rooms, and both entrances were provided with a low step. If indeed the sanctuary was built as a separate phase of activity, we might hypothesise that it originally had the character of an isolated shrine, the altar of which may even have contained the relic of a local saint or founding father.

Phase 1.2

The nave, c. 10 × 3 m, was built abutting the north-western wall of the sanctuary. Note that the south-eastern corner of the nave is not flush with the sanctuary and projects slightly, typical of the haphazard construction techniques frequently resulting in asymmetric building plans. The nave was provided with three sets of entrances that appear to have been used at different times. The original entrance may have been from the north-west, which was provided with an oversized exterior step, possibly once supporting a porch of impermanent materials. This created an axis with two steps leading up to the altar. Again, it is not altogether clear if the addition of the nave represents a discrete phase of construction, but, if it does, then we might argue that this was the moment the shrine became a church.

Phase 2

An irregular rectangular room, c. 6 × 4 m, was built abutting the north-eastern wall of the sanctuary and nave. This may be identified as the proskomedia or prothesis. An innovation of the liturgy in the reign of Justin II (r. 565–578) led to more elaborate rituals for the preparation of the bread and wine used in the Eucharist, resulting in the development of a purpose-built room to the north of the altar that served as the Office of Oblation. How long this innovation of Constantinople took to reach Ctesiphon and gain currency in the East Syriac liturgy is unclear, but we might assume that it had become common practice by the late 6th century. However, the fact that the prothesis was added *after* the construction of the church might be taken to mean that the local community was responding to changing practice in the heartland of their faith, raising the intriguing possibility that the Siniya Church was built before Justin II's liturgical innovation became widely adopted.

A range of rooms was built to the south-east of the sanctuary and nave. There are two distinct architectural components to this, both of which were built of bonded walls, indicating a single phase of construction activity. A small secondary entrance was cut into the southwest wall of the sanctuary leading into a corridor (R6), screened off by an abutting doorjamb to the north-east, which in turn leads to a small square chamber (R12). Another access route passed through the corridor and doorjamb (R6), briefly entering a long narrow chamber (R7) before turning into an L-shaped room (R8). A very similar arrangement is found at al-Qusur, where the excavators found an oven used for the baking of bread and a basin for the washing of vessels used in the Eucharist, which are characteristic of the diaconicon in Byzantine church architecture. Hearths reported in the same location at Sir Bani Yas were probably also part of a diaconicon, and the two notches found on the floor may simply have supported a washing basin rather than the ladder of a church tower as the excavators imagined (Elders 2001: 51).

The other component of the new range of rooms is the long narrow chamber (R7), c. 13 × 3 m, which features low benches built of beach rock and lime plaster abutting the lateral walls. A very similar room was found at al-Qusur that was interpreted as a refectory, a communal space for meals and meetings at the heart of a cenobitic community. Indeed, the narrowness of the room would have facilitated conversation between those seated on facing benches, though the same dimensions appear repeatedly in the architecture of Siniya and other sites in the region and are clearly a result of the available roofing materials. The total length of the benches is around 17 m which, assuming a 50 cm width per person, could seat about 32 adults shoulder to shoulder. Whether or not this represents the total population of the ascetic community, or just a 'council of elders', remains unclear given the incomplete state of excavations. However, given the small size of the neighbouring church or chapel, we might suggest that the Siniya community was perhaps quite small.

The long chamber was provided with five doorways. We have already dealt with the door in the south-east wall providing access between the sanctuary and diaconicon, which was used for the preparation of the Eucharist. Two of the doors in the north-east wall roughly correspond to the two doors in the south-west wall of the nave, suggesting that access between the two rooms was significant to ritual use of the church. Can we imagine that the monks waited in the long chamber before filing into the nave to receive the Eucharist? The third door in the north-east wall and single door in the south-west wall lead to open spaces between the rooms, providing access to the outlying scattered monks' cells on either side of the core complex. This relatively complex set of doorways suggests that the long chamber lay at the heart of the monastery, undoubtedly serving as a refectory but perhaps also playing a role in the church rituals.

Another important construction in this phase is the freshwater cistern built just to the east of the refectory. The structure measures 3 × 12 m and consists of a single wall with no entrances, the interior faces and floor of which are covered by plaster. Probably it would have been filled from the roof and, if we assume a height of 1.5 m, it would perhaps have held about 30 m³ or 30,000 litres of water. No well has so far been found at the monastery site. Although rainwater might well have been harvested on plaster roofs, for which there are interesting ethnographic parallels at Jazirat Al Hamra, the cenobitic community appears to have relied on imported water, as was famously the case at Hormuz in the Middle Ages. We might speculate that the provision of water to the monks was a charitable act by the lay community, or, alternatively, that it points to the organisational capabilities of the Nestorian Church.

A dump was found to the west of the communal complex. Its stratigraphic relationship with the church is unclear since there is no physical relationship and both sit on the same natural sand, but we might suppose that the significant increase in activity in Phase 2, when the church was transformed into a monastery, meant that rubbish disposal became an increasingly pressing issue, and we have thus placed the lowest dump layers in a phase with the construction of the communal complex. This has important ramifications for our dating of the foundation of the Phase 1 church and Phase 2 monastery, since the dump produced radiocarbon dates and ceramics, something we will return to shortly.

Phase 3

This phase is associated with the continued expansion of the communal complex. Two abutting rooms, R11 and R16, were built either side of the Phase 2 sanctuary, together with two free-standing rooms, R14 and Building I, located to the south-east and south-west respectively. It may be significant that these new constructions all cluster around the sanctuary, as if proximity to the Holy of Holies was a priority, while the outlying areas surrounding the nave, refectory and cistern seem to have been less popular. These structures are difficult to interpret since Rooms 14 and 16 were subsequently truncated or demolished, while the finds assemblage of Room 11 and Building I belongs to Phase 4, the final occupational phase, when there may have been a change in function. At the time Building I was abandoned, the presence of several storage jars suggests that this room was being used as a storeroom. Room 16, meanwhile, was demolished to make way for an open kitchen, which, if we assume a continuity of function, may have been because cooking indoors proved too stifling. We might therefore rather loosely interpret the Phase 3 structures as 'ancillary' in nature and somehow associated with feeding the resident monks and visiting pilgrims.

We further place the upper layers of the dump in Phase 3. It is, however, perfectly plausible that the dump in fact continued to be used into Phase 4, after which time dumping activity ceased and the site was abandoned. However, since the third phase seems to have been one of expansion and can be contrasted with a clear slowing of activity in the fourth and final phase, we suggest that the majority of the finds and samples from the upper layers of the dump belong to Phase 3. This has further ramifications for the dating of the abandonment of the monastery, to which we shall return at the end of this paper.

Phase 4

Construction activity slows in the fourth and final phase of occupation. Room 16 was apparently demolished to make way for an open kitchen. We further found two ephemeral stretches of walls from two incomplete buildings, dubbed Rooms 17 and 18, abutting the rear wall of the church. These rooms were probably never completed and simply abandoned when the occupation of the site came to an end, a testament to a general slowing of occupational activity in the final phase.

A circular tank with a c. 3 m diameter was discovered immediately behind the sanctuary. It appears to have been cut down from surface accumulations abutting the church and is clearly late in the occupational sequence. The lime plaster lining was tested during the conservation works, and it was shown that it was of higher salinity than the other buildings, suggesting that the tank had once contained seawater and could not have been used as a cistern. Indeed, a large rectangular cistern had been built in Phase 2, and there is nothing to indicate that it was no longer in use. The location of the circular tank behind the sanctuary might further be significant, and we might read into this that it was conceived as an addition to the church. As such, we can tentatively posit that it was intended for full immersion baptism. Its dimensions would certainly accommodate two adults, a priest and an acolyte, though it would have required a wooden ladder to enter and exit. The construction of a baptismal font in the final phase of occupation is a curious feature that we will return to in the discussion.

The finds assemblage of the church comes from the final occupation (Figure 6). UAQ-TAD excavations retrieved two oversized glass goblets from the sanctuary, found in the corner either side of the empty altar slot. Their large size and find spot suggest that they were used to deliver the Eucharist. A smaller version of the same vessel type was found at Sir Bani Yas, but the context is unclear (King 1997: Fig. 10). Vessels of this type appear to have been

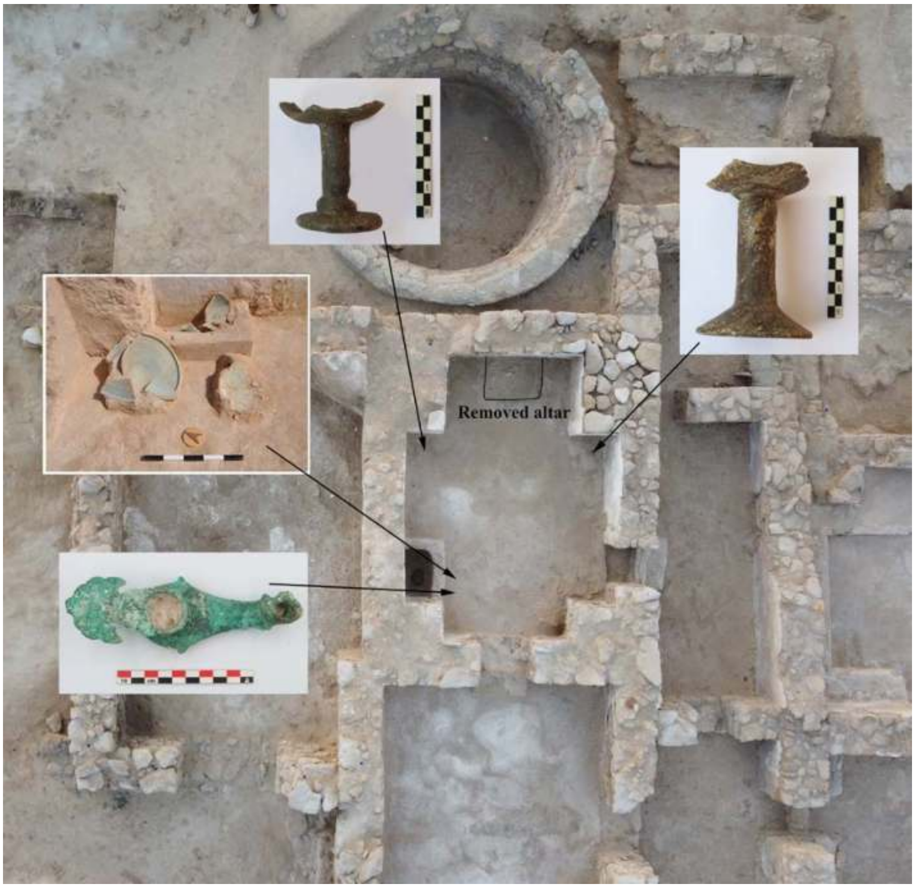


Figure 6: Composite image showing find locations of the material culture of Christian ritual in the sanctuary.

used for wine, as indicated by a passage from the late 7th- to early 8th-century *History of Mar Yonan*, in which a local man, Nuʿaym (an Arab name), brings the saint "a great vessel of glass filled with choice wine" imported from Fars (Bedjan 1890: 498; Payne 2011: 107). Indeed, an installation in the facing corner of the sanctuary may have been used to store wine jars, while a large turquoise alkaline-glazed bowl found on the floor adjacent could have been used for the mixing of the wine with water. We therefore appear to have the material culture of Christian ritual preserved in situ at the Siniya Monastery.

An abbot's house or bishop's palace?

A large double-courtyard building, dubbed Building A, was discovered a few metres to the north-west of the communal complex (Figures 3 and 4). This is a discrete structure and clearly distinct from the communal complex, which consists of a series of abutting rooms that grew over time into a single sprawling building with ancillary structures. Since there is no physical relationship between the two buildings and both sit on the same natural sand, their stratigraphy and phasing are somewhat open to interpretation (Table 1).

Building A appears to have three sub-phases of abutting rooms (Figure 7). Phase 1 represents a rectangular planned structure, c. 8 × 12 m, with an entrance hall flanked by twin rooms leading into a square courtyard with two additional rooms (Rooms 1-6). No traces of a floor or thresholds were identified, suggesting that only the wall footings survive. Phase 2 is characterised by the construction of two abutting perpendicular rooms, of which only Room 7 survives. These probably once framed a second courtyard, although since only the northern room was either truncated away or never completed, this cannot be ascertained. Interestingly, the interior of Room 7 was provided with steps leading down, which might be taken to suggest that the exterior ground surface rose, perhaps indicative of a long period of use. Phase 3 is associated with a second expansion of Building A with the addition of Room 8.

The dimensions and plan of Building A bear a close resemblance to that of a stand-alone structure within its own enclosure abutting the barrack-like dormitories at Khārg. The excavators appear to have interpreted it as an infirmary because, as a self-contained complex, they imagined that it would have been used for quarantine. However, given the power and prestige of abbots and bishops in the world of Late Antiquity, we wonder if these stand-alone buildings at Kharg and Siniya represent the residences of the head of the community. A similar interpretation was put forward for a recently found elite residence at Samaheej in Bahrain, known to have been a diocese of the Nestorian Church whose bishops attended a series of synods (Insoll *et al.* 2021). We therefore suggest that Building A should be understood as the abbot's house or, even, a bishop's palace, given that Mazun was also a Nestorian diocese.

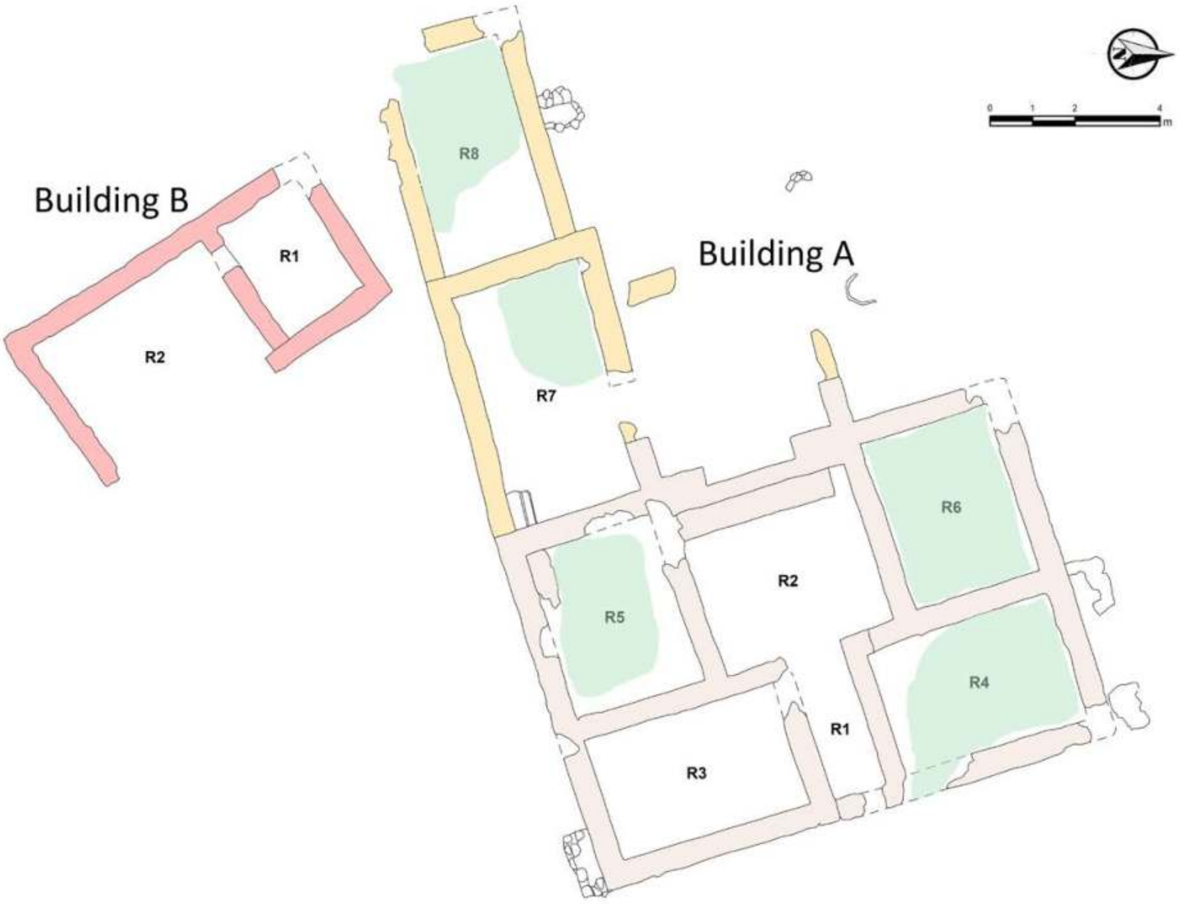


Figure 7: Plan of Building A (abbot's house) with burials shown in green.

For reasons that are not presently clear, Building A was demolished in Phase 4, and the space on which it had stood was reused as a cemetery (Figures 8 and 9). Only burials in Room 8 were excavated in the 2023 season, and an osteological study of human remains from Room 8 was completed. A total of seven primary single burials were found in this area. The status of labile and persistent joints is compatible with a decomposition in a filled space, in simple pit graves cut in the sand, while the compression of one (SU 266) further suggests the use of a shroud. Almost all were aligned east-west and facing east according to Christian practice. The skeletons were in a poor state of preservation, preventing reliable determination of age and sex, though all preserved teeth show a minor degree of wear, suggesting adolescents or young adults. Enamel peptides preserve sexually dependent variants of the protein amelogenin, which revealed that one of the skeletons (SU 231) was likely female, and this burial is further distinguished by the burial position on the right side and the presence of a beaded belt. Excavation of the cemetery will continue in the next season of fieldwork and a full analysis of the human remains, including the study of ancient DNA, is scheduled.

The reason for the demolition of Building A is open to conjecture. A positive interpretation might suggest that space became increasingly constrained

Figure 8: Multiple burials in Building A Room 6 awaiting excavation in the 2024 season.

Figure 9: Single burials in Building A Room 8 excavated during the 2023 season.

by the expansion of the monastery on the narrow peninsula. For example, Building B seems to have been built on the demolition debris of Building A, attesting to the continued need to house an apparently growing popualtion. But the encroachment of cemeteries on formerly inhabited space is often understood as symptomatic of decline, and indeed the stratigraphic position of the burials implies they belong to the final occupation of the site. More hypothetically, we might suggest that the building was demolished when the abbot or bishop moved permanently elsewhere. It is perhaps significant in this regard that the last mention of the Nestorian bishop of Mazun is in 676 CE, a generation before the final abandonment of the Siniya Monastery in the mid 8th century.

Figure 10: Drone photograph of stone huts (monks' cells?) to the south of the monastery.

Cenobitic settlement

Several single- and double-roomed rectangular buildings were discovered in the vicinity of the core complex (Figures 3 and 10). They are scattered randomly with no discernible plan, suggesting that they developed organically as the monastic community increased. This pattern is consistent with the East Arabian monastic sites of al-Qusur and Sir Bani Yas, which conform to the *cenobia* or *laura* model developed in Egypt and the Fertile Crescent between the 4th and 6th centuries CE. They tend to be on a north-west/south-east or north-east/south-west alignment, and as such are parallel with the core complex or double-courtyard building. The significance of this is presently uncertain but raises the possibility of two phases of activity separated by a break in occupation.

The buildings themselves are quite regular. Smaller ones consist of a simple rectangular unit, usually c. 5 × 3 m, with no internal divisions; the width of these suggests that they were provided with palm-trunk roofs. Larger ones, up to c. 8 × 4 m, have a bipartite plan with a narrow transverse room created by a single internal wall; the dimensions of the narrow room again suggest a palm-trunk roof, while the presence of hearths and *tanur*s in neighbouring space suggests an open courtyard. None of these buildings had floors, and the finds assemblage is poor. A domestic function can be determined on the basis of the ceramic water storage jars and pouring jugs with glass cups found together with *tanur*s made of broken storage jars set in the ground. We understand these humble beach-rock huts to be the homes of monks living in a cenobitic community centred on the church.

In the *Treatise on the Solitude of Weeks,* the Nestorian monk Dadishoʿ Qaṭraya (d. 690), who was himself from Eastern Arabia and personally familiar with cenobitic communities like Siniya, distinguishes different levels of asceticism within a single community. These range between *sharwaye,* monks living a communal life, and *iḥidaya qelaya,* 'solitaries of the cells', who might confine themselves for between one and seven weeks at a time (Jullien 2019). Is it thus possible that the material culture of Siniya reflects the range of ascetic practices within a single community? Alternatively, we may be dealing with a village of a lay community such as the Benay Qeyama, 'Sons of the Covenant', who adopted varying degrees of asceticism and who sometimes settled near the monasteries to serve the monks (Vööbus 1961). Much more work needs to be done on the site before we can attempt to resolve these questions.

Anchoritic retreats

Away from the cenobitic settlement and pearling town, we found two smaller and isolated sites that may be interpreted as anchoritic outposts: places where solitaries could retreat further into their spiritual world. The first is located on the north-east peninsula in an open area between the monastery and town,

Figure 11: Map of survey sites in the north-east part of Siniya Island. IIS-53 may be identified as an anchoritic outpost or fisherman's hut.

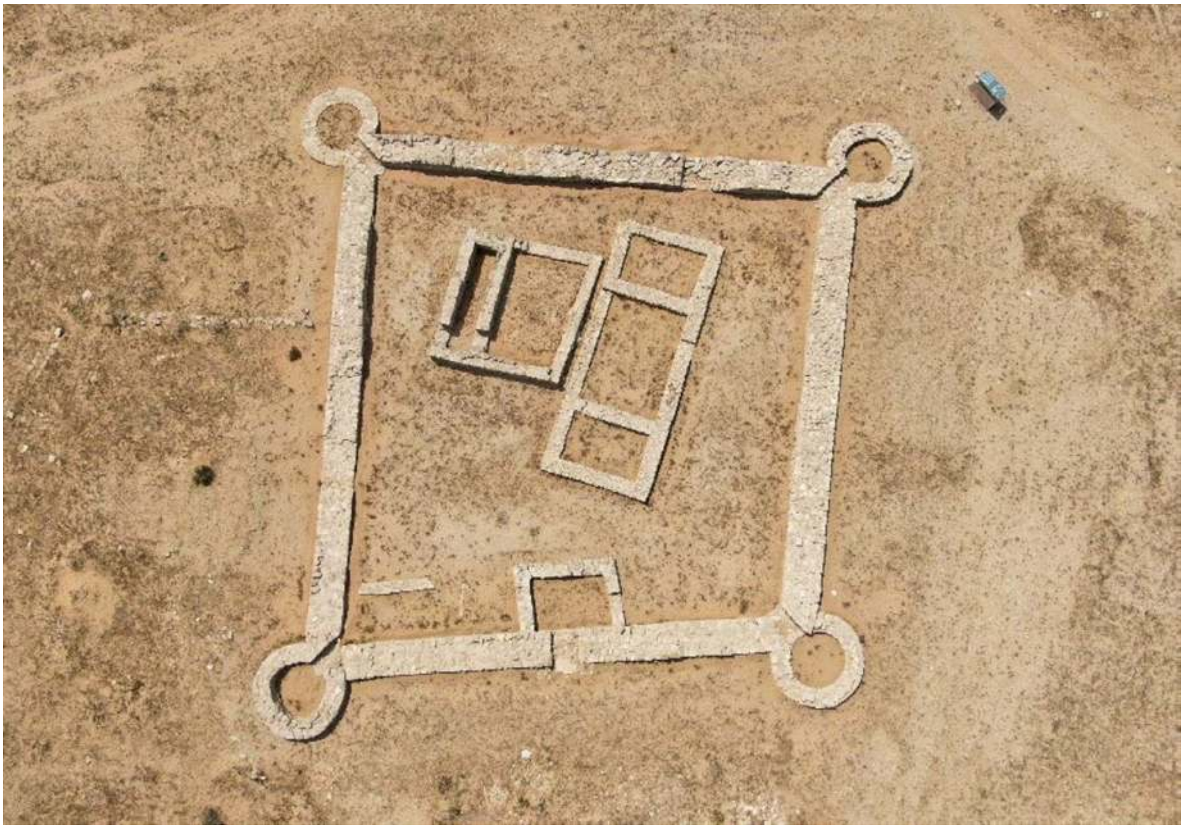


Figure 12: The fort at Area C with a tripartite internal building. (Photo: UAQ-TAD)

on a low rise that may once have been a small island in an intertidal zone. It consists of a single stone hut and small shell midden surrounded by scatters of pottery, glass and disarticulated shell. The second was situated at the hooked tip of the central peninsula (IIS-53), connected to the body of the peninsula by an isthmus and virtually an island in itself (Figure 11). More work remains to be done here, but it presently appears we have a small cluster of two or three stone huts and shell midden surrounded by the usual scatters of pottery, glass and shell. Although it is alternatively possible to interpret these sites as scattered fishermen's huts, it is not hard to imagine the ascetic lifestyle celebrated in the Syriac sources being practised in these out-of-the-way places.

Indeed, the discovery of a cenobitic settlement and potentially anchoritic retreats on Siniya Island sheds new light on the archaeology of the Khor Al Beida. The fort in Area C at Ed-Dur consists of a roughly square enclosure wall surrounding an open courtyard containing two smaller free-standing buildings, one with a tripartite linear plan and one with a rectangular plan divided into a small room and courtyard (Figure 12) (Potts 1990: 275-276). The plans of the interior buildings bear a passing resemblance to the stone huts found dotted around the Siniya Monastery, raising the intriguing possibility that the internal buildings at the Area C fort were constructed during a later reoccupation, when the ruined fort was used as an eremitic retreat. Since the fort was likely built in the early 4th century, it would have been about 300 years old, when the Siniya Monastery was flourishing and its walls may yet have stood. Curiously, the *History of Mar Yonan* records the journey of a Syriac monk to a monastic community in the Lower Gulf, where he found both cenobites and anchorites, and was hosted in "a great cell (*qelayta*) that was called Bokta, for it was a little far from the monastery" (Bedjan 1890: 498; Payne 2011: 107). Whilst we would not want to push this reinterpretation of the Area C fort too far, the discovery of a previously unknown monastery on Siniya Island makes the search for the material culture of Christian mysticism in the historic environment of Khor Al Beida a valid avenue of research.

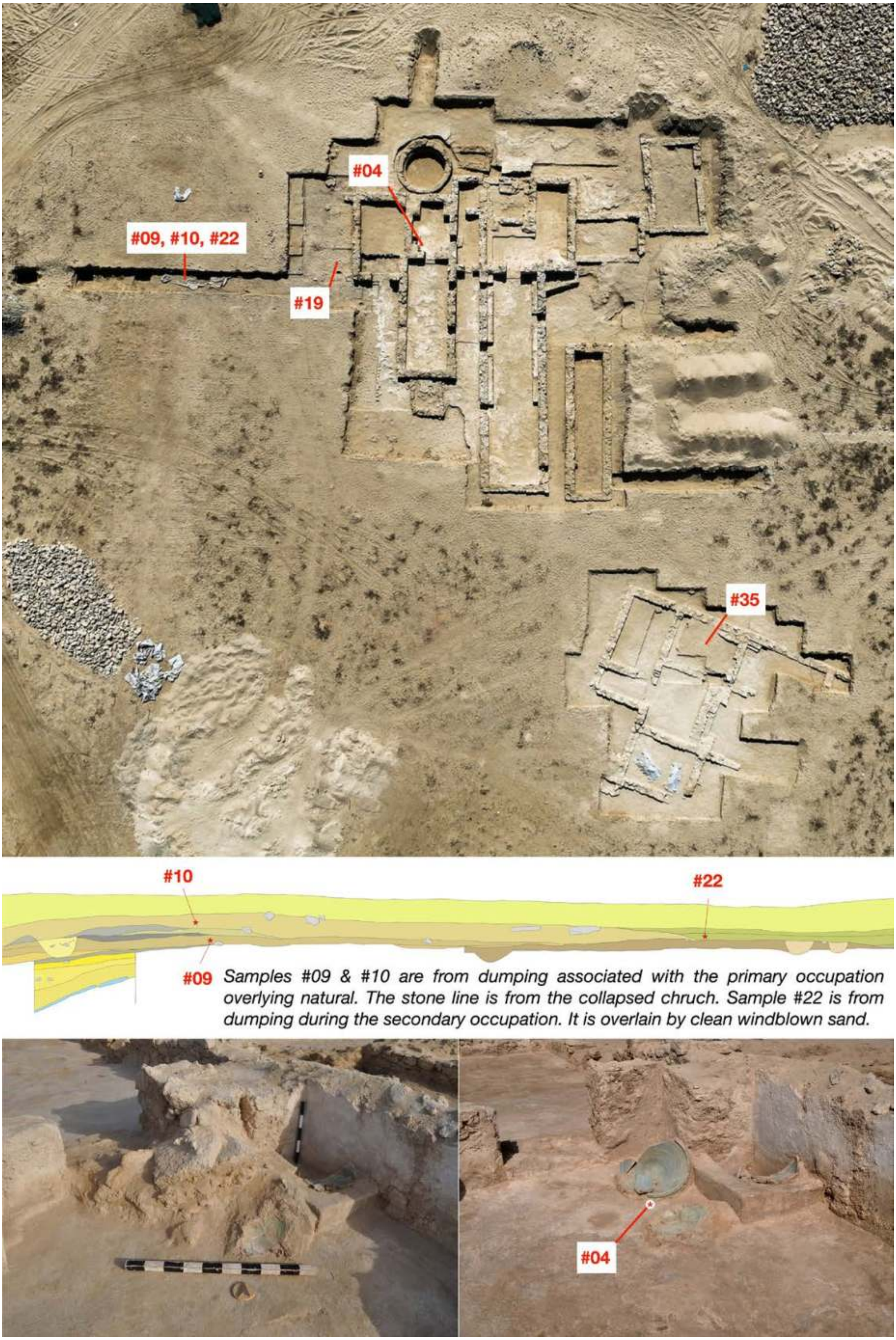
Foundation and abandonment

There is a fair amount of debate about the chronology of the Gulf churches and monasteries. An earlier generation of scholarship tended to assume they belonged to the Late Sasanian period, with a later generation reinterpreting the evidence and placing them in the Early Islamic period. Since the Siniya Island Archaeological Project is still in its early stages and we do not yet possess sufficient evidence to ascertain the foundation date, we have so far held off entering this debate and instead approached the Siniya Monastery with an open mind. A summary of the date evidence so far assembled would perhaps prove pertinent at this point (Tables 1 and 2; Figures 11 and 13).

Table 2: Schematic phase summary and speculative dating.

Phase	Description	Date
1	Foundation of Building A (and church?)	550–600
2	Transformation into a monastery proper	600–650
3	Continued expansion and growth	650–700
4	Demolition and burials. Baptism font. Decline?	700–750
5	Abandonment and partial collapse	750–850
6	Ephemeral ('squatter') activity	850–900
7	Complete collapse and sand deposition	900–1500
8	Islamic burials cutting ruin mound	1500–1600

Phase 1 is presently quite poorly understood. Excavations in the communal complex and abbot's house produced parallel stratigraphic sequences that are difficult to link securely. These buildings were built on natural sand, and there are neither finds nor samples that might furnish a *terminus post quem*, and they are obscured by later phases of building work and occupational activity. However, in the final occupational phase of the abbot's house prior to its demolition and the reuse of the space as a cemetery, a stone bowl containing charcoal was found that produced a radiocarbon date of 564–640 CE. This provides a *terminus ante quem* for the expansion of the abbot's house, the foundation of which is separated from its abandonment by two phases of expansion. The early date is supported by a single sherd of Turquoise Glazed Ware with a distinctive notched


#04
#09, #10, #22
#19
#35
#10
#22
#09
Samples #09 & #10 are from dumping associated with the primary occupation overlying natural. The stone line is from the collapsed chruch. Sample #22 is from dumping during the secondary occupation. It is overlain by clean windblown sand.
#04

rim known as Type 64, widely understood to be a 5th- to 6th-century type fossil (Kennet 2004: 37 and Table 15; Carter 2008: 89; Priestman 2021: 42), that was found in a collapsed layer abutting the external wall of the abbot's house. Excavation of the abbot's house was halted because of the discovery of the cemetery and cannot resume until the human remains are properly dealt with. We must therefore wait until we have enough evidence from the earliest levels of the abbot's house to be clear about the dating, but our preliminary results can be taken to suggest that occupation — including the shrine and church? — began sometime in the second half of the 6th century.

Phase 2 is much better understood because there is more dating evidence. In many ways, this is the key phase of inception, for it witnessed the transformation of a small church or chapel into a monastery proper. We place the beginning of the dump next to the monastery in this phase as part of a wider growth in occupational activity — and so rubbish — at the site. The lower level of the dump produced charcoal with a radiocarbon date of 574–641 CE found together with quantifies of Turquoise Glazed Ware characterised by a distinctive carinated profile known as Type 72, which is generally understood to be a 7th- to 8th-century type fossil (Kennet 2004: 37 and Table 15; Carter 2008: 89; Priestman 2021: 43). As such, we can reasonably date the construction of the Siniya Monastery to around the start of the 7th century.

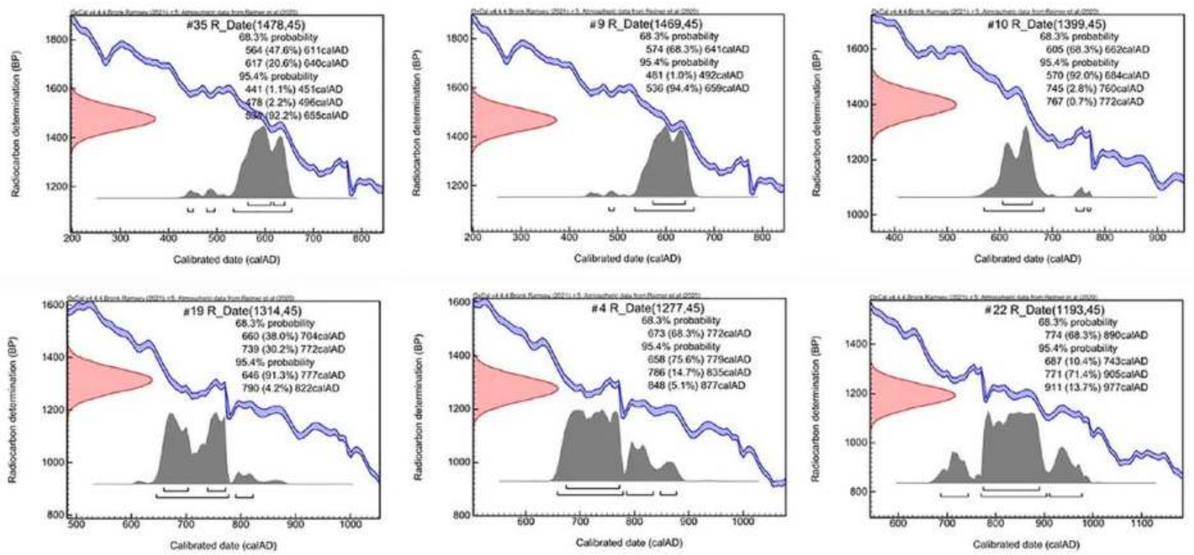
Phase 3 is associated with the continued expansion of the communal complex and the upper level of the dump. Quantities of Turquoise Glazed Ware Type 72 were again found in the dump, associated with charcoal that produced the slightly later date of 605–662 CE. We can therefore likely date this phase to around the middle of the 7th century.

Phase 4 witnessed the demolition of buildings to make way for burials. The general feeling is one of decline indicated by a reduction in the quantity and quality of building work. The putative baptismal font moreover belongs to the final phase of occupation, inviting speculation that there was perhaps a renewed focus on conversion as part of an attempt to bolster the dwindling numbers of the Christian community. Two charcoal samples from the final occupation of the communal complex produced radiocarbon dates of 646–777 CE and 658–779 CE. However, the chronological range may be narrowed by noting the absence of Turquoise Glazed Ware with barbotine decoration, which became common in the Gulf region in the mid 8th century and thus provides a *terminus ante quem* for the final occupation (Kennet 2004: 37 and Table 15; Carter 2008: 89; Priestman 2021: 45). We can likely date the final phase of occupation at the Siniya Monastery to the first half of the 8th century.

Later phases of activity at the site will be dealt with at greater length in a separate paper. Briefly, the communal complex and abbot's house collapsed and were covered by windblown sand to form an increasingly prominent mound in a flat landscape. A few postholes, a single sherd of Samarra Horizon

Figure 13 (opposite): Composite image showing location of charcoal samples used for radiocarbon dating.

Figure 14: Composite image of the radiocarbon curves. Refer to the table which is a summary of location and stratigraphic significance of dated charcoal samples. Radiocarbon data calibrated with OxCal v. 4.4.4 and atmospheric curve IntCal 20. The listed values of the carbon stable isotopes fractionation term (δ13C) are measured by AMS. These values can differ from the natural fractionation and from those measured by IRMS.



Sample and lab code	Location	Description	Calibrated date (σ)	Calibrated date (2σ)	Radio-carbon age	δ13C (‰)
#35 LTL22234	Abbot's house Context (113)	Charcoal sample from fill of stone vessel (F175) found on sandy floor of Building A Room 7, therefore providing TAQ for expansion of Building A.	564–640 CE	441–665 CE	1478± 45	-29.2 ± 0.6
#09 LTL22228	Trench 1 Context (056)	Lowest dump layer. Underlies context (047). Overlies natural beach. In phase with primary occupation.	574–641 CE	481–659 CE	1469± 45	-23.9 ± 0.4
#10 LTL22227	Trench 1 Context (047)	Uppermost dump layer. Underlies line of stones rolled down from collapsed church. Overlies context (056). In phase with primary occupation of the monastery.	605–662 CE	570–772 CE	1399± 45	-22.1 ± 0.3
#19 LTL22232	Room 16 Context (054)	Architectural debris set in windblown sand. Collapsed material from the church. Overlies decommissioned walls of Room 16.	670–772 CE	646–822 CE	1314± 45	-24.7 ± 0.4
#04 LTL22226	Room 2 Context (013)	Architectural debris set in windblown sand. Collapsed material from the church. Overlies plaster floor of the sanctuary (Room 2).	673–772 CE	658–877 CE	1277± 45	-23.1 ± 0.9
#22 LTL22233	Trench 1 Context (044)	Dump layer. Overlies a stone line visible in section originating from collapsed church, therefore belonging to the secondary occupation of the site.	774–890 CE	687–977 CE	1193± 45	-25.3 ± 0.7

pottery and a 9th-century radiocarbon date attest to some limited later activity on the site. The ruins attracted more systematic attention in the 16th century, when a series of Islamic graves were cut into the mound. This seems part of a wider reoccupation of the local landscape, associated with a Sufi shrine just to the north and an Islamic cemetery a little to the south, with the ruined monastery midway between them. We might therefore speculate that the ruins were given some symbolic or even magical significance during the Late Islamic period.

Conclusion

The Siniya Island Archaeological Project has now completed two seasons of fieldwork, and post-excavation analysis of the finds and samples is gaining pace. The purpose of writing this paper was to provide an overview of the constituent architectural units of the monastery together with a discussion of the phasing and dating, so it might serve as a foundation for the specialist studies that are now in preparation or planned. At the same time, our summary of the archaeological dating evidence currently available will allow us to place the Siniya Monastery in an appropriate historical context, to which end we have started working in earnest on the Syriac and Arab sources. These efforts will very likely transform our understanding of the monastery by opening up new perspectives on its society and economy, and we can look forward to some exciting publications in the coming years.

Acknowledgements

We would like to dedicate this paper to Peter Hellyer, who sadly died in July 2023. Peter played a key role in setting up the Siniya Island Archaeological Project and bringing the importance of the discoveries to the attention of the Ministry of Culture and Youth. We would further like to thank UAE University, the Ministry of Culture and Youth and the Umm Al Quwain Tourism and Archaeology Department for funding the first two seasons of fieldwork. Special thanks should go to Sheikh Majid bin Saud Al Mualla and Sheikh Salim bin Abdulrahman Al Qasimi for their leadership and vision, without which none of this would have been possible.

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The Early Islamic period in Al Ain in light of recent archaeological discoveries

Diaeddin Tawalbeh

Abstract: Al Ain (Abu Dhabi, United Arab Emirates) is home to historical and cultural sites dating back to the Neolithic, Bronze Age and Iron Age periods. However, archaeological evidence from Pre-Islamic and Early Islamic periods was lacking until the last few decades, when the Department of Culture and Tourism – Abu Dhabi started extensive excavations in and around the city. Archaeological finds, water systems (*aflaj*) and pottery revealed that Al Ain, which may have been mentioned in historical sources as the city of Taw'am, prospered in the Early Islamic period. Various types of glazed pottery, vessels and sherds are evidence of commercial connections with coastal towns and farther regions such as Mesopotamia.

Keywords: Hellenistic period, Early Islamic period, Ardh al-Jaww, oasis, amphora, Taw'am, glazed pottery, Samarra Horizon

Al Ain in historical and geographical sources

Al Ain is one of the most important historical cities in the United Arab Emirates, with archaeological discoveries showing human settlements dating back to the Bronze Age (3rd millennium BCE) (Cleuziou 1989: 79) and the Iron Age (1st millennium BCE) (al-Tikriti 2017). Settlements were centred in flourishing areas such as Hili, Bidaa Bint Saud, Hafit, Al Qattara, Rumeilah, Al Ain Oasis and other. Archaeological finds also indicate continued settlement in the area during the Pre-Islamic (al-Tikriti 2011: 115) and Islamic eras.

Al Ain became the first UAE site to feature on the UNESCO World Heritage List in 2011.

Several ancient Arab geographers visited the Oman Peninsula, including Abu al-Qasim Muhammad bin Hawqal, who wrote about its cities and ports; Ibn Khordadbeh, who described the Hajj pilgrimage route leading to Mecca from Oman; and al-Maqdisi, who described a number of cities such as Julfar, Dibba, Sohar and others. These cities were also visited by al-Idrisi and Qudama ibn Ja'far Abul Faraj, as well as the traveller Ibn Battuta, who documented his observations during his trip between the port of Dhofar and Qalhat, as did other visitors to the area (Ibrahim 2009: 15).

There are only a few written historical sources about the region of Oman. This may be due to its remoteness from the well-known intellectual centres of the Islamic world since the orientation was towards the south and east during the Umayyad and Abbasid periods. However, we find in biographical books valuable information about Oman and its people's conversion to Islam, the messages sent by the Prophet (Peace Be Upon Him) to Oman and the delegations from the Azd tribe to the Prophet. Nevertheless, the lack of books does not mean the absence of a cultural renaissance, as other signs show the role of the people of the region in navigation, trade and significant activity across the different eras (al-ʿAni 1999: 171).

The messages sent by the Prophet to the people of Oman are essential sources for Islamic history. According to historical sources, the Prophet wrote to the two kings of Oman, Abd and Jaifar, the sons of al-Julanda, calling them to Islam after the year 8 AH. The content of the letter is mentioned by al-Qalqashandi, Ibn Hajar and Ibn Saʿd (al-Rawas 1990: 31). The Sohar Museum in the Sultanate of Oman holds a copy of what it is believed to be one of the Prophet's original messages to the people of Oman.[1]

Also, during his reign, the Rashidi caliph Abu Bakr al-Siddiq sent an army commanded by Ikrima ibn Abi Jahl, Hudhayfa al-Ghalfa'i and Arfajah al-Bariqi to confront the apostates in the Oman region, and some historical sources refer to these events (al-ʿAni 1999: 116). The army reached the Rijama area near Oman (Ibn al-Athir 1997: 226) and then headed to Dibba, a thriving trading centre in which the apostates had fortified themselves. A battle between the two armies ensued resulting in the defeat of the apostates' army (Abid 2005a: 65). The Rijama region mentioned by historians could well be the village of Riyamah in the emirate of Fujairah, nestled in the western mountains of Dibba on the road between Dibba and Ras Al Khaimah (Abid 2005b: 39). Riyamah is c. 30 km from Dibba and about the same distance from the western coast of the United Arab Emirates.[2] Colonel Samuel Miles mentions that, on their way to confront the apostates, the Muslim army reached the Tu'am region in Oman and asked Abd and Jaifar, the Julandi leaders, to meet them at Sohar to reorganise the Islamic forces (Miles 2016: 52).

Historical sources mention that the Banu Sama seized power and established a state in Oman in the 9th/10th century CE (892-929 CE) during the reign of the Abbasid caliph al-Muʿtadid (892-902 CE). They asked the latter to support them in their war against the Yamaniyya tribes, and a vast campaign was organised with aid from the Bahrain ruler, Muhammad ibn Nur. The armies gathered in Julfar with the Nizariyya tribes and headed for Tu'am.

[1] *Al-Bayan* newspaper, 8 February 2007.

[2] www.alyammahi.com, viewed 12/6/2022.

Figure 1: Map showing the Ardh al-Jaww plain in the region extending between the Hajar mountains in the north-east and Jebel Hafit in the south-west (Google Earth, al-Tikriti *et al.* 2021: Fig: 1).

Several battles took place in the area, resulting in the Abbasid army and its allies taking control of Tu'am and other regions — Tu'am itself being entered on the 6th of Muharram 280 AH/893 CE (Hafiz and al-Rashidi 2015).

The region was also mentioned by Omani historians, including Sheikh Hamid bin Muhammad bin Ruzayq (1274 AH) in his book *Al-fatḥ al-mubīn fī sīrat al-sāda albūsʿaydiyyīn*, and Sheikh Abdallah bin Ḥamīd bin Salloum al-Sālimī (1286-1332 AH) in his book *Tuḥfat al-aʿyān bi-sīrat ahl ʿomān*. The region and its villages are frequently mentioned in various sources, as is the name al-Jawf Tu'am, commonly referred to as al-Jaww (Ibn Ruzayq 1992: 262-276; Ibn Ḥamīd al-Sālimī 1995). It is the region in which Buraimi is located and constitutes the north-western part of Al Dhahrah. It is connected to the south through Jebel Hafit, to the north through Sama'il and to the west through the desert (Miles 2016: 380). This area is a vast fertile plain bordered by the Hajar Mountains in the north-east and Jebel Hafit in the south-west and includes two oases: Buraimi and Al Ain (Figure 1).

As described by Arab geographers and historians, water resources were abundant in the Al Ain and Buraimi (Tu'am) oases. Thus, the large inland oasis became an important location in the Islamic period. The numerous ancient *aflaj* irrigation systems show the extent of settlement and organised agriculture in that region. The oasis was mentioned in the context of events that took place in the Early Islamic period, but published archaeological records of the area before Islam or in the Early Islamic period are generally rare (King 2001).

The region before Islam

The eastern part of the Arabian Peninsula experienced a lack of political stability before Islam and saw changes in the balance of power. Alexander the Great (336-323 BCE) raided the eastern region conquering most of the areas. Subsequently, the Hellenistic culture prevailed. With Alexander the Great, the Persian Achaemenid empire ended thus leading to the rise of the Sasanians. The region witnessed nearly three centuries of violent struggles between the Persians and the Byzantines until, finally, the Islamic conquests brought stability during the reigns of the Byzantine king Heraclius and the Persian monarch Khosrow.

Before Islam, the eastern coast of the Arabian Peninsula was dominated by different political powers. In the north-east of the Arabian Peninsula, the influence of the Lakhmids (Arab kings who ruled al-Hirah in Iraq) diminished c. 611 CE. The Abd al-Qays tribe was one of the leading powers in Eastern Arabia, while the Azd tribe in the south-east ruled a large part of Oman, challenging the coastal foothold of Sasanian Empire forces in Persia. The Sasanian and Byzantine empires were both superpowers from the 4th to 7th centuries CE, and their mutually destructive war on the eve of Islam was

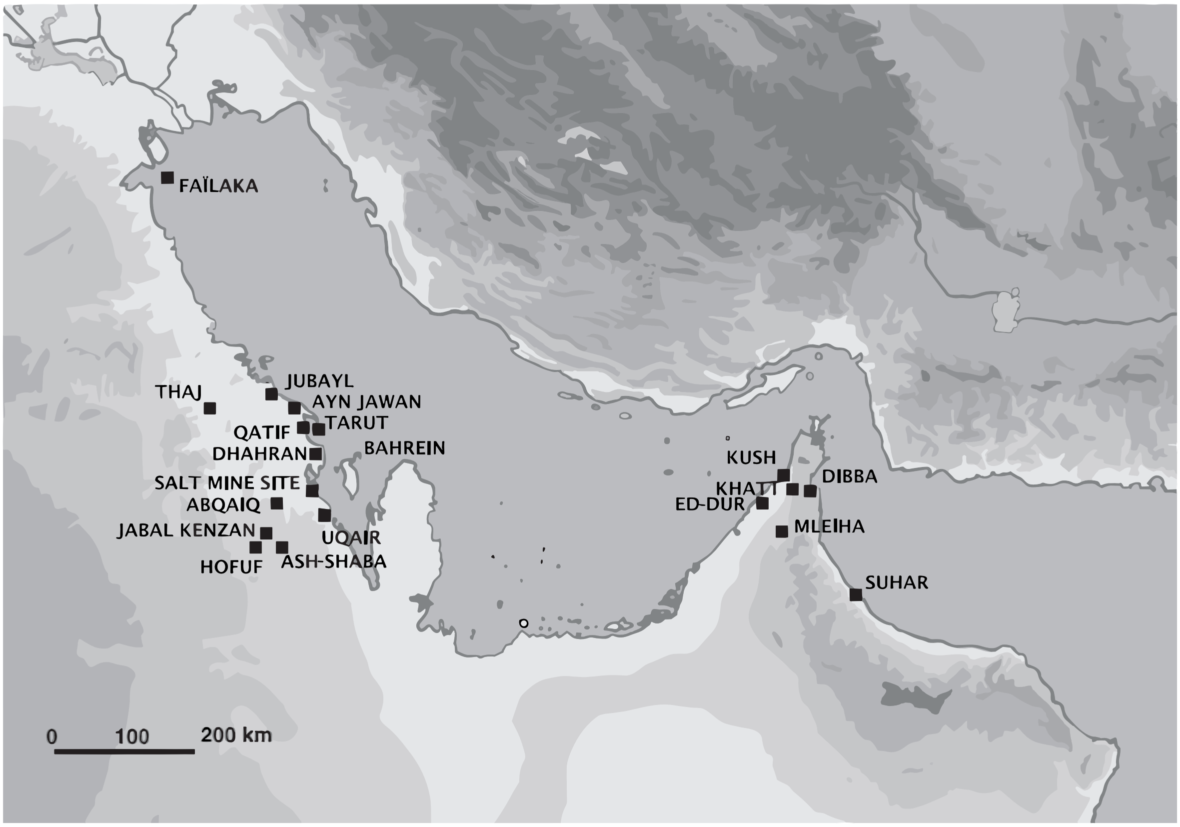


Figure 2: Map showing the spread of urban centres in the north-east and south-east of the Arabian Peninsula before Islam (Mouton 2009: Fig. 1).

the backdrop to the rise of the new religion and the new Islamic state that was to subsume both empires completely. The Sasanians had established a stronghold on the eastern Arabian coast in the 4th century CE. During their wars with the Byzantines, they extended their control over Yemen and installed a governor in Sana'a (c. 570 CE). With the advent of Islam in the 7th century CE, the Sasanians were driven out of Oman and Yemen (King 2001: 76).

Prosperous centres developed along the Gulf coast on the north-eastern and south-eastern parts of the Arabian Peninsula in the Late Pre-Islamic period (from the 4th century BCE to the 7th century CE) (Figure 2); they had economic and trade connections with each other (Mouton 2009). During this period, in the emirates, the cities of Mleiha in Sharjah and Ed-Dur in Umm Al Quwain flourished, becoming important commercial centres. They exchanged goods via inland caravan routes and had maritime links with countries of the Mediterranean basin, the Indian Ocean and southern Africa (Haerinck 1998: 286).

Research and discoveries attest to cultural unity among prosperous centres on the Arabian Gulf coast. Archaeological evidence from the Late Pre-Islamic sites has dramatically increased following the excavations of the last 30 years, although it is still considered limited. The eastern coast of the Gulf is an integral part of the Arab region and the Bedouin environment. Permanent settlements developed there to become safe centres and cities protected by the communities' common interests. At the same time, harsh environments led to continuing survival strategies and specific settlement forms from ancient to pre-industrial times. Each of these centres played a dominant role either as a permanent and stable agricultural town, a seaport, a market or a stop along inland routes (Mouton 2009: 185-207).

Similarly, Christianity flourished in the Gulf coastal areas east of the Arabian Peninsula in the 4th century CE until the first centuries of Islam, according to Syriac texts and sources from the Eastern Church (also known as the Nestorian Church): in the north-east of the Arabian Peninsula and the Bahrain Archipelago; in Beit Qatrayya (Qatar), which had monasteries dating back to the middle of the 4th century CE; the monastery and church on Sir Bani Yas Island in the United Arab Emirates; and another monastery at Al Qusur on Failaka Island in Kuwait (Carter 2008).

Archaeological evidence from the Pre-Islamic period was scarce in Al Ain until the few last decades, with the city witnessing significant urban developments and infrastructure projects. The Department of Culture and Tourism - Abu Dhabi carried out numerous rescue excavations in and around the city, which led to the discovery of fundamental archaeological evidence dating back to the Pre-Islamic period.

These discoveries show that the region flourished before Islam, from the 2nd century BCE to the 1st and 2nd centuries CE, while establishing a clear, uninterrupted historical sequence from the Bronze Age to the Late Islamic period.

Artefacts from the Hellenistic period have been found at various sites east of Al Ain Oasis, in Kuwaitat near the Sheikha Salama Mosque, and in the area of the Al Ain Museum (Figure 3). Numerous graves containing funerary goods, such as pottery jars (amphoras) and metal weapons (swords, daggers, arrowheads, etc.), were also discovered.

In 1994, during the excavation of a private house in Kuwaitat, located in the centre of Al Ain, the local team uncovered two graves containing grave goods, among which two medium-sized jars with a rounded shape body and handles; metal weapons, including an iron sword with a curved blade, a dagger and several metal arrowheads, all dating to the 1st century CE. These artefacts are part of the Al Ain Museum's collection (al-Tikriti 2011: Figs 100-103).

In the central district, near the Sheikha Salama Mosque, a small pottery amphora was found following rescue excavations in 2009 during road infrastructure works. It was dated to the Hellenistic period, c. 2nd century BCE – 1st century CE (al-Tikriti *et al.* 2009). It is thought that amphoras of this style, known as wine amphoras, were imports from southern Mesopotamia and south-west Persia and were used to store date wine for which Mesopotamia was famous (Sheehan *et al.* 2022).

Extensive excavations were also carried out in 2019–2020 around the Al Ain Museum following a long-planned project to restore and extend the museum.

Figure 3: Map showing the areas in the centre of Al Ain where artefacts from the Pre-Islamic period have been found (Google Earth).

Archaeological works revealed a stratified historical sequence starting from the Bronze Age — Wadi Suq (2nd millennium BCE) — up to the Late Islamic period — Sultan Fort and Harat Al Hosn (1820-1970 CE). Evidence dating back to the Pre-Islamic period (150 BCE-150 CE) was found in a grave (Structure A) along with a water well from the same period (Sheehan *et al.* 2022).

The Pre-Islamic archaeological finds from Al Ain and the many graves discovered in Kuwaitat in 2022 (Sheehan 2022) from the same era indicate that a flourishing settlement contemporary to Mleiha in Sharjah and Ed-Dur in Umm Al Quwain probably existed near the Al Ain Oasis during this period, with human settlement continuing into the Islamic periods.

Archaeological discoveries from the Eastern Arabian Peninsula indicate thriving trade relations between the Gulf region and the Greek islands from the 3rd century BCE, as well as across the Indian Ocean, Persia and other areas of the Arabian Peninsula (Ibrahim 2009: 13).

The region on the eve of Islam

The region accepted Islam peacefully early on during the time of Islamic proselytism when the Prophet sent an invitation in the hands of the commander Amr ibn al-As to the two kings of Oman, the sons of al-Julanda. The people of Oman responded, and the region became a part of the Arab Islamic state.

With the people of the emirates and Oman embracing Islam in 630 CE, the Gulf region became more closely linked to Mesopotamia, the rest of the Arabian Peninsula and the Levant. The region saw considerable growth in all stages of the Islamic era, around the valleys and in coastal areas. Seaports were built, fishing developed, and agricultural and industrial settlements thrived near the oases. These centres originated in cities that were known and inhabited in ancient times (Ibrahim 2009: 13).

Before Islam, the region witnessed struggles between local and regional political forces. The eastern coast of the Arabian Peninsula was under the sway of various local tribes and during the period 240-635 CE, the Sasanians controlled parts of the east coast of Oman. The long struggle between the Persian and Byzantine empires continued until the advent of Islam and the spread of the new religion. The Holy Qur'an mentions this struggle in the *Surat al-Rum*: "(2) The Byzantines have been defeated (3) In the nearest land. But they, after their defeat, will overcome" (Qur'an 30: 2-3).[3]

The region flourished after Islam; the cities and urban centres occupied in the Pre-Islamic period continued their development and prospered into Early Islamic times. The most important ones were Sohar, Muscat, Nizwa, Qalhat, Dibba, Julfar and Tawam (Tu'am), mentioned in historical and geographical sources (al-Tikriti *et al.* 2015). On his way to Oman, Amr ibn al-As passed through Buraimi, delivering a message to the Persian governor at Batinah before continuing to Nizwa (Miles 2016: 48).

Thanks to its fertile oases, the Tu'am (Al Ain/Buraimi) region had a unique environment that attracted residents throughout the ages. It was also a central point that linked the eastern and western Arabian Peninsula and a crossroads on the ancient commercial caravan routes that linked the inland areas with the coastal cities of Oman and the western coast. The historical town of Tu'am was mentioned by early Arab historians and geographers namely al-Maqdisi (d. 380 AH), al-Zamakhshari (d. 538 AH) and al-Hamawi (d. 626 AH). In *Muʿjam al-buldān*, al-Hamawi mentions Tu'am as as the name of a town in Oman near the coast. Tu'am is the plural of *taw'am* (meaning 'twin') (al-Hamawi 1977: 54).

On his visit to the Buraimi region in 1875, Colonel Samuel Miles mentions that the word 'Buraimi' refers to seven villages grouped in a 4-mile-long area. Among these villages were Jimi, Qattara, Hili, Al Ain, Saʿra and Hamasa (Miles 2016: 379).

The region in light of recent archaeological discoveries

During the past six decades, several archaeological excavations have been carried out in Al Ain, located near Buraimi (Sultanate of Oman). These two fast-growing twin cities are among the largest inland settlements, far from the coast. They are located on both sides of the Ardh al-Jaww plain, which stretches longitudinally a short distance north of Hili and crosses the border with Oman

[3] http://quran.ksu.edu.sa/translations/english, 19 October 2023.

Figure 4: Map showing the location of Early Islamic archaeological sites in and around the city of Al Ain (Google Earth).

south of Al Ain, bordered to the west by Jebel Hafit and to the east by the Hajar Mountains. As mentioned, previous archaeological works in Al Ain had shed light on various periods: Neolithic, Bronze Age, Iron Age, Pre-Islamic and Early Islamic (al-Tikriti *et al.* 2021), but in the last few years, excavations in and around Al Ain revealed substantial evidence from the Early Islamic period attesting that this inland oasis had flourished, was continuously inhabited and had economic and commercial links with the coastal cities. The discovery of diverse ceramic pottery fragments indicates that vessels were imported from various sources and regions, such as Mesopotamia, and through trade across the Indian Ocean and with southern Africa.

Recent discoveries in and around Al Ain also showed the importance of this area as a crossroads for caravan routes that linked the western Arabian Peninsula with the eastern regions. Below are the most important sites in and around Al Ain that have revealed material evidence from the Early Islamic period (Figure 4).

Al Fou'ah

Formerly Al 'Uha, the site of Al Fou'ah is situated to the north of Al Ain, c. 12 km from the centre, near a petrol station. It was surveyed for the first time in 1991 by Dr Walid al-Tikriti, leading to the discovery of several fragments of glazed and unglazed pottery dating to the Early Islamic period.[4]

Pottery fragments from the site, kept at Rumeilah (Box 107), include blue-glazed sherds from large and small jars of the Turquoise type (TURQ), dating to the Umayyad and Abbasid periods. Some of them have decorations, and

[4] *Pers. comm.* Dr Walid Yassin al-Tikriti, 7 December 2022.

they have all been produced in Basra. Two other dark-brown glazed fragments dating to the 15th century CE, known as Martaban Ware,[5] are imports from southeast China. This type of Tang dynasty vessel (al-Thenayan 2022) is characterised by its hardness and white clay covered by a dark-brown glaze.

Ūd al-Tawba/Al Muʿtaredh

This area in the centre of Al Ain was excavated during the 1999-2000 season, revealing a *falaj* and a contemporary mosque. The study of pottery sherds and radiocarbon dating of two samples of charcoal from fired clay bricks in the *falaj* dated the site to the Early Islamic period, that is, the Late Umayyad era and the beginning of the Abbasid era (8th–10th centuries CE) (al-Tikriti 2002: 133).

During the 2011-2013 excavation seasons at the same site, a settlement dating back to the same Early Islamic period (the Abbasid era) came to light. The discoveries included a complex network of irrigation systems composed of *aflaj* and water canals, in addition to a number of mudbrick buildings, indicating a widespread settlement (Figure 5); the irrigation network may also be evidence of one or more large oases near this settlement. This discovery is of considerable significance, shedding light on the history of Al Ain in its Early Islamic phases, perhaps revealing the location of Tu'am itself (al-Tawalbeh *et al.* 2017).

A study published in *Adumatu* (al-Tikriti *et al.* 2021) of 7326 pottery fragments from the Ūd al-Tawba/Al Muʿtaredh site identified 22 distinct glazed classes and 30 unglazed. Thus 52 classes of pottery from the site were studied and described, most dating to the Early Islamic period (9th/10th centuries CE). The most important glazed types were the light and dark-blue wares known as Turquoise (TURQ), resembling the pottery produced in Mesopotamia since at least the 2nd century BCE, and the so-called Samarra Ware (Samarra Horizon), produced in Mesopotamia, specifically in Basra (221-279 AH/836-892 CE) which comes in several forms and colour variants: Sgraffiato Ware, known for its incised decoration below the glaze and produced from the 9th to the 13th century CE. Other types included Lustre Ware (LUSTRE) and Green Splash Ware (G SPLASH), characterised by green spots under the glaze. The most common are pale yellow vessels with thin walls, glazed inside and out. There are also jars of another type known as Dusun, which have thick walls. These types became known through widespread trade across the Indian Ocean and the Gulf in the 9th–13th centuries CE. As for the unglazed pottery, it consisted mainly of Eggshell (EGG) which are solid white and have thin smooth walls. Other types of unglazed vessels were imports from India, Yemen and the Comoro Islands. A very soft-fired, black sooty ware known as SBBW was also found (Figure 6) (al-Tikriti *et al.* 2021).

[5] Analysis by Samtar Botan, PhD student, Leiden University, 1 March 2023.

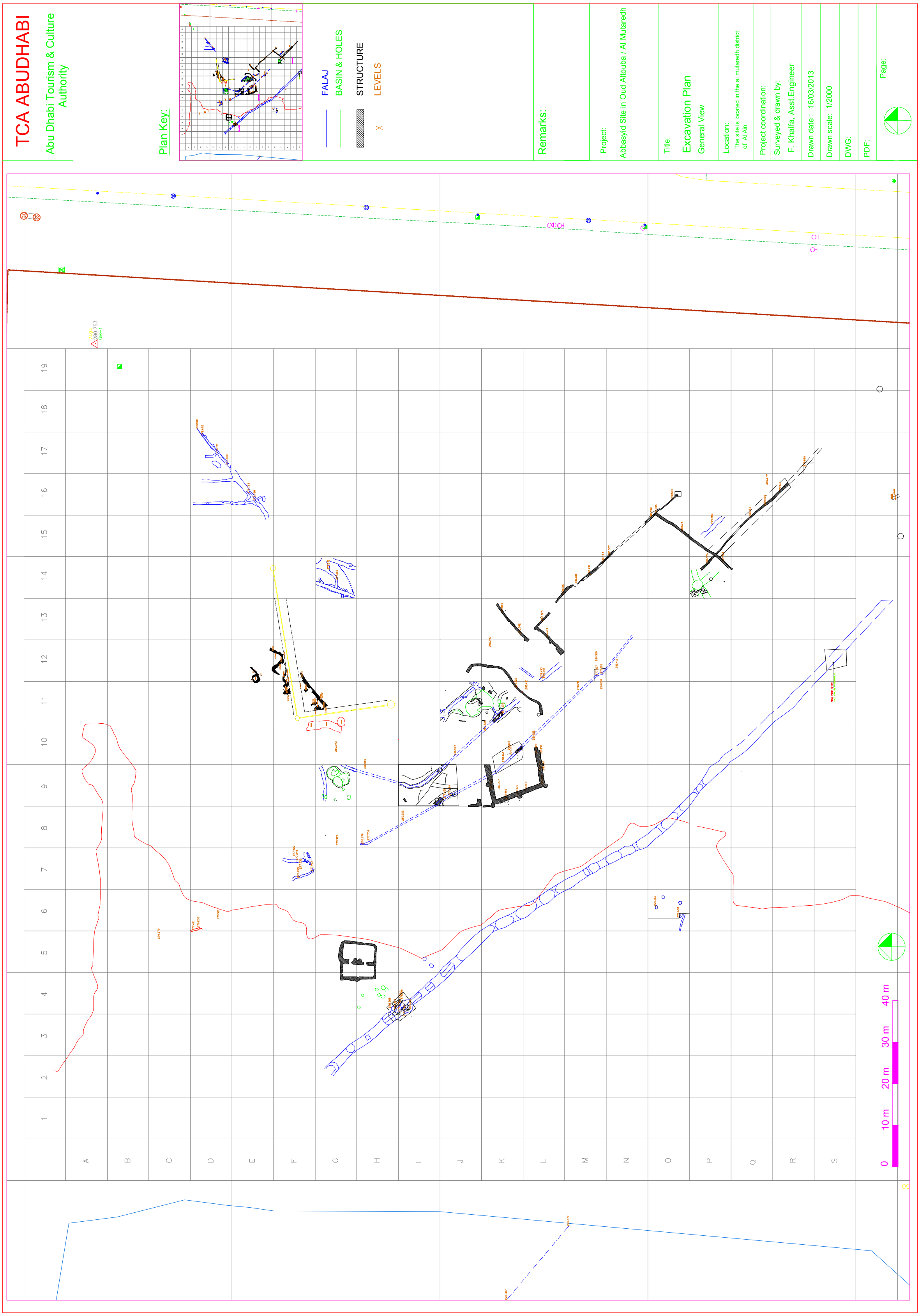
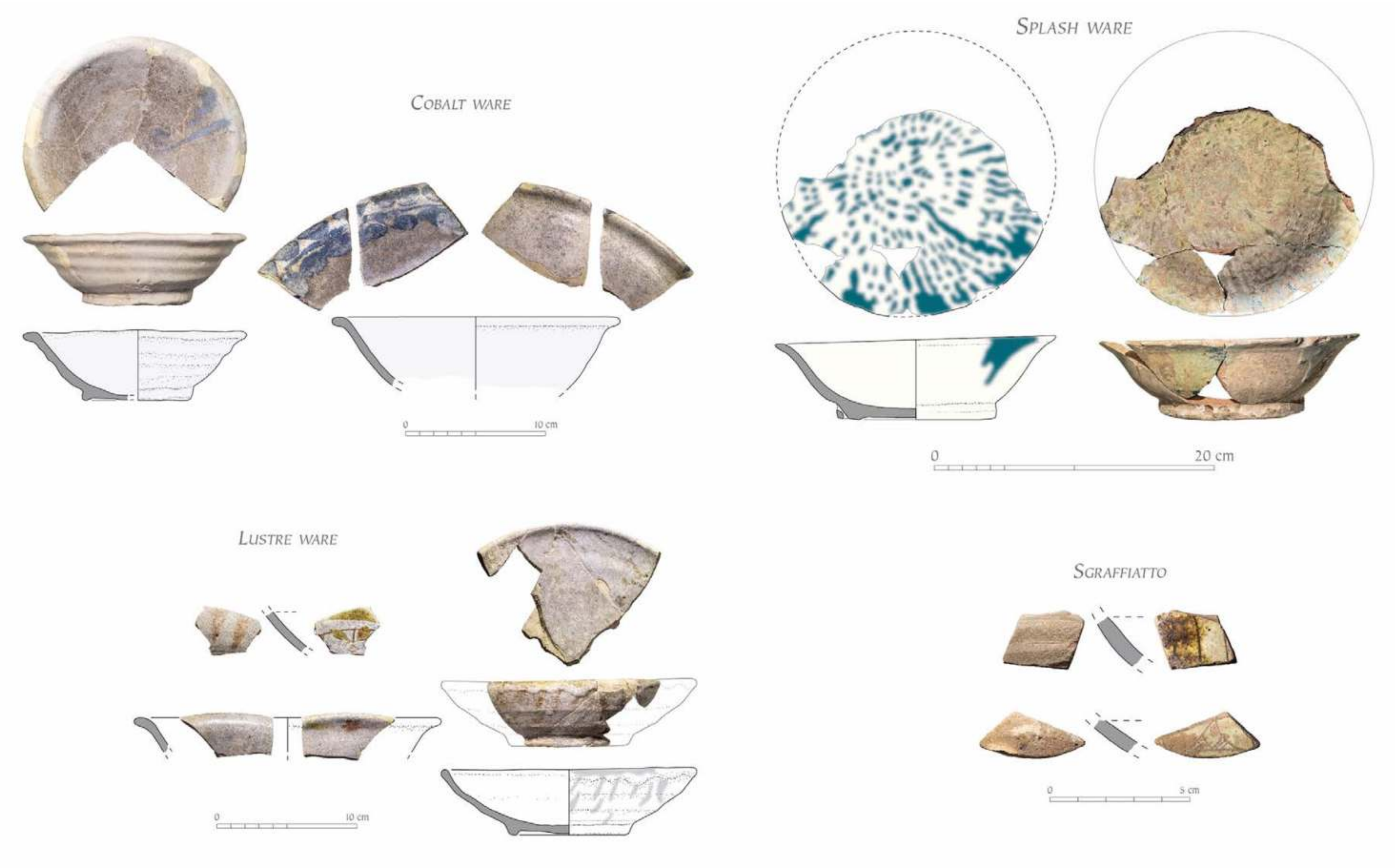


Figure 5: Network of excavation squares (10 m x 10 m) and plans of buildings and *aflaj* (irrigation channels) discovered at the Islamic site of Ūd al-Tawba/Al Mu'taredh in central Al Ain (drawing by Fawaz Khalfa and Ahmad Yahya, DCT Abu Dhabi).


Cobalt ware
0
10 cm
Splash ware
0
20 cm
Lustre ware
0
10 cm
Sgraffiatto
0
5 cm

DCT Abu Dhabi has preserved the archaeological site and undertaken maintenance and repairs of several prominent architectural features and parts of the *falaj* irrigation system for public display, creating an open museum that documents an important era in the Islamic history of Al Ain.

Figure 6 (opposite): Collection of pottery fragments from Ūd al-Tawba/Al Muʿtaredh showing various pottery types from the Early Islamic period (9th/10th century CE) (al-Tikriti *et al.* 2021: Figs 15–24. Drawing by Helene David Cuny).

Al Sulaimi

This site is in the centre of Al Ain, east of Al Ain University, directly to the north of Ūd al-Tawba/Al Muʿtaredh. A local team surveyed it and opened several trenches to explore the early culture of the area as part of a series of development projects by the municipality of Al Ain (PCR 616). Numerous glazed and unglazed pottery fragments dating from the Bronze Age, Iron Age and Islamic period were found, along with remnants of mudbrick buildings (Al Meqbali and Al Tawalbeh: n.d.).

The study of glazed pottery fragments (Rumeilah, Box 132) from the site revealed the existence of pieces dating to the Abbasid period (9th/10th century CE) of the TURQ type, one glazed Sgraffiato sherd, all of which were produced in Basra, in addition to a light-coloured, glazed Sgraffiato fragment from the Middle Islamic period (13th-14th centuries CE).[6]

A joint archaeological survey of the site was conducted by the Historic Buildings and Landscape Section – DCT Abu Dhabi in collaboration with United Arab Emirates University in 2014, followed by a typological and classification study. The most important fragments were TURQ imports from Mesopotamia, SPLASH ware, unglazed EGG ware and other types brought from Persia and China across the Indian Ocean (Al Marzooqi 2022).

Al Qattara and Jimi Oases

Considered natural reserves, the two oases were inscribed on the UNESCO World Heritage List in 2011. Human habitation around these sites is attested over long periods, as indicated by the ruins of ancient buildings (a market, citadels, fortresses, houses, etc.). Following several development and infrastructure projects in the two oases, DCT Abu Dhabi has undertaken rescue archaeological excavation projects, uncovering significant material from different periods.

In 2011, at Al Qattara Oasis, to the west of the border fence with the Sultanate of Oman/Buraimi Oasis, the Historic Buildings and Landscape Section – DCT Abu Dhabi conducted excavations at the Bin Ati Al Darmaki House. The team identified several periods of civilisation and evidence of settlement from the Early Islamic period. Remains of mudbrick walls and a *falaj* channel similar to the Early Islamic one discovered in the Ūd al-Tawba/Al Muʿtaredh area, c. 1.2 km to the south, were found, in addition to pottery fragments from the Early Islamic period. Works at the Jimi Oasis for a new

[6] Analysis by Samtar Botan, PhD student, Leiden University, 1 March 2023.

school building (PCR 616) revealed the remains of a mudbrick structure and pottery fragments from the Early Islamic period (Power *et al.* 2015).

Buraimi Oasis

A historical area and oasis in the Sultanate of Oman, the Buraimi Oasis is associated with the ancient name of Tu'am, i.e. the twin settlements of Al Ain and Buraimi on the UAE-Omani border. Settlements in the area date to the Bronze Age and Iron Age and include citadels, fortresses and other structures.

A joint archaeological survey and excavation project (BOLAP) was conducted at the oasis by Sultan Qaboos University, Zayed University and DCT Abu Dhabi. The project revealed archaeological and settlement evidence associated with the Bronze Age (2000–1300 BCE), Iron Age (1300–300 BCE) and Pre-Islamic period (300 BCE–300 CE). Finds from the Early Islamic period included the remains of mudbrick buildings and pottery fragments dating to the 8th/9th centuries CE, in addition to other glazed and unglazed pottery fragments from the 8th–12th centuries CE (Figure 7). Evidence of *aflaj* irrigation channels associated with the Early Islamic period was also establsihed (BOLAP 14-52); they matched the orientation and layout of the *falaj* discovered by DCT Abu Dhabi. The Buraimi *falaj* extends to the Jimi Oasis on the other side of the border, 425 m to the north-east (Power *et al.* 2015).

These discoveries from the dawn of Islam at the Buraimi Oasis have enriched our knowledge of the area's Early Islamic period, especially regarding the shared history of the twin oases of Al Ain and Buraimi.

Al Ain Museum

The oldest museum of the UAE was established in 1969, following instructions from the late Sheikh Zayed bin Sultan Al Nahyan. The museum is located at the eastern edge of the Al Ain Oasis, one of the components of the Cultural Sites of Al Ain, inscribed on the UNESCO World Heritage List in 2011, next to the Sultan Fort (the Eastern Fort).

Over two years (2019–2020), DCT Abu Dhabi conducted archaeological excavations in the car park next to the Sultan Fort as a preventive measure before starting the museum's restoration and extension project.

The excavations in Al Ain Oasis started in 1976 when a French team carried out investigations uncovering Islamic pottery fragments from the 16th century CE (King 2001: 74–75). Later excavations around the museum and in the carpark (2019-2020) led to the discovery of remains of mudbrick buildings, *aflaj*, a burial site and pottery fragments. These finds reflect a sequence from the Bronze Age (Wadi Suq) period to the Iron Age II, Pre-Islamic, Early Islamic, Middle Islamic and Late Islamic periods (Sheehan *et al.* 2022).

Excavations at the museum site uncovered Falaj 1, characterised by its north-south orientation, dating to the Iron Age. This *falaj* was used to irrigate

Figure 7: Collection of pottery fragments from the 8th to 12th centuries CE, Buraimi region (BOLAP14-66) (Power *et al.* 2015: Fig. 10).

date palm gardens in the oasis and was repaired and reused in Early Islamic times (700–1100 CE). Stones from the grave (Structure A) were reused inside Falaj 1, and the channel's roof was transformed into a vaulted structure of baked brick (Figure 8). The construction of this *falaj* is similar to the Islamic one in the Ūd al-Tawba/Al Muʿtaredh area. In addition, several collections of glazed and unglazed pottery were found (SAMARRA, TURQ, EGG), as well as sherds of vessel imports from India and Africa, all dating to the Early Islamic period (700–830 CE) (Sheehan *et al.* 2022).

North Al Ain Survey

DCT Abu Dhabi conducted an archaeological survey during the first season (NAS-2022) in the northern part of Al Ain, a vast area of sand dunes that stretch between archaeological and historical locations and sites, among which Bidaa Bint Saud (Bronze/Iron Age), c. 25 km north of the city of Al Ain, and then to the north across the dunes for c. 30 km, reaching the sites of Wadi Al Suʿain and Wadi Al ʿAyyay (Iron Age) and the Al Jabeeb *falaj* area in the north.

The survey aimed to provide a more accurate understanding of the distribution of archaeological sites in the area and place them within the historical context of the other known sites in the Al Ain area. The NAS-2022 survey led to the discovery of new sites, notably in the Al Jabeeb area, dating from the Early Islamic period. Pottery fragments of blue-glazed jars (TURQ) dating from the

Figure 8: Modifications using baked bricks to the vaulted roof of Falaj 1 during its repair in the Early Islamic period (Sheehan *et al.* 2022).

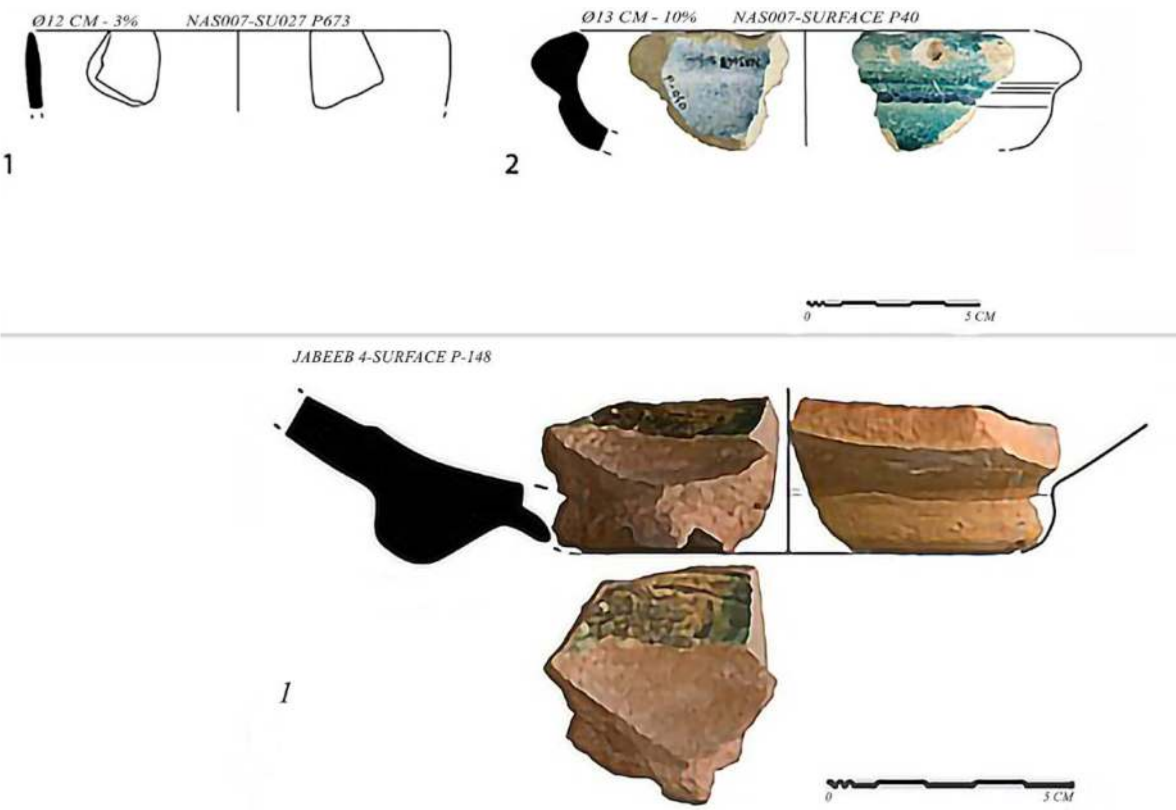


Figure 9: Glazed pottery fragments from the Al Jabeeb region date back to the Early Islamic period (TURQ, Sgraffiato) (Al Meqbali *et al.* 2022: Figs 73-74).

8th–10th century CE were found at the NAS007 and NAS019 sites (Figure 9). This type of pottery was produced in Basra, Mesopotamia (Al Meqbali *et al.* 2022).

Conclusion

Evidence from recent archaeological excavations and surveys in several areas of Al Ain indicates that the region flourished during the Early Islamic period (Umayyad and Abbasid), made apparent by settlement and human activity based on trade between the inland region and the coastal cities. Pottery fragments attest to diverse sources and origins: Samarra and Basra wares from Mesopotamia and other imports via the Indian Ocean trade routes (Yemen, Comoro Islands, South Africa).

Important urban centres developed at different times across the eastern Arabian Peninsula and along the coast of the Arabian Gulf, some of which lasted for centuries, others falling into oblivion for one reason or another.

Most of the urban centres along the Gulf coast emerged and developed because of the need to have ports and maritime trade centres (al-ʻAni 1999: 78). Trade developed during the Umayyad era with the advances made in navigation and the use of triangular sails in commercial vessels — a feature later adopted from Arabs by the Portuguese (Ojail 1998: 197). The region enjoyed even greater prosperity in the Abbasid era, thanks to its industry, technology, trade, wealth, population density, and people activities. According to historical sources, the taxes paid by Oman to Baghdad amounted to 300,000 gold dinars (Miles 2016: 74). Cities spread inland and in agricultural and industrial areas, some becoming markets and supply centres for the vast desert region, and others military centres, fortresses and forts (al-ʻAni 1999: 78).

The most important urban centres in Oman and the emirates included Sohar, Dibba, Julfar, Nizwa, Qalhat, Muscat and Tu'am, as mentioned in historical and geographical sources. In Arabic language dictionaries, *tu'am* refers to two entities, indicating perhaps that the name is associated with two oases or neighbouring villages, called Tu'am. Tu'am is linked geographically with Al Dhahrah, a semi-arid plain that extends from the western foot of the Hajar Mountains towards Rubʻ Al Khali (the Empty Quarter). This plain features many oases and villages, notably the Buraimi Oasis, Al Ain Oasis, Al Qattara and others.

Many cities within the emirates became well-known during the Early Islamic period. The archaeological site of Jumeirah in Dubai is one of the most important historic cities, discovered in 1969. Dating back to the Abbasid era (900–1100 CE), it remained inhabited for a long time. The city was a stop for trade caravans on the main routes between Mesopotamia and the Sultanate of Oman on one side and between India and the Arabian Peninsula on the other. Jumeirah's architecture follows the Islamic tradition, the most significant landmarks being the caravanserai, the governor's house, the market, the mosque and other public buildings.[7]

Another historical site in Al Ain contemporary with Jumeirah is the Islamic one of Ūd al-Tawba/Al Muʿtaredh, with similar architectural styles and glazed and unglazed pottery finds. The two cities may have had commercial and economic links during the Abbasid period due to their locations on the caravan trade routes between the coastal and inland regions. Those caravans passed by stations and camps along the trade routes between large cities and other urban centres.

The city of Julfar in Ras Al Khaimah, mentioned in many ancient sources, was an important port and trade centre from the Early Islamic period to the end of the 17th century CE when the Portuguese controlled the Gulf (Hellyer 1991). It played an essential role during the Abbasid period and the development of trade with eastern Asia. Julfar gained increased importance on key trade routes in the Early Islamic period because of the site of Kush and another site on Al Hulayla Island (Kennet 1997; Whitehouse 1976).

Dibba, in Fujairah, a well-known seasonal trade centre before Islam due to its unique location and proximity to the Strait of Hormuz, became even more important during the Islamic period. It witnessed the Ridda Wars against the apostates during the caliphate of Abu Bakr al-Siddiq (Omar 1987).

In the Early Islamic period, Al Ain was as prosperous as other contemporary cities in Oman and the emirates. The importance of the city and its trade links with the coastal towns is attested by the discoveries made at the Ūd al-Tawba/Al Muʿtaredh site, which include remains of public and private buildings, a mosque and *aflaj* from the Early Islamic period, in addition to a variety of pottery sherds found in and around Al Ain. An oasis environment, this region was known for its agricultural products (dates, cereals, livestock, etc.) and crafts. With its active markets dating back to ancient times, Al Ain was also a station on caravan routes from the Arabian Gulf's western and eastern coasts.

The pottery assemblage from the site of Ūd al-Tawba/Al Muʿtaredh recently studied in *Adumatu* (al-Tikriti *et al.* 2021) indicate that most of the pottery dates to the Early Islamic period (9th/10th centuries CE) and later. The study demonstrates commercial links with distant regions such as Mesopotamia and the Indian Ocean; 7326 fragments were studied and classified into two main groups: glazed (22 classes) and unglazed (30 classes). The glazed wares included samples from the Samarra (TURQ), Green Splash, LUSTRE and Sgraffiato types and another type from Kush (9th to 12th centuries CE). In the unglazed wares category, the most common finds were

7 Municipality of Dubai: *Guide to the Archaeological Site of Jumeirah*, https://www.tourguidetraining.ae/, viewed 28/4/2023.

Eggshell Ware (EGG) in addition to some locally made vessels as well as other vessels imported from India, Yemen and the Comoro Islands (al-Tikriti *et al.* 2021: 18–30).

These varied pottery fragments show how developed villages and towns in inland oases were. They also point to the high standard of living in and around Al Ain in the Early Islamic period due to trade exchange with major coastal towns.

Significant overland and maritime trade routes developed during the Umayyad and Abbasid periods. As a result, the Arab Islamic state became a reputed trade hub between the Arabian Peninsula, Eastern and Western Africa, the Far East (India, China, Transoxiana) and other routes linking Europe to the East via the Mediterranean reaching Egypt, Persia to the Arabian Gulf, and others. Muslims controlled the most important seaports, which contributed to economic prosperity. Overland caravan routes travelled safely, protected by military garrisons. Hotels and caravanserais were constructed along those routes, and wells were dug for drinking water. The Islamic state also had commercial and political agreements with foreign countries to protect trade (al-Lahibi and Mahmoud 2017).

A network of caravan routes crossed the desert, linking the inland oases with the northern and western coasts and other destinations towards the coast of the Gulf of Oman. Camel caravans had used similar routes since the Bronze Age. The use of donkeys during the Iron Age was limited to trips between dunes, such as in Al Suyoh. Based on the study of pottery during the Northern Al Ain Survey (NAS21), it appears that the Iron Age caravans used different routes and itineraries than the ones followed in the Bronze Age (Al Meqbali *et al.* 2022). These routes were also used in the various Islamic periods to travel to the western coast from the oasis regions of Al Ain and Hili.

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Conserving and protecting the Early Islamic Site at Ūd al-Tawba in Al Ain

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Abstract: This paper aims to present the interesting case of the Early Islamic site at Ūd al-Tawba, a site that went through different levels of conservation interventions from the moment it was discovered to when it was made publicly accessible. The Early Islamic site, made mostly of mudbrick, is located in the city of Al Ain and is one of a few sites dating to this period in the United Arab Emirates. A *falaj*[1] and a mudbrick mosque were first discovered in 1999–2000. After almost a decade, excavations resumed and several features, varying in size and function, were revealed, some of which have been backfilled. It was decided that three locations would be opened and exhibited, linking the present arrival plaza of the Sheikh Khalifa bin Zayed Grand Mosque with the past. Although the various earthen remains have been protected, the challenges of monitoring and maintenance continue.

Keywords: Early Islamic, mudbrick, conservation, emergency, shelters

Introduction to the location of the site

The site is situated in the Mutaredh area, near the previous General Secretariat Building of the United Arab Emirates University, in Al Ain (Figure 1). The site was excavated by the archaeology team of the Department of Culture and Tourism - Abu Dhabi in 1999–2000 and 2011–2014. Their excavations led to many significant discoveries composed of various structures such as mudbrick (earthen blocks) buildings, open water channels, basins and several *aflaj*.

Brief on the excavations and discovery of the site

The first stage of excavations was conducted during 1999–2000, revealing two significant architectural structures: a *falaj* and a mosque. The *falaj* was found to be comprised of a cut-and-cover section stretching 175 m, revealing

[1] A *falaj* is a traditional water passage dug into the earth for irrigation, transporting water over long distances to basins or wells (pl. *aflaj*).

Figure 1:
Location of the archaeological remains in relation to the Sheikh Khalifa Grand Mosque. (Google Earth)

a whitish-green clay sediment layer. The construction of this *falaj* used fired bricks, a material not commonly used in the region, distinguishing it from other Iron Age *aflaj* in the region (Al Tikriti 2011).

A small collection of ceramics recovered from the fill and two radiocarbon dating samples extracted from the construction material allowed the archaeologists to consider it of an Early Islamic date. Apart from the *falaj*, the only other architectural feature discovered on site by then was the unexpected traces of a small mudbrick mosque with two mihrabs, one in the prayer hall and another in the courtyard, one of the oldest known mosques in the UAE. Since then, the site has been defined as a 'permanent Early Islamic occupation', in contrast to the settlement pattern, which had been thought to be seasonal, especially during the early phases of Islam, and in contrast to previous assumptions that the Al Ain region was devoid of such settlements (Al-Tikriti *et al.* 2021: 7).

The second stage of excavations started in 2011, when a decision to construct a Grand Mosque on the same plot was taken by the Private Department of the late Sheikh Khalifa bin Zayed Al Nahyan. A grid was laid using 10 x 10 m squares, allowing more extensive excavations. Following this grid, several test pits were opened, which resulted in the discovery of more features. Four building units came to light in addition to cut-and-cover sections of three more *aflaj*. An initial agreement was made with the architect to incorporate only the two archaeological features found first (the *falaj* and mosque), which later became a challenge after the other building units were uncovered.

Description of the main archaeological features

Four out of the 11 (Figure 2) excavated archaeological trenches (units) were left uncovered: Unit 1 (the mosque and Falaj 1), Unit 2 is Building 1, Unit 3 is Building 4, and Unit 4 is a *thugba* (shaft hole) on Falaj 1.

Unit 1 – The mosque

During excavation, it was discovered that the straight walls contained a central niche that projected outwards (Figure 3). Further examination revealed that the niche was a mihrab and the structure was a mosque. Additional extensive excavations led to the discovery of the remaining walls of the prayer hall, which consisted of two short walls (north and south) joined by the eastern wall. The eastern wall contained two doorways, each measuring 0.80 m wide. The interior of the prayer hall measured 7.5 by 3.2 m, which was sufficient for two to three rows of people praying. The walls' width was 0.50–0.55 m and consisted of one and a half bricks, each measuring 0.32 by 0.32 m. The eastern wall was constructed in the same manner, while the two other walls' width was only 0.35 m, equivalent to the size of one brick and the plaster layers on both sides (Al-Tikriti *et al.* 2021: 13).

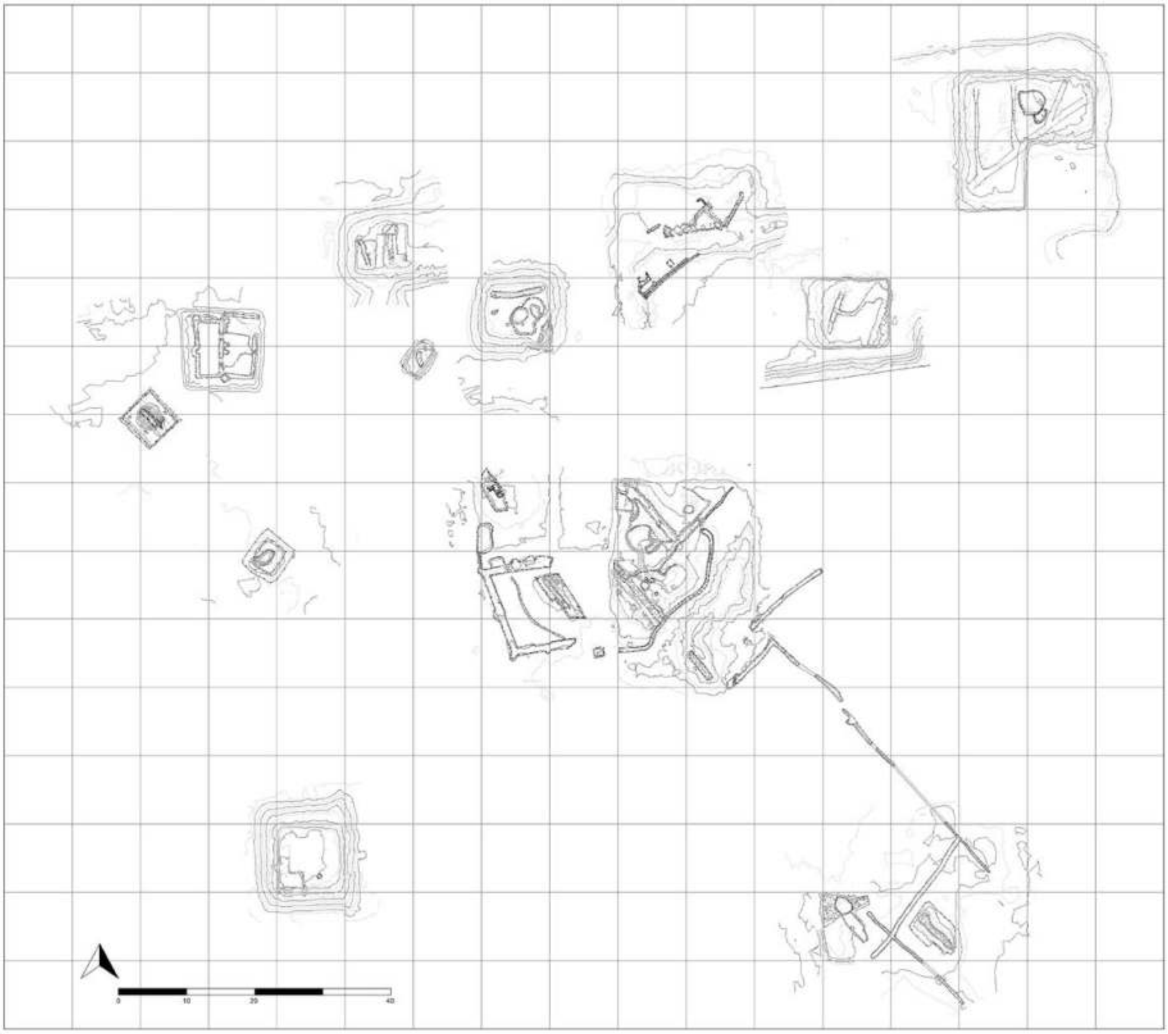

Figure 2: Survey map showing the eleven excavated trenches. (Capital Surveys, 2016)

Figure 3: The mosque before the implementation of the preventive emergency conservation. (DCT Abu Dhabi, 2016)

Unit 1 – Falaj 1 with *thugba*

A channel was discovered, originally dug from the ground surface to a depth of 4 m. It was dug into a 3 m-thick layer of compacted greenish clay (Al-Tikriti *et al.* 2021: 9). After sealing the channel, the remaining depth above the roof was refilled with the excavated earth, and the channel was concealed except for the shaft holes. At the extreme south-east end of Unit 1, a shaft hole (*thugba*) covered with a flat stone was discovered. In the same unit, a well-preserved square shaft hole was built. In some areas, the original roof of the channel was severely damaged, and the bricks of the vaulted roof were replaced in antiquity with flat stones. The clearing of the bottom of the channel at various points indicated that the *falaj* (Figure 4) ran from south-east to north-west (Al-Tikriti *et al.* 2021: 10).

Unit 2 – Building 1

A square-shaped building, with the fourth side of the square missing (Figure 5). The discovered walls are 1 m thick, with buttresses bonded both to the corners and centres of the walls. During the excavation of the building's interior, traces of a plastered floor were found running against the bottom of the walls, but these traces were absent from other parts of the interior. It was suggested that these patches of 'floor' may be eroded plaster from the walls.

Figures 4a (left) and 4b (top right): Falaj 1. (DCT Abu Dhabi, 2022)

Figure 5 (bottom right): Photo of Building 1 after excavations. (Al-Tikriti *et al.* 2021: Fig. 6)

Figure 6: Falaj 2 extending below ground in Unit 2. (DCT Abu Dhabi, 2022)

Apart from the patches of floor, the interior did not reveal further infrastructure. Like the mosque, the foundations of the walls are not situated on the original surface of ground but on a layer of sand. A thin wall was found attached to the northern corner of the building. Excavations there revealed ashy layers mixed with potsherds, indicating a cooking area. The pottery discovered has a white paste with thin walls in addition to fragments of cooking pots and some pieces of carbonised glass, all of Abbasid date. Handles ending with decorative shapes have been found as well (Al-Tikriti *et al.* 2015: 375).

Beneath this building, a channel (Falaj 2) was discovered in the eastern section of the building, cut into compacted soil and partly covered with stone slabs. The channel showed as part of a separate *falaj* running close to Falaj 1 and following the same direction (south-east/north-west). Falaj 2 was examined and found to be extending below ground, having been constructed by tunnelling rather than cut-and-cover (Figure 6) (Al-Tikriti *et al.* 2021: 14).

In the eastern part of this unit, several channels leading into several basins were uncovered. It is suggested that most of these basins resulted from a mining process in the compacted soil layer. The basin, when abandoned, was filled with debris containing fragments of mudbrick and Abbasid pottery (Al-Tikriti *et al.* 2015: 379).

Unit 3 – Building 4

This building was discovered while examining the sections of two wide perpendicular trenches excavated by the contractor to be used for infrastructure purposes. Unfortunately, one of the trenches (south-north) cut the south-west corner of the building, while the other one (east-west) went throughout the structure, dividing it into two halves.

Figure 7: General view of Building 4 looking southwest. (Al-Tikriti *et al.* 2021: Fig. 14)

The southern half contained two adjacent walls running north-east, defining what seems to be the back of the building (Figure 7). The inner wall seems to have been an addition to the exterior, as it is not attached to the short southern wall of the building. The main interior feature of this section of the building is the little open room/corner, which is defined by two pillars with a small gap in between. On the right of these gaps, a small, neat square feature, very well defined with a clay border, was found coated with a burnt, smooth surface; in our opinion, it was a subsidiary cooking area added to the adjacent wall. The function of a third isolated rectangular pillar (60 × 60 cm) is unknown, but we assume that it originally may have supported a roof or a vault. A quite well-preserved living floor was found encircling the pillar; originally, it must have extended over the entire remaining part of this section at least.

The northern half of the building seems to have two vertical phases, as it is occupied by a room built on top of an earlier one; the whole structure(s) may have comprised two small separate buildings rather than just one. It is difficult to confirm this view, as the cut trench in between the two sections was more than 2.5 m wide. The trench section of these two superimposed rooms shows that the lower one was filled with sand and a new floor was established for building the upper room.

The mostly missing eastern wall of the upper room (bulldozed) extends north, forming what seems to be a courtyard. This courtyard seems to have also existed during the early phase of the structure. The fill of the shared courtyard of both phases was found largely occupied with layers of ashes, giving the impression that it was a cooking area. A few more fragments of glazed and unglazed Early Islamic ware were found as well. It should be mentioned that against the western wall of the lower room, a thin, poorly-built wall was added to form a small utility space, which yielded fewer fragments of Early Islamic ceramics. The function of this wall is unknown, but it may have been intended to define another cooking area, as ashes were found in the fill between the main wall of the room and this clumsy wall. The wall may have also served as a perimeter fence for the building; later excavations in the courtyard revealed a well with a depth of over 4 m (Al-Tikriti *et al.* 2021: 15).

Unit 4 – Shaft hole (*thugba*)

In Unit 4, a shaft hole covered with a large stone was uncovered, along with a well-preserved square shaft hole. In some areas, the original roof of the channel suffered significant damage, resulting in the replacement of the vaulted roof bricks with large stones in ancient times. Upon clearing the bottom of the channel at different points, including Unit 4, it was discovered that the *falaj* ran from south-east to north-west (Al-Tikriti *et al.* 2021: 10).

Planning for conservation, protection and presentation

Temporary protection measures, such as covering with geotextile and installing sandbags, were immediately put in place by the archaeology team to ensure that the remains are supported and protected until a clearer vision is established for the future of the site. Later, due to the scale and significance of the discovered archaeological remains and as part of its vision to safeguard heritage and promote the tangible cultural heritage of the emirate, the Department of Culture and Tourism - Abu Dhabi sought to exhibit several parts of these uncovered remains in an open-air museum, linking the present arrival plaza of the Sheikh Khalifa bin Zayed Grand Mosque with the past archaeological landscape.

The main plan for three archaeological units (1, 2 and 3) was that they were to be conserved and exhibited in an archaeological park within the perimeter of the Grand Mosque. The decision on which locations to exhibit was made addressing the significance of the discovered components in each of the units, as well as taking into consideration the effect of exhibiting the features on the original design of the Grand Mosque and its surrounding landscape.

In 2016–2017, in order to prioritise the conservation needs for the various components of the three archaeological locations and develop a vision for the conservation, protection and presentation of the remains, DCT Abu Dhabi recommended that the principal design consultant ICON, responsible for the design and supervision of the landscape works, hire conservation experts to prepare a comprehensive plan for the conservation, protection, interpretation and presentation of the remains. Following this recommendation, ICON sub-contracted TURATH: Architecture and Urban Design Consultants for this job.

Site management planning was undertaken based on identification, documentation and assessment of the site and its components, formulating a strategic framework for its overall protection and long-term management; the conservation and protection of the features; and the interpretation and presentation of the site following international conventions and charters.

As an initial step, TURATH conducted a comprehensive field mission aimed at documenting the situation of all the archaeological features on-site and creating a base for the subsequent material analysis and condition assessment. A series of measured drawings was produced; these drawings varied, from a contour line survey to detailed architectural drawings based on photogrammetric documentation.

The general contour line survey included the site with its 11 trenches and addressed features such as archaeological remains, trees, fences and others, while the detailed range of photogrammetric documentation was only used to document the three archaeological trenches that are planned to be incorporated within the landscape.

The resulting drawings of the photogrammetry were printed out and brought to the site for analysis layers to be added. Two sets of drawings were produced. The first one used colour to indicate all the materials composing the various features. These materials included clay, bedrock, sand, stone, plaster and conglomerate mudbrick, to mention a few. The other set addressed features or changes that took place within each site such as *aflaj,* walls, basins, channels, *tanur*, ashes, window, courtyard, mihrab, bulldozer marks and others (TURATH 2017: 31).

After the documentation work was finalised, an assessment of the site's cultural significance was completed. Following this step was the condition assessment. A comprehensive condition assessment was carried out for the chosen locations, through consultation between different experts to address the state of conservation of the remains. Various degradation issues were observed, such as erosion, detachment, fractures, cavities[2] and others. The intensity of these degradation issues varied from one location to another. Therefore, and since these locations were to be exposed and exhibited, the conservation, protection and presentation plan considered that the erection of protective shelters was necessary to protect the site and reduce the effect of possible environmental threats by stabilising and improving the environmental conditions for the different archaeological remains. Moreover, it was recommended that the design of the protective shelters should provide all the elements that would facilitate the presentation and interpretation of the site.

All the other locations that were not planned to be exhibited were protected and completely reburied to allow the progress of the Grand Mosque's construction.

[2] Circular or semi-circular voids appearing on walls or floors.

Preventive emergency conservation

In 2019, as the construction of the Sheikh Khalifa bin Zayed Grand Mosque progressed in the area close to the archaeological remains east of the mosque, the landscape implementation works also began in parallel.

The imminent construction of all these components and their proximity to the archaeological remains, which until that point were only temporarily protected with geotextile, sandbags and partial backfilling, triggered the need for adequate and permanent protection to prevent the sites from disturbances and vibrations.

Perimeter walls were constructed around each of these locations (units) to protect the exposed remains during the landscape works as well as during the installation of the proposed protective shelters.

The surfaces of the remains were exposed and cleaned. Once cleared from sand and debris accumulated at the base of the walls, several issues came to light, some of which were associated with the original material itself. However, in order to have a complete understanding of the sites and the most adequate way to address these issues, it was necessary in some cases to extend or complete the excavations, especially near the earthen walls, to better understand the foundation system and the stability of the different remains.

A series of workshops was held with the archaeology team to understand the history and value of the sites; agree on a vision for the sites once open to the public; and identify how the proposed conservation interventions could enact and answer these aims. The archaeology and conservation teams collaborated closely throughout the implementation of the two phases, maximising understanding and minimising the extent of intervention.

After the clearing work was completed, further condition assessment was done for all three locations in order to better understand the condition of the remains and prioritise the critical interventions and actions necessary to protect them and bring them to a sufficiently consolidated state, allowing the contractor to proceed with the execution of the landscape and protective shelters. Holistic conservation was planned to be implemented once the shelters and all other new elements were in place and the sites were no longer at risk of any disturbances.

All the interventions proposed took into consideration the material authenticity of the site and followed a set of principles and rules. In fact, part of the archaeological remains discovered were structures built with mudbricks (i.e. adobe) and earthen mortar. To protect the sites without disturbing the original fabric, and because the source of the original soil could not be located, a new compatible soil was used for all the conservation work and repairs. Moreover, the selection of this new soil was part of multiple conversations held between the different stakeholders, since the soil that was available and used for other conservation works differed in colour and grain size distribution from the original found in the earthen walls. Finally, in the areas where it was necessary to apply a new layer of soil, it needed to function both as a protection for the original fabric and as a sacrificial layer, being less resistant than the original materiality of the sites.

It was also agreed that some of the exposed features would be reburied and not exposed to the public; as there was no physical or theoretical connection between the sites and those features, exposing them could be misleading for visitors. In those cases, a series of consolidation interventions were necessary to ensure the good and stable condition of the features before the reburial intervention, which was done by covering the features with a layer of geotextile, then adding sandbags to provide a boundary and protection to the features finally covering them with sand that differs in colour from the original one, giving a clear visual indication of this intervention whenever uncovered in the future.

The general state of conservation was good and stable, which allowed the team to implement minimal interventions with the least impact on the sites. The main concern was the behaviour of the remains and their materials, as once they were excavated and exposed to new climatic conditions, they would be different from those in which they had been preserved for several years. In fact, by exhibiting archaeological sites, we are exposing them to a new environment that can cause a series of conditions that affect them directly. Such was the case for these earthen Early Islamic remains which were exposed to a new extreme climatic condition, with hot days and cold nights creating a continuous expansion and contraction of the walls, causing the creation of new cracks or the extension of those already present.

In fact, a system of superficial cracks was visible over all sites, along with a few medium to deep cracks. Their treatment differed depending on their depth; after proper cleaning, to remove accumulated sand and debris, they were sealed either by filling, gravity grouting or by pressure with the help of injections/syringes. All cracks were filled with a liquid earth grout to strengthen the core of the walls and prevent them from opening again, while avoiding disturbing or otherwise affecting the original fabric. Three kinds of grouts were produced for this intervention:

1. A ‘whitish’ grout, produced from the original fabric collapsed and recovered during the clearing of the sites.
2. A ‘green’ grout, produced from soil sourced and stored by DCT Abu Dhabi, which was also used for the rest of the interventions.
3. A second ‘whitish’ grout, produced from a soil that was found by the contractor while excavating for the foundations of the new shelters, in an area adjacent to one of the archaeological locations. This soil had a similar colour and grain size distribution as the one found in the mosque in Unit 1. It was assumed that this was probably the source of the material used at the sites found.

After carrying out some tests and evaluating its compatibility, it was decided to recover this soil and use it for specific interventions on the remains, especially to create a clear visual distinction between cracks and joints or to clearly identify the different construction periods of the various structures as defined by the archaeology team.

One of the most notable conditions at all the sites was discovered when the team of archaeologists completed clearing the base of the walls. In fact, during the first archaeological excavations, different contexts and multiple stratigraphic sequences were identified, revealing that a significant percentage of the earthen walls lacked foundations or were built on loose sand, putting them at risk of further collapse and settlement. During the excavations, these unstable walls were temporarily supported with sandbags. To provide permanent support, it was necessary to consolidate the bases of the walls. This was done through different approaches, depending on the physical condition of each wall, but most importantly, depending on the difference in levels between the walls and the surrounding context, since in many cases it was this difference in height, caused by the excavations, that was putting the walls at risk.

Slopes or buttresses were created either with strong backfilling soil (a mix of sieved green soil and red sand) or mudbricks, and were implemented whenever the difference in levels was shallow. On the other hand, when the difference was substantial, a new foundation was created with gravel and green liquid earthen mortar to create 'earthen concrete', forming a base for the earthen blocks that were added below the original wall. The sand that functioned as the 'original foundation' of the wall was removed layer by layer, and the earthen blocks were carefully inserted. When necessary, especially when the original earthen blocks were loose and at risk of collapse, they were temporarily removed to create space for a new foundation to be inserted; after that, the walls were rebuilt using the original blocks in their original position. All these new interventions were plastered to a smooth finish, to clearly display and identify them, by maintaining a visual contrast with the original fabric. A similar intervention was needed when the excavations showed that some of the walls of the structures were cut and the rest of the wall was not found, creating a loss of connection. In those cases, the cut edge of the wall was consolidated with a buttress to give support and prevent any further collapse of the original walls.

The structures were also subject to erosion and crumbling.[3] The fact of covering and uncovering the structures with geotextile made the walls more friable and caused weathering on the surfaces. To prevent these conditions from escalating further and to maintain the integrity of the masonry, a temporary layer of green liquid earthen mortar was sprayed over those weak surfaces. Since at that time the remains were not yet covered with a shelter,

[3] Crumbling is when surfaces display active friability by grain loss under finger pressure.

they were also exposed to rain and wind-blown sand. This spray coating would protect the walls as a sacrificial layer.

Furthermore, all the sites presented multiple cavities and holes, sometimes due to material loss or burrowing animals. Depending on the size of the cavities, they were filled either with green earthen mortar or pieces of earthen blocks. This improved the strength of the structure by creating a proper and continuous connection.

While the sites were being cleared, archaeologists once again exposed some of the walls that were backfilled after the initial excavations. It was found that most of the mortar joints between the mudbrick courses had weathered. After removing the sand accumulated inside the joints, they were repointed with green earthen mortar. For the rest of the sites that remained exposed, most of the joints were protected thanks to the soil run-off from the upper part of the walls after the rain.

Basal erosion was minimal and found mainly on some walls of the mosque in Unit 1. The coving was closed and connected with the existing original building fabric using new earthen blocks that were plastered.

The *aflaj* and basins were cleaned to expose them. Minor interventions were carried out, such as consolidating and reintegrating collapsed stones or applying green liquid earthen mortar to weaker points.

The structure recognised as a house in Unit 3 was probably the location that presented most of these issues; not only all the aforementioned interventions were applied there, but also some additional and unique interventions were implemented, such as the reinstatement of the two external walls on the south-west side of the site. These are a reconstruction of the original walls that were mistakenly demolished during the excavation of the site. The excavation split the structure in two, putting the walls at either side at risk of collapse and creating a misleading interpretation of the site due to the loss of their connection. These new walls function as a buttress for the original walls, with a proper foundation carried out in the same way that has already been described, and are meant to visually reinstate the connection between both sides of the structure. To provide visitors with clear and accurate information and to avoid misinterpretations, the new walls had curved tops and were plastered with a smooth finish. The same process was followed with a wall that closes and delimits one of the rooms of the structure, which was also lost during the excavations.

On the north side of the north-east room, a very noticeable difference in levels between the original earthen floor of the room and the current ground floor was putting the original earthen floor at risk of collapse. In order to compensate for this difference in level, a support wall was built by compacting a number of layers of the previously mentioned mixture of sieved green soil and red sand until reaching the level of the original floor.

Figure 8: Building 4 with loose red sand filling the middle room. (DCT Abu Dhabi, 2022)

The 'empty' area (room) between the two parts of the house was filled to the same level as the original earthen floors of the structure with multiple layers of loose red sand (Figure 8), different in colour from the original sand found on site, to provide support to both sides of the structure and to give a better understanding of the site as a whole, not divided into two parts.

New finds were also discovered during the clearing process while excavating and preparing for the construction of the perimeter walls and the other new components around and over the sites. Such was the case for the extension of a previously non-visible earthen wall and the well in Unit 3. In those cases, and whenever necessary, together with the contractor, the original design of the new components was adapted and modified to protect the new findings.

In the case of the well, it was found that the upper, masonry-constructed part of its lateral walls required consolidation and support to prevent future collapse. This was done using the stones recovered during the excavation.

With the interventions on the well, the entire emergency conservation works were completed in the three units. As agreed with the contractor, construction works were halted until the sites were secure, and the enhancement works around and over the sites were completed before beginning the implementation of the platforms for the shelters.

Shelter design and installation

The design of the shelters primarily addressed the needs of the archaeological features in each location (unit) as well as the needs of the wider site, that is the Grand Mosque with its landscaping features. The shelters were mainly

Figure 9: Interpretation panels and walkways: part of the shelters installed. (DCT Abu Dhabi, 2022)

composed of three elements: the protection element, which is the upper cover, consisting of a suitable fabric material to protect the site from factors such as sun and rain, while still allowing light to enter; the structural element, which is the retaining walls marking the edges of the trenches; and finally the visitor and interpretation element, composed of elevated viewing platforms. A handrail was installed around the trenches and along the platforms to provide safety. The size and location of the elevated platforms was designed to provide a closer view of the main archaeological features and include interpretive panels explaining what the visitor is looking at (Figure 9).

The structure of the shelters went through a series of developments, taking into account how the new foundations would affect the remains. The final design aimed at minimising the number of pillars placed inside the trenches to avoid having the foundations close to the archaeological remains. In the case of Unit 2, this decision led to the need of using the truss system, due to the very large spans.

The design of the shelter over Unit 1 was less complex than the shelters over the other units due to its smaller size. It was realised that a single flat roof sloped in one direction would be sufficient to protect the mosque and *falaj* below. For the other two units, the shelters were designed with multiple smaller roofs sloping in different directions, and in a way that incorporates a water drainage system through the pillars of the structure. Unfortunately, and because of the multiple changes that the design went through, this resulted in some negative modifications, including the removal of the water drainage element.

Figure 10: Protection provided over the remains during the installation of the shelters. (DCT Abu Dhabi, 2019)

As the site is expected to receive visitors at night, the shelters were equipped with different lighting elements: soft floodlights to illuminate the archaeological remains, spotlights to illuminate the elevated platforms and linear light to illuminate the interpretive panels (TURATH 2017: 102).

Due to the new findings revealed during the clearing process or in cases where the proposed boundary wall was very close to the remains, the design of the shelters and size of the perimeter walls were modified, taking the conservation of these features into consideration (e.g. in Unit 3, where a well and a wall were uncovered).

To ensure that the remains were secured during the installation of the shelters, DCT Abu Dhabi requested that the contractor provide the appropriate protection measures, through the installation of temporary raised wooden platforms all over the archaeological remains (Figure 10). This ensured that the remains were not subject to any damage or harm should anything go wrong during the installation. Once the shelters were put in place, all these extra protection measures were dismantled.

Holistic conservation

When the Private Department of HH Sheikh Khalifa decided that the Grand Mosque site and archaeological park would finally be opened to the public, the conservation section at DCT Abu Dhabi considered that it was time to implement the already planned holistic conservation interventions to ensure that the site would be well protected, legible and ready to receive visitors. To start with, a physical condition assessment was done to evaluate the situation of the three units and the need for further conservation interventions prior to the opening. The assessment was aimed at understanding the key issues that the site was still suffering from, in addition to any other issues that were not addressed during the preventive emergency conservation works. Moreover, it included assessing the condition of the emergency interventions that were implemented in 2019 to evaluate if any repair work would be required.

The site was observed to be in a good state of conservation due to the effectiveness of the 2019 emergency conservation interventions and the protective shelters, which helped mitigate the effect of the various environmental factors. Some additional repairs and maintenance work were identified. A condition assessment report was produced, including a number of proposed tasks that vary in type and level.

After the condition assessment and prior to the implementation of these tasks, the conservation section requested that the documentation unit conduct photogrammetry documentation for the three archaeological locations as part of a larger documentation initiative started by the unit. The aim of this request was to document the existing situation and support decision-making during conservation, in addition to creating a baseline for the documentation of the later conservation and enhancement interventions.

The holistic conservation campaign lasted 11 weeks. The interventions varied in level; some were minimal and were only intended to enhance the general presentation of the site, such as modifying soil levels or the reburial of specific elements to enhance presentation and interpretation, while others were related to revisiting or maintaining the 2019 conservation interventions, such as reinstatement interventions, cracks and cavity repairs, and replastering. Other interventions were related to the legibility of the site, such as modifications to some of the earlier interventions.

The conservation team continued to meet with the archaeology team throughout the entire implementation process. For example, during the conservation of the well in Unit 3, in order to avoid over-intervention, it was discussed and agreed not to reconstruct or add anything, and instead to only carry out the necessary interventions that would prevent further collapse and stop water flowing through the gullies into the well. Similar to the previous emergency conservation, and to provide a clear indication of this new intervention, gullies and covings were repaired using a compatible mortar (red gypsum) and recovered original stones found on-site and inside the well. It was also agreed to fill the well with a suitable level of clean red sand to reduce its depth and aid in its protection.

Another discussion related to the coving west of Falaj 2 in Unit 2. It was originally assumed that there was an urgent need to stabilise the coving in a way that would prevent the collapse of the top mud layer (floor) into the *falaj*. Solutions such as providing support with earthen blocks or creating a cut at an angle of 30 degrees, to reduce the possibility of collapse, were suggested.

Neither option was preferred by the conservation team, as both would affect the legibility and authenticity of the site and might even create further damage, especially if the decision was to cut the mud layer on top, with insufficient information on its significance or what could be found below. After further observations and comparing the situation of the coving with how it had been two years ago, it was deemed that no interventions were required, and the only necessary action would be continuous monitoring.

Reburial and backfilling interventions were mainly implemented in Unit 2. Two types of backfilling interventions were applied. Simple reburial was carried out for some archaeological remains surrounding the main building by covering the remains with a layer of geotextile and then installing a suitable layer of red sand. This intervention was done to focus the attention on the main building and distinguish it from the surrounding features. Compact backfilling was mainly used for the middle room of the building to adjust its inner ground level to match the levels of the other rooms, in an attempt to present the building as a whole and enhance its understanding while implementing minimal interventions without the need for reconstruction. This was done using a type of local soil close in colour to the original one on-site but distinguishable. This intervention was recommended based on the assessment of the previous emergency interventions where red sand was used to fill the inner spaces of the building; it was noticed that sand had been blown away by the wind and scattered all over the site, leaving the inner spaces empty. In order to reduce maintenance and cleaning needs, Wagan soil was utilised as a heavier and less hygroscopic material.

For the area surrounding the building, to modify its level and as a top layer over the reburied features, several mix samples were prepared, and a combination of yellow soil and Wagan soil was selected and installed (Figure 11).

Minor interventions solely aimed at enhancing the legibility of the site included the removal of the accumulated sand inside the basin in Unit 2 and the rearrangement of the stone pieces to the top of Falaj 2 in Unit 2 to better explain its concept and how it differs in its construction method from the other *falaj* in Unit 1.

Modifications to the installed shelters

The site was still being monitored to assess the effectiveness of the erected shelters, especially during and after heavy rainfall. It was observed that the shelters were undersized, as water seeped into the trenches from the sides. This also caused water to leak through the edges of the trenches due to lack of proper waterproofing. Interim solutions to protect the remains and minimise the egress of rainwater were implemented. DCT Abu Dhabi worked closely with the contractor to solve this issue. Different solutions were explored,

Figure 11: Building 4 with its surrounding area after the installation of a mix of Wagan and yellow soil. (DCT Abu Dhabi, 2022)

considering the visual impact of any modification to the design. The best solution was to extend the shelters laterally to cover a larger area and allow water to drain away from the archaeological trenches, into the soft landscape where possible. Recently, a new extension of 2 m (Figure 12) was installed all along the sides of the shelters in both Units 2 and 3, following the same slopes as the existing ones. For areas where the direction of the slope could not be completely maintained, water collectors were installed (Figure 13).

As mentioned in the section on their design and installation, the shelters erected over the mosque and *falaj* in Unit 1 were smaller in size, consisting only of one flat roof sloped in one direction (Figure 14). The only possible minimal solution to reduce the amount of water seeping into the trenches was installing gutters along with water collectors, collecting the water in one pipe and draining it away from the site. This did not solve the problem completely, as the height of the shelter still allowed some water to enter from the sides, but given the fact that the archaeological remains inside the trench are a bit distant from the edge of the trench, this minor modification was seen as acceptable.

Ongoing monitoring and maintenance

The challenge of maintaining these archaeological remains continues. Earthen structures require special attention when it comes to conservation and maintenance. Monitoring is key in assessing threats and risks as well as understanding the various causes of deterioration and determining when there is a need to intervene.

Figure 12: Shelter over Unit 3 after the installation of the extension and water collectors. (DCT Abu Dhabi, 2022)

Figure 13: During the installation of the water collectors for the shelter above Building 4. (DCT Abu Dhabi, 2022)

In the case of the Early Islamic site, although the conservation works have been completed and the sites have been protected with shelters, the remains are still vulnerable to multiple issues, including erosion and cracks caused by natural factors such as wind or varying temperatures. Moreover, the long-term impact of these shelters needs to be studied.

Figure 14: The shelters over the mosque and Falaj 1. (DCT Abu Dhabi, 2022)

The site is constantly monitored by both the conservation and archaeology teams who conduct regular visits, whether to monitor the site in general, after extreme weather episodes or to examine specific issues and areas, such as the *falaj* that is excavated in bedrock in Unit 1 or the coving west of Falaj 2 in Unit 2. In addition to this, a guard is always on-site, doing regular cleaning and informing the different stakeholders of any issues of concern. This continuous monitoring helps us understand the changing threats facing the site and allows us to employ suitable measures to conserve the site for the future.

A final location of concern is the fourth unit, a shaft hole (*thugba*) covered with flat stones, which was kept exposed and later planned to be exhibited. This unit was not part of the project during the preparation of the conservation and protection plan, neither was it part of the shelter design. To protect and exhibit it, a glass cover was installed on top, which is now causing condensation and humidity problems, due to varying temperatures and lack of proper ventilation (Figure 15). Recently, as an emergency intervention, the remains were partially reburied and a data logger was installed to measure relative humidity and temperature. Currently, this unit is being monitored and several solutions are being studied.

Conclusions and lessons learned

The cumulation of the work done on this site has allowed us to extract some lessons and conclusions that can be grouped as follows:

Coordination and stakeholder management

Closer coordination between both internal and external stakeholders starting at the earliest stages of such projects is essential for the successful conservation of sites that present similar challenges.

Figure 15: The glass cover over the *thugba* in Unit 4. (DCT Abu Dhabi, 2022)

Some of the gaps observed between archaeology and conservation could be filled through the inclusion of conservation experts during all stages of similar projects. An example of this is the immediate actions that can be undertaken during excavation stages that would help reduce the need for later conservation and protection measures implemented on site. Having a clear idea of how all stakeholders envision the site and the experience that will be provided to the visitors would allow for better conservation planning.

Design

Several design-related issues, such as the height, drainage, structure and fabric, were only observed after installation. Other problems observed were related to the implementation and surrounding landscaping, including but not limited to the waterproofing at the retaining walls of the trenches, slopes directing water into the trenches and the lack of a connection to the sewage system.

Inappropriate modifications to the elevated paths and interpretive boards during the implementation phase could have been avoided if all the stakeholders were aware of these modifications.

Other modifications could also have been avoided if complete and accurate documentation were provided to all the stakeholders involved in the design.

All the previously mentioned issues allowed DCT Abu Dhabi to formulate guidelines and principles for the protection and presentation of archaeological remains through protective shelters.

Conservation interventions

The final results of the conservation interventions at the Early Islamic site prove that the conservation of archaeological sites is a continuous process that through planning short- and long-term measures (emergency and holistic), a maximum understanding of the nature and value of the remains could result in the implementation of minimal interventions, respecting the original fabric and leading to a successful conservation project.

The interventions carried out prove that is it possible to introduce new materials and techniques into archaeological sites while still respecting the original fabric, if those materials are compatible and less resistant than the original.

During the implementation of both the emergency and holistic conservation, it was observed that applying a layer of geotextile on archaeological remains that are found to be eroded and extremely fragile following excavation, in this case earthen walls, as a temporary protection, is not always the best solution; it was noticed that it could cause more damage than protection, especially when the remains are being alternately covered and uncovered. It was also observed that in some cases the most suitable intervention is complete backfilling of the original remains.

In order to establish a baseline for any future interventions, it was seen how crucial it is to have proper documentation at every stage of excavation, conservation and implementation of new additions.

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New evidence for the Early Islamic landscape of Al Ain
Fieldwalking and surface ceramics from Slemi, Jimi Region

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Abstract: The Early Islamic archaeology of Al Ain and neighbouring Buraimi is increasingly coming into focus following recent discoveries on both sides of the border. Key sites of this period include an *arish* settlement at Qattara, a mudbrick village found at Hamasa, and a mosque and *falaj* at Oud Al Toubah (Power *et al.* 2011; 2015; Al Tikriti *et al.* 2021). Slemi is located roughly in the middle of these sites and as such fills a gap in the Early Islamic landscape of Al Ain. A fieldwalking study, including the collection of surface ceramics enabling a full typological quantification, was undertaken in collaboration with students from UAE University. The assemblage indicated a 9th- to late 10th-/early 11th century occupation. Surface ceramics from Slemi likely represent an *arish* suburb of the nearby mudbrick settlement at Hamasa or else result from the manuring of open fields or palm groves in the Early Islamic landscape.

Keywords: Landscape archaeology, fieldwalking, ceramic quantification, Early Islamic

Introduction

In November and December 2022, the Historic Buildings and Landscapes section of the Historic Environment Department of DCT - Abu Dhabi collaborated with students from the United Arab Emirates University (UAEU) to carry out a fieldwalking project in an open area in Slemi neighbourhood, south of Jimi Oasis, Al Ain. The site is located east of the Al Ain University Al Ain campus and west of the UAE/Oman border. This area is important because it is one of the last remaining open areas in the neighbourhood of Jimi Oasis, where multiple Early Islamic sites have been discovered in recent years. We initiated this examination of the site due to the impending construction of infrastructure. Our goal was, therefore, to broaden our understanding of the area before it undergoes significant changes.

Fieldwalking surveys and Preliminary Cultural Review (PCR) tests had been carried out on the site in 2014 to understand the potential for future work. The discovery of Early Islamic material at that time was one of the factors that led to our present project.

Figure 1: Al Ain Early Islamic sites in relation to Slemi. Oud Al Toubah is highlighted in blue, Hamasa in red and the Jimi water channel in pink.

Figure 2: Pictures from the ceramic surface collection and pottery quantification processes.

Methodology

A comprehensive fieldwalking survey of the eastern part of the Slemi site was conducted. The survey involved the students walking the area in a systematic way and marking the location of every surface pottery sherd found on the map using GPS tracks, taking on-the-spot pictures of the sherds and labelling the sherds with codes to identify where they were found. This method enabled us to identify where the different concentrations of pottery were located. The sherds collected through the fieldwalking survey were then quantified by utilising type fossils to identify the periods of occupation.

Microsoft Excel was used for data entry. The information entered included the sherd code, its location, type, period and shape. Through this process, we were able to group the pottery into three distinct phases of occupation: Iron Age, Early Islamic and Late Islamic. The Early and Middle Islamic were grouped together due to the significant overlap between the ceramic assemblage. The distribution of the pottery is visible on the map created by the data entered during the fieldwalking survey. The density of the Early Islamic assemblage is highest in the east of the site, closer to the Early Islamic settlement found near Hamasa in Oman. As we moved westwards, the number of Early Islamic sherds decreased. The Iron Age sherds were found mixed with Late Islamic types in the areas where the site was most disturbed due to tree removal and machine digging, causing the pottery to be mixed together.

Results

The ceramic assemblage recovered during the fieldwalking survey provides valuable insights into the site's occupation history. Out of 820 sherds that were recovered from the site, 259 sherds were identifiable and dateable. The majority of the assemblage belonged to the Early and Middle Islamic period, comprising 70 per cent. These two periods were grouped together due to them being transitional periods with significant overlap between the pottery types.

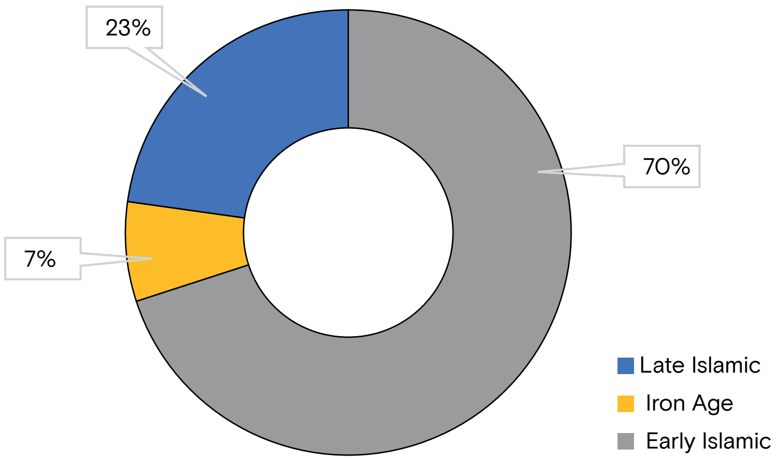


Figure 3: The percentages of identified sherds from the survey.

The second highest pottery concentration was the Late Islamic, comprising 23 per cent of the total assemblage, indicating that there was a light occupation during this period as well. Interestingly, 7 per cent of the pottery assemblage belonged to the Iron Age, providing some evidence of earlier activity at the site.

The 561 remaining pieces of pottery recovered from the site were of common unglazed earthen types. Due to time constraints, because this pottery quantification was undergone during class at the university with the students, these pottery types were separated into three categories based on the colour of their fabric; UNID.R (Unidentified Red Ware), UNID.W (Unidentified White Ware) and UNID.G (Unidentified Grey Ware). Based on the amount of unidentified common wares, there is a great potential for future research to identify the common pottery from the Early Islamic period.

Ceramic Period 1: Iron Age

Eighteen Iron Age sherds were recovered in total. The identified Iron Age pottery classes included Sandy Buff Wares, Other Common Wares and Fine Red Painted Wares.

Sandy Buff Ware (SBW)

A group of pottery locally made in Al Ain during the Iron Age. The fabric ranges from light buff to light orange sandy paste. This group of wares have several sub-groups but only the slipped Sandy Buff Wares were found in Slemi: slipped sandy buff ware with fine temper (SLP-SBW.1) and slipped sandy buff ware with coarser temper (SLP-SBW.2). This group of wares was most common during the Early Iron age (1100–600 BCE). They continue in use during the Late Iron Age (600–300 BCE) but in less abundance (Benoist and Pellegrino 2022).

Other Common Ware (OCW)

A group of pottery that is common throughout the Early to Late Iron Age. These wares have several kinds of fabrics that may originate from different areas of Southeast Arabia. Fabric colour ranges from a red orange to brown, and the inclusions and hardness of the pottery vary due to it being locally produced and not from a centralised production (Benoist and Pellegrino 2022).

Fine Red Painted Ware (FIN-RED)

Only one sherd of Fine Red Painted Ware was recovered. This is a type of Iron Age pottery that was mainly used during the Early Iron Age and survived into the Late Iron Age. This group of pottery is characterised by an orange to red paste, thin width, fine temper and being well fired. This group also has dark red or black decorations directly on the surface or on a red slip (Benoist and Pellegrino 2022).

The Iron Age assemblage was mostly found on the western side of the site, along with most of the Late Islamic assemblage.

Table 3: Summary overview of Iron Age ceramic classes mentioned in text

Ceramic Period 2: Early Islamic

Most of the pottery assemblage was Early Islamic types, which were found mainly at the east end of the site, reducing in quantity as we moved west. In total, 182 were Early Islamic type fossils. The pottery types will be discussed below, from the greatest to the smallest quantities found.

Table 1: Early Islamic Types

Type	Quantity	Percentage
TURQ	62	34%
EGG	49	27%
PROTO	15	8%
WHT-GLZ	15	8%
GRAF	14	8%
UNID	19	10%
SPLASH	7	4%
YUE	1	1%
Total	**182**	**100%**

Turquoise Glazed Ware (TURQ)

The most common pottery class that was found at the site, a total of 62 sherds, equal to 34 per cent of the Early Islamic assemblage. A type that Kennet describes as part of the Alkaline Glazed Classes (Kennet 2004), this type of pottery is dated from the 8th to the 10th century (Priestman 2013).

Eggshell Ware (EGG)

Part of the unglazed ceramic class, as the name suggests, eggshell wares are very fine, unglazed, white or pale yellowish ware with a wafer-thin body and a smooth surface (Kennet 2004), dating to the 8th to 10th century (Priestman 2013). The second most common type found at the site, a total of 49 sherds, amounting to 27 per cent of the Early Islamic assemblage.

PROTO (Proto Julfar)

A hand-made, thick but very light earthen ware, with a light brown colour. It is very hard with numerous angular red inclusions, similar to JULFAR with a lightly burnished surface (Kennet 2004). This type of earthen ware is locally made and is hard to date. Its similarity to the early JULFAR ware may represent its earliest productions. Seventeen sherds were recovered of PROTO type from the site, equal to 8 per cent of the total assemblage.

WHT-GLZ (White Glazed Wares)

A type of glazed pottery with a plain white glazed surface. As with YBTIN (Plain Opaque White Glaze), this class has a fine, pale-yellow body with a thick glaze ranging from white to grey in colour. The glaze is very fragile and flakes easily off the surface of the sherds. This type of pottery is believed to originate from Iraq during the early 8th century CE (Kennet 2004). 8 per cent of the Early Islamic assemblage was WHT-GLZ.

GRAF (Sgraffiato)

This pottery class is made up of different sub-groups of sgraffiato pottery, as in this project we grouped all the Sgraffiato sherds under one main group labelled GRAF. Originating from Iran and dating from the late 10th to the 13th centuries CE (Priestman 2013), Sgraffiato describes the technique of decoration used for incising linear designs through a white slip before glazing. The fabric is red with a white or cream slip, making the incised decoration look darker (Kennet 2004). This type of pottery was also found in the Bayt Bin Ati excavations in Qattara, Al Ain (Power 2018). 8 per cent of the Early Islamic assemblage was Sgraffiato pottery.

SPLASH (Splashed Ware)

This class is characterised by thin-walled bowls with a pure, off-white to buff body, with glaze on the interior and exterior surfaces. As the name suggests, this class is characterised by areas of green, brown, and yellow splashes, with green being the predominant colour. This class has several sub-groups, but in this project all sherds that used the "splash" technique were characterised as SPLASH. It dates from the mid-9th to the 10th century.

Table 4: Summary overview of Early Islamic ceramic classes mentioned in text.

EGG

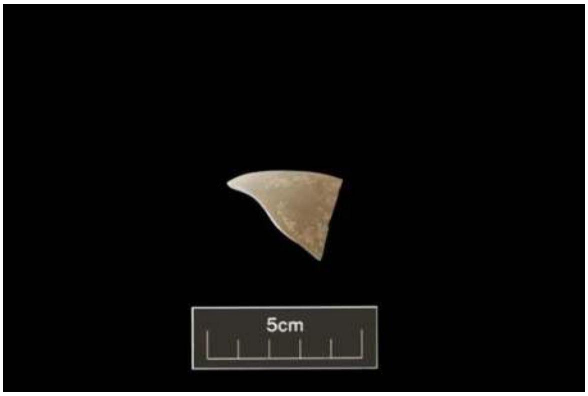
GRAF

PROTO

SPLASH

TURQ

WHT-GLZ



YUE

YUE (YUE Green Stoneware)

This type of ware has a fine-walled dense grey stoneware body and the glaze varies from olive-green to brown or yellow-brown, with some sherds having fine incised decoration (Kennet 2004: 61). Also found in the Hamasa Early Islamic settlement this type of pottery originates in China from the 9th and 11th century (Priestman 2013). Only one sherd of Yue Stoneware was recovered from the site. As with the Hamasa settlement, the majority of the pottery recovered was imported, showing that trade links with the Gulf and Indian Ocean were fundamentally important to Early Islamic Hamasa/Slemi (Power *et al.* 2015).

Ceramic Period 3: Late Islamic

59 sherds were identified as belonging to the Late Islamic period. The pottery classes are listed from the most to the least abundant.

Table 2: Late Islamic Types

Type	Quantity	Percentage
JULFAR	21	36%
WHITE	18	31%
BAHLA	8	14%
COFFEE	5	8%
RED	5	8%
MANGA	2	3%
Total	**59**	**100%**

JULFAR (Julfar ware)

A type of local unglazed pottery used to make cooking pots, bowls and jars. They are hand-made on a slow-wheel, with a brick-red body firing to black or grey and a coarse fracture. The fabric always contains red sub-angular inclusions (Kennet 2004: 70-76). Julfar ware is very important for Al Ain ceramic chronology; it originates from Ras Al Khaimah and was produced from the 12th century to the 20th century (Power 2015).

WHITE (White ware)

One of the most commonly encountered Late Islamic types found in Al Ain. A creamy white unglazed ware with a washed surface. The fabric is very soft, light and porous. Usually, the exterior surface is decorated with incisions or comb scratches or on rare occasions, molded decoration. After JULFAR, this type of pottery is the second most common type found in Al Ain generally and on this site during the Late Islamic period (Power 2015).


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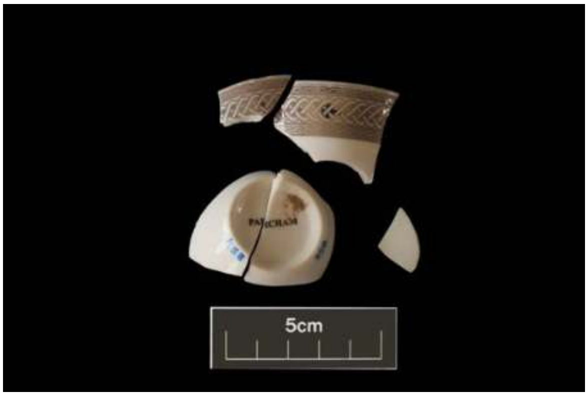
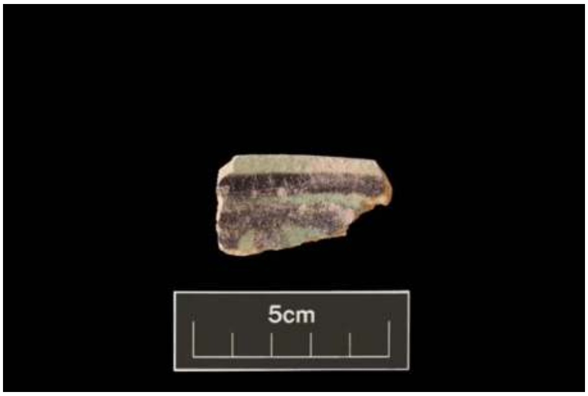
Table 5: Summary overview of Late Islamic ceramic classes mentioned in text.

BAHLA



COFFEE

JULFAR



MANGA

RED

WHITE

BAHLA (Bahla Ware)

This is very similar to the class type KHUNJ noted by Kennet. This class has a well-fired fabric that is similar to stoneware. The fabric has a dual shade of light grey and a pinky red appearing on the same sherd. The glaze is found on the interior and the exterior of the sherds and the colour ranges from light olive green to a dirty greenish brown. It has a distinctive speckled appearance caused by numerous dark-brown particles in the glaze (Kennet 2004: 54). In Al Ain, this type of pottery is commonly found in Late Islamic sequences (Power 2015).

Figure 4 (opposite): Distribution of pottery in Slemi, showing the concentration of Early Islamic on the east of the site. Early Islamic presented in green, Iron Age in yellow and Late Islamic in red.

COFFEE (Japanese/Chinese coffee cups)

A very common Late Islamic type in Al Ain, this class type is characterised by a white porcelain fabric with a clear glaze, decorated by red, blue or green painting. Dating to the Late Islamic 2 period (late 19th and early 20th centuries CE), this type of pottery was found in small quantities at the Bin Ati site, where it was recorded as JCCS (Japanese/Chinese coffee cups) (Power 2015).

RED (Red Ware)

Red ware has similar characteristics to that of the WHITE (white ware), with the exception of having a red-coloured fabric.

MANGA (Manganese painted wares)

This is called MGPAINT (Manganese Purple Underglazed-Painted) by Kennet. This pottery type is characterised by a soft, light yellow fabric with geometric and floral designs with a translucent turquoise glaze on the surface. This type of glazed pottery is the most common type of glazed pottery found in Al Ain, and similarly to Bahla is commonly found during the Late Islamic 1 period (Power 2015).

Discussion

Due to the greatest number of pottery sherds found at the site being Early Islamic, it is clear that this was the period of peak of occupation. The highest concentration of Early Islamic pottery was found at the eastern end of the site, closer to the UAE/Oman border and the Early Islamic settlement at Hamasa in Buraimi (Power 2018). The high number of surface ceramics in Hamasa suggests that the settlement was a large one, and finding surface ceramics in Slemi which relate to the assemblage in Hamasa further reiterates that point. As we move towards the west of Slemi, the Early Islamic pottery significantly reduced, and we find more Iron Age and Late Islamic pottery. This is found in areas where the site has been more disturbed by modern activities.

European refined wares such as Sponge printed (SPONGE) and Transferred Printed (TRANSFER) are from the 19th and 20th century (Late Islamic 2) and are usually very commonly found in Al Ain sites (Power 2015). The presence of S-shaped JULFAR and the lack of European refined white wares suggests a Late Islamic 1 presence (c. 1700 – 1820 CE). The relatively small number of ceramics found scattered across the surface is clearly dominated by 18th-century CE classes and types. This fits the observed pattern in Buraimi, i.e. abandonment post-1820, although these were not systematically collected or quantified in Buraimi (Power 2018).

The site of Slemi is geographically located within the vicinity of several Early Islamic sites discovered in Al Ain. To the south of Slemi is the site of

Oud Al Toubah, constituting of *aflaj*, a mosque and buildings. The Early Islamic *falaj* was found half filled with backfill and roofed with partly baked bricks. Ceramic dating and radiocarbon samples were used to date the *falaj*. Ceramics included Abbasid glazed potsherds from the 9th and 10th century CE, and two radiocarbon samples from the baked bricks dated to the same period. The prayer hall of the mosque and the courtyard both produced a few fragments of glazed pottery indicating that the mosque could be contemporary with the *falaj* or was built later (Al Tikriti 2003). The other buildings in the site also produced ceramics that strongly indicated Early Islamic occupation (Al Tikriti and Maguer-Gillon 2021).

To the east of Slemi, just beyond the UAE/Oman border, is the Early Islamic settlement of Hamasa, which was discovered in the Buraimi area in 2014. The recovery of significant amounts of surface ceramics at the site suggests that this settlement was much larger than has been documented so far. Evidence from surveys and excavations suggests this site dates back to the 8th century CE. The ceramic assemblage recovered from Hamasa includes clear Early Islamic types, with a variety of local and exotic wares, suggesting that the settlement was connected to a wider trade network (Power 2018). Its similarity to the Slemi site suggests that the limits of Hamasa extended this far to the west.

North of Slemi is the former Jimi School excavation, where an open brick-built water channel was discovered in 2011 (Sheehan *et al.* 2022). The bricks used were similar to the partly baked bricks from the *falaj* at Oud Al Toubah. A further section of this Early Islamic water channel was uncovered during the UAE/Oman border fence project in 2021 (Sheehan *et al.* 2023).

Also to the north, and approximately 2.5 km of Slemi, at the Bayt bin Ati in Qattara Oasis, evidence of an Early Islamic arish settlement was discovered during excavations accompanying the creation of the Qattara Arts Center in 2009. The finding of two discrete layers of post-holes, pit and ash spreads separated by windblown sand suggests temporary or semi-permanent occupation. The post-holes were probably used for tents or arish dwellings. Based on the ceramic assemblage recovered from this settlement it was possible to date the site to the 8th – 10th century CE (Power and Sheehan 2011).

Conclusion

In conclusion, this project shows that the Early Islamic period played a significant role in shaping the history of Al Ain. It also emphasises the importance of rescue archaeology in advance of development in preserving and interpreting the historic environment. The urgency of the work requires us to gather data in areas that otherwise would probably not get this level of attention. In addition, involving students in this kind of initiative is crucial for capacity building in archaeology in the Emirates. The pioneering efforts of HBL in this regard are worth noting (Al-ʿAyn Oases Mapping Project: al-Hīlī Oasis 2017, Al-ʿAyn Oases Mapping Project: Jīmī Oasis 2017, Al Ain Oases Mapping Project: Qaṭṭārah Oasis, past and present 2016) (Sheehan *et al.* 2018; Power *et al.* 2017; Power *et al.* 2016), as they demonstrate the potential for collaboration between the academic world and cultural institutions to advance our understanding of the region's rich history. By adopting these strategies, we can continue to preserve historic sites and create future generations of researchers.

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The UNESCO World Heritage Site of Al Ain
Management approaches

Abdulrahman Al Nuaimi

Abstract: The World Heritage List contains cultural and natural treasures from around the world with Outstanding Universal Value adopted by UNESCO, the United Nations Educational, Scientific and Cultural Organization.

The Cultural Sites of Al Ain were the first sites in the United Arab Emirates (UAE) to make UNESCO's World Heritage List in 2011. The inscription of the sites identified them as a serial cultural property with 17 components spread throughout the city of Al Ain in the UAE, which contains a group of archaeological sites, oases and cultural landscapes (UNESCO 2011).

This paper examines documents and policies provided by primary stakeholders in the management of the Cultural Sites of Al Ain, such as the Department of Culture and Tourism - Abu Dhabi (DCT), the Department of Municipalities and Transport (DMT) and the Environment Agency - Abu Dhabi (EAD), for a greater understanding of the impact of governments on heritage management in general and of the UAE Government's policy goals in particular.

There are important polices for the management of the overall site, such as the Site Management Plan, the Plan Al Ain 2030 document, the Urban Design Guidelines, the Development Regulations and Guidelines in the core and buffer zones of the Al Ain Cultural Sites, and various policies and documents in each agency about their areas of intervention, responsibilities and management.

However, the major tools for managing the site were approved recently by the Government in 2019: a steering committee and a joint technical committee in charge of the annual management, implementation plan and monitoring actions. Based on these tools, the author supports using the Historic Urban Landscape approach in the management of the Cultural Sites of Al Ain and developing the city with a unique, integrated identity.

Keywords: UNESCO, World Heritage, archaeology, Historic Urban Landscape, stakeholders, Plan Al Ain 2030, buffer zone, Urban Design Guidelines, NOC, Site Management Plan

Introduction

This paper explores how the management approaches of the main official stakeholders in the Government sector were developed after the inscription of the cultural sites of Al Ain in the United Arab Emirates (UAE) on the UNESCO World Heritage List.

‘Heritage’, as defined by Harrison, is a broad term that connects people with human history, but it is also an important tool in shaping identities on the local and national levels. Heritage reflects how humans influenced the landscape and built great monuments that are now valuable heritage sites (Harrison 2013: 5-42).

Smith suggested that heritage is a contemporary phenomenon that affects people’s lives on a global level (Smith 2006). In her article with Messenger, they argued that heritage is something alive, changing and continuing (Smith *et al.* 2010). Smith also considered heritage a process that concerns people and their collective memories but also cultural and social values and identities (Smith 2007).

In contrast, Blake demonstrated that international heritage laws and policies have been developing since 1945. Many actions were taken across the world with the support of the public and sometimes on behalf of them, such as the decision to safeguard the heritage site of the Abu Simbel Temples in Egypt in the 20th century (Blake 2015).

Laws on the local and international levels have been increasing in number since 1945 (Blake 2015); with the support of a global institution, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), this development has supported defining heritage as a global, living phenomenon.

Harrison referred to heritage as it was defined by UNESCO, that is, a transitional phenomenon crossing many geographical and political borders (Harrison 2013). Likewise, this paper supports heritage as an interdisciplinary concept, as Carman concluded, where heritage can be found in different places and in different categories (Carman 2002). Moreover, heritage makes people think not only about the past but also about where we are going in the future (Smith 2006).

This paper researches the management practices and approaches to the only World Heritage Site in the UAE (at least until the time of writing this research) listed on UNESCO’s World Heritage List, and it examines the governmental approaches to protect, safeguard, present and promote the Cultural Sites of Al Ain by studying the existing management and policy frameworks in the context of managing the city of Al Ain in the UAE.

What is a World Heritage Site?

UNESCO was founded in 1945, and one of its main aims was to ensure peace and security following the Second World War (Duedahl 2016). Since its creation, UNESCO has become a key global player in the fields of education, science and culture, as demonstrated in several cases, including the decision in 1959 by the Egyptian government to build the High Dam. This project would have threatened the Abu Simbel Temples, which are valuable heritage sites of the Ancient Egyptian civilisation (Duedahl 2016).

UNESCO launched an international campaign to safeguard the heritage of Nubia and the monuments of Abu Simbel. Its general aims were to draw international attention to the protection of these heritage sites and to heighten the importance of this local site internationally (Gfeller and Eisenberg 2016).

In 1955, UNESCO led an initiative to call for international experts in archaeology and conservation to remove monuments in the Nile River Valley affected by the development project. This intervention not only helped with the preservation of the cultural heritage but also allowed the documentation and study of the heritage of this area of Ancient Egypt (Gfeller and Eisenberg 2016).

The UNESCO initiative ended successfully by securing and transforming the Abu Simbel monuments, and this prepared the involved parties for the processing and adoption of the 1972 Convention Concerning the Protection of World Cultural and Natural Heritage (Leask 2006).

Archaeological sites become 'heritage' when past human activities can be traced, according to Renfrew and Bahn (2017), but ancient landscapes, such as Greek and Roman ones, are also heritage areas because of their cultural value (Greene and Moore 2010). In addition, Harrison and O'Donnell (2010) argued that natural sites are also heritage, particularly when they consist of special geological and biological remains and features.

Wiliest (Howard 2003) was more open to the broad meaning of 'landscape'. For instance, natural areas, coastal heritage, national parks and cultural sites are considered heritage categories, and immovable monuments, listed historic buildings, national battlefields, architecture and works of art, such as sculptures and even cave dwellings, can be considered heritage depending on their value and history (Howard 2003). Therefore, tangible heritage can be recognised in different forms; it can be ruins, listed buildings and monuments or cultural and natural landscapes (Howard 2003).

The 1972 Convention Concerning the Protection of World Cultural and Natural Heritage, sometimes known as the World Heritage Convention, was ratified by 20 countries at first; today, more than 180 state parties have joined it (Leask 2006).

As stated on UNESCO's official website, the mission of the convention is to protect, conserve and present the world's cultural and natural heritage based on its outstanding universal value and to avoid the loss of heritage around the world (UNESCO 2005e).

According to the convention, the World Heritage Committee oversees designating heritage sites around the world (Leask 2006). The state parties who ratified the convention can nominate their cultural sites, natural sites or mixed sites for inscription on the World Heritage List. There are four natural criteria and six cultural criteria for evaluating the sites proposed for inscription. Sites can be nominated based on one criterion or more, but they should present an exceptional form of outstanding universal value (Leask 2006).

The first World Heritage Sites were inscribed on the World Heritage List in 1978, totalling 12 at first. This number has increased over the years and reached 1,121 properties by 2020, representing 167 state parties. The number is divided between the main three categories of World Heritage Sites: 869 cultural sites, 213 natural sites and 39 mixed sites (UNESCO 2020d).

The World Heritage List recognises the tangible part of heritage by focusing on the idea of universal value (Smith and Akagawa 2009). For example, Italy's Piazza del Duomo, Pisa, was inscribed on the World Heritage List in 1987. This World Heritage Site is the location of famous monuments well known around the world, including the 'Leaning Tower'. This style of medieval architecture influenced art and monuments between the 11th and 14th centuries and met the criteria of influencing the development of architecture and monuments in the history of humanity. The integrity, authenticity and attributes of the site's monuments communicate an outstanding universal value that deserves to be protected for future generations (UNESCO 2007).

The second category is natural sites. The Dorset and East Devon Coast in the United Kingdom, for instance, was inscribed on the World Heritage List as a natural site in 2001 based on only one of the 10 criteria for inscription on the World Heritage List because of its outstanding universal value and significance in terms of geological and geomorphological features, representing 185 million years of the planet's history (UNESCO 2005c).

The mixed sites category is the least represented on the World Heritage List, with 39 sites in total (UNESCO 2020d). Mixed World Heritage Sites are where cultural and natural heritage can be found at the same site, such as Kakadu National Park in the Northern Territory of Australia, which was inscribed on the World Heritage List in 1981. The site has been inhabited for more than 50,000 years, and the Aboriginal people still live there. This site has a great variety of ecosystems; Kakadu National Park is one of the largest preserved national parks of its kind in the world (UNESCO 2005d). Archaeological sites and exceptional rock art are evidence of a long inhabitancy by the Aboriginal people, as are the unique ecosystem, rivers and ancient geology of the site, dating back more than two billion years of geological history and constituting outstanding universal value for such a site.

However, the World Heritage List's focus on the tangible aspects of cultural and natural heritage has been a topic of discussion in the literature. Lixinski (2019) believed that the World Heritage Convention had a narrow definition of heritage by focusing only on the protection of cultural and natural properties.

Joy (2019), in his article 'UNESCO is what?', argued that UNESCO's founding philosophy was to help spread peace on a global scale, but UNESCO, being based in Paris, is influenced by French intellectual traditions and enlightenment theory, which positions it as a Western institution.

Leask (2006) made similar conclusions, noting that the World Heritage List was biased and driven by the Western understanding of heritage, with built heritage and cultural sites being the most represented categories in the list and most inscribed sites located in the northern part of the world.

The interpretations of heritage on a global scale are potentially different, as many communities and nations exist with their own ways of considering the nature of heritage for them. In 2003, and because of different perceptions of heritage, UNESCO adopted an intangible culture convention to include such forms of heritage as rituals, festivals, expressions and social practices (UNESCO 2020c; Smith and Akagawa 2009).

However, in contrast, countries that nominate sites for inscription on the World Heritage List are given important opportunities to exchange with international conservation expertise, and tourism is expected to increase as a result of inscription on this prestigious list, which typically benefits the economy of the country (Leask 2006).

With more than 1,000 listed properties, the World Heritage List is receiving more nomination file requests from state parties. For example, at the World Heritage Committee meeting in St Petersburg in 2012, the Committee examined 49 nomination files, whereas similar past committee meetings had to consider only 15 (Brumann 2019).

Many countries clearly think that the designation of a World Heritage Site would not only ensure the best position for their sites in terms of protection, conservation and presentation but also that the designation will function as a strong marketing tool for the site on a global level, eventually feeding the local economy.

In fact, UNESCO does not force countries to list their heritages but rather advises state parties to become part of its global framework (West and Ansell 2010).

The state of heritage has obviously expanded, and the emblem of the UNESCO World Heritage Site has become a global brand indicating that the site has outstanding universal value and is a destination worthy of visiting. The globalised idea of the World Heritage List has thus become connected to both domestic and international tourism (Harrison 2013).

Designating a World Heritage Site and nominating the Cultural Sites of Al Ain to the World Heritage List

Only state parties who have ratified the World Heritage Convention in 1972 can submit a nomination request and proposal to nominate their heritage to UNESCO's World Heritage List (UNESCO 2005e).

Nominating a heritage site involves several steps before achieving inscription. The state party should have its own inventory of important cultural and natural heritage properties in its territory. This inventory forms the so-called 'Tentative List'. According to UNESCO protocol, no nomination to the World

Heritage List is accepted without it being in the state party's Tentative List. The state party should then select the property and start preparing the nomination file (UNESCO 2005e; Donnachie 2010).

The next stage is preparing and submitting the complete nomination file to the World Heritage Centre at UNESCO to be processed for evaluation (UNESCO 2005e). The evaluation is conducted by advisory bodies of the World Heritage Committee, and the evaluation depends on the type of nomination file. The International Council on Monuments and Sites (ICOMOS) makes its recommendation to the World Heritage Committee on cultural and mixed properties proposed for inscription by state parties, while the International Union for the Conservation of Nature (IUCN) evaluates the natural heritage properties proposed for inscription on the World Heritage List. Both the IUCN and ICOMOS are non-governmental organisations, but the right to evaluate nomination files is limited to these organisations (UNESCO 2005e; Donnachie 2010).

There are 10 existing selection criteria, six of which are for cultural sites and four for natural properties. The nominated sites must meet at least one of these criteria and prove their outstanding universal value. The World Heritage Committee meets once a year and formally decides on sites to be inscribed on the World Heritage List (UNESCO 2005e).

The UAE ratified the World Heritage Convention in 2001 (date confirmed by the Abu Dhabi Judicial Department), and the Cultural Sites of Al Ain have been on the UAE's Tentative List since 2008. The nomination of the Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and the Oases Areas) was officially submitted by the Abu Dhabi Authority for Culture and Heritage to the UAE Federal Government for nomination processing. The UNESCO World Heritage Centre received the complete nomination file in 2010.

The nomination was discussed during the 35th World Heritage Committee session held in Paris, and the site was inscribed on the World Heritage List on 27 June 2011. The Cultural Sites of Al Ain, at the time of writing, are still the only UAE heritage site on the UNESCO World Heritage List.

The World Heritage Committee decided to inscribe the Cultural Sites of Al Ain based on three criteria: (iii), (iv) and (v). The World Heritage Committee also adopted an updated version of the outstanding universal value statement of the site during the 36th session of the World Heritage Committee held in 2012 in St Petersburg based on the same three criteria (UNESCO 2012):

> *Criterion (iii): The Cultural Sites of Al Ain provide exceptional testimony to the development of successive prehistoric cultures in a desert region, from the Neolithic to the Iron Age. They establish the existence of sustainable human development, bearing testimony to the transition from hunter and nomad societies to the sedentary human occupation of the oasis, and the sustainability of this culture up until the present day.*

Criterion (iv): The tombs and architectural remains of the Hafit, Hili and Umm an-Nar cultures provide an exceptional illustration of human development in the Bronze Age and the Iron Age on the Arabian Peninsula. The aflaj system, introduced as early as the 1st millennium BCE, is testimony to the management of water in desert regions.

Criterion (v): The remains and landscapes of the Oases of Al Ain appear to testify, over a very long period of history, to the capacity of the civilizations in the northeast of the Arabian Peninsula, notably in the protohistoric periods, to develop a sustainable and positive relationship with the desert environment. They knew how to establish the sustainable exploitation of water resources to create a green and fertile environment.

The inscription of the Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and the Oases Areas) identifies them as a serial cultural property of 17 components in four main assemblages with 76 sub-components:

Jebel Hafit Assemblage

1. Jebel Hafit Desert Park
2. Jebel Hafit North Tombs
3. Al Ain Wildlife Park Tombs
4. West Ridge Hafit Tombs
5. Al Naqfa Ridge

Hili Assemblage

6. Hili Archaeological Park
7. Hili 2
8. Hili North Tomb A
9. Hili North Tomb B
10. Rumailah

Bidaa Bint Saud Assemblage

11. Bidaa Bint Saud

Oases Assemblage

12. Al Ain Oasis
13. Hili Oasis
14. Jimi Oasis
15. Qattara Oasis
16. Mutaredh Oasis
17. Muwaiji Oasis

Management of Heritage Sites

In the age of globalisation, when the local is becoming global, heritage faces challenges and is affected by communities and stakeholders engaging in the globalisation process (Biehl and Prescott 2014). Heritage is significant to all societies; however, the spread of modernisation is accelerating, so it is becoming more important to manage the problems facing the heritage sites now and in the future (UNESCO 2013).

The first step after listing a World Heritage Site is properly implementing the World Heritage Convention (Hall 2006). Monitoring a World Heritage Site involves the World Heritage Committee protecting its value (Makuvaza 2018). UNESCO considers outstanding universal value to transcend national boundaries, and it is important to be safeguarded and passed to future generations; therefore, a management planning process is an important requirement (Makuvaza 2018).

Heritage places are not isolated. Changes in their surroundings impact them, meaning that surroundings management is important, as is ensuring that the outstanding universal value of the site is maintained and well protected (UNESCO 2013).

Cities around the world face different situations; some are expanding, while others are in decline. Urban heritage, for instance, is not a separate part of this process. Urban planning has started to face new challenges in terms of heritage conservation (Bandarin and van Oers 2014). In this context, the main objective of World Heritage Site management is to protect value, for which management plans are good tools (Leask 2006).

A historic environment is a resource shared by all humanity. People value their environments, as they are the places of their heritage. Therefore, significant places of cultural and natural heritage should be managed and sustained, and decisions concerning change at such sites should be reasonable (English Heritage 2015). A World Heritage Site can also contribute to local economic development and sustainability and be a source of pride for the local community (Department for Communities and Local Governments 2009).

According to the operational guidelines for the implementation of World Heritage Conservation, the state party is responsible for long-term legislative and regulatory protection, management of the property inscribed on the World Heritage List and the sustainability of its outstanding universal value (UNESCO 2005e).

The state party should protect the property from the economic and social pressure that might impact its authenticity and integrity, including taking proper protection measures, such as providing an adequate buffer zone for the property that surrounds the nominated property as an additional layer of protection (UNESCO 2005e).

Moreover, the state parties should have a proper management plan or management system in place for each property nominated to UNESCO's World Heritage List (UNESCO 2005e).

Cleere, however, believed that the information about World Heritage Site management given in the operational guidelines of the World Heritage Convention was generalised because of the diversity of the nature and size of World Heritage properties. There are also differences between state parties in their legislative and administrative structures and differences in histories and traditions (Cleere 2010).

Furthermore, many international charters apply to the management and conservation of cultural sites, including natural and historic places. The Burra Charter, for example, provides practical guidance for the management and conservation of heritage places, and its first article defines conservation as the careful management of changes to retain cultural significance (ICOMOS 2013).

The main steps of applying ICOMOS and the Burra Charter are as follows:

- Assessing and understanding the cultural significance of the place;
- Developing a conservation management policy and strategy;
- Conducting the implementation plan.

Authenticity is a key concept in the field of heritage conservation and management. The World Heritage Convention concentrated on this concept by requiring the outstanding universal value of nominated sites to gain inscription on the World Heritage List. Later, there was a series of critiques of the method of understanding and interpreting the authenticity concept. The Nara Document on Authenticity from 1994 is a clear example of this debate (Poulios 2014).

There are many approaches to heritage conservation management; the values-based and living heritage approaches are well-known examples. The values-based approach has been developed since the 1980s, and it focuses on the values ascribed to heritage. It is preferred to postmodernism (Poulios 2014), and it is largely based on the Burra Charter. The World Heritage Committee endorsed this approach when considering the values of various stakeholders, communities, groups and indigenous cultures (Poulios 2014).

The living heritage approach is associated with communities living at heritage sites, which are changing and evolving. The difference is that the values-based approach is managed by professionals and focuses more on the sites, while the living heritage approach is mostly associated with local communities (Poulios 2014).

However, many World Heritage Sites are not just a single property. There is an urban heritage element, for example, that includes urban historic cities, such as Venice, Marrakech and many others, which are increasingly represented on the World Heritage List. In 2011, 300 World Heritage Sites

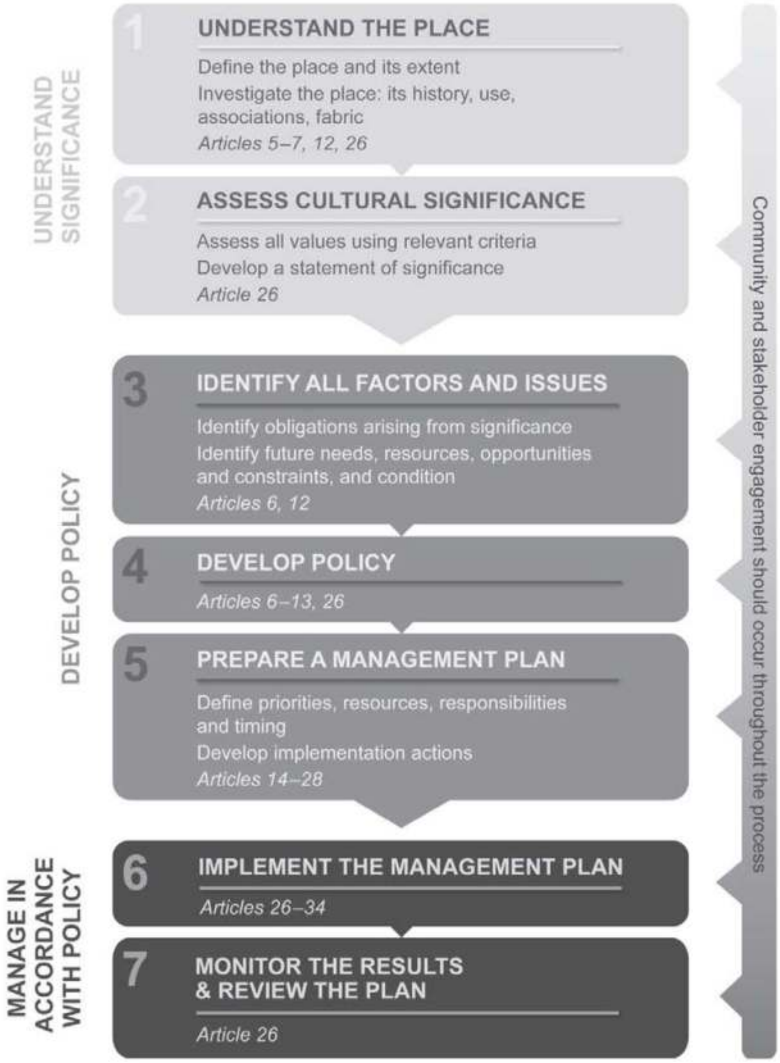

Figure 1: The Burra Charter process (ICOMOS 2013).

of 936 represented urban historic sites (Bandarin 2012). Ripp (2011) believed that World Heritage worked as an engine of urban development by protecting heritage with an integrated management system that balanced preservation and development.

Inhabited places and cities are dynamic; no historic city in the world has retained its original character (Bandarin and van Oers 2014). UNESCO adopted the recommendations concerning the historic urban landscape approach in November 2011 (UNESCO 2011).

However, this approach was not a new concept, nor did it constitute a separate category of heritage. It was in fact the development of heritage urban conservation with approaches to managing change and greater consideration of the social and economic function of cities (Bandarin 2012).

In 2015, UNESCO also adopted the policy of integration from a sustainable development perspective in the World Heritage Convention to support state parties in achieving the 2030 United Nations agenda and contributing to sustainable development in general (UNESCO 2015a).

Aims and methodology

The overarching aim of this research is to explore the implications of the inscription of the Cultural Sites of Al Ain on the World Heritage List in the Government sector. The research will explore the extent to which the approaches to the management of the Cultural Sites of Al Ain have been developed by official stakeholders in terms of policies and practices since their inscription.

Through data collection and analysis, this paper answers the following questions:

- What is the impact of the inscription of the World Heritage Site of Al Ain on local UAE authorities?
- What policies and actions have been adopted and implemented by the site's various stakeholders since the time of its inscription on the World Heritage List in 2011?

This case study uses a qualitative method to provide a holistic, comprehensive understanding of the topic through an in-depth investigation of the relationships among all the variables (Merriam 1988).

The author identified the main official stakeholders involved in the management of the Cultural Sites of Al Ain and studied their efforts during the years since the sites' inscription on the World Heritage List in terms of management approaches and policy development towards sustainable management practices.

The focus of the study will be a single case: the management approach to the World Heritage Site of the Cultural Sites of Al Ain. The work will focus on the following objectives:

- To examine the reasons for studying the approaches to managing the World Heritage Site of the Cultural Sites of Al Ain and to identify the stakeholders and challenges they face;
- To observe and assess the values-based and participatory approaches to planning and managing the World Heritage Site of Al Ain;
- To understand how management practices and policies have evolved since the sites' inscription on the World Heritage List;
- To conduct research on potential developments and enhancements of the components of the Cultural Sites of Al Ain;
- To conduct research on all the efforts of various stakeholders to improve the management practices of the World Heritage Site by requesting written policies from the stakeholders;
- To collect the available data related to the research question from the stakeholders and then analyse and identify existing management policies and practices;
- To discuss the different approaches of the stakeholders, analyse the current situation and identify a practical way forward;

- To summarise the results of the research and conclude with recommendations for future research.

Content analysis of the data — gathered by the author from websites, leaflets, policy and strategy documents produced by the stakeholders, information gathered from conversations with staff, data from previous property and heritage site visits and academic sources, such as journal and newspapers articles — will lead to a greater understanding of the practical day-to-day management practices of the stakeholders in this case study.

In fact, the research methods explained above offer multiple ways of understanding and assessing the management approaches of the stakeholders, and they will bring us to a holistic imagination of the collective efforts towards the management of the World Heritage Site of Al Ain.

Another issue requiring consideration is that the data provided by the stakeholders are huge in some cases, so the study will simply highlight main themes and principles to help answer the research questions. For example, there are Urban Design Guideline policy documents developed for each component of the Cultural Sites of Al Ain with all relevant documents that cover everything; these documents are larger than the size of this report, so the research will give examples of this approach to management rather than studying every Urban Design Guideline for the Cultural Sites of Al Ain World Heritage Site components and its surroundings in detail.

Finally, this report will assess mostly qualitative data, such as the policies and strategies of governmental institutions and local authorities. The following section will discuss the findings and analyse the data.

Case Study: Inscribing the Cultural Sites of Al Ain on the World Heritage List

State parties can have many expectations when listing a World Heritage Site. For example, they are expected to enjoy more international and local tourism at World Heritage Sites after their designation on the World Heritage List. Local governments, as a result, care more for the property and protecting the heritage (Hall 2006).

However, being on the World Heritage List has other implications that can be unpleasant for the state party, one of which is updating and changing regulations, management structures and policies to enable local authorities to better implement the World Heritage Convention. The implementation of the World Heritage Convention is an ongoing process. Inscribing a World Heritage Site is not the end but merely the beginning of planning and implementation.

The implications of inscribing a property on the World Heritage List are not limited to the property itself but affect its surroundings as well (Hall 2006).

Planning policies were changed in England, for example, in reaction to inappropriate developments around World Heritage Sites in 1994 (Hall 2006). Therefore, development proposals affecting the outstanding universal value of the site will need a formal environmental impact assessment to ensure heritage protection for future generations. Furthermore, local planning authorities should work closely with World Heritage Site managers to ensure the physical conservation of the sites and plan clear policies for managing the work (Hall 2006).

In the case of the Cultural Sites of Al Ain, the nomination file was discussed at the 35th World Heritage Committee session in Paris in June 2011 (UNESCO Decision 35 COM 8B.B4). The nomination proposed the inscription of the Cultural Sites of Al Ain as a serial property with 17 components and 74 sub-components.

Cultural Sites of Al Ain

The Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and the Oases Areas) were nominated and inscribed on the World Heritage List as a serial cultural property. The 17 components of the site are located in the city of Al Ain, which is part of Abu Dhabi emirate in the UAE.

The Cultural Sites of Al Ain have been grouped into four assemblages based on their geographical locations, periods, and characteristics. There are sub-components for each group as well.

Hafit Assemblage

Jebal Hafit is a mountain that formed around 25 million years ago. The natural heritage of Jebal Hafit, including its diverse flora and fauna, is exceptional. It is the only mountain in Al Ain city. People lived close to this mountain and practised funerary traditions around 3000 BC, with hundreds of tombs discovered from this period dating between 3200 and 2700 BC. The site is well surveyed and excavated, and it became known internationally as a type-site for the Hafit period (DCT 2019a).

Many discoveries were made during the excavations, such as important pottery from Mesopotamia in the tombs, indicating an active trading relationship during that period. Beads, copper and bronze items were discovered, many of which are curated in the Al Ain Museum.

Hili Assemblage

The Hili area contains one of the most important Bronze Age archaeological sites in the UAE and the region. The settlements and tombs dating back to this period have revealed thousands of artefacts that reflect how the ancient society there lived. The Hili Assemblage, with the other components of the Cultural Sites of Al Ain, is an exceptional testimony to the development of

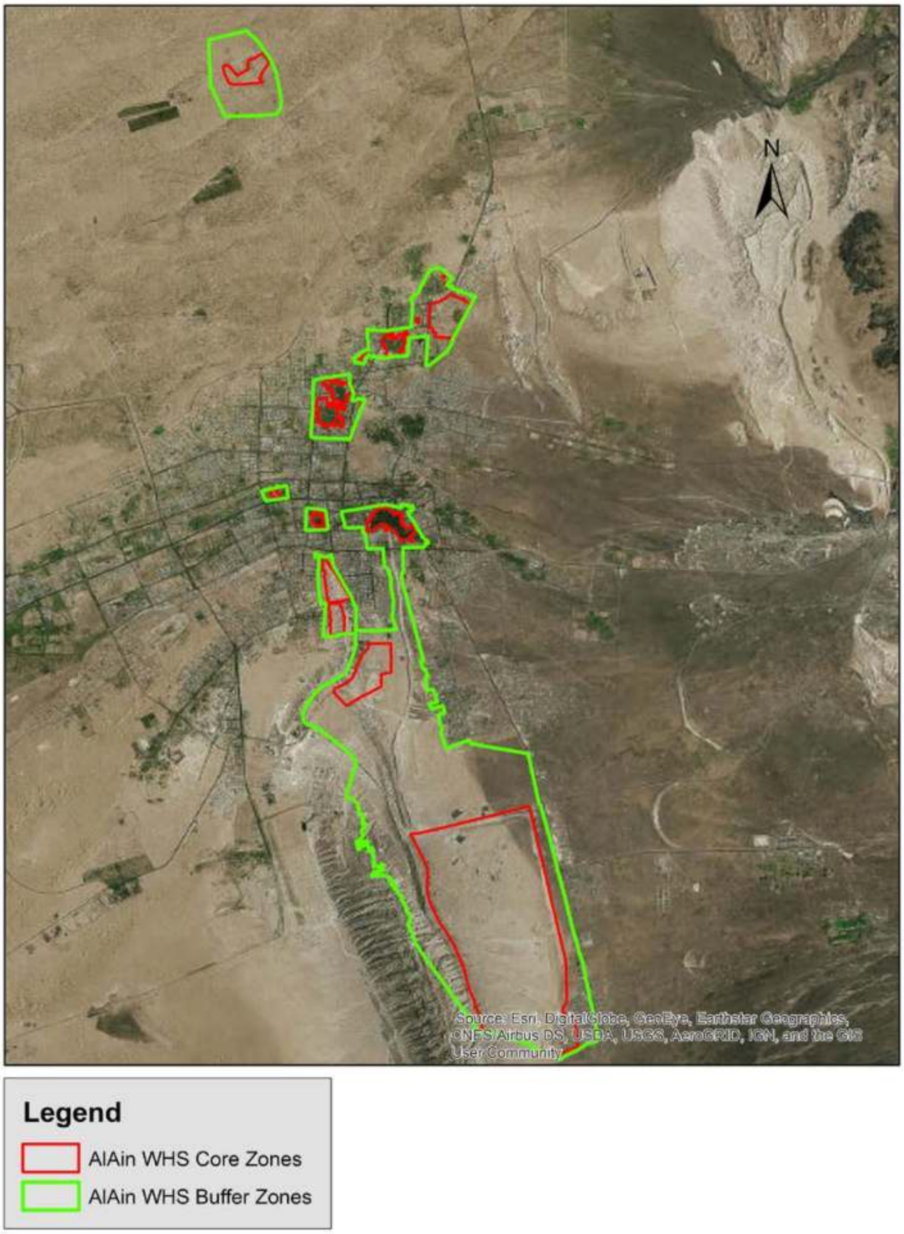

Figure 2: The Cultural Sites of Al Ain (DCT Abu Dhabi).

The invention of the *falaj* irrigation system in the Iron Age started at Hili around 3000 BC, resulting in an expansion in agriculture and settlements in the Iron Age by allowing the emergence of oases in the harsh desert environment (Al Tikriti 2011).

Bidaa Bint Saud Assemblage

Bidaa Bint Saud is part of the Cultural Sites of Al Ain, with important archaeological sites dating back to the Bronze and Iron Ages. The site is located to the north of the Hili Assemblage. Excavations there revealed skeletons in tombs with stone vessels, beads, bronze arrowheads, daggers, blades and pottery as well as an Iron Age building close to a *falaj* from the same period.

The tombs' architectural remains provide an exceptional illustration of human development in the Bronze Age and the Iron Age on the Arabian

Peninsula, and the *aflaj* system, introduced as early as the 1st millennium BCE, is a testimony to the management of water in desert regions, which is the main attribute of the outstanding universal value of the Cultural Sites of Al Ain (DCT 2018-2019).

Oases Assemblage

The six oases are the fourth assemblage of the World Heritage Site of Al Ain: Al Ain Oasis, Hili Oasis, Al Jimi Oasis, Al Qattara Oasis, Al Mutaredh Oasis and Al Muwaiji Oasis (Power and Sheehan 2018).

The oases of Al Ain are important components of the cultural landscape of the city, where the settlements developed over time. There are ecological and intangible values associated with the oases, such as palm trees and date harvesting, which still survive as important activities associated with this assemblage.

There are important archaeological remains and historical buildings in the oases, such as forts, mosques and other heritage features. In fact, most Al Ain Historic buildings are located in or around the oases, where current conservation and documentation projects are happening (Power and Sheehan 2012).

In 2012, at its 36th session in St Petersburg, the World Heritage Committee adopted a new statement of outstanding universal value (UNESCO Decision 36 COM 8B.65). One year prior, at the session of inscription in Paris 2011, it issued the following specific recommendations:

> *a) Clarify the situation regarding public ownership within the property, for the parks and the tombs outside the parks in particular, as well as for the private ownership of buildings and land within the property;*
>
> *b) Pass the new law for the protection, conservation, management and promotion of cultural heritage and confirm the drafting of a law on the protection of water resources for the traditional aflaj system;*
>
> *c) Pursue research to clarify the issues of authenticity and integrity of the restorations of the protohistoric tombs and mud brick constructions performed prior to the 2000s;*
>
> *d) Extend the systematic monitoring to include tourism;*
>
> *e) Improve the distinction between the archaeological spaces and leisure spaces in the Hili Archaeological Park;*
>
> *f) Mark out the boundaries of the property sites and buffer zones in open areas.*

However, at the time of writing this research, only point (b) has been implemented by enacting Law No 4 of 2016 regarding the Cultural Heritage of the Emirate of Abu Dhabi and its by-laws in 2019.

Despite the state's pride in the global fame of UNESCO's recognition of the Cultural Sites of Al Ain, and despite the appreciation of the designation on the World Heritage List, the size of the surrounding area of protection quickly became a burden on the local authorities and population.

One reason for these challenges is that coordination between the main stakeholders did not have enough time. The issue of nominating many archaeological sites and oases inside the city was not discussed clearly due to the lack of time during the file preparation, and the local stakeholders did not reach an agreement on the proposed nomination file prior to sending it to the World Heritage Centre. The practical approaches of managing the buffer zone and issues related to the surroundings of the cultural heritage properties were not finalised at that stage.

Therefore, local authorities in the city of Al Ain, landowners and residences complained about the restrictions imposed on them after inscribing the Cultural Sites of Al Ain on the World Heritage List.

The identified buffer zone in the nomination file was huge. The surrounding protection area of the 17 components of the Cultural Sites of Al Ain covers 128 square kilometres, which is about one-sixth of the urban area of the contemporary city of Al Ain. The authorities and residents considered the size of the buffer zone and the restrictions imposed on construction and other activities in this area as obstacles that delayed the development of the city.

This information gave rise to new challenges for the governmental stakeholders in the management of the World Heritage Site of Al Ain and how listing the Cultural Sites of Al Ain on the World Heritage List affected daily life in the city. The data below illustrate how the local authorities responded to the challenges and what policies they adopted, which illuminates the Government's goals through its policies and actions.

Who are the stakeholders?

Many stakeholders participated in the management of the Cultural Sites of Al Ain. DCT Abu Dhabi was a main stakeholder in regulating, promoting and developing cultural and natural heritage as a global destination (DCT 2020).

DCT Abu Dhabi's Culture Sector and the Historic Environment Team currently oversee the protection, presentation and preservation of cultural and natural heritage, including the Cultural Sites of Al Ain. Several specialised sections exist in the Historic Environment Department to achieve this mission. For example, the Archaeology and Palaeontology section oversees archaeological surveys, excavations and documentation, and a conservation section supervises the conservation of the historic environment of Abu Dhabi, including the Cultural Sites of Al Ain, whereas the Historic Buildings and Landscapes section manages historic buildings and cultural landscapes (DCT 2018-2019).

A new section in the Historic Environment Department was created after the inscription of the Cultural Sites of Al Ain on the World Heritage List: the World Heritage Sites Management Section, which is now responsible for the implementation of the World Heritage Convention and monitoring activities related to the Cultural Sites of Al Ain or any future inscribed World Heritage Site in the emirate.

The Department of Municipalities and Transport (DMT) is another main stakeholder in the management of the Cultural Sites of Al Ain. Responsible for managing the urban planning and transport sector, the department was established in 2019 and supports the growth and urban planning of the emirate of Abu Dhabi, including the Al Ain region, where the Cultural Sites of Al Ain are (DMT 2020).

DMT is in charge of new urban-planning strategies, master plans, policies and regulations and works closely with the local municipalities, including Al Ain Municipality, which has the Town Planning, Aflaj and Oases Departments. These departments play important roles in the management of the Oases Assemblage of the Cultural Sites of Al Ain. For instance, the Aflaj Section in Al Ain Municipality handles patrolling, water management inside the oases and monitoring the palm tree services, such as garbage removal and dealing daily with the individual plot owners. In addition, the Town Planning Sector in Al Ain Municipality oversees the city planning of Al Ain in coordination with DMT (Al Ain Municipality 2020).

The Environment Agency – Abu Dhabi (EAD) is another stakeholder in the Government that safeguards Abu Dhabi's natural resources and regulates and enforces the local environmental laws. The agency manages the desert landscape of the Jebel Hafit area, which is also a component of the Cultural Sites of Al Ain on the World Heritage List as well as a part of the wider naturally preserved National Park area announced by the Government in 2017 (EAD 2020). The area of Hafit National Park is rich in flora, fauna and biodiversity. The Environment Agency also protects underground water that supplies the Oases Assemblage (EAD 2020).

More key stakeholders, the General Secretariat of the Executive Council and the Abu Dhabi Executive Office, are in charge of developing and monitoring general policies and overarching strategies for local governmental entities. These administrative bodies support the Executive Council to make strategic decisions (Abu Dhabi Executive Office 2020).

Many more stakeholders in the Government sector are involved, such as the General Authority of Islamic Affairs and Endowments, Police, Civil Defence, Abu Dhabi General Services (Musanada) and others.

Of course, the local society is a key stakeholder. The 17 components of the Cultural Sites of Al Ain are in an active urban area of the city where many families live. The oasis plots are owned by various local owners and families, so they are one of the most important groups of stakeholders. Coordination and relations with plot owners are channelled through the Aflaj Section in the Al Ain Municipality.

Another large group of stakeholders are the local owners and residents in the buffer zone of the Cultural Sites of Al Ain, representing all parts and levels of society and mainly in contact with the Al Ain Municipality and, closer to the World Heritage Sites themselves, DCT Abu Dhabi.

Universities and schools are permanent stakeholders that visit the World Heritage Sites of Al Ain regularly to conduct research, educational activities and a variety of initiatives. The Department of Education and Knowledge works closely with DCT Abu Dhabi on developing joint educational programmes related to the Cultural Sites of Al Ain.

Businesses, tour operators, visitors and tourists also interact with the Cultural Sites of Al Ain. Statistics provided by the Cultural Sites Management Department show increasing numbers of visitors, which is perhaps a reason for the rising number of sites accessible by the public in recent years.

All this shows the complexity of managing a serial property on the World Heritage List with 17 components and many stakeholders with diverse perspectives and interests related to the same sites and its surroundings in a growing city.

The Tourism and Culture Authority (TCA) started working in 2014 to limit the impact of the surrounding protection buffer zone on the city of Al Ain. In the nomination file of the Cultural Sites of Al Ain, a large buffer zone was identified to protect the 17 components of the property and to preserve the functional and the visual link between the protected heritage areas and the surrounding urban and agriculture landscape and preserve the viewing corridor and what remains of the traditional city skyline.

For this reason, TCA, which became DCT Abu Dhabi in 2018, studied and formulated a new name for the buffer zone in 2014 by dividing it into subzones that provided different levels of protection for protecting the heritage components and the sub-components of the property.

Development regulations and guidelines for the core and buffer zones for the Cultural Sites of Al Ain by the Department of Culture and Tourism

A duty and responsibility of DCT Abu Dhabi was to define protection areas and site boundaries in accordance with the operational guidelines of the World Heritage Convention. In response to the recommendations of the World Heritage Convention, 'reversing the current trend' (i.e. everything around the listed property from a negative development) was a prerequisite for protecting any future intervention (DCT 2019b).

The World Heritage Committee supports the process of listing sites with their positive and negative statuses, whether those situations are related to conservation measures, violations or other problems related to site safety. However, the adoption of the World Heritage Committee for newly listed sites does not imply its acceptance or approval of existing threats to sites. On the contrary, the World Heritage Convention is clear about holding the state responsible for stopping the deterioration of the site, addressing activities that harm it and changing the course of current unwanted trends, including violations. This obligation does not need to be fulfilled immediately but should be implemented within a reasonable period (UNESCO 2005; DCT 2019b).

In 2019, DCT updated the initial document prepared in 2014 by TCA, which was about the guidelines for construction activities in protected historical areas and surrounding protection areas.

The new document, 'Development Regulations and Guidelines for the Core and Buffer Zones in the Cultural Sites of Al Ain World Heritage Site', was written as a formal policy where the new division of the buffer zone fulfils the specifications and applies the recommended approaches and practices. The reason behind the division of the buffer zone of the 17 components of the Al Ain Cultural Sites was precisely this need for special protection requirements.

The boundaries of the buffer zone were drawn primarily to save the largest possible area by using the city grid and cover an area of potential antiquities that would contribute to the site's outstanding universal value. According to officials at DCT Abu Dhabi, the buffer zone area around the World Heritage property was discussed with Al Ain Municipality and the Abu Dhabi Urban Planning Council at the time of the nomination in 2011. However, this matter did not have enough discussion, and many disputes occurred with the city's authorities after the listing on UNESCO's World Heritage List. Therefore, reforms have become imperative and, most importantly, have raised awareness of problems.[1]

DCT responded to the matter and delineated the boundaries of the buffer zone by creating three sub-protection zones to address the concerns of Al Ain City Municipality, local authorities and society and to provide clear, specific recommendations for the interventions rather than overarching guidelines. New names were proposed to divide the buffer zone into three sub-zones to add more protection to the main property. The sub-buffer zones were arranged according to their proximity to the main protected areas: Buffer Zone (A) is the closest to the listed property, followed by Buffer Zone (B) and Buffer Zone (C).

This policy aimed to redefine the relationships of the conservation areas with the surrounding buffer zones in terms of housing, utility services and infrastructure in addition to preserving the cultural and aesthetic value of the heritage components and archaeological and architectural characteristics.

[1] Phone conversation with S. Hadi, 25/07/2020.

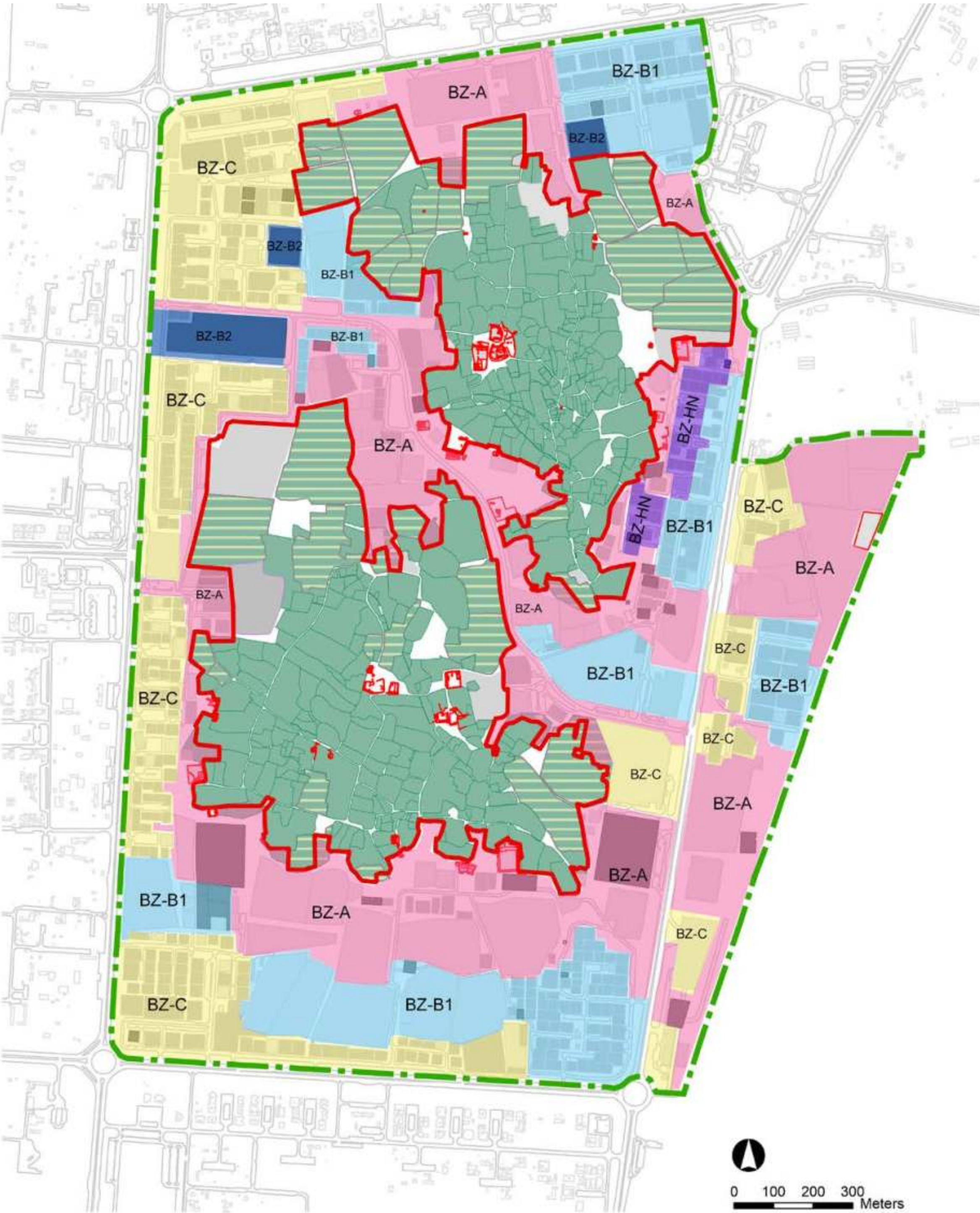

Figure 3: An example of the division of the buffer zone of the Al Ain Cultural Sites BZ-A, BZ-B and BZ-C (DCT Abu Dhabi).

Buffer Zone (A) surrounds the core World Heritage areas and includes the most sensitive areas in relation to them and their sub-components. Buffer Zone (A) areas do not contain many buildings, and it is characterised by its proximity to the main World Heritage Site components.

The measures taken in these areas are monitoring activities, which cover all aspects and arrangements that might affect the property's authenticity and integrity. Moreover, any existing functions that are inconsistent with the World

Heritage property should be reviewed and changed over time (DCT 2019b). The chief roles and activities of DCT Abu Dhabi in Buffer Zone (A) are to monitor all changes and establish guidelines for urban design and to propose suitable projects.

Second, Buffer Zone (B) is the area surrounding Buffer Zone (A) and contains some protected components. These areas have gradually been affected by inconsistent urban developments that might affect the protection of the World Heritage Site of Al Ain.

Buffer Zone (B) is divided into two protection sub-zones with different functions:

1. Buffer Zone (B), B1: Where interventions to change buildings and develop housing are permitted on a small scale while subject to the development guidelines;
2. Buffer Zone (B), B2: Where large-scale development and interventions related to developing open spaces and dividing streets are subject to the Urban Design Guidelines issued by DCT Abu Dhabi.

Depending on the sensitivity of the area and the types of permissible interventions, monitoring covers all aspects in this buffer zone, and DCT Abu Dhabi establishes building guidelines, sets standards for Urban Design Guidelines and monitors large-scale projects.

Buffer Zone (C) is the area least connected to the main property. It includes urban areas, a network of streets and already developed urban areas without expectations of relevant change occurring. Al Ain Municipality development regulations and Abu Dhabi Urban Planning laws apply in Buffer Zone (C). All current uses are authorised and approved. However, projects conducted on an area of more than 3,000 square metres should be reviewed and approved by DCT Abu Dhabi (DCT 2019b).

What follows is a summary of the Development Regulations and Guidelines for the Core and Buffer Zones for the Cultural Sites of Al Ain:

In Buffer Zone (A):

- New constructions on vacant plots are not permitted;
- In the case of construction approval on plots in Buffer Zone (A), demolition works are allowed without reconstruction. In the Development Regulations and Guidelines (DRGs), only restorations, repairs and renewals of existing buildings are allowed after receiving official approval, unless specified in the Urban Design Guidelines (UDGs).

In Buffer Zone (B):
'Strategic areas' in Buffer Zone (B), B2, are defined by the Urban Design Guidelines. These areas are subject to further detailed planning.

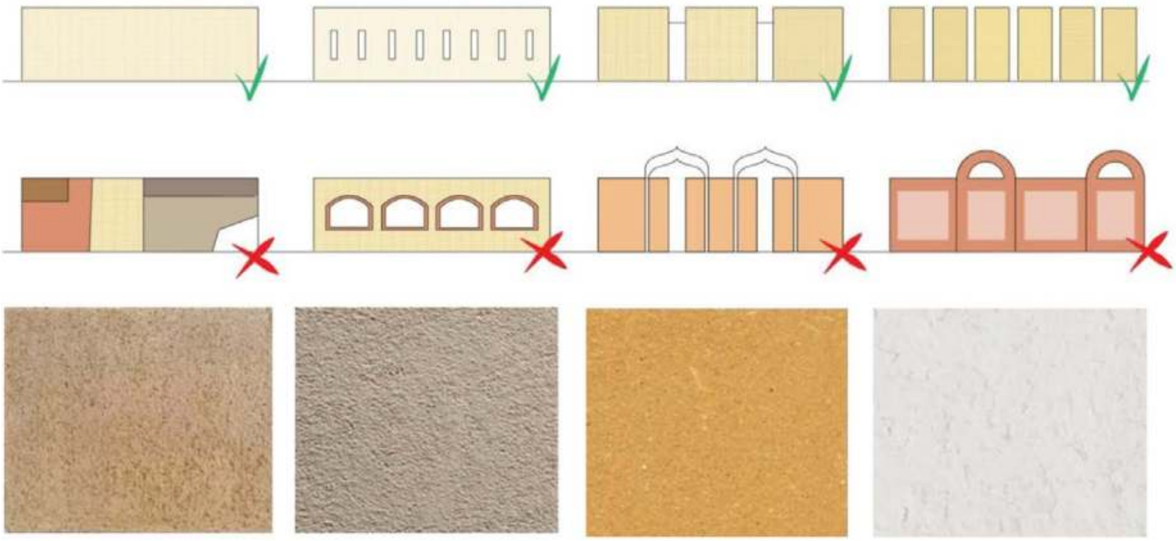

Figure 4: Examples from the guidelines in the document (DCT 2019b).

Figure 5 (opposite): Results of Al Ain Oasis buffer zone Urban Design Guidelines (DCT 2017a).

In Buffer Zone (C):
The development regulations of Al Ain Municipality for construction are in effect.

The application of the building rules and their content are as follows:

- Investment land;
- Residential units;
- Agricultural land.

These rules contain specifications related to the following:

- Building setbacks;
- Building heights;
- Plot coverings;
- Architectural features: style, facades and openings, size, materials, colours, walls, exterior, lighting and excavations.

The Urban Design Guidelines policy for the buffer zone of the Al Ain Cultural Sites

The buffer zone of the World Heritage Property of Al Ain gradually became problematic for all concerned agencies and institutional stakeholders. The Urban Design Guidelines policy provided new approaches and solutions to resolve the encroachment issues in the World Heritage buffer zone of the Al Ain Cultural Sites.

The Urban Design Guidelines policy contributed to halting the uncontrolled encroachment of the World Heritage Site by new construction and provided a new approach. The Urban Design Guidelines policy also aimed to establish the required regulations, policies and guidelines for the protection and valorisation of the outstanding universal value of the World Heritage

Figure 6: The Urban Design Guidelines reconnect the oasis component of the Al Ain Cultural Sites to the city and even extend the oasis effect while enhancing the heritage conservation and achieving sustainable urban development (DCT 2017a).

property for all main official stakeholders while ensuring a controlled, qualified city expansion according to the vision of the Plan Al Ain 2030, which was developed since 2007 as a general plan for the city of Al Ain (DCT 2017a).

The main objective of the Urban Design Guidelines is to combine and integrate conservation and development interventions based on the accurate identification and assessment of all heritage features, such as archaeological sites and cultural landscapes, to define conservation needs and priorities. In addition, development interventions are based on a comprehensive analysis of existing urban planning tools and projects to evaluate development potential and opportunities. This policy also provides a realistic evaluation of the possible conflicts between conservation needs and development opportunities.

For example, the Urban Design Guidelines of the buffer zone area of the Al Ain Oasis were drafted by an international non-profit consultant company specialising in heritage urban planning. Policy management was led by DCT Abu Dhabi in close coordination with DMT and Al Ain Municipality.

The drafting of the Urban Design Guidelines policy included the following:

1. Field surveys and preparation of the field survey report;
2. Urban planning document and data collection followed by an assessment report on planned developments and project proposals;
3. Strategy report outlining the conservation potentials and development opportunities;
4. Zoning and regulation report;
5. Final report and annexes.

The final report and annexes include:

1. The final report;
2. A map of the revised buffer zones and regulations;
3. The urban design layout, composed of the general layout, proposed circulation, proposed urban building intervention and proposal of strategic project areas;
4. Development code regulation (DCR);
5. Architecture guidelines;
6. Landscape and public realm guidelines;
7. Guidelines for visual impact.

The design provided a solution for the height of the buildings and created a visual relationship with the ancient oasis. Moreover, the general layout respects and emphasises the present urban openness.

Plan Al Ain 2030: Urban Planning Policy

Plan Al Ain 2030 was designed by the Abu Dhabi Urban Planning Council in 2007 to respond to present and future developments needs by introducing a set of policies and guidelines for future urban planning.

Interestingly, the urban structure plan of Plan Al Ain 2030 studied the cultural and environmental identity of the city of Al Ain as a starting point for developing the conceptual document. In fact, the plan celebrated the history of Al Ain and its environment, such as the desert landscape, Jebel Hafit mountain and the oases around the city. Plan Al Ain 2030 respects the low-scale urban form of the city, where the building height is limited to G+4 (ground + four floors building in height). The plan emphasises that Al Ain city is an authentic Arabic city where a desert, oases and a mountain exist in a single place with a rich heritage next to a 21st-century city.

The initial Plan Al Ain 2030 document recommended that the Al Ain Oases be treated to protect them and connect them to the city and then expand the city to be known as the 'city of oases', the cultural homeland of the country. The plan's policies covered many aspects, such as land use, open spaces, urban design, infrastructure and development.

Currently, DMT is responsible for supporting growth and urban development in the Abu Dhabi emirate and in the Al Ain region. The last version of Plan Al Ain 2030 was produced in 2009, so the existing plan was produced before the inscription of the Cultural Sites of Al Ain on the World Heritage List. In addition, the Development Regulations and Guidelines for the Core and Buffer Zones and Urban Design Guidelines of the World Heritage property were developed later and are not reflected in Plan Al Ain 2030. The Site Management Plan of the Cultural Sites of Al Ain 2019 recommends updating Plan Al Ain 2030 to include events since the sites' inscription on the World Heritage List in 2011.

According to the updated information provided by DMT officials, updating Plan Al Ain 2030 is ongoing at the time of writing this research. The purpose of the revision is to develop three framework plans for land use, environment and cultural heritage, respectively. The basic principles are the protection of the natural environment and the definition of the city as an oasis while maintaining the city's high quality of life and embodying its role as the source of the emirate, strengthening its Arab values and culture. Further economic development will be based on these principles. Moreover, the land use plan will consider the city's obligations under the World Heritage Convention.[2]

Electronic Non-Objection Certificate Programme for Utilities and Infrastructure

The Electronic Non-Objection Certificate (NOC) Programme for Utilities and Infrastructure was officially launched by the Abu Dhabi Government in 2014. The Executive Council of Abu Dhabi supervised this ambitious initiative to ensure that all new construction and building activities were well reviewed by all the relevant parties in the local Government at the same time. This programme was meant to enable all entities to apply the relevant policies at the same time and to reach a final say on the overall approval for each application quickly (Zawya 2013).

The adoption of this programme is reflected positively in managing the change within the boundaries of the World Heritage property of the Cultural Sites of Al Ain. Nowadays, relevant staff in DCT Abu Dhabi and DMT can conduct detailed reviews of each development application within the limits of the World Heritage Site and its surrounding buffer zones. These specialised teams provide summary reports and recommended actions for each case. The introduction of this online NOC programme helped relevant parties strictly monitor development around the World Heritage properties, but it was also a tool to implement existing related policies and guidelines.

A preliminary cultural review (PCR) is also part of the Environmental Impact Assessment (EIA) study and applies to development and construction activities.

The site-management plan for the Cultural Sites of Al Ain

The city of Al Ain was included in the UNESCO World Heritage List because of the importance of its exceptional cultural resources. Nevertheless, certain risks and challenges must be addressed to preserve the authenticity and integrity of these antiquities. Therefore, a site-management plan was developed from 2018–2019 to address the potential risks and challenges in an action plan for better management of the World Heritage Site of Al Ain.

[2] Phone conversation with Humaid Al Kaabi, DMT, in 2020.

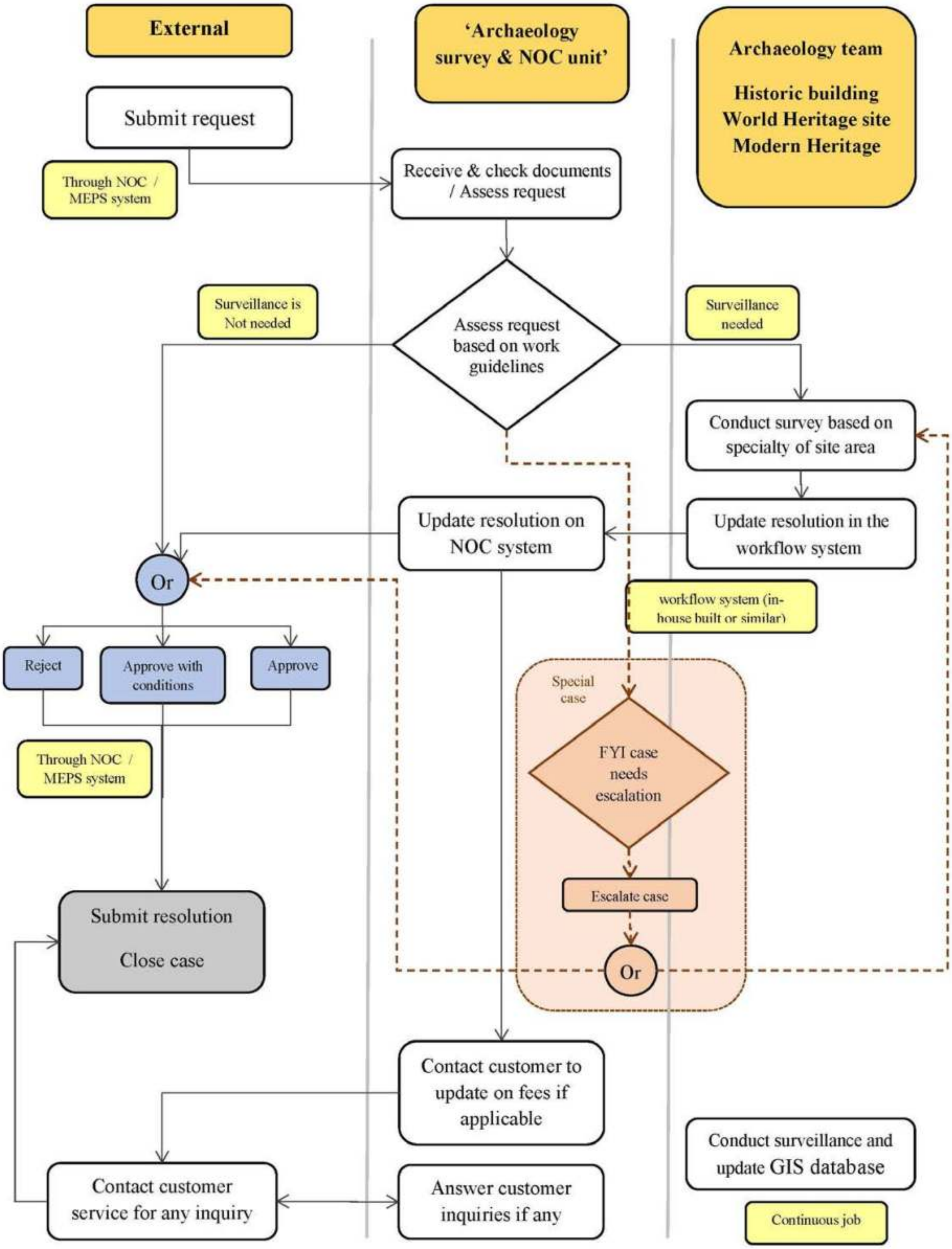

Figure 7: Workflow chart of the NOC unit process (NOC's Team).

One risk, for example, is the loss of the territorial framework that enabled the formation of the city of Al Ain and its nature as an oases city. In addition, isolating the archaeological and historical sites from their natural and cultural context is an emerging issue, with risks of losing the physical nature of oases and their historical elements.

The main purpose of the site-management plan is to preserve the outstanding universal value of the Cultural Sites of Al Ain and support the sustainable development of the city by improving the population's quality of life and creating economic opportunities.

In its inclusion of the city of Al Ain on the World Heritage List, UNESCO relied on the interpretation of the site's elements as separate archaeological sites, as mentioned in the inscription criteria (iii), (iv) and (v). Accordingly, each component was reviewed separately from its historical and contemporary context. As a result, these places and buildings are treated as independent monuments, which has had consequences, such as the lack of understanding of the origin and significance of ancient human settlement in the area such as the ancient archaeological sites in the city.

Clearly, the concerned authorities lack sufficient interest in integrating these monuments into the actual life of the city, such as the intangible heritage at the historical roots of the city.

The vision of the site-management plan addresses the entire site, while policies and procedures provide a framework for the management across a range of activities planned within the site. To facilitate the incorporation of policies and procedures, the following were used:

- A legal and institutional framework (including administrative structure and capacity-building);
- Documentation, inventory and evaluation;
- Adequate use, including adaptive reuse;
- Conservation;
- Maintenance and monitoring;
- Interpretation, presentation and programmes;
- Communication, education and awareness;
- Tourism management;
- Facilities, services and infrastructures;
- Opportunities for community participation and economic development;
- Investment, financing and marketing.

The structure of the site management plan is as follows:

- General description of all elements and evaluation of the condition of all elements;
- Appreciation of the value and importance of the World Heritage Site;
- Summary of the main issues affecting the property;

- Response, policies and procedures dealing with each major category of site management;
- Governance and implementation.

Statement of significance from the Site-Management Plan of the Cultural Sites of Al Ain 2018–2019:

> *Al Ain is a site of outstanding universal value [OUV] due to its cultural significance as a place where the origin and evolution of oasis economy and mode of production can be traced. This OUV is further enhanced by the historic and scientific values of the archaeological and historic remains, by the physical presence of many sites and buildings linking Al Ain to the memory of the late Sheikh Zayed and the Al Nahyan family, and by a rich intangible cultural heritage still very much alive and vibrant.*
>
> *Al Ain World Heritage Site, with its various components and the regional context in which it is situated, provides testimony to the use and exploitation of an arid landscape. Occupied since the Neolithic, the region presents vestiges of numerous prehistoric cultures, notably from the Bronze Age and the Iron Age. Al Ain is situated at the crossroads of the ancient land routes between Oman, the Arabian Peninsula, the Gulf, and Mesopotamia. Very diverse in nature, the tangible elements of the property include remains of circular stone tombs and settlements from the Hafit and Umm an-Nar periods, wells and partially underground aflaj irrigation systems, oases and mud brick constructions assigned to a wide range of defensive, domestic and economic purposes. This expertise in construction and water management enabled the early development of agriculture for five millennia, up until the present day. The cultural landscape of the oases offers the opportunity to learn about traditional management and agricultural practices, the processes associated with them, and the social structure that has allowed this system to continue up to these days. The forts and palaces built in the vicinity of the oases are associated with the Al Nahyan family. This complex of buildings and forts, their distribution across the various Oases of Al Ain, and their association to persons and historic events narrates the story of the birth of a Nation.*

Discussion of the Objectives and Policies of the Site-Management Plan for the Cultural Sites of Al Ain

With the site-management plan document and the proposed action plan, the legal and institutional framework aims to establish an administrative infrastructure and operational framework to ensure the preservation of the outstanding universal value of the site. It also ensures the protection and authenticity of the site while taking conservation and management measures in coordination with Al Ain Municipality and the Department of Municipalities and Transport. There are over 30 suggestions for implementing these policies, starting with the structure and composition of the World Heritage Sites Management Section and the related committees. In addition to the measures needed to protect the sites, the proposed actions include the necessary development measures for capacity-building programmes for the benefit of new and current staff.

In terms of documentation, inventory and evaluation, more than 10 proposals exist for the policies related to the implementation of programmes aimed at documentation activities, protocols for archiving digital information and the integration of digital data.

There are also procedures for proper use, which include implementing and conducting studies in collaboration with Al Ain Municipality to study the process of water flow in the *aflaj* irrigation system and present alternative proposals for the current water supply, with rules to preserve the traditional oases.

There is also encouragement of researchers to conduct more research to obtain more information about the history and importance of Al Ain's cultural heritage, as research will be conducted according to the highest possible standards. The publications targeted to various audiences will include immediate publication of the results.

The procedures for implementing the research policy include developing a research strategy, imposing responsibilities to follow up on archaeological missions, preparing reports, requesting immediate publication of research data and developing an appropriate plan to archive the data.

A main aim of the site-management plan is to ensure the preservation of the outstanding universal value of the sites and ensure their integrity and authenticity through comprehensive conservation programmes. Implementing the procedure includes developing action plans for each site that needs conservation measures, establishing guidelines for the preservation process, conducting studies to analyse and assess the impact of the threats and appropriate mitigation strategies, and establishing monitoring methodologies and protocols to safeguard the site's outstanding universal value.

Interpretation and presentation procedures will be conducted correctly to meet the expectations of visitors while minimising their impact on the heritage sites by applying the interpretation plan to various components of

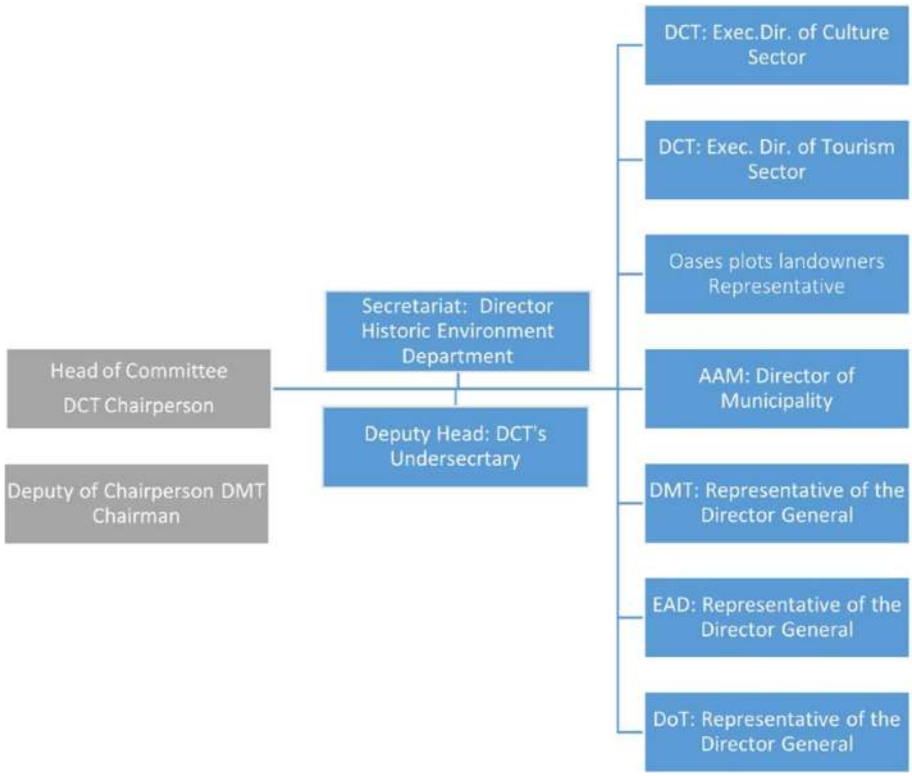

Figure 8: The steering committee structure (DCT 2018–2019).

the World Heritage Site of Al Ain. The measures supporting education and awareness policies in the management plan include developing strategies and programmes for inclusion in the annual plan and engaging schools and universities. However, tourism management will depend on studies on the extent of the flow of tourism.

Regarding facilities, services and infrastructure, more than 15 measures have been taken to deal with relevant policies in the management plan, ranging from business development and operational plans for new and existing facilities to the establishment of facilities that enhance the value of these sites.

Community participation has also been encouraged by involving schools, in the presentation of the site and creating opportunities for the economy based on culture and tourism.

Besides the annual budget allocated for site maintenance and all current activities, various sources may support the development of sites and activities through grant funding. In addition, community activities will be supported to promote heritage site development and community participation.

Finally, the site-management plan proposed two new organisational structures, a steering committee and a technical committee. The steering committee oversees the implementation of the management plan and provides suggestions to the joint technical committee for corrective actions to be undertaken. It convenes once a year. The joint technical committee supervises the preparation of the site annual plans and monitoring actions. It convenes twice a year and informally when necessary.

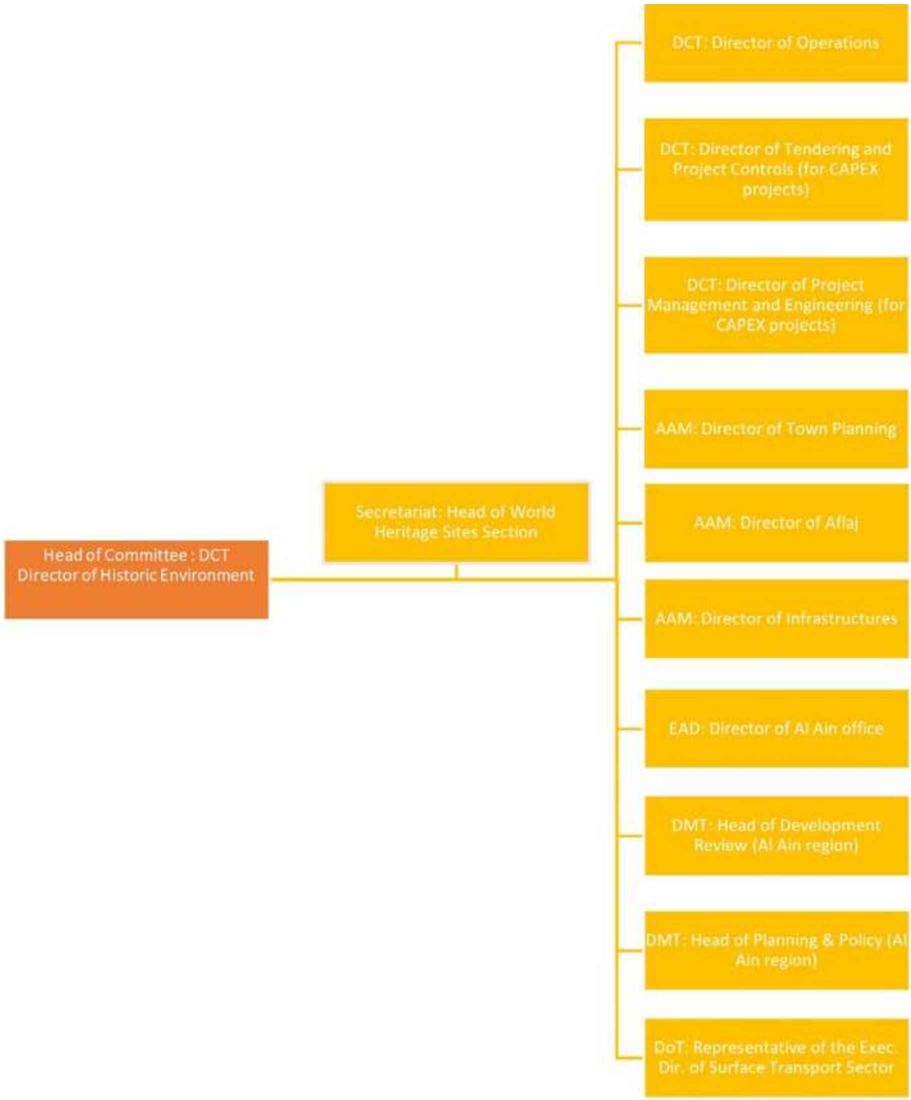

Figure 9: The technical committee structure (DCT 2018–2019).

The Site-Management Plan of the Cultural Sites of Al Ain (2018–2019) recommends using the historic urban landscape approach in the management of the World Heritage Site:

> *[The] Historic Urban Landscape will facilitate the integration of the cultural elements into economic, social, and infrastructural development programs. With this approach, Al Ain will develop as an integrated whole, giving to the city a unique identity.*

Conclusion

There is a positive influence by official stakeholders on the management of the Cultural Sites of Al Ain. This is reflected in the achieved policies since the sites' inscription on the World Heritage List in 2011. The stakeholders are aware of urban encroachment and the risk of losing parts of heritage in the process of continuing development activities.

Therefore, the policies and regulations adopted by various official stakeholders, such as the regulations of the buffer zone around the Cultural Sites of Al Ain and the NOC process, are important for the conservation of the World Heritage Site, especially when dealing with building activities.

To avoid the isolation of the archaeological sites and the components of the Cultural Sites of Al Ain, the Urban Design Guidelines policies were also developed to integrate the Cultural Sites of Al Ain into the contemporary context of the city of Al Ain.

The proposed update of Plan Al Ain 2030 is also considering the historic urban landscape approach for managing the city of Al Ain in the future by defining it as a World Heritage City in the proposed plan update.

Finally, the creation of the steering and technical committees that are chaired by DCT Abu Dhabi and have representatives from the main stakeholders — DMT, EAD and the Al Ain Municipality — is an effective long-term approach for monitoring the implementation of the various strategies, plans and policies developed for the management of the Cultural Sites of Al Ain in the World Heritage List.

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Developing a Historic Environment Record system for the management of heritage resources in the emirate of Abu Dhabi

Tariq Yousif Alhammadi, Richard Thorburn Howard Cuttler, Mark Jonathan Beech and Ahmed Abdalla El Faki

Astract: The capacity for heritage professionals to effectively manage heritage resources is contingent on access to reliable, up-to-date information. Over the past four years, the Department of Culture and Tourism - Abu Dhabi has developed the Abu Dhabi Historic Environment Record (ADHER). This is bespoke, geospatial software for cultural heritage management. The software features interfaces in Arabic and English, and includes data input wizards, detailed records, resources and reports. Designed with intuitive user interfaces, the software allows for a comprehensive range of search options, while communication protocols (APIs) enable data exchange and filtering with a range of applications used by other departments and external entities. The software has been developed with mobile applications for patrolling conservation areas and change monitoring. While the geospatial data set is an essential baseline for informed decision-making, the software offers important opportunities for a more dynamic interaction with museums, schools, universities and local communities.

Keywords: Big data, historic environment record, cultural heritage management, GIS, software development, data standards

Background

For antiquities departments and heritage authorities around the world, the effective management and protection of cultural resources presents a major challenge. Meeting this challenge requires access to information regarding the importance, location, extent and threats to cultural heritage. As the pace of development increases, there is growing pressure on heritage authorities to provide detailed curatorial and development control advice in advance of planning proposals. While commercial-off-the-shelf geospatial databases assist with understanding the distribution and location of sites, the absence of ‘linked data’ means that often the depth of information is woefully inadequate. A dynamic, geospatial Historic Environment Record (HER) enables informed decision-making at local, regional and national levels, while the wider opportunities offered by a HER include a comprehensive repository of digital and non-digital heritage resources for researchers, educators and the general public. The need to record heritage is recognised through various international conventions and charters such as the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (Article 6:3 1972), the ICOMOS Principles for the Recording of Monuments, Groups of Buildings and Sites (1996) and the UNESCO Convention on the Protection of Underwater Cultural Heritage (Articles 2 and 10, 2001).

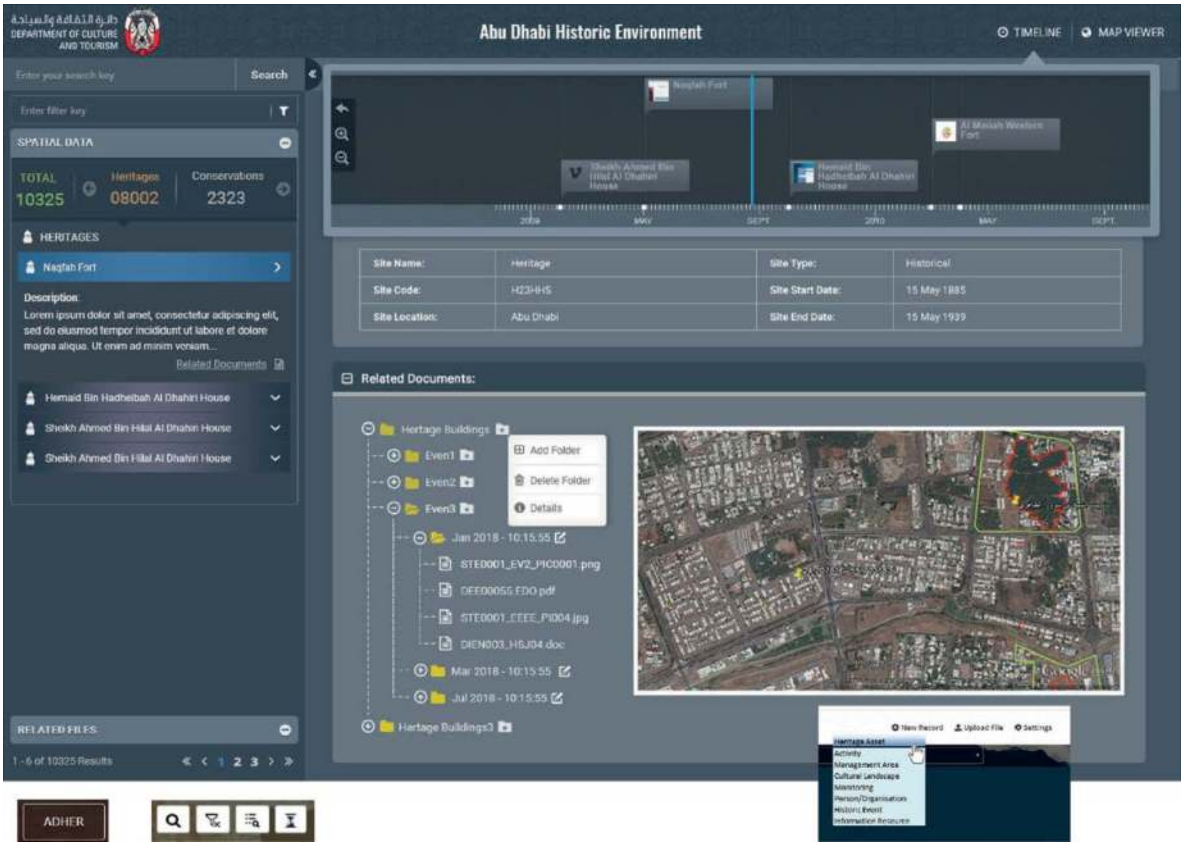
Another important incentive for developing ADHER was that a significant amount of data had accrued since the early archaeological missions in Abu Dhabi in the 1950s. While data was under the custody of the Department of Culture and Tourism – Abu Dhabi (DCT), it had been generated and stored by different organisations and could not be easily accessed, searched or retrieved. Data was stored in multiple locations and formats (such as hard copy reports and different computer file formats), and the development of ADHER was seen as an ideal opportunity to ensure data was accessible within one platform.

Interface design

When designing a database, what to record and at what level of detail significantly affects the scale and resolution of the data. This issue also impacts data retrieval and the amount of time needed to create and enhance records. It may be tempting to develop interfaces with multiple mandatory fields that require very detailed information for each new record. While the prospect of a comprehensive data set is appealing, the value and quality of data must be worth the user time invested in data entry with particular reference to the value of the data set to end users. This means that when finalising the resolution of data entry (the number and type of mandatory attribute fields) significant consideration should be given regarding which data fields will be searched and retrieved by future business users and how data may be practically applied by the business user to improve our understanding of the historic environment. Furthermore, the desire for a comprehensive dataset should not place a major burden on users and thereby a disincentive for the entry of new data. The number of mandatory fields within ADHER has been kept to a minimum in order to encourage the easy creation of new records and use of the system.

Data Entry Wizards and interface design

The design of a software interface should be appealing but should also support an intuitive workflow. When a user creates a new record, ADHER opens a Data Entry Wizard interface to guide the user logically through data entry. A few important fields are mandatory to complete, while the use of drop-down/pick lists helps constrain data entry to a limited range of terms. Constraining data



entry is very important, as it prevents users from creating new or duplicate names for existing attributes that might then be missed during a data search. It also helps to improve the quality and standardisation of data.

Figure 1: Early design concept for the ADHER main user interface. This includes a Data Search Results window within the left-hand side of the interface and a timeline search across the top of the interface.

Wherever possible, interfaces have been developed using standard icons on buttons rather than a word. The same icons are used in both the Arabic and English interfaces and, unlike words, do not require translation. Standard icons include, for example, the schematic depiction of a floppy disk. While a floppy disk is old technology, everyone using a computer recognises this as the icon for ‘Save’. Similarly, the schematic image of a printer is the button for ‘Print’. The developers provided the initial interface design proposals (Figure 1), which included a Data Search results and timeline window. However, it was clear that the Map View window needed to be a comparatively large window within the interface as the visual representation of the map and map features were important to the user experience. The ADHER project team held a series of meetings with DCT software designers discussing the purpose of the software, the user experience and business workflow. The software design team returned with several iterations of the interface before the design of the main interface was finalised.

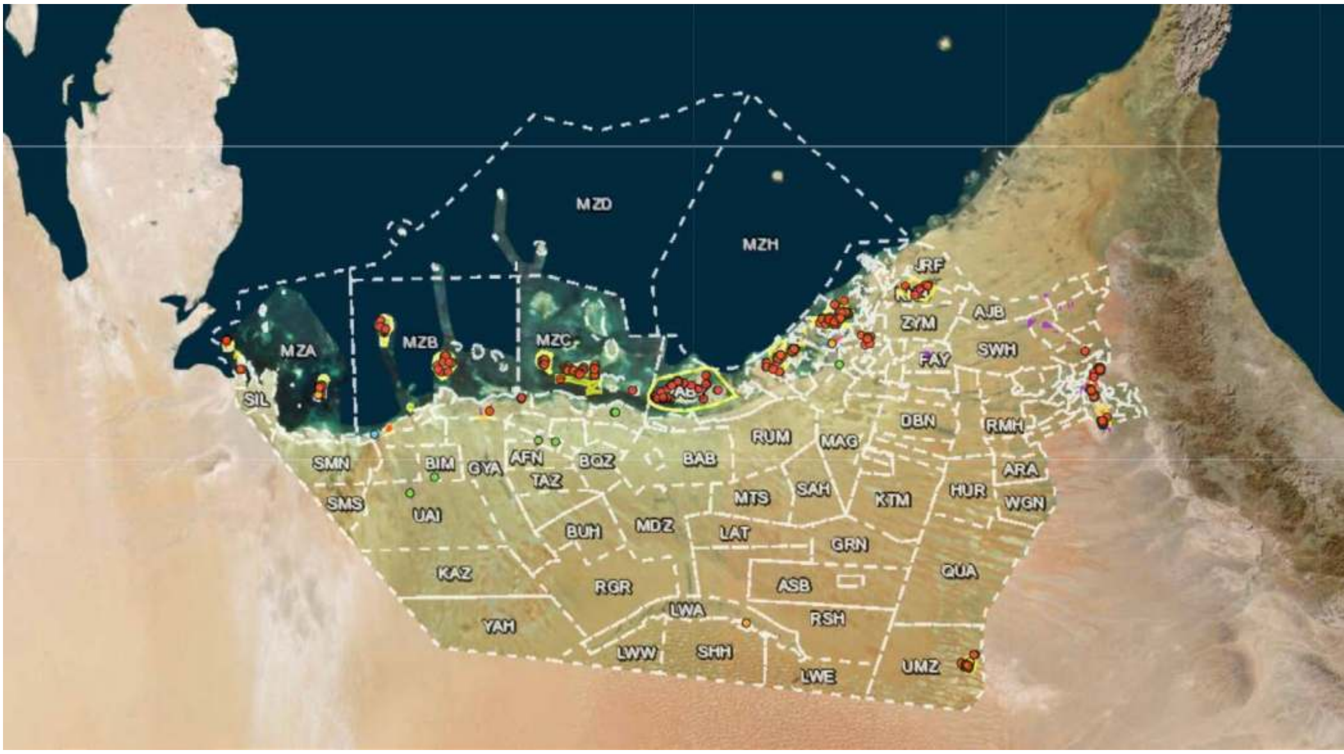
Data standards

The ADHER project commenced in 2018 with a situation assessment report and audit of existing data. This highlighted the type and extent of data held by the DCT and identified existing data standards that should be included within ADHER. For example, the Historic Environment Department has for many years ascribed each Heritage Asset with a unique identifier or site code. This nomenclature of site codes follows a system of three letters and four numbers. The first three letters are determined by the area name of the site (for example, sites at Hili will have a three letter HIL prefix), and the following four numbers are allocated sequentially, providing a unique number for each Heritage Asset. These site codes were used over many years on recording forms (context, survey pro forma, etc.) reports, artefacts, finds bags etc. Creating a new data standard and allocating new codes to legacy archives would have involved renumbering the site codes on a vast number of archives and was therefore considered impractical. An alternative was to record previous site codes as a separate attribute field, and while this option was included in ADHER, the existing nomenclature and data standard (three letters and four numbers) was retained as the unique identifier for heritage assets.

Site codes and unique identifiers

As pre-existing site codes were based on site names, the ADHER team used spatial analysis to ensure a unique site code (based on legacy codes) could be provided for all sites within the terrestrial and marine areas in Abu Dhabi as a unique reference for each site (three letters and four numbers, Figure 2). Each area has a different alpha code (the first three letters), totalling 240 across the emirate. The characters of each site code are based on the location and the number and are provided from three sources. The first source relates to the first three letters and uses existing site codes, all of which remain the same as the initials of the legacy codes for each area. The second source also relates to the first three letters and is from new areas where no previous legacy heritage data was available. The site code assigned to these areas is based on the municipality name or old names used in the past. Data relating to the first three letters of the site code are contained within a GIS geospatial layer (the DCT areas). When a new site is added to ADHER, the third source, the next available number, is automatically generated. Since location is a mandatory attribute, the user must select a location for the site, which generates the first three letters based on the site code assigned to the location within the geospatial layer and provides the next available number within that location. This avoids any duplication as the system will not accept more than one site with the same site code.

While legacy data is being entered, it will be possible to change the allocated site code. This is because there needs to be the flexibility to change the



site code to align with site codes that have already been used. However, once all the legacy data has been entered, the plan is to lock the Site Code field. This means that ADHER will provide the business user with the site code (or unique identifier) as each new record is created.

Figure 2: Polygon of ADHER site codes showing the three-letter prefix for each polygon.

System development

Two popular methods for developing bespoke software are 'waterfall development' and 'agile or sprint development'. Waterfall development is linear and broken into separate phases, whereby each phase is completed before commencing work on the next phase. Usually this is accompanied by detailed design documentation that is agreed prior to the commencement of works. A waterfall development has the advantage of having a predefined, clear structure, with approved design standards that can be referenced throughout the development. However, with this approach there is less flexibility to change the direction of the design or functionality of the development once work has commenced.

An agile or sprint development involves iterative cycles in which multiple development phases run concurrently. During each phase, the business user tests and feeds back to the programmer, allowing some flexibility for the direction of the software to be changed before proceeding to the following stage. Agile developments generally begin with a high-level scoping document for application design, with much of the detailed design undertaken as the development progresses. The design is then reviewed and updated as the cyclic process of development, testing and refining of each 'sprint' is completed.

For the development of ADHER, an agile approach with a total of eight sprints was adopted. Each sprint was 1 to 1.2 months in development. This approach offered greater flexibility, but the lack of detailed design documentation became an issue as there was no clear agreement on the functionality of interfaces and no data standard for the colour scheme and interface design. This was to some extent resolved by insisting a design document was produced and agreed prior to the start of each sprint. Any thesauri to be included in the attribute fields were added to an Excel spreadsheet, which was also translated into Arabic for the Arabic interface. At this point the data standards and data resolution were finalised. This detailed the mandatory attribute fields required for a basic record and the number of non-mandatory data fields. The number of mandatory fields was reduced to an absolute minimum so as not to be a deterrent to system users. All mandatory attribute fields were included in the data entry wizard to assist the user when a new record is created and ensure standardised data entry between users. Following the completion of the Data Entry Wizard, the user may open the new record and enhance the data with associated attribute fields not previously available in the Data Entry Wizard.

Data standards

A Historic Environment Record is much more than simply a geospatial register of heritage assets, since it links map features with multiple attribute fields and data sources, broadly termed 'Events' and 'Resources'. Events include any activity relating to how and who gathered heritage information (field surveys, geophysical surveys, excavations, marine diving inspections, building recording, organisations, people, and so on). This is important as it helps to understand the reliability of, and biases within, the data. Normally an 'event' is recorded as a polygon, but it may also be recorded as points or lines. A single event may be linked to multiple sites (for example, where field survey records multiple sites) and one site may be linked to any number of events. This is important where multiple projects have been undertaken on one site. Events may also be linked to each other.

'Resources' include all published and unpublished documentation relevant to a Heritage Asset or an event, such as old excavation reports, grey literature and journal articles. This also includes old photographs, aerial photographs, maps and plans, site archives and information about people and organisations involved in the collection and analysis of heritage data. Most importantly, these different kinds of data can be linked or referenced together so that a keyword search of the database will retrieve all related data irrespective of the data source. ADHER was therefore designed to address the issues of multiple file formats and storage by providing a central repository that could form a 'single point of truth' for heritage data in Abu Dhabi.

System architecture

ADHER is a bespoke software based on ArcGIS Java Script 3 with multi-tier architecture comprising Web, application and data services tiers. The Web tier includes the Web adapters for the portal and ArcGIS servers, which are accessed by the user through a Web browser as the system's entry point. The application tier contains the back-end components of Esri and Microsoft, which provide the geospatial capabilities and expose them through Web services. Data is stored in the form of tables within a Relational Database Management System (RDBMS) database that is based on Microsoft Structured Query Language (SQL) Server Enterprise Edition. The RBMS contains the schemas, which store information such as heritage assets, events, areas, metadata and attribute information, and provides a dependable method of storing and retrieving large amounts of data without compromising system performance.

Operating environments

ADHER software is hosted simultaneously on three different environments: the Development Environment, the Staging Environment and the Production Environment. The Development Environment is used almost exclusively by the programmers and is constantly updated as new functionality is written into the software, or as technical issues (system bugs) are identified and resolved. Business users generally do not access the Development Environment as it is

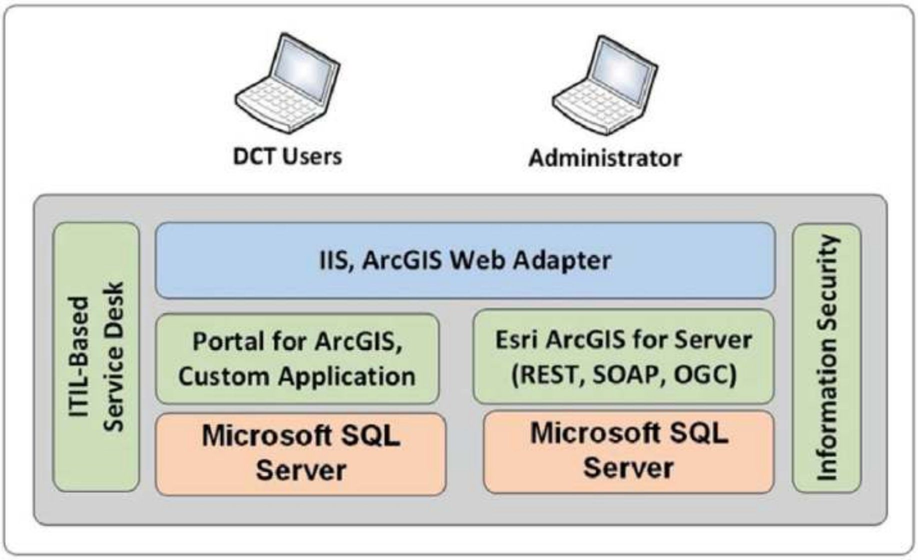


Figure 3: ADHER is a Web-based platform accessed through a standard HTML web-browser.

possible that new code or updates may cause the environment to be unstable or hang. Once changes to the Development Environment have been verified as appropriate by the programmer, the Staging Environment is updated with the new code. The Staging Environment is mostly accessed by the ADHER system administrators for the purposes of testing newly developed functionality and to check the resolution of bugs. It is also used for staff training. Issues in the Staging Environment are monitored by the ADHER administration teams and reported back to the programmer through a ticketing system. The Production Environment is the 'live' platform containing ADHER data and is accessed by the DCT team. When a team member encounters an issue on the Production Environment, the issue is reported to the ADHER Administrator and reported back to the programmer through the same ticketing system. Both the Staging and Production environments should be hosted on the same platform and server to ensure that an issue in Production is reproduceable in the Staging Environment.

The ADHER user interface

When considering the development of a software or platform the design of the user interface is critical and an issue that developers need to pay particular attention to during the early stages of development. A well-designed interface should be user-friendly, visually pleasing and provide a good balance between practical functionality and access to information.

Support in Arabic and English

ADHER is fully bilingual supporting Arabic and English languages, with the Arabic interface designed right-to-left and the English from left-to-right. Importantly both interfaces read from the same database to ensure there will not be any differences in information between interfaces. Once a record has been created in one language/interface, the same record may be opened and enhanced in the other interface. However, if attribute fields are completed in only one language, this attribute field will appear in both interfaces irrespective of the language. For example, if attribute fields are completed in the Arabic interface but not in the English, if the English interface is opened, the attribute fields will display the Arabic text. This functionality ensures that the user is always aware that fields have been completed rather than the system displaying an empty attribute field because the data is in a different language. Note that attribute fields with pre-defined picklists have been used wherever possible. This is because attributes in picklists can be stored as code and recalled and displayed in any language without a requirement for manual translation.

Figure 4: The finalised ADHER interface design with annotated functionality.

The main user interface

The interface displayed when ADHER is first opened has five main sections (Figure 4). Each section deals with different functionality. The first part is the Vertical Control Bar (VCB), which includes different widgets; the second part is a 'Gallery View', allowing the user to choose between the different base maps and historical images; the third part is a search bar; the fourth part is the navigation bar; and the final part is a layers panel, which contains a legend for the map layers and functionality for importing temporary layers.

Vertical Control Bar and the Data Search Results (DSR) window

Aligned down the left-hand side of the ADHER interface (English version) is the Vertical Control Bar (Figure 4). The first three buttons at the top of the VCB enable the user to select functionality relating to the main feature layers (Heritage Assets, Events and Designated Areas). Selecting one of these buttons (for example, the Heritage Asset records) opens the Data Search Results (DSR) window to the right of the VCB. The DSR subsequently provides the user with a summary of all Heritage Asset records. At the top of the DSR are filters that allow the user to filter out records of the sites not displayed within the map viewer (the eye symbol, Figure 5). The user can also display selected records within the DSR or see records that are filtered following a search. It should also be noted that records listed in the DSR are linked to and therefore dynamic with features displayed in the Map View window. As the user hovers over or selects a record in the DSR, the associated map feature is also highlighted or selected. Similarly, if the user hovers over or selects a feature in the Map View window, the associated record is highlighted or selected in the DSR.

Gallery view

Where base maps may be used on a regular basis, ADHER has a selection of preloaded base maps, satellite images and vector base maps. In addition, the gallery includes georeferenced historical satellite images, which help the user to understand land change over time and to investigate the history of a study area prior to field survey. In some cases, this can save significant amounts of time. For example, understanding the extent of reclaimed land may help to reduce survey areas and minimise time spent on field survey.

Vertical navigation bar

The vertical navigation bar provides the map navigation tools required to zoom in and out of the map, to select and unselect map features, and to identify the map features. A coordinates selector enables map co-ordinates to be easily selected, copied and pasted.

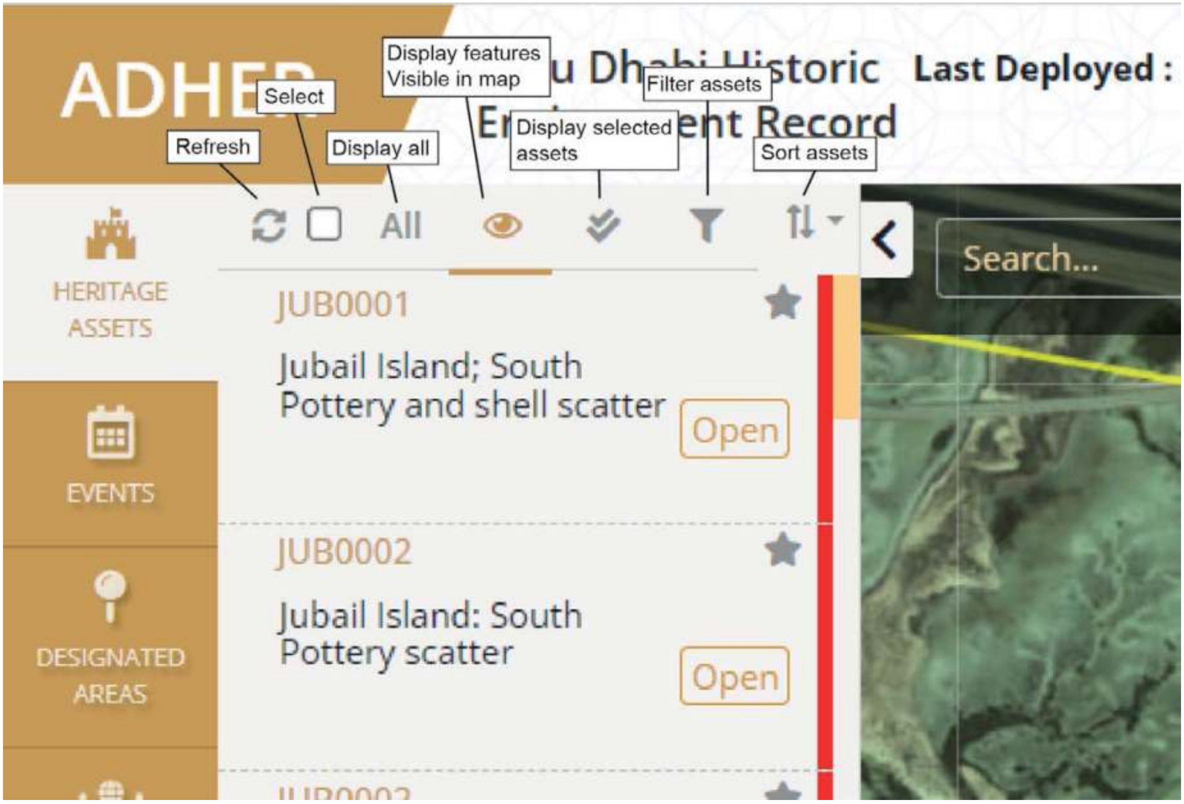


Figure 5: Filtering options for the DSR window.

The layer panel

Within the right-hand side of the main interface is the map legend and map layers. This allows the user to select or unselect map layers and to control the visibility of map features. There are also options for freezing the layer and the option to change the colour palette.

Search strategies

For Historic Environment Records (HERs), it is not only important how data is entered but also how data is searched and retrieved. HERs include multiple types of information and resources, so the system must include options to search with different levels of complexity. Dynamic search strategies assist the user by filtering and displaying data based on how the user navigates the software. For example, as the user navigates to a desired area on the map, the DSR window displays a summary of records associated with features displayed within the Map View window. Included within dynamic search strategies, ADHER has three types of searches: the basic search, advanced search and period filter.

Basic search

The attributes and data returned during a basic search will depend on the tab selected from the VCB. For example, if the Heritage Assets button is selected on the VCB, the search bar will automatically change to Heritage Assets attributes so the user may search by site code, title or any text from the summary, description or notes. Further searches are customised when the user selects Events, Designated Areas, resource types, people or organisations from the VCB.

Advanced search

To provide more options to find specific information, ADHER includes an advanced search functionality. This provides for Spatial search, Administration search, Keyword search, No Objection Certificate (NOC) search and a search using Structured Query Language (SQL) expressions. Search results are displayed in the DSR window and may be selected and exported in multiple formats.

1. *Spatial search:* The user may draw a point line or polygon within the Map View window to search for sites or search the map extent. The user can also specify the size of a buffer around existing or imported geometry to identify sites located within a specific distance from existing sites. This is particularly useful for searching areas of new development, for example, extracting all sites within the buffer zone of a new pipeline.
2. *Administration search:* The user may use the preloaded Municipality Administration layers to search for sites within a specific area. This enables searches within three municipality areas (Abu Dhabi – Al Dhafra – Al Ain), within specific locations within each area by using the Districts, Communities or plot layers or by using predefined DCT Areas.
3. *Keyword and NOC search:* A No Objection Certificate is required from each government entity when a developer submits a planning application to the Department of Municipalities and Transport (DMT). Of importance to DCT is the monitoring of legacy planning requests that have an archaeological or heritage condition. A Keyword search provides the ability to search for any text by selecting the appropriate tab in the VCB (Heritage Assets, Events, Designated Areas, NOC, etc.). As the system is integrated with the Municipality NOC system, the user can search for legacy NOCs by application number, reply date, municipality region or district.
4. *SQL search:* The SQL search provides advanced functionality for searching in ADHER. The user may specify a 'clause' or build queries by specifying more than one clause and linking them together. For example, to search for sites of international value with a specific site code, the user will add two clauses: The first will be for a site code that begins with ABCXXXX, and the second clause will be where the Cultural Value Index (CVI) is equal to International. This is one of many query examples available for searching based on the purpose and the selected tab in the VCB.

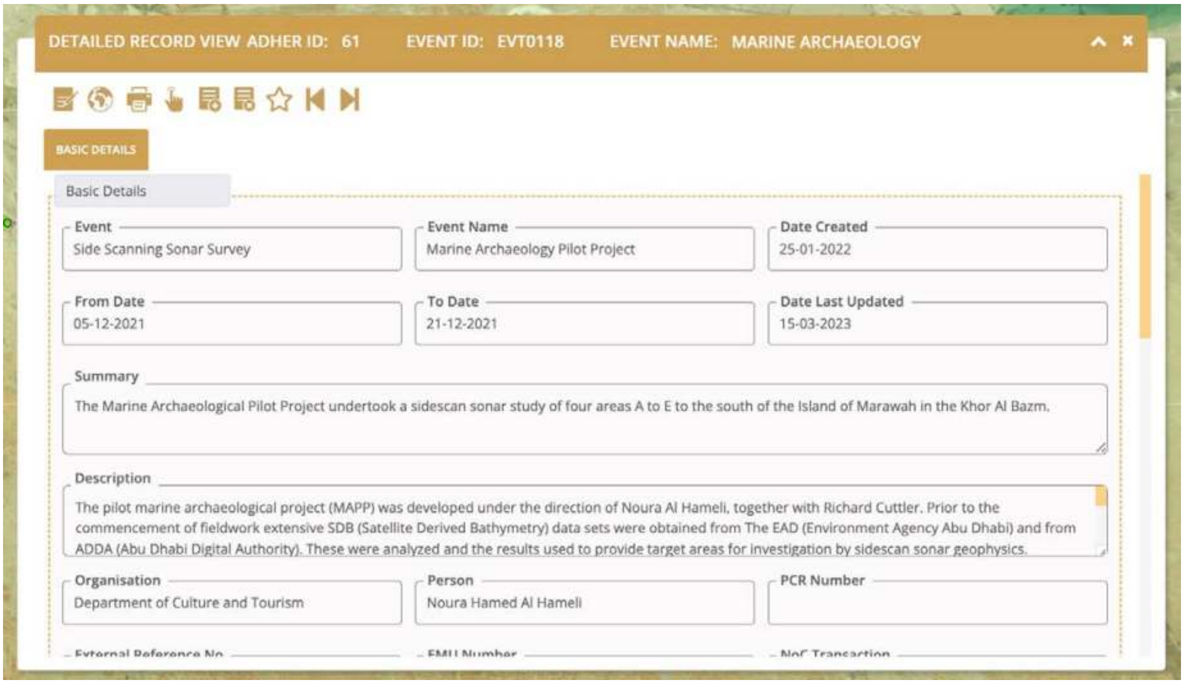


Figure 6: The period filter showing the details of the Neolithic period.

Figure 7: The Detailed Record View showing the details of an Event.

The period filter

ADHER has detailed records about heritage sites from multiple periods. The period filter details all periods from 145 million years ago to the present. The user may explore the heritage assets from each period by selecting one or multiple periods from the timeline, which provides an image and description of each period within the period filter interface. This displays filtered sites within the Map View window and lists filtered sites within the DSR.

Detailed record view

Each asset within the ADHER has its own detailed record interface that displays comprehensive information about Heritage Assets, Events and Designated Areas. Detailed records have two main interfaces, Browse mode and Editor mode. Browse mode provides the main attribute fields of the record without allowing the user to edit any of the fields. Browse mode includes a short summary, description, the type and period and many other details.

Editor mode allows users with editing privileges to open the main detailed record interface and review all the data associated with a heritage asset, event or designated area. The user may also enhance information or link resources, such as photographs, reports etc. to the record.

Resources

To enhance the information of the detailed record view, resources are linked with the records for heritage assets, events and designated areas. ADHER supports different types of resources, such as reports, GIS and Raw data, publications, finds pictures, site photographs and videos, audio and URL links. All these types of resources are classified into different tabs to organise and find data easily.

Generating automatic reports from detailed records

The assembling of data and the preparation of detailed reports, gazetteers or information requests using HER data is a routine part of the work that can be particularly time-consuming. ADHER provides the advantage of being able to assemble selected information from the attribute fields of detailed records into a predefined report template. For example, it is possible to use a specified buffer to search for sites within the distance of a geometry. These sites can then be selected and displayed within the DSR window. If the user then specifies a report with a specific template, ADHER will use the selected data to generate a report that can be exported in Microsoft Word and edited further based on requirements.

Exporting and importing the data

As the system uses geospatial data to visualise assets, it supports the export and import of data in multiple formats. For exporting data, the user specifies the individual layers and the extent of the area to be exported together while defining the output format and the spatial reference. The system supports the export of data as GIS Shapefiles, GIS Geodatabase, Google Earth KMZ files, CAD files and JSON files. Data can also be imported in these formats through the reference tab of the Layer Panel. When map features are imported through the Layer Panel, they are imported as 'temporary map features'; however, they can be converted to permanent map features if they are linked with a detailed record. This option is particularly helpful when reviewing ADHER data together with external data. For example, it is possible to temporarily import the geometry of development proposals and then request the system to search for all sites within a predefined buffer around the development.

Share maps

ADHER supports map layouts based on a user specified location. A map can then be generated and exported using different layout templates and page sizes.

Integration

ADHER communicates with and displays data from other databases. These include databases held internally within DCT, such as EMu and the Inventory of Abu Dhabi Modern Heritage (IADMH) and databases held by external government entities including the No Objection Certificate (eNOC) system managed by DMT. Importantly, where data is shared with ADHER (rather than displayed), the original database continues to be the 'single point of truth' that updates ADHER. This is to ensure that there is no duplication of data or mismatch in data entry between the two databases.

1. *EMu:* A collections management software for museums developed by Axiell that includes information on the finds from excavations and other assets. Finds data is stored in EMu to avoid duplication and data conflicts. Communication between the systems is one way only, from EMu to ADHER. This provides the user with the option to review different finds together with their details and resources by using the site code as a unique identifier.
2. *IADMH:* A geospatial database developed by the Modern Heritage Unit within the Conservation Department at the Historic Environment Department at DCT. This system contains very comprehensive information about all modern heritage assets that are both inscribed and not inscribed. An API exposes ADHER to the important attribute fields of sites that are considered worthy of protection. When a site is inscribed within IADMH, the record and map features are updated to ADHER. While data is updated from IADMH into ADHER, IADMH remains the 'single point of truth', which means that when a record is updated in the IADMH database, the corresponding record is updated in ADHER.
3. *eNOC:* This provides data from the NOC system administered by DMT and enables ADHER users to review new planning and infrastructure proposals in relation to the geometry of heritage assets in ADHER. This enables a visual review to understand the situation and the conflict with the heritage sites in ADHER. Since the eNOC system receives more than 100,000 planning applications per year, business rules are set to filter legacy applications to only show applications that are assigned to DCT.

Workflow data validation

To ensure the quality of data entered into ADHER, a workflow interface is used for the validation of new data entered by the Historic Environment Department (HED) team. This includes the validation of new sites and resources that are added to the system but does not include temporary geometry added through the Layer Panel. Once the user adds a new site or resources, it is sent to the relevant unit supervisor for review and approval or rejection with comment.

Mobile application

Mobile applications are developed as a part of improving the field monitoring practices. This is particularly important within the area of the Al Ain World Heritage Site. The ADHER mobile applications provide the ability for HED rangers to record, report and update ADHER regarding the condition of sites. A dashboard within ADHER manages all the field activity and schedules rangers' routes and workloads for each week. Information gathered by rangers is reported to the relevant supervisor within the dashboard via the ADHER mobile application.

Future development

Although ADHER has many functions, continuous development is planned over the next few years, as there is no limit to how the system may be enhanced. In particular, it is important to ensure that ADHER is supported and is compliant with updates to other software packages. The main developments will focus on the following issues:

1. *3-D models of heritage sites:* The HED team already use photogrammetry to record and produce 3-D models of heritage sites. This improved methodology for recording and visualisation should be reflected in the way that ADHER displays data. ADHER aims to provide information about sites, and 3D models will be enabled within the Map View window in ADHER for displaying heritage sites. In order to complete this step, the system will be upgraded from JavaScript 3 to ArcGIS Maps SDK for JavaScript 4.
2. *Public Web Interface:* Part of the ADHER objective is to disseminate information about the heritage sites of Abu Dhabi to the wider public, researchers, teachers and people involved in higher education. For this purpose, a light version of ADHER will be developed for public access. This will involve some screening of data from the ADHER database. This is because there may be sensitive sites that can be damaged through unsupervised public access or issues around copyright for the distribution of images etc.
3. *Survey application:* As the ADHER has a mobile application for monitoring existing sites, a new application will be developed to support archaeological

fieldwork. This will enable archaeologists to survey monuments and enter the details directly into ADHER as data from new sites is being recorded. This will include the ability to see the existing sites and add new sites using smart devices.

Discussion

By developing ADHER, DCT has created a robust backbone and user-friendly online portal for storing and managing geospatial and non-geospatial cultural heritage information. The system facilitates easy access, search and query functionality of Abu Dhabi cultural heritage information by both core system users (the Historic Environment Department) and other users within and external to DCT in accordance with each user's role and access privileges.

However, the development of a software or appropriate system for the storage and retrieval of heritage data is only one part of the development and curation of data. A second and equally challenging part is data research, development and the entry of legacy data. DCT is currently in the early stages of an ambitious digitisation programme, involving the scanning and archiving of large amounts of paper-only and dispersed digital reference material that is currently held as legacy data. The programme involves the transfer of paper files to digital media and the creation of new and enhanced records within DCT. As for any database, the system only becomes effective and powerful once a meaningful level of data has been entered and data can be purposely retrieved.

As with any software platform, the system requires maintenance and support. This is not only to resolve the inevitable bugs that arise within the system, but also to ensure that the system remains up to date with changes in both software and hardware architecture. As with any database, the curated information requires review and updating to ensure that information is relevant. An effective data management process is important because it ensures that the information is accurate, reliable and as up to date as possible for everyone who needs to access it for analysis, reporting and making business decisions. However, such a system is invaluable for assisting heritage managers in understanding the extent, location and importance of heritage, while assessing threats and providing informed, knowledgeable advice for planning control.

Finally, while it remains the responsibility of every region to manage their own heritage data, many of the principles and concepts used for the development of ADHER are transferable to other regions, and with minor modification, the software could form the basis of a robust platform for heritage management and support in other regions, particularly within the Middle East and North Africa region, as much of the Arabic front end and thesauri have been extensively developed.

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Historic mosque architecture in Abu Dhabi

Hamdan Rashed Al Rashedi

Abstract: This paper details the history and features of historic mosques in the emirate of Abu Dhabi. It includes most of the mosques, inland and in the emirate's coastal areas, demonstrating architectural design styles, complementary elements, functions and building materials.

Keywords: Mosques, Islamic architecture, traditional buildings, places of worship, building techniques and materials

Definition of *masjid*

In *Lisān al-ʻArab*, Ibn Manẓūr (1414 AH: 204-205) defines *sajada, yasjudu, sujūdan* as 'putting one's forehead on the ground'. In *Tāj al-ʻarūs*, Murtada al-Zabidi says: "Al-Layth said *al-sujūd* [prostration] is the position of the body, and the ground is called *masājid* [mosques] and the singular is *masjid*. He said: *Al-masjid* is the name of a *jāmi*ʻ [mosque] where people worship (al-Zabidi 1965: 174), and then the mosque is called the place of prostration on the ground." As such, the mosque is a place of worship and means the building constructed on the site of prostration (Shuaib 2008: 1094-1095; Al Dusari 2013: 264; Musa 2008: 15-16).

Some scholars define the mosque as any place on the ground, based on the Hadith of the Prophet (Peace Be Upon Him): "The ground was made as a place of prostration and a means of purification for me." A mosque, therefore, is any place on the ground, regardless of whether it has been prepared for prayer. Others limit the definition of a mosque to a place prepared for performing the five prayers (Wali 1993: 16; Al Haddad 2003: 16-17; Al Dusari 2013: 268; Musa 2008: 16; Al Shabi 1994: 3).

Mosques as places of worship are mentioned in many parts of the Holy Qur'an, including the statement of the Almighty: "The only ones who should tend God's places of worship are those who believe in God and the Last Day, who keep up the prayer, who pay the prescribed alms, and who fear no one but God: such people may hope to be among the rightly guided" (Qur'an: 9:18).

This holy verse refers to the fact that the construction of mosques relates to belief in God and the Last Day. Therefore, Muslims began building mosques to exalt the word of Almighty God. Mosques have been the nucleus for the establishment of Islamic communities. Where you find a mosque, you will find a community. It is not strange that the centre of the first Islamic cities was occupied by a mosque, around which houses and markets were mapped out.

Function of a mosque

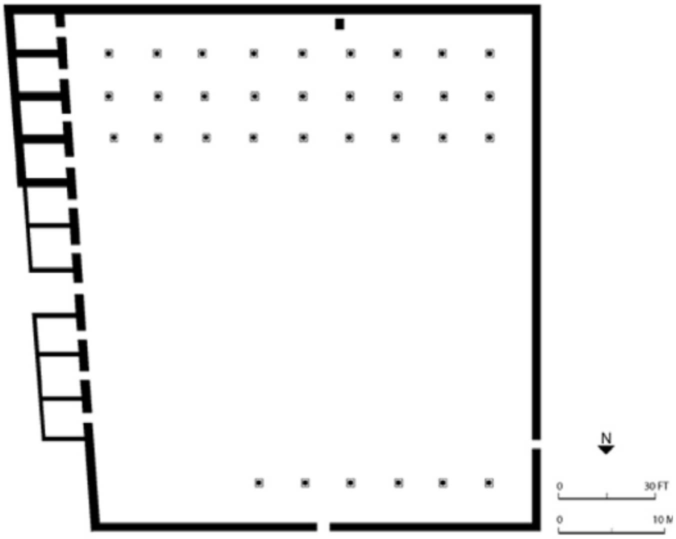
In addition to their religious function, mosques were political, economic, cultural and social centres at the dawn of Islam. They were places for announcing state decisions. The governors of the Rashidun (Rightly Guided) Caliphs used them as headquarters for managing government affairs. During the Umayyad era, the mosques became central locations for the governors of the major provinces. Each governor would go to the mosque of the province appointed to him by the caliph, and from the pulpit, he would announce his new policies to the people. The caliph's letters and orders would be read to the people in the mosques. The governors would call on the people to come to pray together, even on days other than Friday. The mosques were the places where armies gathered and from which they went out to conduct military operations and make conquests (Al Kharbutli 1961: 194-195).

Mosques were also places where caliphs and governors kept the public treasury. Money changers would sit at the gates to carry out currency exchange operations or provide loans to people in need. Markets were often established near the mosques, which also served as learning centres for knowledge seekers, and they were often where literary gatherings and dialogues would take place (Al Kharbutli 1961: 196-197).

Mosque architecture in the Arabian Gulf

The architectural models of the Early Islamic mosques followed the design of the Prophet's Mosque (Figures 1 and 2). Most consisted of a canopy at the qibla wall, followed by an open-air walled courtyard surrounded by porticoes on both sides and in the area opposite the qibla canopy (Mu'nis 1981: 95-97).

Qibla canopy, prayer hall or qibla portico are all technical terms for the architectural component in Islamic architecture known as the front of the *jāmiʿ*. This component usually consisted of an area dedicated to prayer covered by a flat or vaulted roof, sometimes divided into porticoes, and it included many architectural elements, the most prominent of which was the curve of the apse and the pulpit (Al Haddad 2003: 35-37).



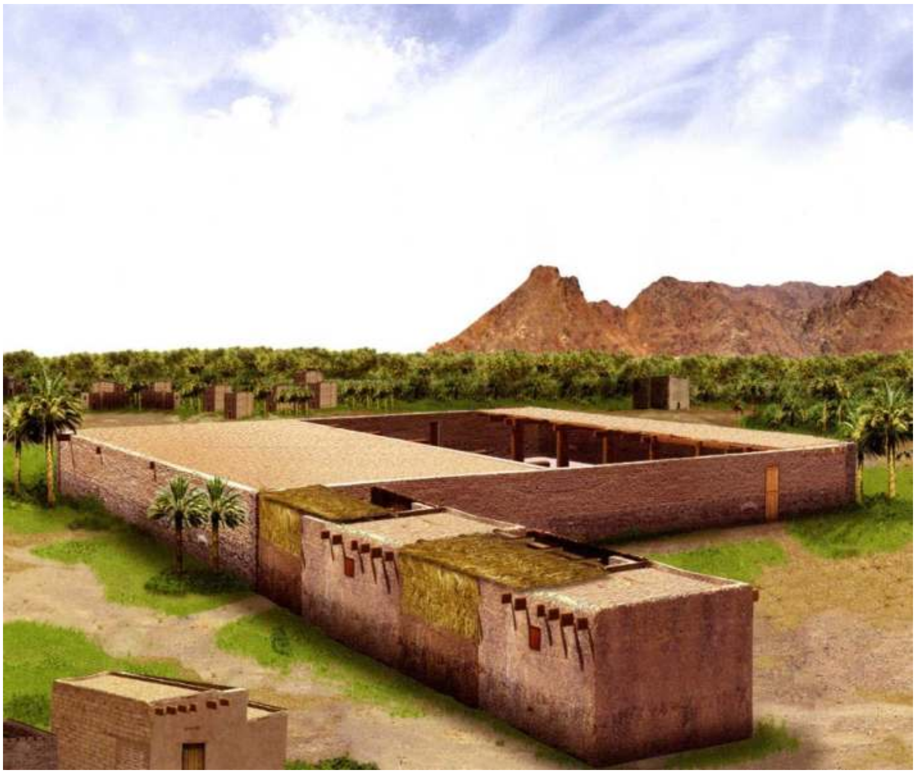


Figure 1: The design of the Prophet's Mosque. (Mahbub Rashid, Islamic Architecture)

Figure 2: An approximate visualisation of the Prophet's Mosque when it was first built. (Fathallah, al-Madina al-Munawwara Ma'riz al-Iman)

There is a difference between the mosque's courtyard and its sanctuary. The courtyard is the area situated within the mosque's walls, comprising an unroofed courtyard; the sanctuary is the area surrounding it, including buildings adjacent to its walls or external courtyards (Mu'nis 1981: 61-62; Al Haddad 2003: 135-136; Al Shabi 1994: 54; Wali 1993: 316-317).

In terms of design, most mosques of the Arabian Gulf trace their origin to the Prophet's Mosque in Medina. They generally consist of an open-air courtyard with a qibla canopy, which usually has a roof, in front of it. The qibla wall has the curve of the apse in the middle, to the right of which is the pulpit, located internally or protruding from the wall, while the open-air courtyard can be entered through three entrances. The main one is in the area opposite the qibla wall, and the other two are on either side of the courtyard. A fountain is provided for ritual ablution, sometimes in the courtyard and sometimes outside, adjoining the mosque. Many mosques also have minarets, while others do not (Al Khulaifi 2003a: 35; Al Fahal 2021: 69; Al Khalifa 2017: 54-55; Mubarak 2021: 19-20).

Among the mosques built in the Arabian Gulf region based on the design of the Prophet's Mosque are the Jawatha Mosque (Al Shamari 2011: 184), a mosque in Al Qatif Oasis (King 1980: 253-254) in Saudi Arabia, the Ain Abu Zaydan Mosque (Insoll *et al.* 2020: 110-111; 2016: 222-225), the Siyadi Mosque in Bahrain (Al Khalifa 2017: 84-85) and the Murwab Mosque in Qatar (Al Haddad 2000: 183-187; Al Shamari 2011: 186; Ramadan 2009: 46).

In the Arabian Gulf region, there were also styles of mosques bearing an Ottoman influence, especially in Al Ahsa, such as Al Fatih Mosque (Almudarra *et al.* 2018: 90-96; Almudarra 2017: 396-397) and the Ali Pasha Mosque (Almudarra *et al.* 2018: 95-100).

The mosques of the Arabian Gulf followed the model of the Prophet's Mosque in not having minarets, with some exceptions, such as Al Khamis Mosque in Bahrain, which has two minarets. The first was built in 518 AH/1124 CE and the second one in 730 AH/1330 CE (Al Khalifa 2017: 60, 63).

As a substitute for minarets, low platforms were used for the call to prayer. These platforms were sometimes built with stairs and sometimes without, as in Al Muraykhi Mosque on Delma Island, and the exposed platform in the mosque in Julfar in the emirate of Ras Al Khaimah, which dates to around the 14th to 15th centuries CE. A platform minaret was also found in the mosque located in Al Falayah in Ras Al Khaimah (King 2010: 14-15).

This platform style was characteristic of the mosques of the Arabian Gulf, at least during the 14th and 15th centuries CE they restricted to this area, being relatively widespread in the Arabian Peninsula. The platforms are usually to the right of the main entrance, as at the Abbas Mosque in Abu Arish in Saudi Arabia on the Red Sea (King 2006: 174).

Mihrabs in the Arabian Gulf region have distinct characteristics. In Qatar, Bahrain and Kuwait, the mosques built in the early decades of the 20th century contain a concave mihrab with a single dome or two smaller domes built on the concave part of the mihrab on the external surface of the qibla wall. Examples of these are found in the Western Qalali Mosque in Bahrain, which dates to 1910, and the Simaisma Mosque in the city of Al Khor in Qatar, built in 1938 (Al Khulaifi 2003a: 39; Al Khalifa 2017: 65-67).

Some mihrabs had windows or openings so that the imam's voice could be heard outside the mosque. An example is the mihrab of Al Jami' Mosque in Bakha in Oman (Costa 2006: 166-169).

Figure 3:. Minbar and mihrab of Al Falayah Mosque in Ras Al Khaimah (King 2009).

Some mosques in the Arabian Gulf had two mihrabs, one inside the prayer hall and the other on the wall of the open-air courtyard adjacent to the prayer hall. The probable function of the outside mihrab was for use if the mosque was crowded with worshippers and they needed to pray in the area in front (Muhammad 1981: 43; Al Harithi 1995: 107). An example is at Al Dalil Mosque in Sharjah in its qibla canopy (Al Azzawi 1998b: 10-47).

Among the architectural characteristics of some mosques in the Arabian Gulf is the ‘mihrab built together with the minbar’ in the qibla wall. This old tradition appears in many mosques in the Arabian Peninsula, such as Al Shafi‘i Mosque in Jeddah, which was built in 649 AH/1251 CE (King 2010: 16).

The absence of the minbar as a separate element can be seen specifically in the mosques of Bahrain and Kuwait, where the imam uses the covered area in the mihrab to deliver the Friday sermon (Al Khalifa 2017: 65). Minbars that are specifically for Friday prayers are found in some mosques in Oman, but they are usually a fixed part of the building, like the minbar of Al Jami‘ Mosque in Manah (Costa 2006: 82).

In Al Falayah Mosque in Ras Al Khaimah, a fixed minbar (Figure 3) occupies the right half of the mihrab. The same kind of minbar is also found in mosques dating to the 16th century CE, in Hofuf’s Ibrahim Pasha Mosque, in Jeddah’s Al Shafi‘i Mosque (King 2006: 175-176) and Oman’s Bahla Mosque (Costa 2006: 109-114; Baldissera 2007: 57-61; Al Busaidi 2004: 41-42).

Most mosques in the Arabian Gulf region were covered with flat roofs of palm-tree trunks with mats or reeds (bamboo) on top of them and layers of clay mixed with straw to increase cohesion and prevent cracking. Although Arabian Gulf architects preferred building mosques with flat roofs, there are still a few examples of the use of domes in the region, such as Al Bidya

Figure 4: Al Bidiya Mosque. (Sosa, Al Bidiya Mosque)

Mosque, which is topped with four domes (Figure 4), the Bur Dubai Grand Mosque (1850 CE) and Al Qubaib Mosque in Qatar (Al Khulaifi 2003a: 37; Al Khalifa 2017: 63-64).

General characteristics of the historic mosques in Abu Dhabi

Design

The design of the historic mosques of Abu Dhabi was highly influenced by the style of the Prophet's Mosque. Based on previous research, it has been possible to narrow down the architectural design styles of the historic mosques in Abu Dhabi to the following:

Architectural style 1: This style usually consists of a prayer hall, an open-air courtyard and a rear part, such as in the Abbasid-era mosque in Al Ain, Qasr Al Muwaiji's mosque and Al Muraykhi Mosque. Examples of this style are also found with an added tower, such as in the Sheikh Ahmed bin Hilal Al Dhaheri Mosque (Figure 5); two rooms, as in the Ali bin Salem Al Kindi Mosque; or one room, as in the Bin Hazam Al Dhaheri Mosque.

The design of Al Ain's Abbasid-era mosque is similar to that of the Murwab Mosque in northern Qatar, whose construction dates back to the 3rd century AH (9th century CE). Both mosques are divided into a prayer hall and an open-air courtyard, though the Abbasid-era mosque is distinguished by having a second mihrab in its courtyard (Ramadan 2009: 16).

Likewise, the design of Qasr Al Muwaiji's mosque is similar to the design of Al Qubaib Mosque (Sheikh Jasim bin Mohammed Al Thani) dated 1878 CE

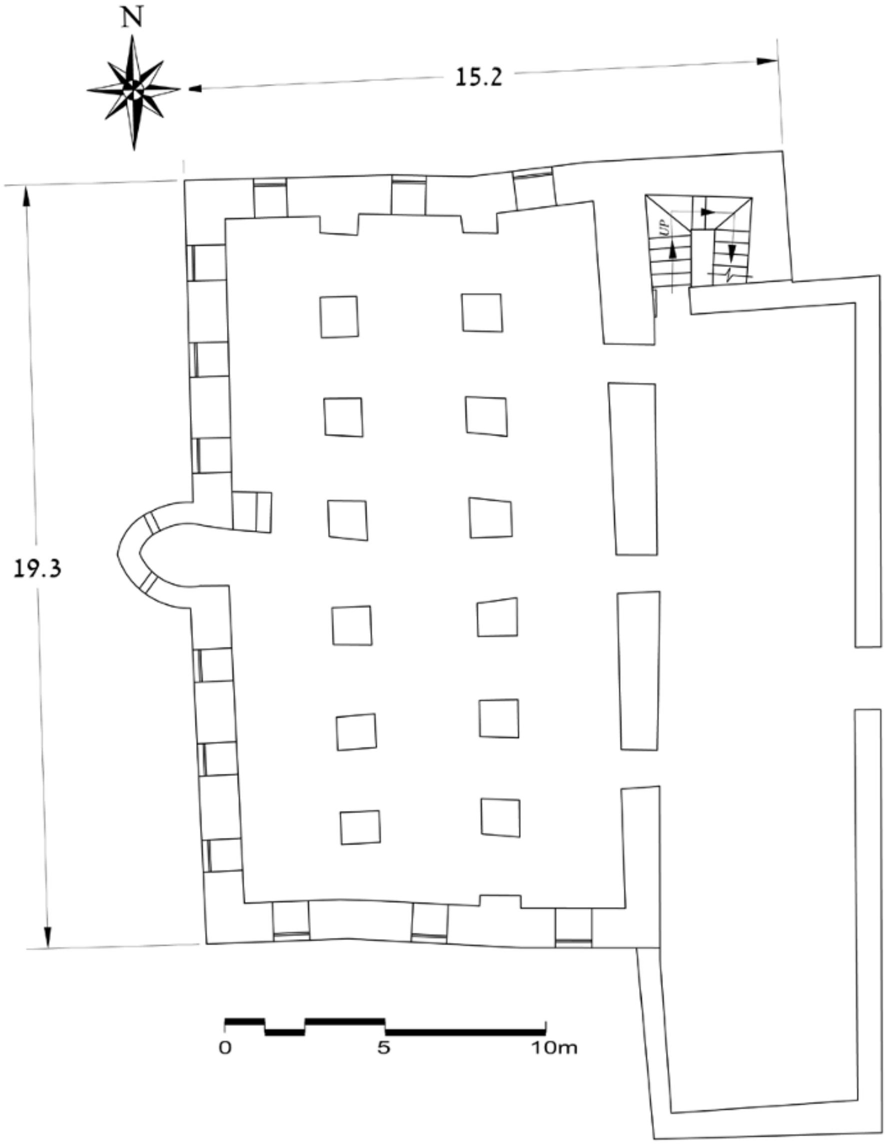


Figure 5: Plan of the Sheikh Ahmad bin Hilal Al Dhaheri Mosque. (Department of Culture and Tourism – Abu Dhabi)

in Qatar, without facilities in the courtyard of the Qasr Al Muwaiji mosque as there are in Al Qubaib Mosque; the covering of the prayer hall in Al Qubaib Mosque also forms a point of difference, being topped with shallow domes in the style of Ottoman mosques (Ramadan 2009: 17, 52).

Architectural style 2: This style usually consists of a prayer hall, a pergola and an open-air courtyard, as at Al Muhannadi Mosque (Figure 6), the Rashid Al Haytah Al Darmaki Mosque and the Bin Ati Al Darmaki West Mosque. There are also examples of this style to which a room has been added, such as the Isa bin Sultan Al Dhaheri Mosque.

The design of Al Muhannadi Mosque is largely similar to the design of Al Jamiʿ Mosque in Bakha, Oman. There is also a mosque design that consists of a prayer hall, a pergola and an open-air courtyard in Bin Obaid Mosque (1935 CE) in Qatar (Ramadan 2009: 18, 69; Jaidah and Bourennane 2009: 278-280).

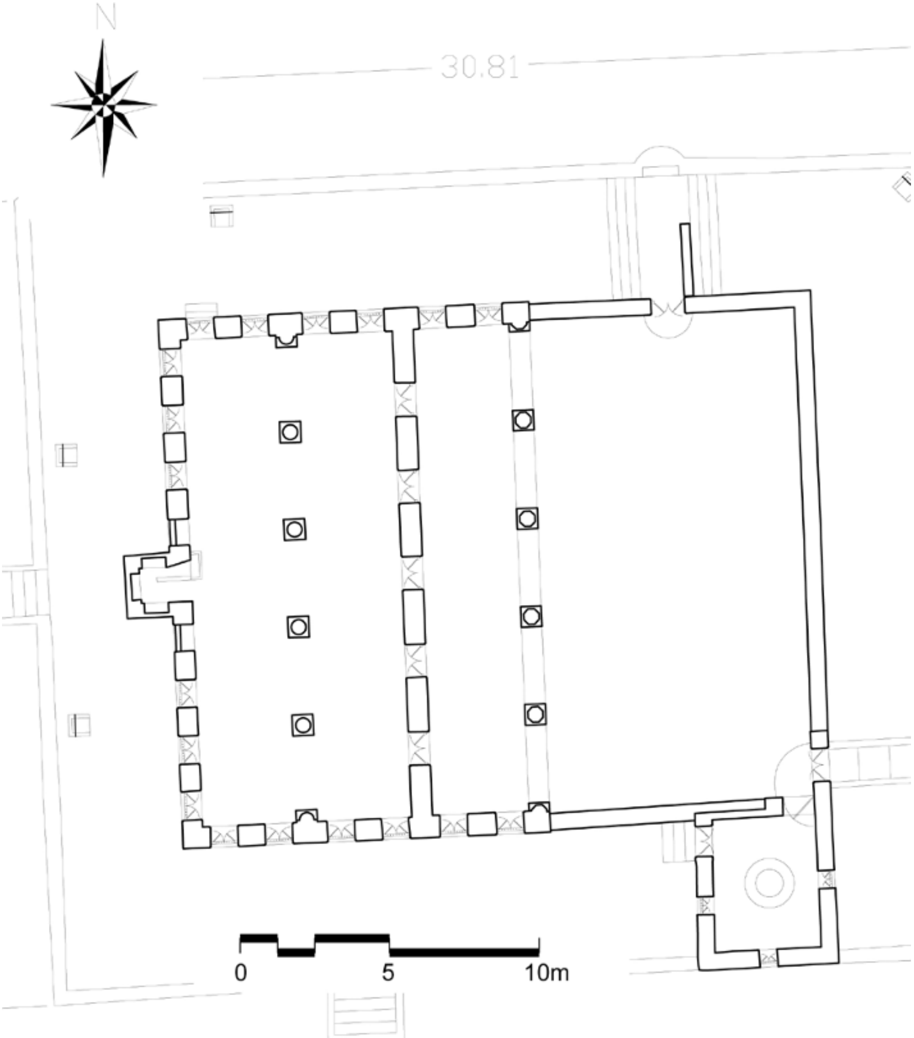
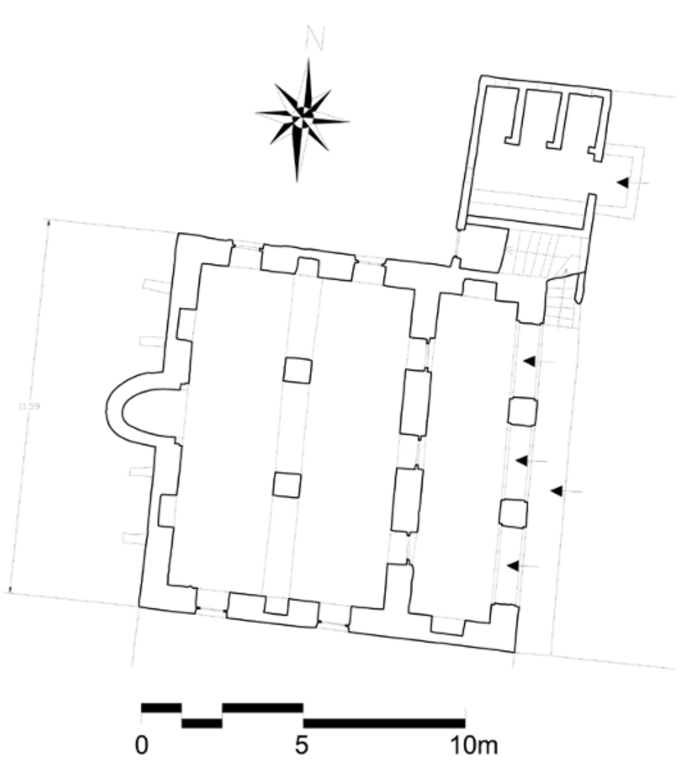


Figure 6: Plan of Al Muhannadi Mosque on Delma Island. (DCT Abu Dhabi)

Architectural style 3: This style usually consists of a prayer hall, a pergola and a room, as in the Rashid bin Al Mutawa Al Dhaheri Mosque and the Mohammed bin Ahmed Al Dhaheri Mosque (Figure 7).

Architectural style 4: This style usually consists of a prayer hall and a rear area, as at the Bin Ati Al Darmaki East Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Khalfan bin Rashid Al Mutawa Mosque and Al Liffah Mosque. There are also examples of this style to which a room has been added, such as the Saif Bal Haima Al Dhaheri Mosque and the Abdullah bin Salem Al Darmaki Mosque. The design of the latter mosque (Figure 8) is similar to the design of the Ein Sinan Mosque in northern Qatar, which dates to 1940, with the location of the hall attached to the Abdullah bin Salem Al Darmaki Mosque differing from that attached to the Ein Sinan Mosque, since the hall is to the south of the former mosque and to the north of the latter (Ramadan 2009: 17).



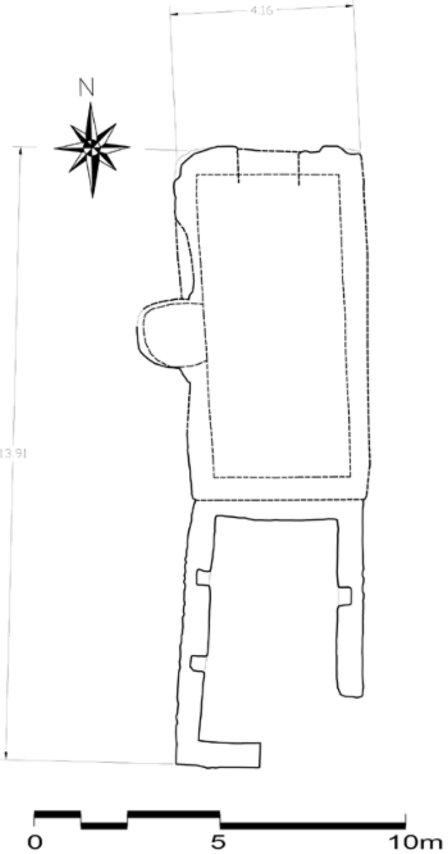


Figure 7 (left): Plan of the Muhammad bin Ahmad Al Dhaheri Mosque. (DCT Abu Dhabi)

Figure 8 (right): Plan of the Abdullah bin Salem Al Darmaki Mosque. (DCT Abu Dhabi)

Minarets

There are not many minarets in the mosques of Abu Dhabi, although in the eastern corner of the courtyard of Al Muraykhi Mosque, a raised section is thought to have probably been designated for the muezzin for the call to prayer (Al Azzawi 2000: 141; King 2009: 52; 2006: 157-160).

Some mosques were fitted with stairs used to reach the roof. Their function may have been for the muezzin to reach the top of the mosque to sound the call to prayer. Examples have been found in the Jahili Mosque and the Mohammed bin Ahmed Al Dhaheri Mosque. In the northern part of the Sheikh Ahmed bin Hilal Al Dhaheri Mosque courtyard, a square tower with a flight of stairs inside was used as a minaret. The only known minaret among the mosques of Abu Dhabi is the ruined one in the Khalaf Al Otaiba Mosque (Figure 9), which used to be similar to the minaret of the Ibrahim Pasha Mosque in Hofuf, dating back to the Ottoman era (King 2010: 18).

Mihrabs

The historic mosques in Abu Dhabi featured mihrabs in their prayer halls as a central architectural element. Their protrusion distinguishes them from the vertex of the qibla wall on the outside, while they are concave on the inside.

Figure 9: Minaret of the Khalaf Al Otaiba Mosque in Abu Dhabi (King 2009).

In one type, the projection assumes a semicircle, such as the mihrabs of Al Ain's Abbasid-era mosque, Jahili Mosque and Qasr Al Muwaiji's mosque. There is a type with a rectangular projection that ends with a semicircular shape, such as the mihrabs of the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque and Al Muraykhi Mosque. There is also a type whose projection assumes a rectangular shape on the inside and the outside, such as the mihrab of Al Muhannadi Mosque.

Some mosques had two mihrabs, one in the prayer hall and the other in the open-air courtyard, as in the Abbasid-era mosque. The mihrabs are usually covered on the inside with a vaulted ceiling, such as the mihrabs of the Qasr Al Muwaiji mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque (Figure 10), the Juma bin Rahma Al Darmaki Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Ali bin Salem Al Kindi Mosque, the Bin Shabib Al Dhaheri Mosque, Al Muraykhi Mosque and Al Dawsari Mosque. In some mihrabs, windcatchers were built for ventilation and to convey the imam's voice outside the mosque. These windcatchers appear in the mihrabs of the Juma bin Rahma Al Darmaki Mosque, the Rashid

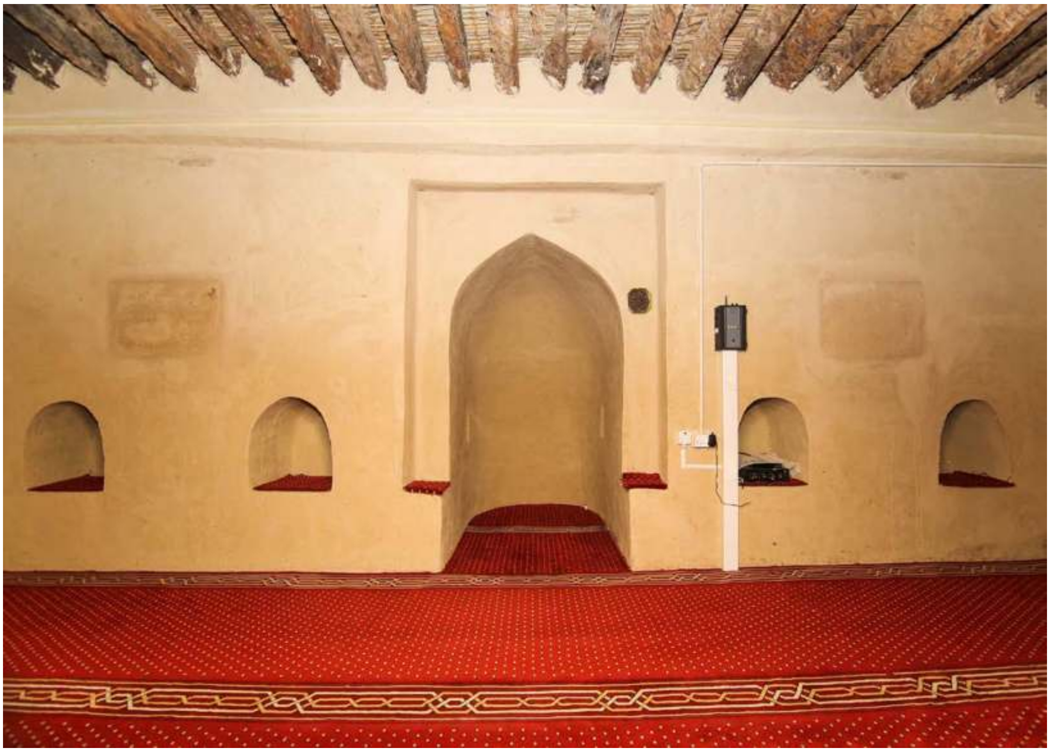


Figure 10: Mihrab of the Rashid bin Al Mutawa Al Dhaheri Mosque. (DCT Abu Dhabi)

Al Haytah Al Darmaki Mosque, the Bin Ati Al Darmaki West Mosque , the Ali bin Salem Al Kindi Mosque, Al Muraykhi Mosque and Al Dawsari Mosque. Above the mihrab in Al Dawsari Mosque, there was a foundation plaque that reads: "In the name of God the merciful, the compassionate. Construction was completed with the help of the All-Hearing Creator in Shawal 1349 AH." It is now kept at the Delma Museum.

Minbars

Adjacent to the mihrab in Al Muhannadi Mosque is a stone minbar accessible from within the mihrab by four stairs. It overlooks the prayer hall, with a decorated stepped railing that matches the mosque's decoration, which lends credence to the belief that it was used for the Friday prayer and the sermon. There is also a minbar to the right of the mihrab in the Bin Shabib Al Dhaheri Mosque. The Qasr Al Muwaiji mosque has a mihrab (Figure 11), its lower part covered by an openwork screen, behind which is a seat used as a minbar.

Entrances

The historic mosques in Abu Dhabi were fitted with entrances, most of which open onto the exposed courtyard, as in the Abbasid-era mosque, Jahili Mosque, Qasr Al Muwaiji's mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Isa bin Sultan Al Dhaheri Mosque and the Mohammed bin Ahmed Al Dhaheri Mosque.

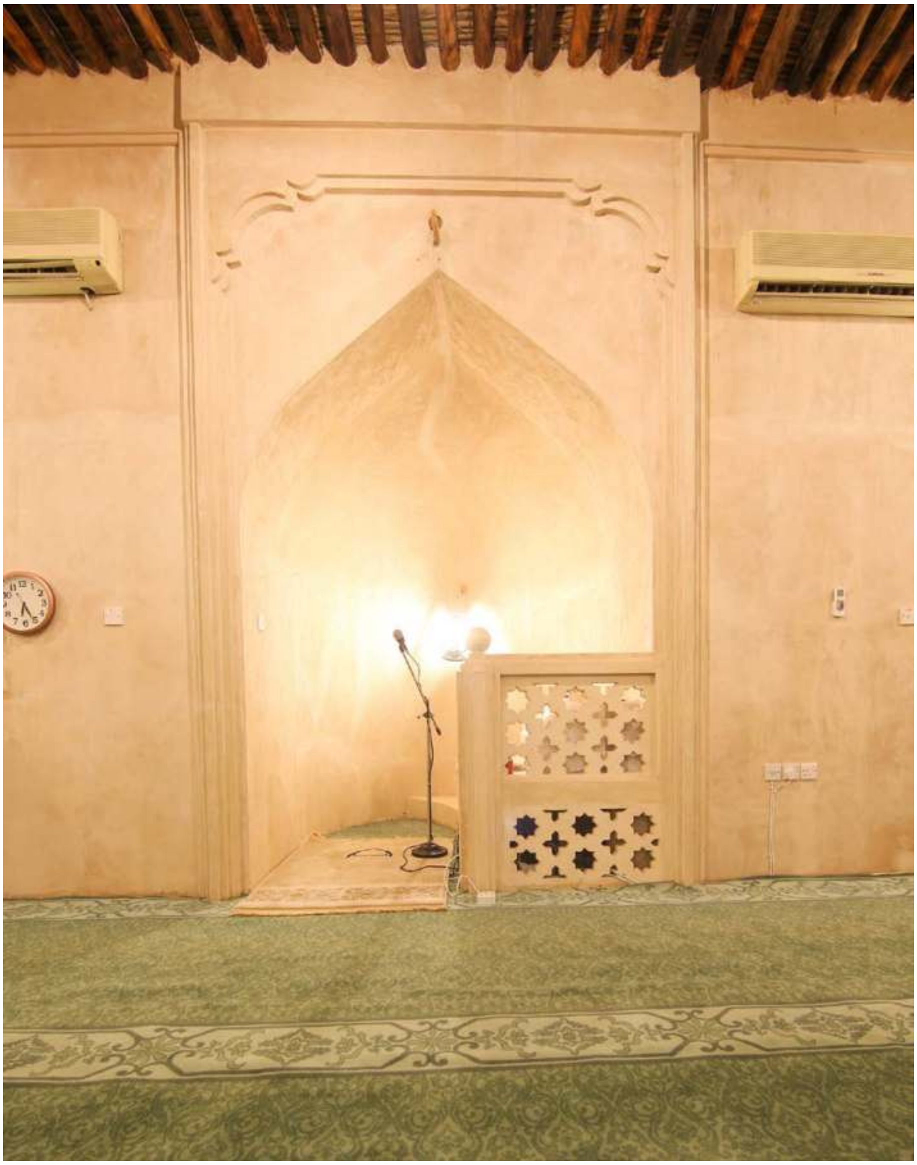


Figure 11: Mihrab and minbar of the Qasr Al Muwaiji Mosque. (DCT Abu Dhabi)

Doors

The outer doors of Abu Dhabi's mosques were designed to have three to six panels, sometimes three on one of the two leaves and four on the other. The leaves were decorated with large iron nail heads, called *finjan* locally, equidistant from each other. The central column of the doorway is almost always decorated with simple and beautiful geometric decorations, such as circles and squares. The middle section contains two connected floral shapes surrounded by asymmetrical organic shapes from above and below. The fourth type resembles the first since it is divided into three large rectangles, each containing intersecting triangles and large and small circles.

For example, in Al Muraykhi Mosque, Al Dawsari Mosque, Al Muhannadi Mosque, the Bin Ati Al Darmaki West Mosque, the Sultan Al Khamisani Al Dhaheri Mosque (Figure 12), the Isa bin Sultan Al Dhaheri Mosque, the

Figure 12: Door flanked by two kutubiyyat recesses in the Sultan Al Khamisani Al Dhaheri Mosque. (DCT Abu Dhabi)

Humaid bin Isa Al Dhaheri Mosque and the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the entrances were covered with double-leaf doors and decorated with strips of Abu Kubba nails. The entrance to the courtyard in Al Muraykhi Mosque was covered with a wooden door decorated with rows of nails of the Abu Kubba type and geometrically configured decorations.

Windows

There are several words for windows in the United Arab Emirates, including *shubbak*, *sharbak*, *darishah* (plural *darayish*) and *banjara*, a Persian word (Al Mutwali 2007: 36; Kent 2018: 99).

The mosques in the emirate of Abu Dhabi have two types of windows. The first has decorated iron bars and wooden leaves, while the second is decorated with types of plaster panels locally known as *jali* (Zaghl 2012: 88; Al Azzawi 1998a: 51; Al Mutwali 2007: 36). The first type usually had one leaf divided into two halves: upper and lower, separated, so that each can be opened or closed independently, thereby providing a better ventilation system. These windows are located near ground level, and they overlook the courtyard. In this way, they function as air conditioners by providing cool air through the lower half of the window while the hot air rises and goes out through the small air holes above the wall near the roof (Al Mutwali 2007: 36).

The second type is designed to allow as much ventilation as possible through engravings cut into panels of plaster or *jali*. It was used in vaulted entrances and porticoes opposite the windows of the adjacent rooms, called *rawzana hawa* locally. These windows may fill the extent of a rectangular window or serve as part of an entrance with a semicircular arch.

In the walls of the prayer hall in the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Humaid bin Isa Al Dhaheri Mosque and the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, rectangular apertures were opened into which wooden windows were installed from the inside and an iron screen from the outside.

Supports and pillars

Supports were used in Al Muraykhi Mosque, the Qasr Al Muwaiji mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque and the Bin Shabib Al Dhaheri Mosque to support the roof of the prayer hall, while cylindrical pillars were used in Al Muhannadi Mosque to support the roof of its prayer hall.

Vaults

Various types of vaults are used in the mosques of Abu Dhabi.

Semicircular vaults: This type of vault is found in Pre-Islamic architecture. It appeared in Islamic architecture for the first time in the Umayyad era in the Dome of the Rock (72 AH/691 CE). It then became common in Umayyad and Abbasid castles (Rizk 2000: 194-195; Abd al-Malik 2002: 578-579; Hammoud 2002: 4; Al Tayyar 2016: 37). A semicircular vault was used, for example, in Al Muraykhi Mosque, Al Dawsari Mosque, the Qasr Al Muwaiji mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque and the Rashid Al Haytah Al Darmaki Mosque.

Tapered vaults: This type became widespread in Islamic architecture from an early period. Several types, such as the ordinary tapered vault planned from two centres, are known. This vault appeared for the first time in Islamic architecture in the Umayyad Mosque of Damascus (Rizk 2000: 197-198; Abd al-Malik 2002: 568-572; Hammoud 2002: 4; Al Tayyar 2016: 38; Al Mutwali 2007: 35; Edwards and Edwards 1999: 72-74). The tapered vault with four centres was the invention of Muslim architects, and it was found for the first time in the Baghdad Gate in Raqqa (about 155 AH/771 CE) (Al Jumaa 2000: 44-45).

The tapered vault was used, for example, in Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque and the Saif Bal Haima Al Dhaheri Mosque.

Triangular vaults: This is a vault that takes a triangular shape. This type of vault was used in mosques of the emirate of Abu Dhabi in the Hamad bin Sultan Al Darmaki Mosque and the Bin Hammouda Al Dhaheri Mosque.

Kutubiyyat

These are places or small recesses in the walls where copies of the Qur'an are placed. Examples of them are found in the walls of Al Liffah Mosque, the Qasr Al Muwaiji mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque and the Sultan Al Khamisani Al Dhaheri Mosque (Figure 12).

Fountains for ritual ablution

Many historic mosques in Abu Dhabi have a fountain for ritual ablution. For example, in Al Muraykhi Mosque, Al Dawsari Mosque and Al Muhannadi Mosque, a fountain is located in the south-eastern corner of the mosque. Outside the Qasr Al Muwaiji mosque, there is a rectangular fountain divided on the inside into ablution areas. Meanwhile, some mosques, such as the Hamad bin Sultan Al Darmaki Mosque, were supplied with wells for drawing water.

Roofing

The mosques of Abu Dhabi were covered with flat roofs consisting of palm-tree trunks as crossbeams, on top of which were layers of bamboo canes, and on top of that was a reed mat (*bariya*), then a mat of palm-tree leaves and finally a layer of plaster. Examples of this can be found in Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, Al Dawsari Mosque and Al Muhannadi Mosque.

Plaster curtains

The small windows above the doors were covered by perforated plaster curtains at the front to allow light and air into the prayer hall, as in Al Muraykhi Mosque, Al Dawsari Mosque, Al Muhannadi Mosque, Qasr Al Muwaiji's mosque and the Rashid bin Al Mutawa Al Dhaheri Mosque (Figure 13).

Façades

The historic mosques of Abu Dhabi were distinguished by their simple façades. Al Muraykhi, Al Dawsari (Figure 14) and Al Muhannadi Mosque have four simple façades whose tops terminate with spouts from palm-tree trunks. The Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque (Figure 15) and the Hamad bin Sultan Al Darmaki Mosque have four façades that terminate with indented balconies, and the Rashid Al Haytah Al Darmaki Mosque has two façades that end with indented balconies.

Figure 13 (top left): Window in the Rashid bin Al Mutawa Al Dhaheri Mosque. (DCT Abu Dhabi)

Figure 14 (top right): Plan of Al Dossari Mosque on Delma Island. (DCT Abu Dhabi)

Figure 15 (right): Façades of the Jum'a bin Rahma Al Darmaki Mosque. (DCT Abu Dhabi)

Construction materials

Adobe brick (*madar*)

Adobe brick, called *madar* locally, is one of the oldest building materials in the world (Abd al-Jalil 2000: 65). It is found in riverbeds or on riverbanks. It is mixed with water and straw for increased resistance to weather factors, and lime, derived from burning calcareous rocks. It is then trampled by foot, shaped in rectangular moulds and left to dry in the sun (Abd al-Jalil 2000: 65-66; Zaghl 2012: 89; Rashid 2016: 39; Al Midilawi 2007: 55; Al Azzawi 1998a: 96; Al Mutwali 2007: 28).

Sometimes, clay is used as mortar or joining material or as a casing, in which context it is called *layt* (plaster). Several ways were found to make clay resistant to rain and moisture by covering the bricks with a layer of a mixture resistant to weather factors (Abd al-Jalil 2000: 66).

Adobe brick is considered a primary construction material in most mosques of the Abu Dhabi emirate, especially in the oases. Examples are the old Abbasid mosque, Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque, the Bin Hammouda Al Dhaheri Mosque, the Ali bin Salem Al Kindi Mosque, the Abdullah bin Salem Al Darmaki Mosque, the Bin Hazam Al Dhaheri Mosque, the Bin Rayeh Al Darmaki Mosque, the Ali bin Khalfan Al Mutawa Al Dhaheri Mosque, the Bin Shabib Al Dhaheri Mosque and the Khalfan bin Rashid Al Mutawa Mosque.

Coral rock

Locally known as *bim* (singular *bima),* this fan-shaped coral rock is also called *suna*, or *shanidi,* for the solid type. It is a circular or rectangular *salafa* on the side of which are attached small snails, bent and firmly connected. Removing these rocks from above the dry surface is complex and requires using a crowbar and the shell from a cannon (*qalula*). First the stones are hit with the *qalula* until they split, then again with a crowbar. They can then be collected at low tide after the water recedes. They are then cut and left for six months until they have dried and become harder, and the percentage of salt has decreased. Coral rock was commonly used in coastal areas for construction, especially for its ability to provide thermal insulation due to its porous nature (Zaghl 2012: 89; Abd al-Jalil 2000: 67; Rashid 2016: 39; Al Azzawi 2001: 100; Al Kuwaiti 1995: 302, 312; Al Azzawi, A.S. 1998a: 96; Al Mutwali 2007: 26; Al Khulaifi 2003b: 18).

Mosques of Abu Dhabi that were built with these stones include Al Liffah Mosque on Marawah Island and the three mosques on Delma Island: Al Muraykhi, Al Dawsari and Al Muhannadi.

Sarooj

Sarooj is a type of local red clay. It is mixed with cow dung and pure clay, not mixed with sand. A 5- to 15-cm thick layer of this sticky mixture is spread on the ground and left to dry. It is then cut and placed in a hole in the ground with burning embers, then covered with dirt to prevent heat escaping. *Sarooj is also distinguished by its low thermal conductivity, strong resistance, cohesiveness and low permeability to water. It is used as an adhesive material if later mixed with water*, the same as cement (Abd al-Jalil 2000: 70; Zaghl 2012: 89, 124; Al Mutwali 2007: 28).

In the emirate of Abu Dhabi, *sarooj was used to line wells in Al* Muraykhi Mosque, Al Dawsari Mosque and Al Muhannadi Mosque, and to cover the walls of Qasr Al Muwaiji's mosque.

Stucco or lime

In Abu Dhabi, stucco is made from rocks, oysters and sea coral. They are left in a hole with a burning fire for three to four days, after which they are removed and pulverised into a powder to use as an adhesive in construction. This type of stucco was known as 'stucco of the sea'. The second type of stucco consists of calcareous rock. The gravel found abundantly in the city of Al Ain near the foot of Jebel Hafit is piled up on a base of palm-tree trunks arranged horizontally, forming a 4 x 4 metre square. Then, another layer of palm-tree trunks is placed above the piles of gravel, but in the opposite direction. Openings are left at the bottom to ignite the wood and for ventilation to keep the combustion going. This fire is usually left to burn for 12 days or until it is extinguished. After the burning phase, the height of the rock piles decreases as the wood becomes ashes. When the fire is completely extinguished, the rocks are collected and pulverised with a wooden stick until they reach the consistency of sand. Stucco was the primary construction material for walls, built to be one metre thick for defence purposes. It was also used as an interior coating for constructions and to cover roofs, protecting them from rain. Stucco is also characterised by its essential role in insulation since thermal penetration is slow. It was therefore used to weld coral rocks and build walls (Rashid 2016: 39; Abd al-Jalil 2000: 68; Zaghl 2012: 89, 124-125; Al Azzawi 2001: 101; Al Kuwaiti 1995: 303; Al Azzawi 1998a: 96; Al Mutwali 2007: 26-28).

Examples of Abu Dhabi mosques where stucco was used are the Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Bin Ati Al Darmaki East Mosque, the Bin Ati Al Darmaki West Mosque, the Sultan Al Khamisani Al Dhaheri Mosque, the Isa bin Sultan Al Dhaheri Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Bin Hazam Al Dhaheri Mosque, the Bin Rayeh Al Darmaki Mosque, the Ali bin Khalfan Al Mutawa Al Dhaheri Mosque, the Bin Shabib Al Dhaheri Mosque, the Khalfan bin Rashid Al Mutawa Mosque, Al Muraykhi Mosque, Al Dawsari Mosque and Al Muhannadi Mosque.

Wood

Several types of wood were used in the mosques of the emirate of Abu Dhabi, including:

Palm trunks: Palm trunks and other palm products, such as branches, *du'un*, leaves and fibres, have historically been used as construction materials in the region. Excavations show the use of palm trees as a basic element of traditional construction, as in the archaeological remains of Hili, north of the city of Al Ain (Abd al-Jalil 2000: 71; Kent 2018: 96).

Depending on the construction location, cut palm trunks were used in roofing or above door openings, windows and curvatures. They were cut into two parts or four sections, depending on their condition and size, and their intended use in the building (Al Azzawi 2001: 101; Zaghl 2012: 87).

Palm trunks were used in the Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Bin Ati Al Darmaki East Mosque, the Bin Ati Al Darmaki West Mosque, the Sultan Al Khamisani Al Dhaheri Mosque, the Isa bin Sultan Al Dhaheri Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque and the Bin Hammouda Al Dhaheri Mosque.

Du'un: *Du'un* refers to conjoined palm leaves used to construct a barrier or fence for houses. Woven, they are also used as a second layer over palm trunks or beams for ceilings. The (dry) palm leaves are peeled off. The stalks are then tied with rope (hemp) and placed amid the palm trunks and the beams, while the rest are placed above them widthwise (joining them together). They would form an overlapping linked section, similar to woven fabric, based on palm branches stripped of their leaves lengthwise and widthwise. The *du'un* are rarely placed on the ceiling without cleaning because they begin to crumble and fall after the palm leaves have dried. Therefore, they are only used stripped from their leaves. The stripping method must be considered during the peeling process so as not to cut or remove a section of the palm leaf's body (*jarida*), thus keeping it whole and sound and ready for use on ceilings (Al Azzawi 2001: 102; Abd al-Jalil 2000: 72).

Du'un were used in the Jahili Mosque, Qasr Al Muwaiji's mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Jum'a bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Bin Ati Al Darmaki East Mosque, the Bin Ati Al Darmaki West Mosque, the Sultan Al Khamisani Al Dhaheri Mosque, the Isa bin Sultan Al Dhaheri Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque and the Bin Hammouda Al Dhaheri Mosque.

Jandal or shandal: *Jandal* is a type of *Rhizophora* mangrove tree or tree stump (Al Khulaifi 2003b: 18). These trees are mentioned in several Greek and Latin sources dating back to the third century BCE. They contain clear references to their growth on the southern coasts of the Red Sea, the eastern coast of Africa and the coasts of the Arabian Gulf region. *Jandal* was brought from

Pemba Island, known in Arabic as the Green Island, which is located south of Zanzibar. J*andals* are tied in bundles of 20 called a *korya* or *korja*, which is originally a Swahili word. *Jandal* was indispensable in the Arabian Gulf for ceilings. Their length varied between 2.5 and 3 metres, thus determining the width of the room. This led to the similarity of the rooms in width, and the people in any one room were seated close together. The green *jandal* wood is dyed with tar to protect it from termites and other insects, making it often black in colour. *Jandal* was used for long crossbeams between pillars, joined together at equal distances to support the ceiling. It is then covered with layers of *du'un* and clay (Abd al-Jalil 2000: 71; Zaghl 2012: 87-89, 125-126; Al Mutwali 2007: 29; Al Azzawi 2001: 101; Rashid 2016: 39; Al Kuwaiti 1995: 312).

Jandal was used for ceiling supports in Al Muraykhi Mosque, Al Dawsari Mosque and Al Muhannadi Mosque.

Teak: Teak is a variety of tropical tree growing in South and Southeast Asia, especially in India. It is appreciated for its sturdy wood and is characterised by its resistance to termites (Al Alawi 1997: 57; Al Shunaikat 2012: 113).

Teak was used in the construction of doors and windows in Al Muraykhi Mosque, Al Dawsari Mosque, Al Muhannadi Mosque, the Juma bin Rahma Al Darmaki Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Bin Ati Al Darmaki East Mosque, the Sultan Al Khamisani Al Dhaheri Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Sheikh Ahmed bin Hilal Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque and the Bin Hammouda Al Dhaheri Mosque.

Metals

The use of iron and copper in the mosques of the emirate of Abu Dhabi included window bars and for the nails used in the manufacture of doors, windows and exterior latches (Al Azzawi 2001: 104; 1998a: 97).

Iron bars are found on the windows of Al Muraykhi Mosque, Al Dawsari Mosque, Al Muhannadi Mosque, the Rashid bin Al Mutawa Al Dhaheri Mosque, the Juma bin Rahma Al Darmaki Mosque, the Hamad bin Sultan Al Darmaki Mosque, the Bin Ati Al Darmaki East Mosque, the Bin Ati Al Darmaki West Mosque, the Sultan Al Khamisani Al Dhaheri Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque and the Mohammed bin Ahmed Al Dhaheri Mosque.

Dating Abu Dhabi's historic mosques

Dating mosques is one of the biggest challenges facing researchers studying religious architecture in the United Arab Emirates, specifically Abu Dhabi. The construction dates of most mosques are unknown due to the lack of contemporary historians or historians who lived closer to that time. Therefore, most of them have undetermined dates. Moreover, some mosques fell into oblivion or were rebuilt. Hence, it isn't easy to find information about the construction dates of those mosques, the periods when they were built or the name of the founder who ordered their construction (Rashid 2016: 44-47).

Despite this problem, the dating of some mosques in Abu Dhabi has been possible based on the following:

1. Foundational texts and verses of poetry that recorded the construction date by using the letters of the alphabet according to their numerical value. Qasr Al Muwaiji has its construction date inscribed on the door, i.e. 3 Shaaban 1328 AH (the middle of 1910 CE). It has been determined that its mosque was also built on the same date.

2. Archaeological finds, as in the case of the Abbasid mosque in Al Ain. Based on samples found at the site, it was possible to determine the mosque's construction date in the Abbasid era (Al Shamsi 2019: 103).

3. Contemporaneity of the founders with known historical persons, such as Sheikh Ahmed bin Hilal Al Dhaheri, the representative of Sheikh Zayed bin Khalifa in Al Ain (1855–1901).

4. Many mosques in Abu Dhabi were built simultaneously with defensive fortifications or houses. One instance is the mosque in Al Jahili Fort. The fort was built in 1316 AH/1898 CE during Sheikh Zayed bin Khalifa's rule, concomitantly with Qasr Al Muwaiji. This can be confirmed by the locations of the mosques relative to the two forts and the similarity in the design. Qasr Al Muwaiji appeared in a photograph taken by Wilfred Thesiger in 1948. Other examples are the Juma bin Rahma Al Darmaki Mosque, which was constructed about 500 years ago and is contemporary with the construction of the Juma bin Rahma Al Darmaki house (Al Shamsi 2019: 112); the Hamad bin Sultan Al Darmaki Mosque in Hamad bin Sultan Al Darmaki Fort in Al Qattara Oasis, which dates back to the 18th century CE; and Al Muraykhi Mosque, which dates back to the period between the end of the 19th century and the early 20th century, based on the construction of Al Muraykhi House, built by the same merchant.

5. Oral accounts of settlers can be used to date the Sultan Al Khamisani Al Dhaheri Mosque, whose construction is said to date back to the last quarter of the 19th century CE (Ali 2005: 390, 395); the Isa bin Sultan Al Dhaheri Mosque, whose construction dates to the middle of the 19th century CE; Al Dawsari Mosque, which was built in 1931 CE; and Al Muhannadi Mosque, which was built in 1946 CE.

6. Architectural style: By comparing architectural styles, it has been possible to date some of the mosques whose construction date was unknown, such as the Rashid bin Al Mutawa Al Dhaheri Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Saif Bal

Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque, the Bin Hammouda Al Dhaheri Mosque, the Ali bin Salem Al Kindi Mosque, the Abdullah bin Salem Al Darmaki Mosque, the Bin Hazam Al Dhaheri Mosque, the Bin Rayeh Al Darmaki Mosque, the Ali bin Khalfan Al Mutawa Al Dhaheri Mosque, the Bin Shabib Al Dhaheri Mosque, the Khalfan bin Rashid Al Mutawa Mosque and Al Liffah Mosque.

Mosque names

The absence of historical records on the dating of mosques in the emirate of Abu Dhabi is reflected in the names of those mosques, which were given according to:

1. The location: The Jahili Mosque was given that name in connection with the Jahili area in the city of Al Ain.

2. The founder: Some mosques were named after their founder, such as the Rashid bin Al Mutawa Al Dhaheri Mosque, the Rashid Al Haytah Al Darmaki Mosque, the Humaid bin Isa Al Dhaheri Mosque, the Saif Bal Haima Al Dhaheri Mosque, the Mohammed bin Ahmed Al Dhaheri Mosque, the Bin Hammouda Al Dhaheri Mosque, the Ali bin Salem Al Kindi Mosque, the Abdullah bin Salem Al Darmaki Mosque, the Bin Hazam Al Dhaheri Mosque, the Bin Rayeh Al Darmaki Mosque, the Ali bin Khalfan Al Mutawa Al Dhaheri Mosque, the Bin Shabib Al Dhaheri Mosque and the Khalfan bin Rashid Al Mutawa Mosque.

3. A historical event: Some mosques were named after some historical events, such as the Qasr Al Muwaiji mosque in the Al Muwaiji area, referring to *al muwaiqiʿi*, i.e. the place where a famous incident had taken place, and during which several men were killed (Rashid 2016: 102).

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