Bat Archaeological Project

Report of the 2024-25 Season

by

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Executive Summary

The Bat Archaeological Project (BAP) conducted its 2024-25 season of excavations and survey from 29 December 2024 - 2 February 2025. Our research concentrated on five specific areas: 1) archaeological excavations of an large Umm an-Nar period building at Rakhat al-Madrh (رخة المدره); 2) test excavations of Umm an-Nar period architecture at the Bat Settlement Slope; 3) a program of community outreach and engagement; 4) geomorphological and archaeobotanical survey of the Wadi al-Hijr; 5) site monitoring and photogrammetry of the historic Husn al-Wardi; and 6) continued programs in community-based heritage outreach to further engage the local community.

At Rakhat al-Madrh, excavations explored the Umm an-Nar period structures along the edge of the site's central depression. Building on the results of BAP's previous three years of work at the site, this season focused on the especially large RaM 3 building, while also continuing investigations in RaM 2 and a nearby Hafit tomb. RaM 3's massive architecture, multiple occupational phases, and evidence for pyrotechnic installations, copper working, and bead production point to its role as a specialized craft-production center during the Umm an-Nar period. Later reuse during the Wadi Suq, Iron Age, and Islamic periods—often involving fire-based activities—reflects the building's enduring utility and prominence within the basin. Excavations in RaM 2 revealed two ovens at the courtyard wall foundation, expanding evidence for food preparation or processing activities, while geomorphological sampling continued to inform understanding of basin formation. The Hafit tomb, though lacking preserved remains, was fully documented in 3D. Together, these results highlight Rakhat al-Madrh's significance as a multi-phase settlement where specialized production, environmental adaptation, and repeated reoccupation intersected over centuries.

Test excavations at the Bat Settlement Slope continued to clarify the architectural and occupational history of the site. Three small trenches in Structure SS6 confirmed severe erosion and lack of intact floor deposits, though they yielded abundant ceramics and data to support future architectural reconstruction. Continued work in Tomb 201201 recovered highly fragmented and commingled human remains, including a probable adult male with dental pathology and burned bone consistent with high-

temperature exposure of wet bone, alongside beads and funerary ceramics. These results refine understanding of Umm an-Nar settlement architecture, preservation challenges, and complex mortuary practices within the Bat oasis landscape. At the Husn al-Wardi, we continued our annual monitoring program of the mudbrick architecture of the Husn al Wardi through photography and 3D photogrammetry, intending to identify structural integrity risks and recommend actions for conservation.

The project also counted its expanded community engagement and outreach program to more systematically integrate Bat residents' perspectives into its research and engagement practices. The initiative combined structured feedback—via surveys and interviews—with interactive events designed to connect the community to ongoing archaeological work. Two gender-specific "Welcome Day" gatherings introduced seasonal research plans, encouraged site visits, and collected community input, while a final "Open Day" attracted ~75 attendees for presentations of excavation results, artifact displays, 3D models, heritage photographs, traditional food, and hands-on activities for children. These efforts strengthened dialogue between archaeologists and residents, addressed historic gaps between research and local involvement, and established a model for responsive, mutually beneficial heritage work that aligns with community needs, the Oman Ministry of Heritage and Tourism's priorities, and future tourism development through the Bat Visitor Centre.

We deeply appreciate the Ministry of Heritage and Tourism's ongoing collaboration and support of this research.

Acknowledgements

We would like to thank His Excellency Undersecretary for Heritage Affairs Mr. Salim bin Mohammed Al-Mahruqi, Advisor to the Minister of Heritage Mr. Sultan al-Bakhri, Director General of Archaeology and Museums, Director of World Heritage Sites Ms. Ibtisam al-Mamari, Director of Excavations and Collections Mr. Ali al-Mahroqi, Mr. Ibrahim al-Maqbali, and all the staff members of the Department of Excavations and Archaeological Studies, the Ministry of Heritage and Culture, Sultanate of Oman, for their wonderful support to our mission.

We are also grateful to the ministry staff members working in the field and offices, particularly to the Ministry of Heritage and Tourism Representatives at Bat, Mr. Mohammed al-Kaabani, Mr. Mohammed al-Essai, Mr. Suleiman al-Jabri, Ms. Asma al-Jassassi, Mr. Badr al-Badi, and Ms. Sumaia al-Marmarri in particular.

Our project was financially supported by the Omani Ministry of Heritage and Tourism, the NINO Fieldwork Grant from Leiden University, the Penn Museum Director's Field Funds of the University of Pennsylvania, and the generosity of Dr. Paul Rissman. Logistical support was provided by Dr. Lauren Ristvet and the Near East Section of the Penn Museum, University of Pennsylvania. The richness of Oman's archaeological record is matched only by the generosity and kindness of its people. We are especially grateful to Bat's modern residents for their hospitality, friendship, and partnership in learning from the region's deep past.

1. Introduction

Jennifer Swerida[1]

1.1 Bat Archaeological Project (BAP)

The Bat Archaeological Project (BAP began in 2007 under the direction of the late University of Pennsylvania Professor Gregory L. Possehl. The first six seasons (2007-2012) focused in part on survey and excavation of the towers in and around Bat, focusing particularly on Kasr Al-Khafaji (Tower 1146), Matariya (Tower 1147), and Tower 1156 (Cable 2019; Mortimer & Thornton 2018; Thornton *et al.* 2016). The project joined forces for several seasons with the Japanese Team headed by Dr. Yasuhisa Kondo (Research Institute for Humanity and Nature, Japan) in what was known as the American-Japanese Bat Archaeological Project (AJBAP). Several field and study seasons followed with a new focus on third millennium BCE settlement and agriculture and resulted in the completion of three new PhD dissertations on the research at Bat (Swerida 2017; Nathan Staudt 2017; Dollarhide 2019).

Now in its 18th season, the Bat Archaeological Project (BAP) is furthering our recent focus on the complex set of Early Bronze Age human-environment interactions evidenced at the site through the lens of cultural landscape. BAP has reformed our understanding of Bat's Early Bronze Age landscape and how cultural interactions with it enhanced the resilience of its ancient populations (Swerida *et al.* 2020; Dollarhide *et al.* 2022; Swerida *et al.* 2023; Swerida *et al.* 2024; 2025; Dollarhide *et al.* in prep.). Building on this theme, BAP's 2023-24 field research targeted evidence for place-making and identity-shaping activities found in the site's Umm an-Nar period (ca. 2800-2000 BC) settlement spaces. The fieldwork detailed in this report addresses three primary research questions:

- (Q1): What kind of resource access (water, fertile soils, minerals, etc.) existed inside and outside of the Bat oasis in the Bronze Age?
- (Q2): How did the challenging environment of Bronze Age Bat act as a setting for innovation and resilience?
- (Q3): What was everyday life like of the Bronze Age residents of the Bat landscape, beyond the well-studied tombs and towers?

By combining the results of these interlinked questions, the project aims to understand the cultural processes and socio-ecological strategies practiced by Bat's Bronze Age inhabitants. The resulting reconstruction of an ancient cultural landscape will re-situate the critically understudied Omani interior in ongoing debates on connectivity and human-environment interaction in prehistoric societies and build a case study for a persistent, thriving cultural landscape in an arid environment. In highlighting the autochthonous social and technological developments visible at Bat, our results will shift narratives away from basic questions regarding access to water and

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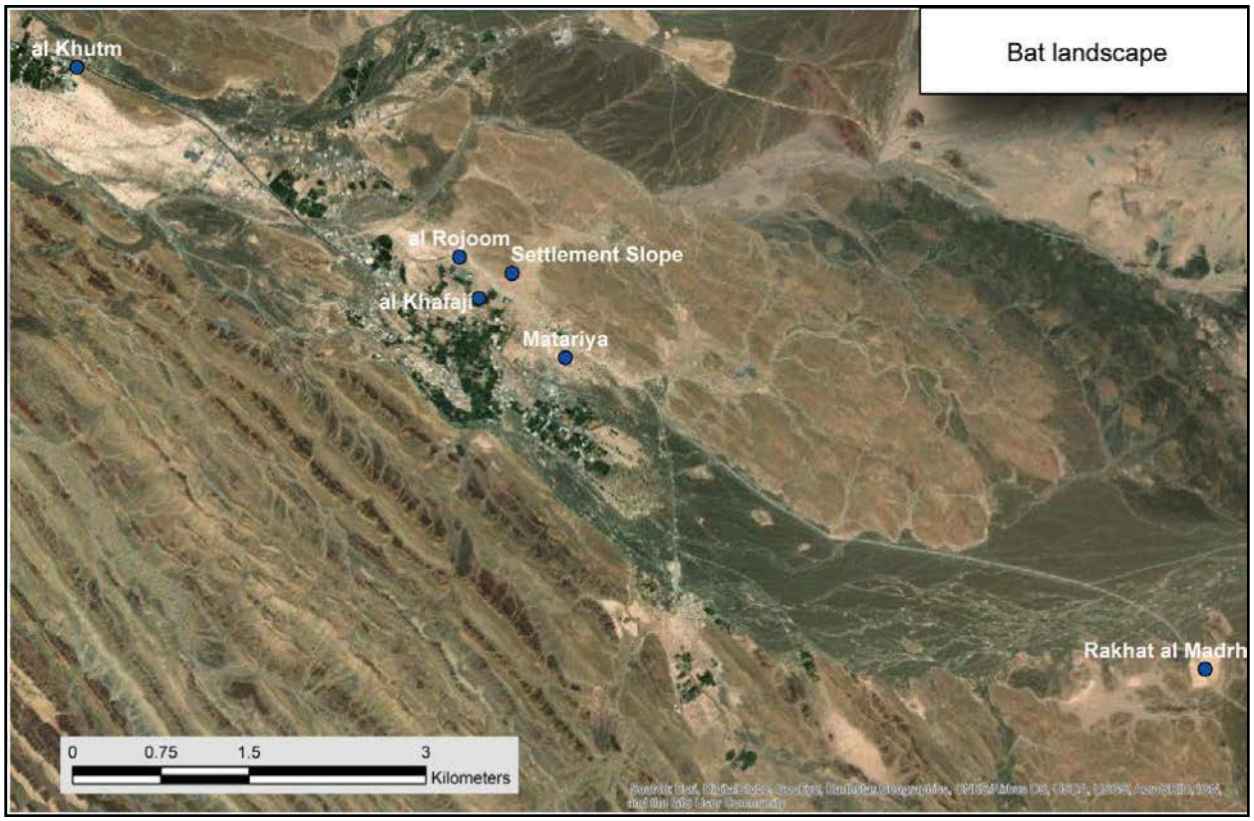

Figure 1.1 - The Bat Landscape. Research this season focused on Rakhat al-Madrh, the Settlement Slope, and outreach events with the modern Bat's local community.

highlight the complex ways in which Umm an-Nar people transformed different physical spaces into culturally-meaningful places.

To this end, in the winter of 2024-25 the project conducted surveys, excavations, and environmental research in the Bat oasis and the settlement of Rakhat al-Madrh, 7.5 km southeast of Bat. In addition, BAP has assisted the Ministry of Heritage and Tourism by providing technical expertise in several areas:

- Identification of areas for further study in the face of modern development;
- Providing feedback on the ongoing Visitor Center plans;
- Identifying areas for protection;
- Participating in regional media events;
- Developing school programs, professional training, and outreach materials.

1.2 Research Programs of the 2024-25 Season

The 2024-25 season of the Bat Archaeological Project began on 29 December 2024 and ended on 2 February 2025. Research focused on several areas: first, at the satellite

settlement of Rakhat al-Madrh 7.5 km to the southeast of Bat; second, on test excavations in the Bat Settlement Slope; third, on a program of community outreach events in Bat village; and fourth, on monitoring and 3D modeling the historic Husn al-Wardi in the Bat oasis. The season was dedicated to six goals:

(1) to understand the function of the especially large RaM 3 building at Rakhat al-Madrh;

(2) to date and better characterize the ancient structures in the Bat Settlement Slope;

(3) to conduct artifacts and ceramics analysis to temporally and materially link Bat's environs;

(4) to better understand the physical and environmental landscape of the Bat region;

(5) to engage and present opportunities for participation by local community members, especially students, in the research process and to more effectively communicate project results;

(6) to document and monitor the preservation of the historic Husn al-Wardi in the Bat oasis;

(7) and to use these results and strategies to inform the site's development for tourists.

1.2.1 BAP team members

BAP's research programs this season involved the following members (Figure 1.2):

Directors

Dr. Jennifer L. Swerida, Leiden University, the Netherlands & the Penn Museum, University of Pennsylvania, USA

Dr. Selin Nugent, Oxford Brookes University, UK

Assistant Director

Mr. Robert Bryant, University of Pennsylvania, USA

Excavation team

Ms. Rita Kremer, Leiden University, the Netherlands

Ms. Zoë van Listenburg, Leiden University, the Netherlands

Mr. Ruben Hartman, Leiden University, the Netherlands

Ms. Aiyana Plasman, Leiden University, the Netherlands

Ms. Lidwien Meulenkamp, Leiden University, the Netherlands

Mr. Christopher Kotkin, Cambridge University, UK

Ms. Georgia Vance, Johns Hopkins University, USA

Figure 1.2 - Photograph of the BAP 2025 field team.

Mr. Tim Boekema, Leiden University, the Netherlands

Ms. Olivia Franscina, Leiden University, the Netherlands

Ms. Rebekka Achterstraat, Leiden University, the Netherlands

Outreach team

Dr. Selin Nugent, Oxford Brookes University, UK

Ms. Nora Al-Aati, University of Pennsylvania, Kuwait

Specialists

Dr. Akshyeta Suryanarayan, Oxford University, UK — Lipid Analysis specialist

Mr. Robert Bryant, University of Pennsylvania, USA — GIS specialist

Ms. Alessandra Dominguez, University of Pennsylvania, USA — Archaeobotanist

Mr. Aleksandre Prosperini, Sorbonne University, France — Geomorphologist

Ms. Brittany Brown, Mississippi State University, USA — Bioarchaeologist

2. Rakhat al-Madrh

Jennifer Swerida, Robert Bryant,[2] Aiyana Plasman,[3] Zoë van Listenburg,[4] & Rita Kremer[5]

2.1 Introduction

A fifth season of excavations at the Umm an-Nar settlement of Rakhat al-Madrh resumed in the BAP 2024-25 season. The site, which is located approximately 7.5 km southeast of the modern Bat village, was first identified during a BAP survey conducted between Bat and ʻAmlah during winter 2017 (Dollarhide 2019; Dollarhide *et al.* 2017). This initial discovery and subsequent fine-grained survey (Swerida *et al.* 2020) have

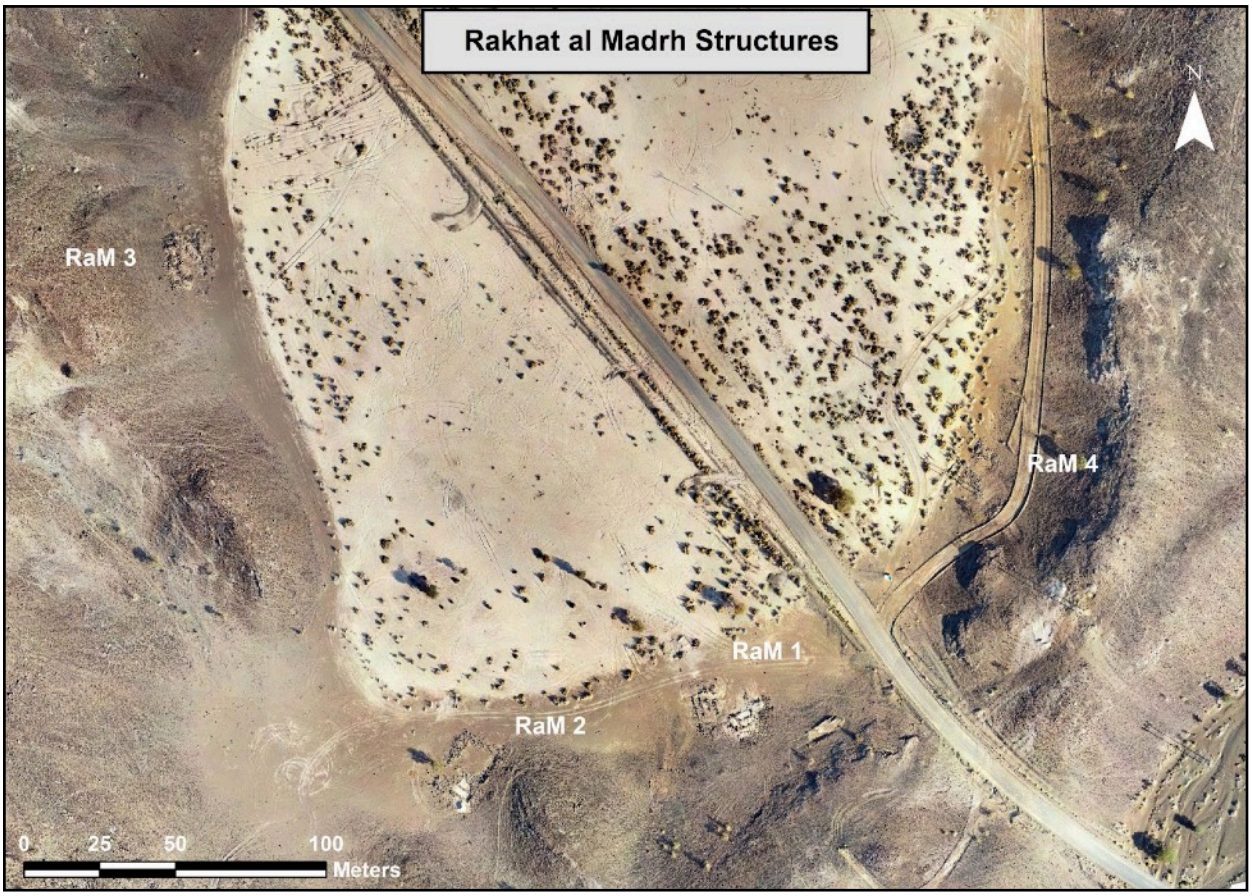

Figure 2.1 - Aerial photo of Rakhat al-Madrh with structures highlighted. RaM 3 was targeted for excavation during the BAP 2024-25 season.

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revealed at least four Umm an-Nar structures at the site arranged around a natural basin next to the main course of the Wadi al-Hijr (Figure 2.1). Geomagnetic and ground penetrating radar survey also identified two potential buried structures (Figure 2.2).

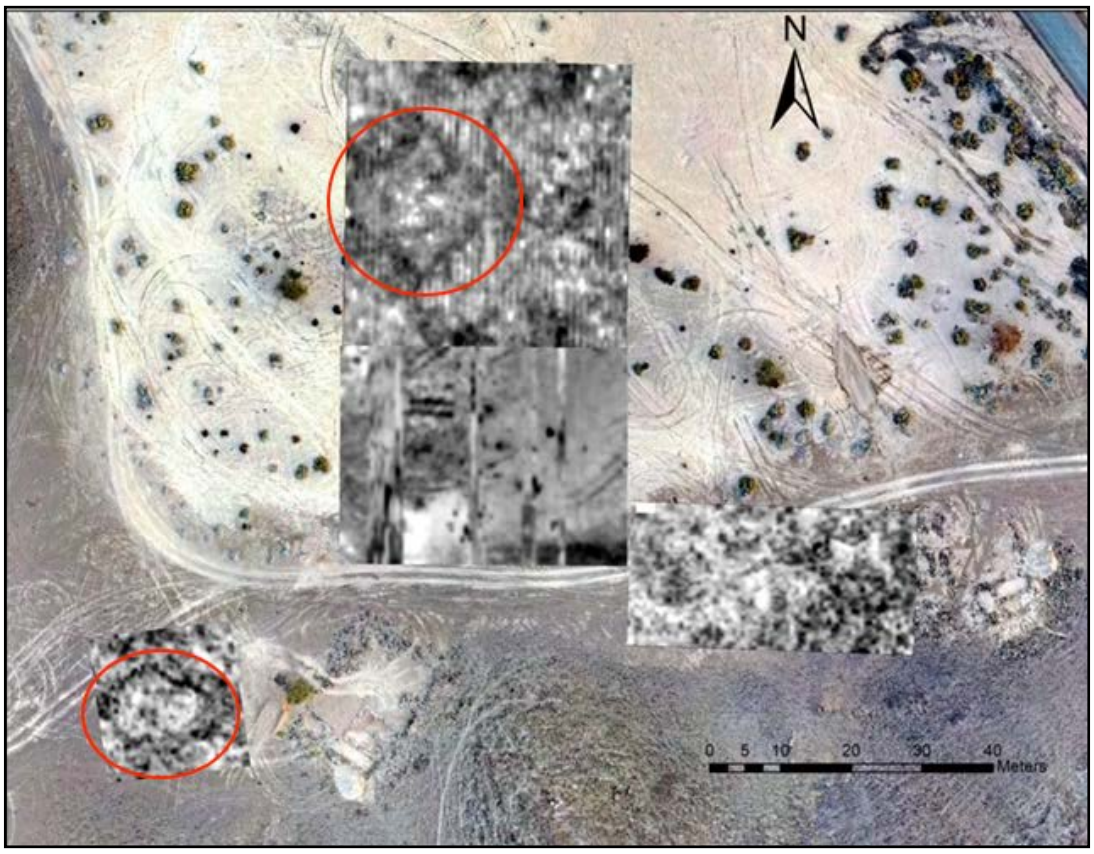

Figure 2.2 - Plan of GPR survey from BAP 2022-23 season with potential buried structures circled in red.

2.2 Summary of Previous Results

The first four seasons of excavation at Rakhat al-Madrh probed the interior contexts of all four buildings visible at surface level: RaM 1, RaM 2, RaM 3, and RaM 4 (see Dollarhide 2020; Dollarhide, Rissman, & Swerida 2022; Dollarhide *et al.* 2023; Swerida *et al.* 2025). The surface remains of each structure is similar in plan and layout to other excavated Umm an-Nar structures at Bat–featuring long compartmented rooms organized around a central walled courtyard (see Swerida *et al.* 2021 for further comparisons). Excavations revealed a substantial quantity of charred material and subsequent ^{14}C dates (see Table 2.1). These dates represent a history of human interaction with the Rakhat al-Madrh basin beginning at least as early as the Hafit period and continuing through the Late Umm an-Nar period — an occupation potentially spanning 750 years.

Additional details regarding the nature and duration of RaM's occupation were revealed through artifact and architectural analysis. Ceramics recovered from excavation in all four RaM structures revealed a variety of domestic Umm an-Nar wares and styles consistent with Middle and Late Umm an-Nar types known elsewhere from Bat (see Swerida *et al.* 2021). Architecturally, excavations in RaM 1, 2, and 4 revealed that the stone walls visible on the modern ground surface were two-three courses tall and served as the foundation for a mudbrick superstructure. Over time, these walls melted and collapsed both within and outside the structures. Alterations occurred in all buildings over the course of their occupations, both enlarging the structures through the addition of enclosed courtyards and further compartmentalizing the interior spaces. The large structure RaM 3 was exposed as a particularly complex structure with multiple architectural phases and unusually large masonry (see Dollarhide *et al.* 2023; Swerida *et al.* 2024; Swerida *et al.* 2025).

Phase	Bat Site	Contest Description	Sample	Conventional 14C Age	OxCal – IntCal 2020 Caleb. (2-sigma) cal. BC
Hafit	RaM 1	Wood charcoal sample from cultural level below the RaM 1 foundations	D-AMS 048471	4272 ± 29	2926-2871 (92.4%); 2800-2781 (3.1%)
Middle Umm an-Nar 1	RaM 1	Wood charcoal extracted from mortar in RaM 1 interior wall foundation	D-AMS 038700	3987 ± 29	2576-2460 (95.4%)
Middle Umm an-Nar 2	RaM 1	Wood charcoal extracted from mudbrick associate with the RaM 1 primary occupation	D-AMS 048472	3879 ± 30	2465-2283 (91.3%); 2250-2233 (2.9%); 2219-2210 (1.2%)
Middle Umm an-Nar 2	RaM 2	Charred seed from ash context associated with oven Feature 221844	D-AMS 053202	3765 ± 24	2286-2247 (17.1%); 2237-2132 (70.8%); 2086-2050 (7.6%)
Middle Umm an-Nar 2	RaM 2	Wood charcoal from within oven Feature 221844	D-AMS 053203	3752 ± 26	2282-2251 (9.1%); 2231-2220 (1.3%); 2210-2122 (65.3%); 2095-2039 (19.7%)
Middle Umm an-Nar 2	RaM 3	Wood charcoal from hearth on lowest identified floor level, at bottom of sounding	D-AMS 053204	3806 ± 26	2342-2192 (82.8%); 2180-2142 (12.6%)

Phase	Bat Site	Contest Description	Sample	Conventional 14C Age	OxCal – IntCal 2020 Caleb. (2-sigma) cal. BC
Late Umm an-Nar	RaM 3	Wood charcoal from burned context on floor associated with Wall 233221 in sounding	D-AMS 053205	3755 ± 24	2282-2251 (10.0%); 2231-2220 (1.3%); 2210-2127 (68.4%); 2092-2041 (15.7%)

Table 2.1 - Summary of ^{14}C dates from excavations at Rakhat al-Madrh (after Swerida *et al*. 2025: Table 2).

Archaeobotanical analysis of carbonized seeds and phytoliths collected from especially well-preserved contexts in the RaM 2 structure provide information on environmental conditions and human-environment interactions that took place at Rakhat al-Madrh during the Early Bronze Age (see Swerida *et al*. 2024). ^{14}C analysis dates these contexts to the Middle Umm an-Nar 2 and Late Umm an-Nar periods. Species identified from these botanical remains (which included carbonized seeds, caprid dung, and phytoliths) included wheat, barley, goatgrass, cyperaceae, and palm. This assortment suggests a moist environment, perhaps an intermittent wetland, in which the human communities interacting with the Rakhat al-Madrh basin engaged in an agropastoral subsistence strategy (Swerida *et al.* 2024; 2025).

2.3 Excavation Strategy

This season, archaeological excavation at Rakhat al-Madrh (RaM) continued with the following primary goals:

1) Understand the function of the site and the subsistence strategies practiced by its early Bronze Age inhabitants in light of new agricultural and water management evidence at the site;

2) Understand the function and diachronic use history of the unusually large RaM 3 structure;

3) Continue the geomorphological study of the formation of the RaM basin (see Chapter 5);

4) Probe the preservation of a Hafit tomb in the hills neighboring the RaM basin;

5) Align these newly discovered remains with BAP's long-term goal of interpreting the wider Bat landscape.

In order to achieve these goals, excavations were carried out in three locations: (1) within and surrounding the RaM 3 building, (2) within and adjacent to the RaM 2 courtyard; and (3) in a Hafit tomb located on a hill neighboring the basin. Trenches in each of these structures were laid out on a grid system, first established in Rakhat al-Madrh's 2020 excavations The datum and backsight for total station use established during the BAP 2022 season were maintained to record excavations this season (Table

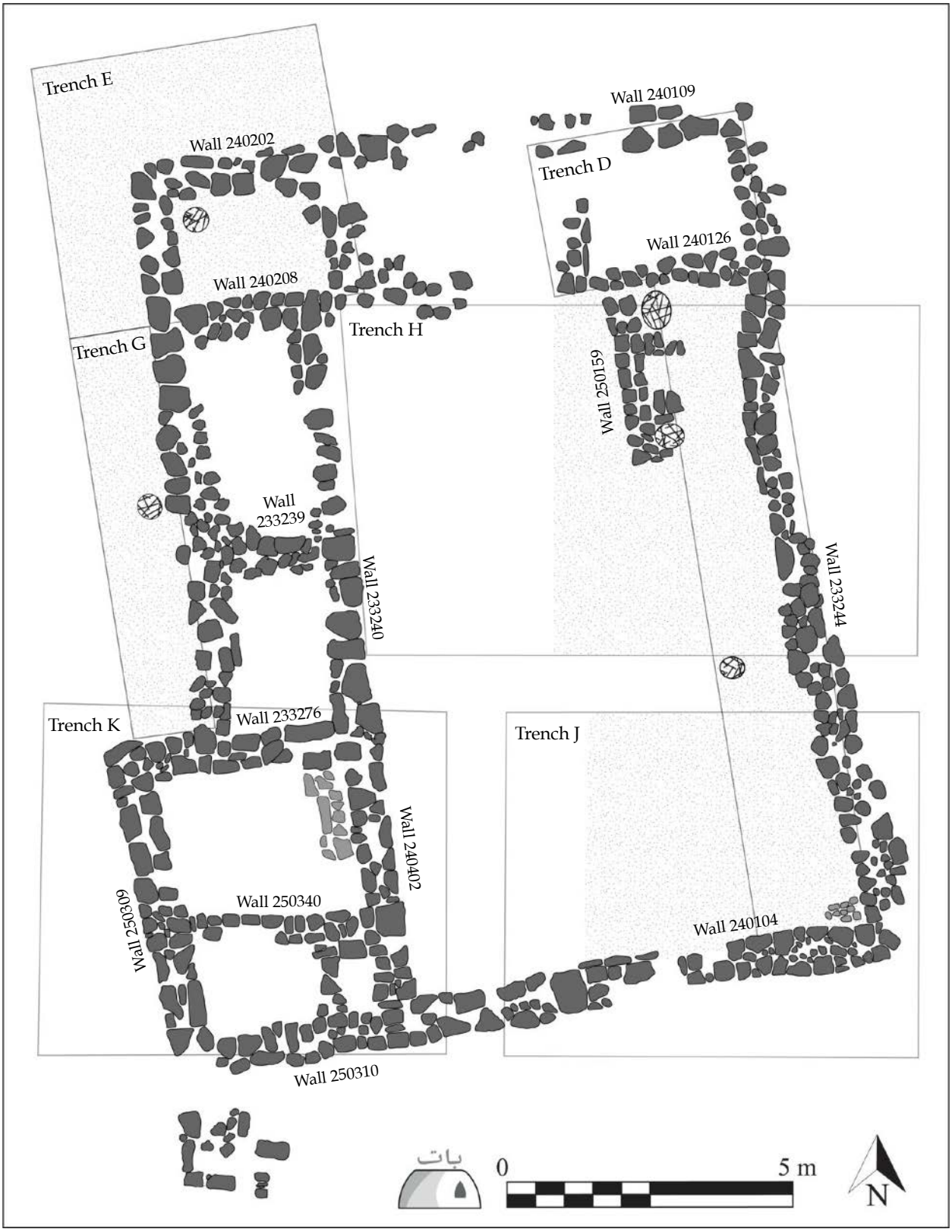

Figure 2.3 - Plan of RaM 3 indicating trenches and Umm an-Nar period walls.

Figure 2.4 - Aerial photo of RaM 3 with trenches outlined in red. RaM 3 was targeted for excavation during the BAP 2024-25 season.

2.2). All elevation and coordinate data were collected with a Differential GPS unit using these coordinates.

Master Datum: N 2569259.2000m E 480350.9000m Z 544.1400m	Backsite: N 2569273.3467m E 480350.8925m Z 542.2978m
Projection: WGS 84 / UTM 40N	EPSG: 32640

Table 2.2 - Rakhat al-Madrh datum and backsite specifics.

Recording at each structure followed standard BAP protocol; namely, providing a unique "lot number" to identified stratigraphic/dirt units; features; architecture; scientific samples; or artifacts of note. Lots this season from RaM excavations began with the prefix "250" followed by a three digit identifier (e.g., 250001). Photographs of each lot were taken and notes recorded by excavators on lot recording forms and in individual notebooks alongside starting and finishing elevations.

2.4 RaM 3

Excavations at RaM 3 began on 31 December 2024 and concluded on 29 January 2025. RaM 3 is the largest of the four known structures surrounding the central depression in the Rakhat al-Madrh basin. In addition to its size, previous excavations indicated that the building also has a longer and more complicated use history than the other three identified buildings at the site (Swerida *et al*. 2023; 2024; 2025). BAP returned to RaM 3 in 2024-25 with the goals of better defining the building's cultural function and chronology. To these ends, three trenches were excavated in various parts of the building (see Figures 2.3 & 2.4):

- Trench H: a 6x10 m trench sampling the northern portion of the RaM 3 courtyard. Due to the depth and complexity of cultural deposits, only half of the trench was excavated.
- Trench J: a 6x7 m trench sampling the southern portion of the RaM 3 courtyard.
- Trench K: a 6x7 m trench sampling the large southwestern room of RaM 3.

Excavations in all trenches encountered a similar sequence of occupational phases, with the presence and extent of earlier phases varying depending on the depth of context and excavation in each trench:

Phase 1: Intermittent visitations to the building characterized by ephemeral fire features, likely dating to the Medieval / Early Islamic period. This phase is related to the burial activity to the north of RaM 3, reported in the BAP 2020 and 2022 season reports.

Phase 2: A phase of large pitting associated with pyrotechnic activity and ephemeral walling, likely dating to the Iron Age II. This date estimate is based on the encampment identified in the northeast corner of RaM 3 in the BAP 2023-24 field campaign.

Phase 3: A packed clay surface associated with Wadi Suq ceramics and additional pyrotechnic pitting activity. Based on the elevation of this floor surface, it represents a reoccupation of the earlier RaM 3 building.

Phase 4: A smooth clay floor associated with Late Umm an-Nar ceramics, a mud brick surface, and a small corridor featuring three metallurgical installations.

Phase 5: An irregular clay surface characterized by Middle Umm an-Nar 2 ceramics and small burned features. This surface is situated below the foundation level of the RaM 3 courtyard walls and is likely an exterior space, possibly relating to an earlier phase of the building.

Phase 6: Small pyrotechnic features situated just above bedrock and associated with no identified material culture. The date of these features will be determined by ^{14}C analysis.

2.4.1 Trench H Summary

Excavations in Trench H were supervised by Ms. Aiyana Plasman between 31 December 2024 and 28 January 2025. The easternmost strip of the trench, excavated last season as Trench D, had already been taken down to a Late Umm an-Nar floor. Four occupational phases were identified:

Phase 1

The latest activity identified in Trench H is represented by a collection of pits of varying sizes. The number of pits and fire features indicates that RaM 3 experienced extensive reuse after its primary abandonment. The final phase likely dates to the Medieval/Early Islamic period and relates to burial activity north of the RaM 3 building, reported in 2020 and 2022. However, significant earlier pitting—from the Umm an-Nar through the Iron Age—suggests a prolonged pattern of activity (see Table 2.3). Many pits are ephemeral fire features, likely representing brief episodes of use, but others are larger or located in notable contexts.

Pit Lot #	Description	Phytolith	Charcoal	Depth - top/bottom (m)
250103	Circular ashy pit	Yes	No	541.293/541.266 (SE)
250104	Red fire pit/lens	Yes	No	541.287/541.279 (SE)
250105	Red fire pit/lens	Yes	Yes	541.295/541.235 (SE)
250124	Large ashy pit	Yes	Yes	541.224/541.035 (SW)
250125	Rocky fire pit	Yes	Yes	541.308/541.228 (NE)
250142	Red fire pit/lens	No	No	541.208/541.197 (SE)
250145	Red fire pit/lens	No	No	541.199/541.163 (Ave)
250150	Large ashy pit	Yes	Yes	541.090/540.823 (NE)
250151	Red fire pit/lens	No	No	541.169/541.158 (SE)
250168	Ashy fill in southern installation niche	Yes	Yes	541.118/541.007 (SE)
250173	Ashy fill in northern installation niche	Yes	No	540.937/540.921 (SE)
250182	Ashy pit, continuation of 250124(?)	Yes	Yes	541.039/540.914 (SW)
250190	Dark grey ashy pit	Yes	No	540.974/540.954 (SE)
250199	Small ashy pit	Yes	No	540.928/540.893 (Ave)
250909	Light brown ash/fire pit	No	No	540.851/540.821 (SE)
250913	Rocky filled area/pit?	No	No	540.777 (SE)—not excavated

Pit Lot #	Description	Phytolith	Charcoal	Depth - top/bottom (m)
250918	Ashy pit beneath mudbrick	Yes	No	540.882/540.849 (SE)

Table 2.3 - Summary of pits excavated in RaM 3 Trench H; bolded lot numbers further discussed in trench summary.

Phase 2

The only structural feature from this phase is Wall 250116 (Figure 2.5). The wall, unrelated to RaM 3's main structure, survives to a maximum of two courses. Excavation of its matrix (Lot 250121) produced sparse Iron Age II pottery, providing an approximate date for this addition. This material is tentatively associated with the Iron Age encampment identified in the northeast corner of RaM 3 during the 2024 season. Radiocarbon analysis will refine the dating.

Figure 2.5 - Wall 250116 from south.

This phase is most clearly represented by Pit 250150, a large, ashy pit in the trench center. Its dark grey, charcoal-rich fill contained Umm an-Nar and Iron Age pottery; the base was defined by a red-orange soil ring surrounding darker brown soil. Stratigraphic position and ceramics suggest an Iron Age date, pending ^{14}C analysis of large charcoal samples.

Beyond pits, this layer yielded abundant charcoal, much of it unassociated with features. Larger pieces were sampled for species identification. Notable finds include two groundstone artifacts (Lots 250130 and 250180), a modified carnelian fragment (Lot 250179), and a copper fragment (250185). The modified carnelian is significant given the fully crafted bead found last season (Swerida *et al.* 2024: 18–20), suggesting possible bead production at RaM 3.

Phase 3

While no clear Wadi Suq surface was identified in Trench H, Wadi Suq pottery was found in the collapse deposits of the Umm an-Nar Wall 250159. Associated finds included a crushed globular vessel (Middle Umm an-Nar typology) and some Wadi Sûq sherds, notably a beaker rim. This lack of secure contexts may be the result of the substantial later pitting activity in this area or an ephemeral Wadi Suq period presence.

In the southern part of the trench, a semi-linear ditch feature (Lot 250916) cuts roughly north-south through the RaM 3 courtyard, continuing into Trench J. The soft

Figure 2.6 - Semi-linear ditch feature (Lot 250916) outlined in orange.

brown soil in the ditch extended to the Late Umm an-Nar floor in the east.

Phase 4

Multiple possible Late Umm an-Nar period floor levels were reached during the BAP 2024-25 season. The Late Umm an-Nar floor level reached in Trench D during the 2023-24 season was identified (excavated as Lot 250198), becoming visible after removal of all backfill along the eastern edge of the trench, and used as a guide for subsequent excavations. This surface had a notably thick and lumpy texture. However, reaching this same level in the middle part of the trench did not produce a convincing continuation. While the soil broke at the same elevation, indicating a surface, it lacked the same texture.

An unusual wall, Lot 250159, was uncovered in association with a lower Late Umm an-Nar surface (Lot 250906, see Figure 2.7) after removing multiple layers of rock collapse from the northern part of the trench. This removal revealed numerous large pieces of Umm an-Nar pottery, including an in-situ crushed globular vessel, likely destroyed by the collapse (Figure 2.8). Typologically, these sherds belong to the Late Umm an-Nar period. The wall abuts the large northern Wall 240126, indicating that it was built later but still within the same cultural horizon. ^{14}C samples were taken from activity areas adjacent to this wall to provide a more secure date.

Wall 250159 survives to only two courses high, suggesting it was intended as an internal divider rather than a full wall—though the collapsed material above it could indicate a higher original height. Two short projections to

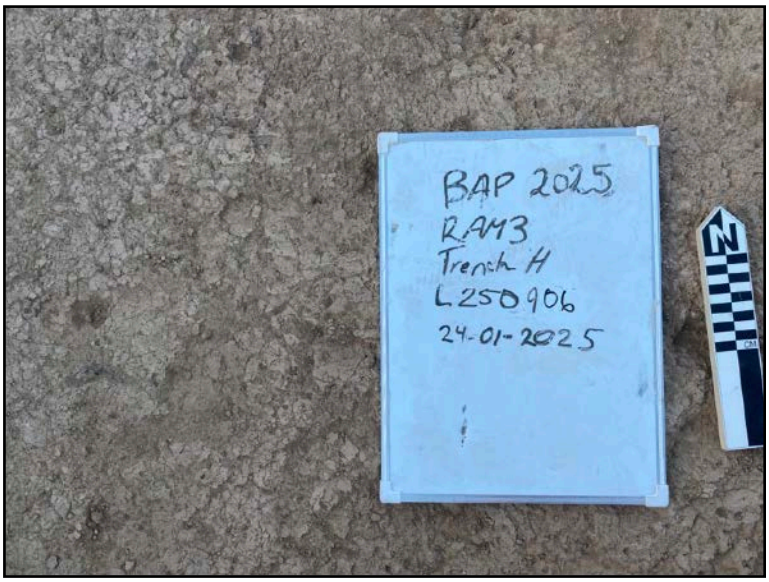

Figure 2.7 - Close-up photograph of Late Umm an-Nar period clay floor surface.

Figure 2.8 - Late Umm an-Nar period pottery associated with Wall 250159 and the instillations.

Figure 2.9 - Late Umm an-Nar period Wall 250159 and installations.

the east create three niches along its length (see Figure 2.9). The northernmost and southernmost niches both contained ashy fills, suggesting fire-related, possibly craft, activities. These features, Lots 250168 and 250173 respectively, are visible in Figures 2.9, 2.10, and 2.11.

The northern niche yielded no notable finds, but the southern niche contained in-situ fragments of baked clay vessels (Figure 2.12). These could tentatively indicate metallurgical activity—such as the use of poorly fired crucibles (Giardino 2019: 69)—although the vessel forms do not match typical crucibles. Copper slag from Trench H lends some support to this interpretation, though no copper was recovered in close association here this season. It remains possible that the area was used for metallurgy, but another craft activity cannot be ruled out.

The middle niche lacked ash and instead featured a mudbrick floor/platform, perhaps serving as a clean storage area for tools or materials associated with activities in the other niches. It aligns with Feature 250913 to the west, a rock- and silt-filled area possibly used for waste disposal from the craft area (Figure 2.13). This feature was only partially excavated; its silty matrix contained bone fragments (unusual in Umm an-Nar

Figure 2.10 - Top-down photograph of Wall 250159 and metallurgical installations.

Figure 2.11 - Northernmost metallurgical installation (Lot 250173) abutting walls 240126 and 250159.

Figure 2.12 - Baked clay feature in southern installation (Lot 250173).

contexts in the Bat landscape) as well as Umm an-Nar pottery sherds. Its alignment with the middle niche supports the waste-disposal interpretation.

Due to time limitations, excavation in Trench H ended at the level of the second Late Umm an-Nar floor (Lots 250906 and 250917). Further cultural material remains in place below this level.

Figure 2.13 - Silt and cobble Feature 250913, with Wall 250159 visible on the right.

2.4.2 Trench J Summary

Excavations in Trench J were supervised by Zoë van Listenburg and took place between 31 December 2024 and 28 January 2025. Six primary phases of occupation were identified:

Phase 1

The first excavated layer was the topsoil (Lot 250201), extending 5–10 cm below the modern ground surface. It covered most of the trench except for the northern area, which had been excavated in 2024. Two Iron Age body sherds were recovered from this layer. Initially believed to be homogeneous, the eastern extent of the lot proved darker and more humic, likely due to the high concentration of pits in that area. Within the topsoil was a small feature consisting of a flat rock with an ash patch partly on and beside it (Figure 2.14). This was sampled for phytoliths (Lot 250205 A–G; six from within, one as background) and the remaining ash was collected for flotation (Lot 250208).

Phase 2

Beneath the topsoil lay a beige sandy silt (Lot 250210) excavated to define the extent of pit 250204. This layer contained a mix of Umm an-Nar, Wadi Suq, and Iron Age pottery, including Wadi Suq beaker fragments. Notably, it and the layer below contained abundant lithics absent from the in-situ cultural layers. Its stratigraphic position and mixed ceramic assemblage suggest it is not a secure archaeological context, but a disturbed matrix resulting from cut features and repeated flooding events in the RaM basin and courtyard.

This layer was cut by a large Islamic Age pit (Lot 250204), partially excavated and sampled in 2023 (Lot 233269). While clearly visible in the eastern profile, its full horizontal extent was harder to determine because charcoal flecks in the surrounding matrix obscured the pit fill. The pit measured roughly 1.5 m in diameter and 50 cm

Figure 2.14 - Overview photo of lot 250201. Visible in the profile to the East is the large pit cut of lot 250204, and 'floating stone' is feature 250203.

deep. Its fill comprised three layers: an upper loose dark brown sandy silt with charcoal inclusions; a middle light grey ashy layer with large charcoal chunks; and a compact reddish clay base indicative of in-pit burning. The fill contained abundant mixed archaeological material, including Umm an-Nar sherds (one from a suspension vessel), Wadi Suq beaker fragments, and Islamic Age pottery (Figure 2.15).

Figure 2.15 - Post excavation photo of pit 250204. The different fills are clearly visible in the pit lining.

Two smaller pits, Lots 250213 and 250217, were also identified in layer 250210. Pit 250213, ~20 cm northwest of 250204, contained dark grey silty ash with charcoal. It was sampled for phytoliths (250214), flotation (250215), and C14 (250216). Pit 250217, ~60 cm west of 250213, lay atop a brittle heated stone (unlike the stone in feature 250203) and was sampled only for flotation (250218). Its fill was fine brownish-grey ash.

Below dirt Lot 250210 was another homogeneous silty layer (Lot 250221) with friable, heat-affected reddish rocks and many lithics. Pottery was predominantly Umm an-Nar body sherds, with some Iron Age fragments; several belonged to a fine suspension vessel. A small, poorly preserved bone fragment was also recovered. This layer was cut by ash pit 250223, sampled for phytoliths (Lot 250224) and C14 (Lot 250228, 250229). The pit began as a small patch but proved difficult to define. Its fill was loose, sandy, and ashy, with compact sediment patches.

Evidence in the southern wall (Lot 240104) indicates a post–Bronze Age breach allowed repeated flooding of the courtyard, visible in the weathering of interior wall stones (see Figure 2.16). This likely contributed to mixing of deposits.

Figure 2.16 - Northern view of Southwestern part of wall 240104 and wall collapse 250219. Visible on the wall stones are concentric lines which are the result of repeated water activity. Collapse also visible continues into Western balk towards Trench K.

Phase 3

In the southeastern corner of the trench, beneath wall 240104 collapse, shallow grey ash patches appeared, interspersed with compact brown matrix possibly from wall fill or plaster. Initially, a fire-related breach was hypothesized, but the lack of further burning evidence and signs of prolonged flooding make this unlikely. These lenses were recorded as Lot 250265.

Lowering the surface revealed a compact reddish clay in the southwestern corner (Lot 250254), interpreted as highly weathered mudbrick. The surrounding clayey but less dense matrix (Lot 250255) likely resulted from flooding mixing mudbrick with surrounding soils. About 5 cm of the compact clay was removed for examination, but the remainder was left in place for further identification of structural features.

Phase 4

Beneath the clay and mudbrick matrix lay a sloping layer (Lot 250268) descending eastward, consistent with the slope of the hill west of RaM3. This layer contained scattered charcoal, three large pieces collected as Lots 250271–250273.

Northwest of the mudbrick and below Lot 250268, patches of a compact grey clay floor surface were uncovered (Lot 250275), more degraded in the south than the north. The surface extended into Trench H (Lot 250906). Disruptions were noted in the floor (see Figures 2.17 and 2.18). A nearby stone cluster containing Iron Age sherds (Lot 250277) contrasted with the otherwise late Umm an-Nar–dated surface. Two C14 samples (Lots 250278 and 250279) were taken from the cluster. A possible posthole (Lot 250286) was block-lifted for fibre analysis. The floor dipped beneath the stone cluster, possibly from a roof collapse. The relationship between mudbrick and floor was obscured by flooding. The mudbrick may have sagged onto the surface, limiting understanding of its original extent.

Figure 2.17 - The extend of the Late Umm an-Nar surface Lot 250275.

Phase 5

To reach earlier deposits, a strip of soil was excavated down to the Middle Umm an-Nar layer (Lot 250280), yielding scattered Umm an-Nar sherds but no intact surface. Beneath it, another grey compact clay floor (Lot 250288) was found, weathered and cracked (Figure 2.19). Its western extent was obscured by a perpendicular ditch. Two large charcoal pieces (Lots 250289 and 250290) were collected from the floor.

In the profile of a deep sounding, excavated as Trench DJ, a pit was visible underneath the Middle Umm an-Nar surface. We sampled this pit on the last day as we

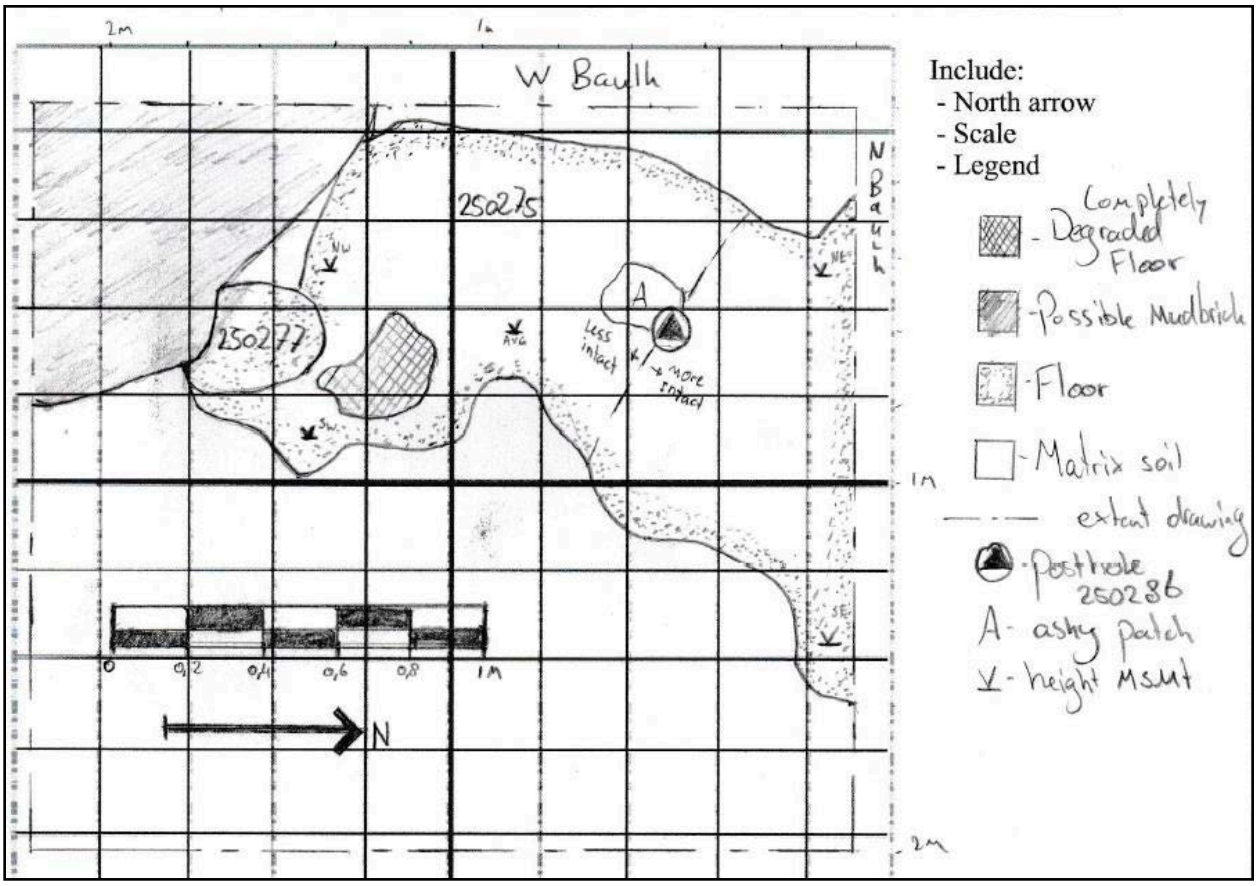

Figure 2.18 - Drawing of Late Umm an-Nar surface in NW quadrant of Trench J. Drawing by Ruben Hartman.

did not have time for thorough excavation, but seeing as the pit was located directly underneath the surface it would be pertinent for flotation (Lot 250291) and for radiocarbon dating (Lot 250293). The pit fill was very dark grey in color and was estimated to have had a diameter of ~50 cm.

Two features became apparent after removing dirt Lot 250280: the aforementioned ditch (Lot 250295), defined but not excavated, with a soft humic brown matrix and few inclusions. One charcoal piece was collected (Lot 250296). The ditch continued into Trench H, where it was more distinct. West of the ditch was a shallow ash lens, sampled for flotation (Lot 250298).

Phase 6

Sounding DJ was excavated to the level of bedrock. The context directly above the friable limestone bedrock, Lot 250210, was a fine silt. No material culture was collected from this context, however three features suggest a pre-Umm an-Nar phase of activity: an ash concentration (Lot 250612) and two small pits (Lots 250614 and 250617) cut into bedrock.

Figure 2.19 - Overview photo of lots 250288 (Middle UaN surface), 250291 (ash lens), and 250295 (ditch).

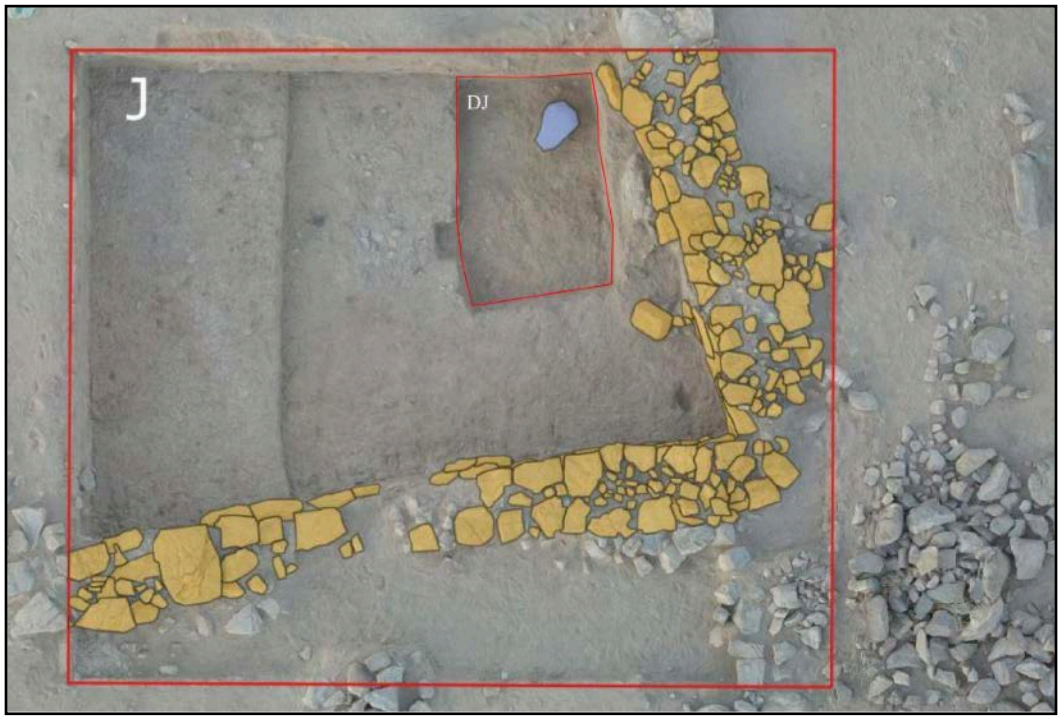

Figure 2.20 - Post excavation orthophoto of Trench J and Trench DJ. Photographed by Mansur. Modelled and annotated by Ruben Hartman, with additional annotation by author.

2.4.3 Trench K Summary

Excavations in Trench K, supervised by Rita Kremer, took place between 1 and 28 January 2025. Due to its higher position on the hillside, the deposits in Trench K were more severely affected by erosion and collapse than those in Trenches H and J. Work focused on the southwestern room of RaM 3 (Figure 2.21). Four phases of occupation were identified:

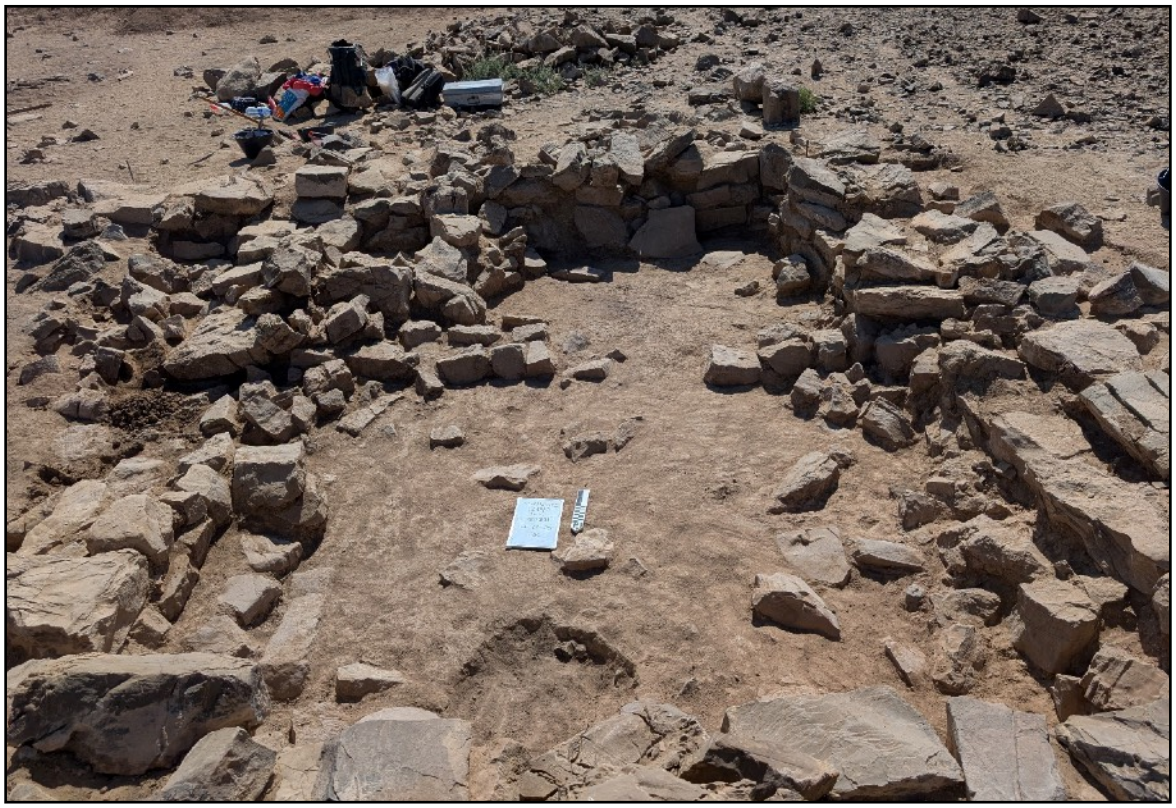

Figure 2.21 - Interior of southwestern-most room(s) of RaM 3 following excavation, from north.

Phase 1

The interior space was filled with windblown sand and collapse. The upper surfaces of the exterior walls (Lots 250309, 250310, 233276, and 250313) were visible at the modern ground surface. The uppermost contexts consisted of sandy silt and stone collapse, with occasional charcoal flecks and pottery sherds dating to the Iron Age, Wadi Suq, and Umm an-Nar periods.

A Neolithic arrowhead (Lot 250323; Figure 2.22) was recovered from the fill between stones of Wall 250309. It was almost certainly displaced from earlier contexts uphill to the west.

Figure 2.22 - Neolithic Arrowhead (Lot 250323).

Phase 2

No contexts clearly matching Phase 2 deposits from Trenches H and J were identified in Trench K. Iron Age pottery recovered from the collapse layers suggests some Phase 2 activity occurred either inside the structure or uphill to the west.

Phase 3

Trench K yielded the highest concentration of Wadi Suq materials thus far found at RaM 3. This assemblage—spread across Lots 250311, 250216, 250321, and 250331—is associated with a large hearth (Lot 250335), 65 cm in diameter and 12 cm deep (visible in foreground of Figure 2.21). The hearth contained back ash with chunks preserving the wood structure. Numerous stones, mostly bearing charcoal on their bases, were found in the pit; only a few were mixed with charcoal. Charcoal, flotation, and phytolith samples were collected. Several smaller ash pits were also found (Lots 250312, 250316, 250327, 250328, 250329, and 250343), each with more ash than charcoal.

A small Wadi Suq tomb (Lot 250333; Figure 2.23) lies just east of Wall 240402. The burial structure consists of a 14 cm-thick slab surrounded by five upright flat stones, abutting Wall 240402 on the west. Stones from the wall, including one of two large doorway stones from Lot 250341, were likely reused in the grave. The central slab matches the dimensions of the large doorway stone on the south side of the entrance. The tomb was not excavated due to the low likelihood of bone preservation, though its form suggests a Wadi Suq attribution. A Wadi Suq body sherd (Lot 250338) was found just across the wall, adjacent to the large hearth. The sherd was unburned—possibly evidence of feasting linked to the burial. A second Wadi Suq grave was found outside the building in Trench G.

Figure 2.23 - Wadi Suq grave (Lot 250333) with cap stone.

Phase 4

No secure Umm an-Nar contexts have yet been identified in Trench K, but structural relationships suggest a Late Umm an-Nar origin for the architecture (Figure 2.24). All walls in the building are double-faced with sand-and-gravel cores. Wall 233276, to the narrowest, belongs to a small rectangular northern building, the oldest wall in Trench K. Walls 250313, 250309, 250310, and 240402 were added later. Wall 250313 and Wall 240402 abut the northern building; Wall 240402 also abuts the southern Wall 250310. Walls 250313, 250309, and 250310 interlock with each other.

The southwest room's orientation also notably differs from that of the rest of the

Figure 2.24 - Top-down photograph of Trench K architecture post-excavation.

structure. Wall 250313 runs roughly southwest–northeast, contrasting with Wall 233276's west–east alignment, producing a bend. Notably, Wall 250313 extends only 1.5 m before angling southeast—an unusual choice, as extending Wall 233277 southwards would have been simpler. The interior was later divided by an east–west wall (Lot 250340) abutting Wall 240402 in the east and Wall 250309 in the west. This double-faced wall, 40 cm thick, contained a 40 cm-wide doorway with a stepping stone. It was likely built after Feature 250308, as the two have parallel walls without an intervening space.

Below the Phase 3 cultural material, a dense clay layer covered Wall 250340 and two features: a bench along the interior face of Wall 240402 (Feature 250348; Figure 2.25) and a bin built into the corner formed by Walls 250340, 240402, and 250310. The bench rests 34 cm below the wall's top, with an adjacent upright slab 60 cm long, 10 cm thick, and set on its 17 cm edge. Wall collapse from 233276 lies north of the bench; to the south, the corner comprises three stone courses. This may represent a two-plank shelf for storage (Lot 250346), built after Walls 240402 and 233276. Umm an-Nar and Wadi Suq body sherds from this lot confirm Bronze Age contexts.

Lots 250341 and 250342 represent collapse from a doorway in Wall 240402 (Figure

2.26). The disordered stones and lack of collapse on the east side were apparent from higher levels. The south side of the doorway features a neatly cut 45° corner stone; the north side lacked a similar element until it was noted that the central slab of the Wadi Suq grave (Lot 250333) matched its dimensions. Below Lot 250342, Lot 250345 contained three large flat stones that may have formed the threshold. An even lower stone (Lot 250349) raises the possibility of a multi-layer threshold. Although the base is not fully excavated, the top lay above the interior floor level, consistent with other Bronze Age houses where raised thresholds likely prevented water ingress.

Figure 2.25 - Lot 250348 with wall Lot 240402 in the back and doorway Lot 250342 on the right.

Figure 2.26 - Lot 250342 doorway in Wall 240402.

2.4.4 Summary

The RaM 3 structure stands apart from other buildings at Rakhat al-Madrh for its massive stone architecture, extended use-life, and diverse activity evidence. From its earliest phases in the Umm an-Nar period, the building appears to have served as a centre for craft production rather than domestic habitation. Installations such as the ashy niches and mudbrick central feature of Wall 250159, along with associated finds of copper, carnelian, groundstones, and baked clay, point to metallurgical and bead-making activities. The spatial organization of the courtyard and adjacent areas, though altered by later use, may have facilitated multiple, possibly concurrent, production tasks.

The repeated presence of large ash pits, fire installations, and charcoal-rich deposits in both interior and courtyard contexts suggests that fire-based activities were

a recurring feature of the building's life. While some of these events may relate to craft production, the scale and character of the burning in certain deposits hint at occasional larger-scale or communal gatherings, though any ritual dimension remains speculative.

Following the Umm an-Nar period, RaM 3 continued to attract intermittent use. Wadi Suq and Iron Age materials indicate reoccupation or reuse, likely as a sheltered, convenient space within the RaM basin. The building's massive walls would have made it an appealing refuge for travelers or temporary occupants, while the basin's position near water and resources offered further incentive for return. Even in later, more ephemeral phases, burning events persisted, leaving their mark across successive layers.

The cultural phasing across Trenches H, J, and K reveals a complex palimpsest of activities shaped by both deliberate reuse and natural processes such as flooding and collapse. In some cases, post-Bronze Age pits and disturbances blurred earlier contexts, yet the overall sequence preserves clear evidence of multi-period activity spanning craft production, transient shelter, and intermittent communal or task-based use.

Future radiocarbon results from well-defined contexts will refine the chronology of these phases, clarifying the temporal scope of RaM 3's production activities and subsequent reuse. For now, the evidence suggests that its role as a specialized, non-domestic building—valued for both its functional facilities and durable architecture—was central to its longevity in the settlement's history.

2.5 RaM 2 Sounding

A 1x5m sounding was excavated perpendicular to the courtyard wall of the RaM 2 structure in order to continue BAP's geomorphological study of the formation of the RaM basin. Results of the geomorphological research are forthcoming. The sounding also unexpectedly encountered two oven features just outside of and level with the foundations of the RaM 2 northern courtyard wall (Figure 2.27). These are typologically consistent with an oven feature excavated inside the RaM 2 building in the BAP 2023 campaign (Figure 2.5). The contents of both ovens were sampled for archaeobotanical and radiocarbon analysis and will add to our understanding of the use history of the building.

Figure 2.27 - Oven features located just outside the RaM 2 northern courtyard wall.

Figure 2.28 - 3D photogrammetry model of the excavated Hafit tomb to the north of the RaM basin.

2.6 RaM Tomb

In order to study the earliest known residents of the RaM basin, a Hafit tomb located on the hill to the north of the site was selected for excavation. The fine, wind-blown silt within the tomb chamber was excavated down to the level of bedrock. Unfortunately, no artifacts or human remains were encountered. It is likely that the environmental conditions at the site do not allow for the preservation of human remains.

A 3D model of the tomb structure was created using photogrammetry (Figure 2.28). This model records the tomb's location and architectural composition with sub-centimeter accuracy.

3. Bat Settlement Slope

Robert Bryant, Lidwien Meulenkamp,[6] & Jennifer Swerida

3.1 Introduction

The Settlement Slope is a long hill located at the northern edge of the ancient Bat oasis. It is characterized by a series of Bronze Age tombs stretching along the top of the hill crest, an Early Umm an-Nar tower built into the low western end of the hill, and a chain of Middle and Late Umm an-Nar period settlement buildings running along the south-facing slope. This site was first studied by Karen Frifelt in the 1970s, who excavated a series of test trenches into the tower and the largest building on the hillside—Structure SS6 (Frifelt 1985). Based on the results of a long test trench excavated through the center of Structure SS6, Frifelt concluded that contexts within the building were entirely destroyed by erosion. BAP returned to the Settlement Slope to investigate the tower monument (2010-2012; Thornton *et al.* 2016) and surrounding buildings (2013-2015; Swerida 2017) at the western end of the hillside. More recently (2019-2020; 2022-2023), BAP shifted its focus to structures at the eastern end of the hill, including an Umm an-Nar house (Structure SS12) and neighboring tomb (Tomb 201201) (Swerida 2020; Swerida & Nugent 2022).

This season, BAP returned to the Settlement Slope once again to probe the preservation and function of the large Structure SS6. As the SS6 test trench was left open following Frifelt's work at Bat, significant further erosion has impacted the building. Additionally, BAP continued excavations of Umm an-Nar Tomb 201201 to expand our understanding of the mortuary practices preformed there.

3.2 Methodology

Excavations on the Settlement Slope began on 19 January and concluded on 24 January 2025. Research targeted the large Structure SS6 on the western hill slope and Tomb 201201 on the eastern hill slope (see Figure 3.1). Excavations were recorded in reference to the Master Datum and 5x5 m grid previously established across the entirety of the Settlement Slope (see Table 3.1). They were conducted with the goal of clarifying the function of the large building and lived experience of individuals who resided on and interacted with the Settlement Slope hill during the Umm an-Nar period.

[6] Faculty of Archaeology, Leiden University

Master Datum: N 2572747.000m E 474418.600m Z 497.000m	Backsite: N 2572756.911m E 474418.587m Z 498.274m
Projection: WGS 84 / UTM 40N	EPSG: 32640

Table 3.1 - Settlement Slope datum and backsite specifics.

Consistent with the methodology established in the 2020 excavations at the Settlement Slope, the locations of each trench and the excavated contexts within them were recorded on paper forms and in digital records. During excavation, all Settlement Slope contexts or "lots" (dirt context, feature, artifact, or sample) were given a unique number consisting of the project season prefix (25-) plus a unique number beginning with 251701. Lot numbers were continuous across the excavated trenches in this location. Finds data, dimensions, and other characteristics of individual lots were described on a paper-based form. Each lot was also photographed and the images logged. Later, during post-processing, the disparate data sets were partially integrated for spatial visualization. The building designation—Structure SS6—is consistent with a numbering sequence already established in published research of the Settlement Slope (Swerida 2017; Swerida & Thornton 2019a).

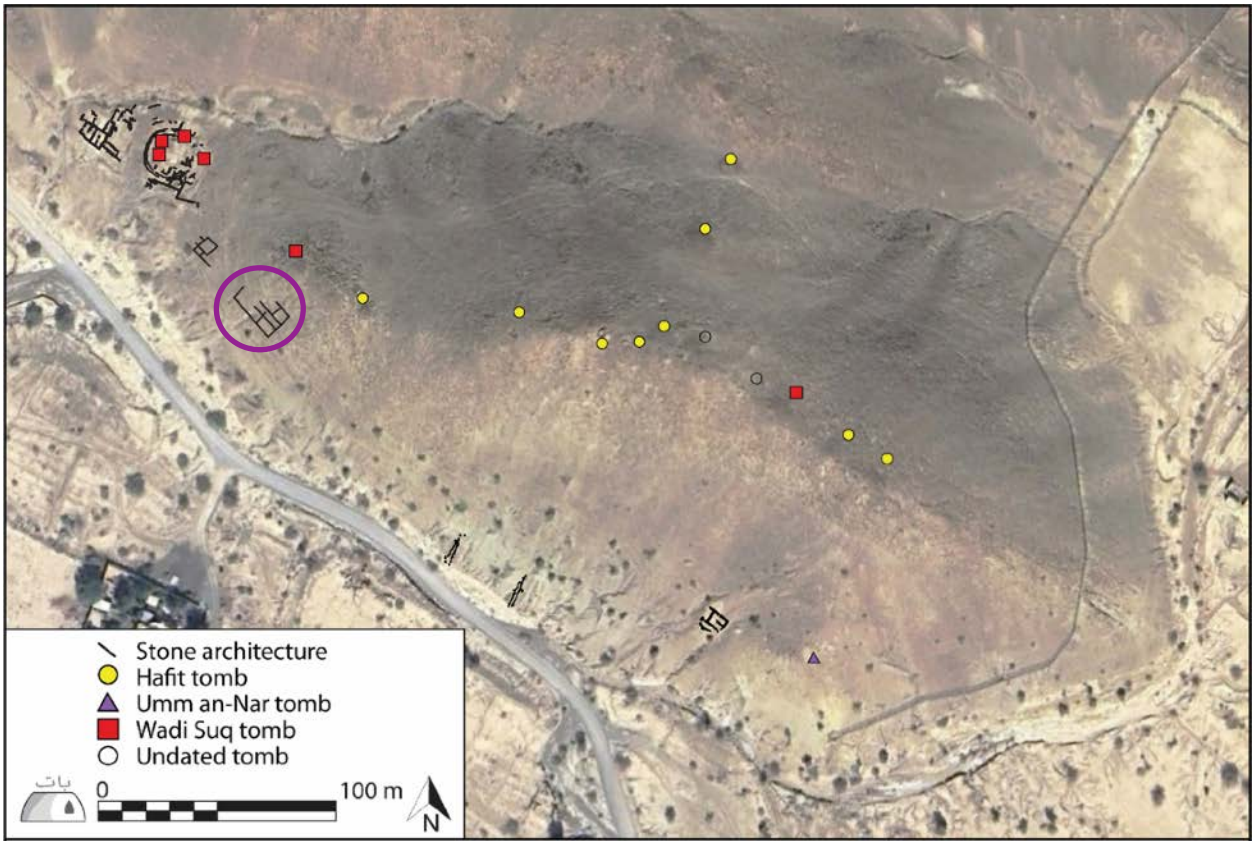

Figure 3.1 - Map of the Settlement Slope hill indicating the location of Structure SS6.

3.3 Structure SS6 Test Trenches

Excavation in Structure SS6 was supervised by Robert Bryant and Lidwien Meulenkamp. Three 1.5x1.5m test trenches were excavated and subsequently backfilled to prevent any further erosion damage:

1) Trench A: located along the interior face of the building's central northern (uphill) wall;

2) Trench B: located in the interior of the buildings southeastern (downhill) corner;

3) Trench C: located in the center of the building, just west of Frifelt's sounding.

All trenches were rich in Umm an-Nar period ceramic finds, however none contained in situ or well preserved contexts. Trenches A and C were excavated down to bedrock, which was encountered after approximately 30cm. The Structure SS6 walls in these trenches were constructed onto the surface if the bedrock. Contexts in Trench B were significantly deeper due to irregularities in the underlying bedrock formation. While the scree and gravel matrix continues well below the foundation level of the Structure SS6 walls, no floor level was identified.

Future research at Structure SS6 will produce a stone-by-stone plan of the building layout that can be compared with other large scale Umm an-Nar period buildings at Bat and elsewhere.

3.4 SS Tomb 201201 — by Brittany Brown

Following the limited results from the Hafit tomb at Rakhat al-Madrh, BAP returned to Umm an-Nar tomb 201201 at the Settlement Slope. This tomb was partially excavated by BAP in the 2022-23 season and left backfilled with the intention to return in a future season. Goals for the short study possible in the 2024-25 season were to assess the state of preservation of the tomb and expand our knowledge of the unusual burial practices reflected by the human remains.

3.4.1 Excavation Methods

Excavation was conducted by Brittany Brown from 15 until 27 January 2025. An area of 112 cm east to west and 140 cm north to south was excavated towards the opening of the tomb; approximately 5 cm of tomb fill was processed. Excavations began with trowels, beginning where excavations ended in the 2024 field season. After excavations with brushes continued. Fragmented remains that were removed with a brush were collected in the field and analyzed in the lab. If the skeletal element was identifiable, it was separated and given a new lot number and photographed. Along with human remains, three paste beads and Umm an-Nar funerary ceramics were found. The beads were found in the western section of the excavated chamber, and the ceramics were found in the northern wall and the central section of the excavated chamber.

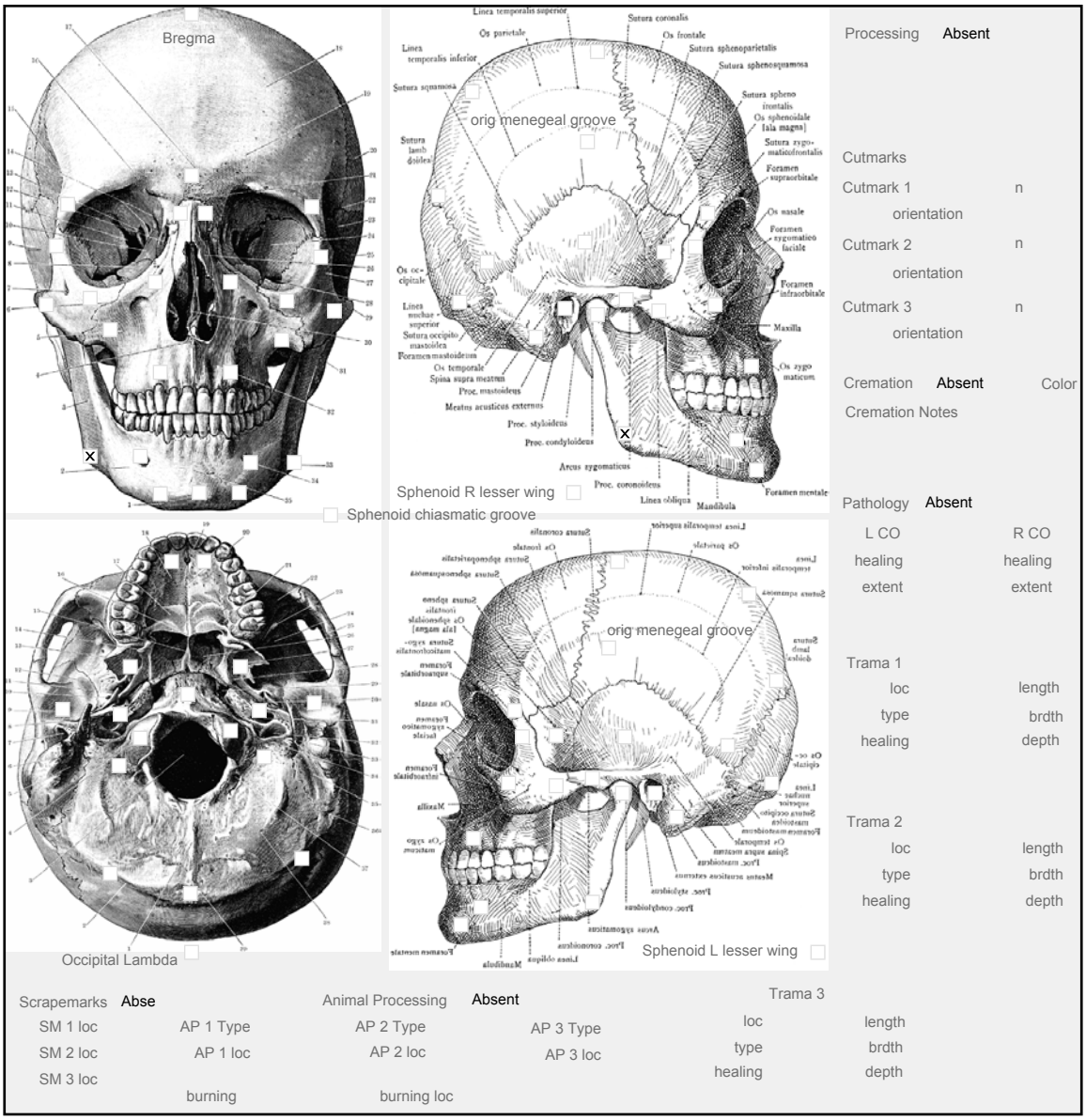

Figure 3.2 - Skull Number 251026.

Estimate Age: Adult (18+ years)
Estimate Sex: Male Possible

Ascending ramus scored as a 4, mandibular body scored as a 3. Possible male. Age based on eruption of third molar.

Right adult mandible, found with second and third mandibular body present. No pathology present other than extreme antemortem tooth ware on the second and third molar. The third molar is complete, but in fragments. No caries are present. WRK measurement is 35 mm, showing a robust ascending ramus. The PREI scored as 4, despite being g very thing and showing taphonomic damage from poor preservation.

MNI 1 Individuals Assigned

General Notes Burned bone found in several parts of the tomb. Most are brown heat altered carbonized bone. They also show a predictable heat-altered cracking. This suggests high levels of heat. There is no organic material left, only burned cortical bone. Bone is warped. The color and wariness suggests that the bones were burned while the bones were wet (Ubelaker 2008;),. However, a microscope and other research needs to be conducted to fully determine when the burning occurred. Paste beads (n=3) were found in the NW section of the excavated tomb. No pathologies present so far aside from abscess on the tooth.

Individual 1		Individual 2	
Estimated AAD	Refined AAD	Estimated AAD	Refined AAD
Estimated Sex		Estimated Sex	
General Summary	01/16- 251006- max with molar 251005- Max w premolar with abscess (Both right)	General Summary	
associated forms	251012- cranial fragments ;=4	associated forms	
dental	251002- bone frags from the north and south walls above tarps 251007- bone frags from chamber (n=394)	dental	
cranial	251017 cranial frag	cranial	
shoulder	251015- r mandibular incisor root (juv?)	shoulder	
arm	251019- tooth fragment	arm	
hand	251020- burned bone fragments from the NW section of the tomb 251021- rib fragments	hand	
os coxa	251023 - burned bone in nort east corner (photographed in situ)	os coxa	
leg	251024- burned bone in north west corner 251025- large accumulation of skeletal elements in a concentrated area (mainly long bone fragments)	legs	
foot	251026- right adult mandible with second and third molar.	foot	
vertebrae		vertebrae	

Figure 3.3 - Summary of bone recovered from Tomb 201201.

Figure 3.5 - Periosteal surface of burned cortical bone.

Figure 3.6 - Inside of endosteal surface, showing pieces of burned and non-burned cortical bone.

Figure 3.7 - Premolar with abscess.

3.4.2 Results

The human remains consisted of very fragmented and commingled bones, few of which are identifiable.

The skeletal elements that were present are as follows: a right adult mandible with a second and third molar in occlusion, right metatarsal, a rib fragment, right mandibular incisor root, unidentifiable burned bone (most likely from long bones),

Figure 3.4 - Burned bone from Tomb 201201 in situ.

pieces of a crania, right maxillary premolar, and a right maxillary molar in occlusion with a maxilla (Figure 3.2 and 3.3). There were also over 300 unidentifiable skeletal fragments present.

The sex of this individual(s) cannot be determined with the elements present. No oscoxae or mental eminence of the mandible has been excavated thus far. However, based on the WRK measurement is 35 mm, showing a robust ascending ramus. The PREI scored as 4, despite being very thin and showing taphonomic damage from poor preservation. Ascending ramus scored as a 4 and the lower border of the mandible was scored as a 3. These measurements and scores suggest a possible male for at least one individual in this assemblage.

The age of an individual is adult due to tooth morphology. A premolar and a molar was excavated and collected for further analysis. Lack of a crypt in the maxillary fragment articulated with the premolar, and lack of deciduous teeth suggest this individual is an adult. No juvenile skeletal elements have been present.

There was no perimortem trauma on these remains; however, there were noticeable postmortem alterations to two of the skeletal elements. These elements were burned, possibly before complete decomposition. Most are brown heat altered, carbonized bone (Figure 3.4). They also show a predictable heat-altered cracking. This suggests high levels of heat. Only burned cortical bone and a few pieces of non-burned cortical bone remain (Figures 3.3 and 3.4). The bone is warped. The color and wariness suggest that the bones were burned while the bones were wet (Ubelaker 2009; Schmidt & Symes 2015; Symes *et al.* 2012), and at high temperatures. However, due to unburnt bone under the burned bone might suggest that they were not cremated as long. However, a microscope and other research needs to be conducted to fully determine when the burning occurred.

There was noticeable pathology on the right premolar (Lot 251006; Figures 3.5 and 3.6), showing a large abscess on the lingual side (circled on Figure 3.7). No other pathologies have been observed.

The remains are fragmented and in poor preservation. Some remains show signs of soil staining of an orange color. The remains show no signs of pathology or postmortem trauma, aside from the burned skeletal elements and the abscess on the tooth.

3.4.3 Conclusions

The remains are highly fragmented due to the poor preservation and mortuary practices of the Umm an-Nar culture. The minimum number of individuals is one currently, due to none of the skeletal element's repeating. Sex can also not be estimated except on the mandible, which scored as a probable male. Age for most of the elements is estimated to be adult. Only one pathology is present, which is an abscess on a maxillary premolar. Trauma includes postmortem cremation on a few skeletal elements located in the western, eastern, and central part of the excavated chamber.

4. Pottery & Artifacts

Jennifer Swerida & Rita Kremer

4.1 Introduction

Material collections in the BAP 2024-25 field season included ceramics, small finds, and ground and chipped stone artifacts. Ceramics were analyzed by Dr. Jennifer Swerida; small finds, ground stones and litchis were analyzed by Ms. Rita Kremer. Raw data and preliminary analysis results are presented below

4.2 BAP 2024-2025 Lot Summary

All material culture was collected according to a location-based lot number. A summary of lot number ranges and locations is below.

Lot Ranges	Site	Trench
250001-250099	RaM 3	Backfill
250101-250199	RaM 3	H
250201-250299	RaM 3	J
250301-250399	RaM 3	K
250401-250499	RaM 2501	Tomb
250501-250599	RaM 2	Z
250601-250699	RaM 3	D
250701-250799	RaM 3	L
250801-250899	RaM 3	G
250901-250999	RaM 3	H
251001-251099	SS Tomb	-
251801-251899	SS6	A
251901-251999	SS6	B
251701-251799	SS6	C
252001-252099	al-Ahliya	-

Table 4.1 - Summary of Lot Ranges per Excavation Unit

4.3 Summary of BAP 2024-25 Pottery Collections

The analysis of ceramics during the BAP 2024-25 field season examined 789 sherds. Ceramic analysis utilized a macro-stylistic approach and non-destructive techniques. Sherds were analyzed and sorted according to vessel form, ware/fabric type, surface treatment, and decoration. This information was then utilized to assess the time period

in which each sherd was produced, in consultation with previous excavations at Bat and other published archaeological ceramic assemblages from the region.

Sherds from the following chronological periods were analyzed during the 2020 BAP field season (adapted from Swerida *et al.* 2021; Thornton & Ghazal 2016; Potts 1992; Magee 1996; Whitcomb 1975; and Kennet 2004):

Early Umm an-Nar	2800-2500 BCE
Middle Umm an-Nar	2500-2200 BCE
Late Umm an-Nar	2200-2000 BCE
Wadi Suq	2000-1600 BCE
Late Bronze Age	1600-1300 BCE
Iron Age I	1300-1100 BCE
Iron Age II	1100-600 BCE
Iron Age III	600-300 BCE
Late Pre-Islamic	300 BCE - 635 CE
Early Islamic	635-1055 CE
Middle Islamic	1055-1500 CE
Late Islamic / Early Modern	1500-1750 CE
Modern / Ethnographic	post 1750 CE

Table 4.2 - Chronological framework utilized in this season's ceramic analysis.

All sherds sherds were photographed in the context of their find lot. Particularly significant or complete examples were also illustrated and individually photographed.

4.3.1 Rakhat al-Madrh Ceramic Analysis

Ceramics from the following contexts 2024-25 excavations at Rakhat al-Madrh were examined as part of this season's artifact analysis: RaM 3 Trench H, RaM 3 Trench J, RaM 3 Trench K, and RaM 2 Sounding. A total of 609 sherds were collected during excavations. Ceramics were examined in the context of their find areas and are reported by sherd count in the following table (Table 4.3).

A few trends and significant examples were evident in this collection. In contrast with previous years of excavation at Rakhat al-Madrh, this season's collections included sherds stylistically datable to the Middle and Late Islamic, Iron Age II, and Wadi Suq periods, as well as to the Umm an-Nar period. This further suggests that RaM 3 is an unusual building in the site's otherwise predominately Umm an-Nar occupational

history. Heavily weathered Islamic sherds, mostly coarse earthen wares, were all found in surface collections, almost certainly representing visitations to the site. Fragments of a distinctive Iron Age II bowl are the first indication of an Iron Age presence at the site — most likely in the form of a temporary encampment. Several sherds of Wadi Suq beakers and jars were also recovered from the building's courtyard and southwestern room, suggesting a more substantial reuse of the structure in the Middle Bronze Age.

The vast majority of the RaM 3 ceramic collection is stylistically datable to the Late and Middle Umm an-Nar period (see Swerida *et al.* 2021), confirming the building's primary use phases. A poorly preserved vessel of technical ceramic—possibly a a small crucible—was also found in a secure Late Umm an-Nar context within the RaM 3 Trench H (see Figure 2.16).

Lot #	Periods rep	Rims	Bases	Dec. Body	Painted	Diag Total	Non-Diag	Slip	Weight (g)	Domestic Ware	Funerary Ware	Buff Ware	Gray Ware	Indus /BSJ	Total Sherd Count
Surface	UaN; IA	0	0	0	0	0	2	1	19.7	2	0	0	0	0	2
240345	WS	0	1	0	0	1	0	0	2.4	1	0	0	0	0	1
250001	UaN	1	0	0	0	0	1	0	21.3	1	0	0	0	0	1
250002	UaN; IA	1	1	0	0	2	4	2	62.2	6	0	0	0	0	6
250003	UaN; IA	0	0	2	0	2	4	2	47	6	0	0	0	0	6
250101	UaN; IA	0	0	0	1	1	5	3	18.9	6	0	0	0	0	6
250102	UaN; IA	0	1	0	0	1	2	3	13.1	3	0	0	0	0	3
250102	IA	0	0	0	0	0	1	1	11.6	1	0	0	0	0	1
250113	UaN	0	0	0	0	0	2	1	9.5	2	0	0	0	0	2
250114	UaN; IA; Islamic	0	0	0	1	1	14	6	130.8	8	0	0	0	0	15
250115	UaN; WS; IA	1	0	0	3	4	4	5	26.0	7	0	0	0	0	8
250119	UaN; IA; Islamic	1	0	0	1	2	10	6	38.6	11	0	0	0	0	12
250119	UaN; WS	3	0	0	0	3	12	8	119.1	15	0	0	0	0	15
250121	IA; Islamic	0	0	0	0	0	5	1	62.2	5	0	0	0	0	5
250124	UaN	0	0	0	0	0	1	0	0.8	1	0	0	0	0	1
250135	UaN; WS	0	0	0	1	1	1	1	14.5	2	0	0	0	0	2
250136	UaN	0	0	0	0	0	1	1	125	1	0	0	0	0	1
250139	UaN	1	1	0	0	2	7	9	108	9	0	0	0	0	9
250140	UaN	1	0	0	2	3	5	7	38.08	8	0	0	0	0	8
250140	UaN; IA	3	1	0	0	4	5	9	85.93	9	0	0	0	0	9
250140	UaN	1	0	0	0	1	3	4	52.09	4	0	0	0	0	4
250140	UaN	1	0	0	0	1	0	1	1.79	1	0	0	0	0	1
250140	UaN; IA	1	0	0	3	4	8	11	105.49	12	0	0	0	0	12
250142	UaN	0	0	0	0	0	1	0	2.3	1	0	0	0	0	1

Lot #	Periods rep	Rims	Bases	Dec. Body	Painted	Diag Total	Non-Diag	Slip	Weight (g)	Domestic Ware	Funerary Ware	Buff Ware	Gray Ware	Indus /BSJ	Total Sherd Count
250147	UaN; IA	3	1	0	2	6	7	7	330	13	0	0	0	0	13
250147	UaN	4	0	0	1	5	5	10	159.57	10	0	0	0	0	10
250148	IA	0	0	0	0	0	2	1	21.6	2	0	0	0	0	2
250150	UaN; Islamic	0	1	0	0	1	10	3	89.1	11	0	0	0	0	11
250157	UaN	0	0	0	0	1	0	1	8.82	1	0	0	0	0	1
250157	UaN	0	0	0	0	0	1	0	1.36	1	0	0	0	0	1
250157	UaN	0	1	0	0	1	0	1	38.55	1	0	0	0	0	1
250162	UaN; WS (?)	0	1	0	2	3	1	4	30.15	4	0	0	0	0	4
250174	UaN; WS	1	0	0	1	2	1	3	9.92	3	0	0	0	0	3
250174	UaN	1	0	0	3	4	11	15	154.88	15	0	0	0	0	15
250174	UaN	1	0	0	1	2	8	10	65.23	10	0	0	0	0	10
250175	UaN	2	0	0	1	3	0	3	17.8	3	0	0	0	0	3
250175	UaN; IA	1	0	0	1	2	5	7	83.53	7	0	0	0	0	7
250175	UaN; IA	0	1	0	4	5	4	8	79.2	10	0	0	0	0	9
250192	UaN	0	0	0	2	2	2	4	88.05	4	0	0	0	0	4
250195	UaN	3	0	0	1	4	6	10	32.7	10	0	0	0	0	10
250197	UaN	4	0	0	0	4	8	9	44.3	12	0	0	0	0	12
250198	UaN	1	1	0	6	8	9	16	109.3	17	0	0	0	0	17
250201	IA	0	0	0	0	0	2	0	9.47	2	0	0	0	0	2
250204	UaN; WS; Islamic	2	2	0	5	9	11	9	167.8	17	1	0	0	0	20
250209	IA	0	0	0	0	0	2	0	3.0	2	0	0	0	0	2
250210	UaN; WS	3	0	0	7	10	6	15	54.1	16	0	0	0	0	16
250211	UaN	0	1	0	0	1	0	1	49.7	1	0	0	0	0	1
250213	UaN; Islamic	0	0	0	0	0	1	1	28.1	1	0	0	0	0	1
250219	UaN; WS	0	0	0	1	1	3	3	16.9	4	0	0	0	0	4
250220	WS	0	0	0	1	1	0	1	0.5	1	0	0	0	0	1
250221	UaN; IA	1	3	0	3	7	16	10	105.3	19	4	0	0	0	23
250230	UaN; Islamic	0	0	0	0	0	8	5	75.4	7	0	0	0	1	8
250231	UaN	0	1	0	0	1	2	2	9.9	3	0	0	0	0	3
250232	WS	0	0	0	1	1	1	1	2.8	2	0	0	0	0	2
250233	UaN; Islamic	0	0	0	0	0	5	1	66.2	5	0	0	0	0	5
250234	UaN; IA	1	0	0	0	1	5	5	74.8	5	0	0	0	1	6
250238	IA	0	0	0	0	0	1	0	8.8	1	0	0	0	0	1
250246	UaN; IA?	8	0	1	8	17	31	19	463.4	46	2	0	0	0	48
250248	UaN	0	0	0	2	2	0	2	42.9	1	1	0	0	0	2
250254	IA	0	0	0	0	0	3	0	28.7	3	0	0	0	0	3
250254	UaN; IA	0	1	0	0	1	5	2	69.4	6	0	0	0	0	6
250254	UaN	0	0	0	0	0	1	0	1.4	1	0	0	0	0	1
250255	UaN; IA	0	0	0	1	1	7	3	63.1	7	1	0	0	0	8
250255	UaN	0	1	0	0	1	4	5	56.9	5	0	0	0	0	5
250256	UaN	0	0	2	0	2	1	2	13.8	3	0	0	0	0	3
250256	UaN; WS	2	0	0	1	3	2	5	27.4	5	0	0	0	0	5

Lot #	Periods rep	Rims	Bases	Dec. Body	Painted	Diag Total	Non-Diag	Slip	Weight (g)	Domestic Ware	Funerary Ware	Buff Ware	Gray Ware	Indus /BSJ	Total Sherd Count
250257	UaN; IA	0	1	0	1	2	7	4	143.7	9	0	0	0	0	9
250265	UaN	0	0	0	0	0	1	1	27.4	1	0	0	0	0	1
250268	UaN	0	0	0	0	0	1	1	0.6	1	0	0	0	0	1
250275	UaN	0	0	0	0	0	1	1	3.5	1	0	0	0	0	1
250277	IA	0	0	0	0	0	5	0	20.0	5	0	0	0	0	5
250280	UaN	1	0	0	0	1	3	4	36.8	4	0	0	0	0	4
250280	UaN	0	0	0	3	3	2	5	81.8	5	0	0	0	0	5
250302	IA	0	0	0	1	1	1	2	23.9	2	0	0	0	0	2
250307	UaN; Islamic	0	0	0	0	0	4	0	134.33	4	0	0	0	0	4
250307	UaN	0	0	0	1	1	0	1	8.2	1	0	0	0	0	1
250307	UaN	0	0	0	1	1	0	1	8.2	1	0	0	0	0	1
250311	UaN; IA	0	0	0	0	0	4	3	6	4	0	0	0	0	4
250311	UaN	0	0	0	1	1	1	2	12.8	2	0	0	0	0	2
250311	WS	1	1	0	0	2	3	5	88.2	5	0	0	0	0	5
250316	WS	0	0	0	0	0	3	0	10.3	3	0	0	0	0	3
250320	UaN	0	0	1	0	1	0	1	10.2	1	0	0	0	0	1
250321	UaN; WS; IA	4	1	0	3	8	2	8	38.2	10	0	0	0	0	10
250321	UaN	3	0	0	0	3	3	6	34.5	6	0	0	0	0	6
250331	UaN; WS	0	0	0	0	0	2	0	5.7	2	0	0	0	0	2
250331	UaN; WS	0	0	0	0	0	3	0	4.5	3	0	0	0	0	3
250332	IA	1	0	0	0	1	0	0	7.8	1	0	0	0	0	1
250338	UaN	0	0	0	0	0	1	0	39.7	1	0	0	0	0	1
250339	UaN	0	0	0	0	0	2	0	28.3	2	0	0	0	0	2
250342	UaN; WS	1	1	0	0	2	2	1	16.1	4	0	0	0	0	4
250342	WS	0	0	0	2	2	0	2	3.8	2	0	0	0	0	2
250345	UaN; WS	0	3	0	0	3	5	0	38.1	8	0	0	0	0	8
250346	UaN; WS	0	1	0	0	1	1	0	6.3	2	0	0	0	0	2
250348	UaN	0	0	0	0	0	1	1	12.2	1	0	0	0	0	1
250509	UaN	0	0	0	1	1	0	1	14.9	1	0	0	0	0	1
250512	UaN	1	0	0	1	1	2	2	29.0	3	0	0	0	0	3
250517	UaN	0	0	0	0	0	1	1	9.8	1	0	0	0	0	1
250522	UaN	1	0	0	0	1	3	2	24.9	4	0	0	0	0	4
250608	UaN	1	0	0	0	1	1	1	2.6	1	1	0	0	0	2
250631	UaN	0	1	0	0	1	2	3	6.6	3	0	0	0	0	3
250701	UaN	9	1	0	4	14	6	26	353.5	35	2	0	0	0	20
250802	UaN	0	0	0	0	0	2	1	38.1	1	0	0	0	1	2
250804	UaN	1	1	0	1	3	3	4	46.9	6	0	0	0	0	6
250904	UaN	0	0	0	0	0	2	2	11.84	2	0	0	0	0	2
250904	UaN	0	0	0	0	0	6	6	25.67	6	0	0	0	0	6
250908	UaN	0	1	0	1	2	2	4	95.05	4	0	0	0	0	4
250908	UaN	0	0	0	0	0	2	1	7.7	2	0	0	0	0	2
250913	UaN	1	0	0	0	1	1	1	4.65	2	0	0	0	0	2
250921	UaN	0	0	0	1	1	0	1	8.3	1	0	0	0	0	1

Table 4.3 - Rakhat al-Madrh pottery.

4.3.2 Settlement Slope Ceramic Analysis

Ceramics from the following contexts from the BAP 2024-25 excavations at the Bat Settlement Slope were examined as part of this season's artifact analysis: SS6 Test Trenches A-C and SS Tomb 201201. A total of 180 sherds were collected during excavations. Ceramics were examined in the context of their find areas and are reported by sherd count in the following table (Table 4.4). Sherds are overwhelmingly Middle Umm an-Nar in style.

Lot #	Trench	Periods rep	Rims	Bases	Dec. Body	Painted	Diag Total	Non-Diag	Slip	Weight (g)	Domestic Ware	Funerary Ware	Buff Ware	Gray Ware	Indus/BSJ	Total Sherd Count
251702	C	UaN	0	0	0	0	0	6	4	49.9	5	0	0	0	1	6
251701	C	UaN; Unknow	3	0	1	1	5	25	23	589.2	27	3	0	0	0	30
251801	A	UaN; IA	5	2	0	3	10	23	21	722.2	34	0	0	0	0	33
251702	C	UaN; Unknow	0	0	0	2	2	11	7	87.0	12	1	0	0	0	13
251701	C	UaN; IA	2	0	1	0	3	4	3	143.5	7	0	0	0	0	7
251705	B	UaN	0	0	0	2	2	2	4	61.0	4	0	0	0	0	4
251704	C	UaN	0	0	0	0	0	1	1	34.8	1	0	0	0	0	1
251703	C	UaN; Unknow	0	0	0	1	1	11	5	197.4	11	0	0	0	1	12
251803	A	UaN	0	2	0	3	5	17	10	418.8	21	1	0	0	0	22
251804	A	UaN	1	1	0	0	2	8	3	126.3	10	0	0	0	0	10
251901	B	UaN	0	2	1	0	3	13	9	445.1	16	0	0	0	0	16
251902	B	UaN	0	0	0	0	0	1	0	26.2	1	0	0	0	0	1
251804	A	UaN; IA	1	1	0	4	6	9	11	225.7	14	0	0	0	1	15
251003	201201	UaN	0	0	0	0	0	1	1	4.0	0	1	0	0	0	1
251010	201201	UaN	0	0	0	0	0	1	1	0.4	0	1	0	0	0	1
251001	201201	UaN	0	1	0	0	1	1	2	47.1	0	2	0	0	0	2
251011	201201	UaN	0	0	0	0	0	2	2	3.0	0	2	0	0	0	2
251003	201201	UaN	0	0	0	0	0	4	4	16.2	0	4	0	0	0	4

Table 4.4 - Settlement Slope pottery.

4.4 Small Finds, Lithcs, & Ground Stones

This summary of miscellaneous, lithic and ground stones from RaM 3 and RaM 21006 will present the finds according to its find location and in its quantity. Special finds are highlighted here. Most finds originate from RaM 3 Trenches H, J, and K and the space around the trenches with surface finds. Trench RaM 21006 is a tomb on a different location than RaM 3.

4.4.1 Small Finds

Small finds are summarized in Table 4.5. There are three copper finds and one bronze find. The three copper fragments consist of two small lumps (Lots 250185 and 250606) and one sheet fragment (Lot 250325). The bronze object is a fragment of a chisel, elongated and tapering to a rounded tip (Lot 250226). Given its good state of preservation, it likely dates to the Islamic period.

Trench	Lot	Material
H	1	Copper
J	1	Bronze
J	1	Organic
J	1	Copper
K	1	Copper
X	1	Softstone
Total	**6**	-

Table 4.5 - Small Finds from Rakhat al-Madrh.

Figure 4.1 - Softstone fragment with zig-zag decoration.

The softstone vessel fragment is made of fine, dark softstone (Lot 252001) (Figure 4.1). The date of the softstone vessel is ambiguous: the engraved zigzag decoration suggests an Iron Age date, but the fine material and thinness of the sherd point to the Bronze Age.

The organic find is likely a coprolite (Lot 250275). It weighs 5.2 g, has a sausage-like shape, and measures 29 × 14 × 12 mm.

4.4.2 Lithics

In total, there are 61 lithics of various types (Table 4.6), of which 60 are made of chert and one is made of quartz.

A notable find is a medial fragment of an arrowhead. It is a foliated, fusiform point with a diamond-shaped section and slightly oblique, parallel pressure retouch (Lot 250323) (Figure 4.3). The edges converge slightly, and at one end they are

Trench	Number	Type
H	15	3 drills, 1 scraper 1 blade, 1 core, 7 flakes, 1 indeterminate
J	24	3 drills, 2 knives, 4 scrapers, 10 flakes, 2 cores, 1 blade, 1 indeterminate
K	7	1 arrowhead, 1 chip, 2 blades, 2 cores, 4 flakes, 1 scraper
X	15	4 drills, 1 knife, 2 scrapers, 2 blades, 2 cores, 4 flakes

Table 4.6 - Lithics from Rakhat al-Madrh.

more convex than at the other. It is most likely a tanged point, Type 3.a, with the stem and tip missing (Charpentier 2008: Fig. 7/3, 5, 6). Such points have been found at Suwayh 1, Raʾs Shaqallah, and Sharjah Tower (Charpentier 2008: 68). However, a short fusiform point, Type 1.b, is also possible (Charpentier 2008: Fig. 6/1, 2, 4), examples of which also occur at Suwayh 1 (Charpentier 2008: 67).

These types of points date to the Neolithic, between 4500–3700 BC. We found the fragment in a Late Umm an-Nar (2200–2000 BC) context, which implies that it is not in situ. As the house is located at the foot of a slope, it is likely that the arrowhead was washed in by water running down the hill and penetrating the structure.

Figure 4.2 - Chert Arrowhead (Lot 250323).

Two flakes without percussion waves or negatives are classified as indeterminate. One is a very irregular flake with a tip on one edge that might have been used for perforation (Lot 250221-6). The other is an angular flake with a notch on one edge that may have been used for working materials (Lot 250114-3).

Five cores were found in RaM 3, three of which are unidirectional and two multidirectional. These cores provide evidence for flint production on the site (Lots 250404-11; 250404-14; 251901; 250221-3; 250221-4).

Lot 250219 is a translucent quartz flake with a shallow percussion bulb on the ventral surface and percussion negatives on the dorsal surface (Figure 4.3). The surfaces are quite irregular, and it does not appear to be a tool or an attempt to make a bead.

Figure 4.3 - Quartz (Lot 250219).

4.4.3 Groundstone

Only a few ground stones were found in Rakhat al-Madrh excavations (see Table 4.7). One of the eight stones is an unmodified carnelian (Lot 250179), which may have been collected as raw material for bead production. However, there is no evidence for bead

Trench	Number	Type
H	4	3 hammer stones; 1 carnelian
J	2	2 hammer stones
K	2	2 hammer stones
Total	**8**	**-**

Table 4.7 - Ground stones from Rakhat al-Madrh.

Figure 4.4 - Carnelian (Lot 250179).

production at the site so far (Figure 4.4). Moreover, this opaque stone was not a preferred quality for bead-making, in contrast to translucent varieties. It may instead have been collected for its attractive orange color.

All other ground stones are hammer stones used for hammering or grinding. Four are fragments or damaged, and three are complete. Four were used for both hammering/crushing and grinding (Lots 250157, 250207, 250307, 250356), two for hammering only (Lots 250140, 250246), and one for grinding only (Lot 250180). Most are made of basalt, one of limestone, and one of undetermined material.

The variety of ground stone types in RaM 3 is very limited. Only rough hammer stones were found, more than half of which are fragmented. Notably, large grinding slabs, such as those typically found in domestic contexts, are entirely absent.

4.4.4 Miscellaneous

A notched tool (Lot 250401) was found in a tomb (Figure 4.5). It exhibits patination on both the dorsal and ventral surfaces, although some areas are lighter where the patina is missing. The artifact may have been damaged during its deposition in the ground, or it may have been knapped and reused hundreds of years after the patina had formed. Unfortunately, we do not know how long patination takes to develop under the local conditions.

Figure 4.5 - Notched tool (Lot 250401).

5. Geoarchaeological Survey

Aleksandre Prosperini[7]

5.1 Introduction

The area studied by the Bat Archaeological Project (BAP) geoarchaeological survey corresponds to the watershed of the Bat archaeological site. The study, carried out by Aleksandre Prosperini (PhD student at Sorbonne University), focused on the Bronze Age settlement 'RaM 3', located at the northwestern edge of the Rakhat al-Madrh basin. Test soundings were also excavated at the Early Bronze Age sites of az-Zebah and the Bat Settlement Slope in the Wadi al-Sharsah.

The aim of this research was, on the one hand, to understand the occupation patterns of the RaM 3 structure and, on the other, to reconstruct the landscapes and natural dynamics of the Bronze Age and their evolution. The results also provide fundamental data for Prosperini's PhD thesis, *Les sites périphériques oasiens de Bat, Oman. Étude géoarchéologique d'un territoire de l'âge du Bronze: Environnement, ressources en eau, aménagement et géopatrimoine*, prepared under the supervision of Professor Éric Fouache at Sorbonne University.

In total, eight soundings and sections were excavated, yielding 286 samples for sedimentological analysis, 10 micromorphology samples, four samples for OSL dating, and 24 samples for radiocarbon dating (Figure 5.1). Additionally, 18 water samples were taken. The sediment and water samples will be analyzed at the ISTeP (Institut des Sciences de la Terre de Paris, UMR 7193) and at the Geomorphology and Geoecology Laboratory at Heidelberg University. The ^{14}C and OSL samples will be used to date the phenomena identified in the stratigraphy.

This work was made possible thanks to the supervision and logistical support of the Bat Archaeological Project, the help and permission of the Omani Ministry of Tourism and Heritage, funding from OPUS (Observatoire des patrimoines de l'Alliance Sorbonne Université), and mobility assistance from the Faculté des Lettres de Sorbonne Université, as well as material and analytical support from the ISTeP (UMR 7193), the Geomorphology and Ecogeography Laboratory at Heidelberg University, and the METIS laboratory (UMR 7619).

5.2 Rakhat al-Madrh Soundings: S10 interior, S10 exterior, and S11

Two soundings were excavated in the Rakhat al-Madrh basin in association with the site's Bronze Age structures. The first sounding, S10, was oriented to bisect the courtyard wall of RaM 2 and to sample contexts both within the courtyard and in the basin immediately outside the building (Figure 5.2). The second sounding, S11, was

[7] MEDEE (Mer, Désert, Environnement), Geoarchaeological program of the CEFREPA (Kuwait) leads by Eric Fouache and Stéphane Desruelles

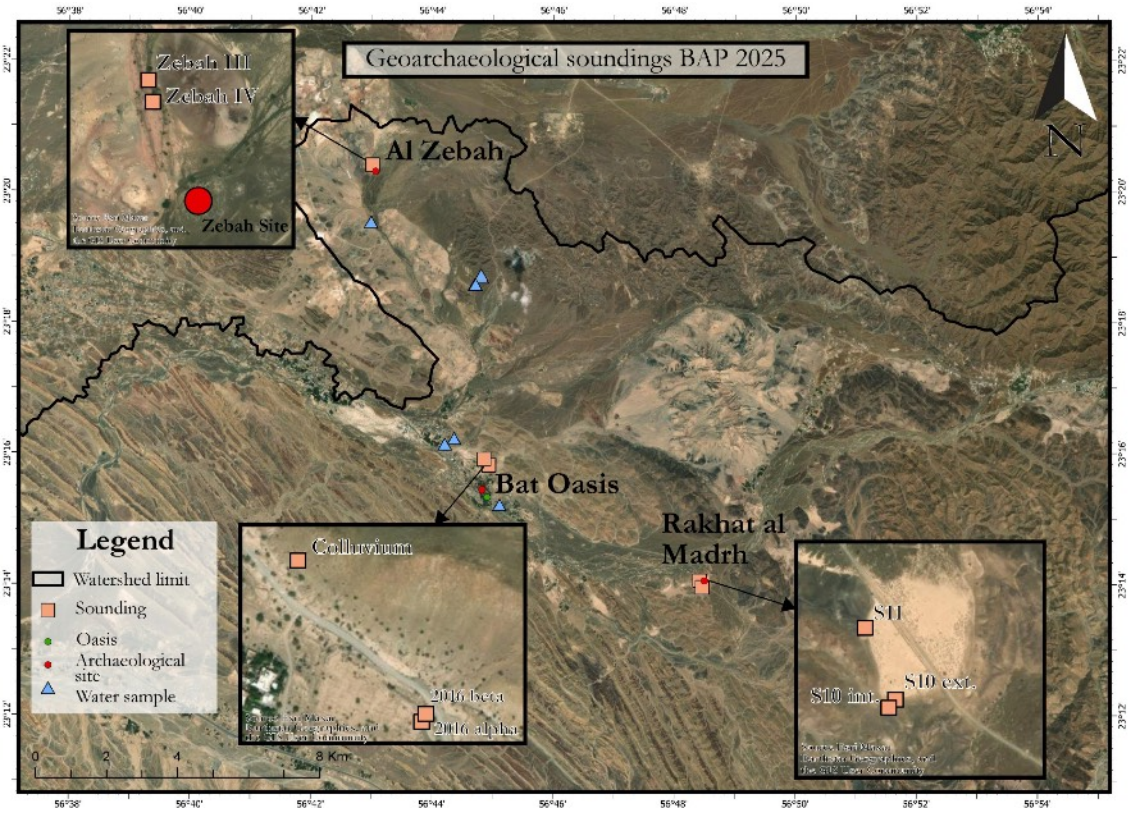

Figure 5.1 - Location of all geoarchaeological soundings.

oriented parallel to the outer wall of the RaM 3 structure in order to reveal the geomorphology of the building's immediate surroundings.

5.2.1 Archaeological Contexts

The archaeological site of Rakhat al-Madrh is located 7.5 km from the oasis of Bat. It is unique in terms of the quality of the remains preserved there. At the base of the slopes, on the edges of the hills, there are four large buildings associated with multiple activities: pastoralism, crafts, and habitation (Swerida *et al.* 2024). On the ridgeline of the neighbouring hills are Hafit tombs. Everything suggests that this site was frequented both by the inhabitants of the Bat oasis and by more transient populations, such as shepherds and merchants. The location of RaM is especially interesting: close to the oasis, it does not have abundant water resources but does have abundant vegetation for the area. In addition, the area around Rakhat al-Madrh is particularly green, with surface water and wells. To the west lies the oasis; to the east is a large alluvial plain and a few Bronze Age sites identified at 'Amlah.

The RaM 2 site is important because it combines small inhabited rooms typical of Umm an-Nar architecture with a large space whose size suggests that it was not a living area but rather an enclosure for animals (Dollarhide *et al.* 2022). Inside one of the small

Figure 5.2 - Soundings S10 interior, S10 exterior and S11 in the Rakhat al Madrh depression. Each trench is associated with an archaeological site.

rooms of the structure, a *tanur*-type oven was found. During the 2025 campaign, two other ovens of this type were found outside the structure. It is therefore a site that is particularly representative of the way of life and housing of Bronze Age societies.

The RaM 3 site is located northeast of the Rakhat al-Madrh depression. It is characterized by its size (Swerida *et al.* 2024), which made it the central focus of the BAP's 2025 campaign. It is dominated by several tombs from the Hafit period and seems to have had several different uses (copper crafts, jewelry).

5.2.2 Environmental Context

Rakhat al Madrh is a small depression (1,600 m²) straddling the Wahrah Formation to the west and the Matbat Formation to the east (Al Ayn Formation according to Blechschmidt et al. 2004). The latter consists of quartzite (green/brownish quartz sandstone according to Blechschmidt *et al.* 2004). These formations are capped by fragments of conglomerates, of which at least three generations have been documented (Swerida *et al.* 2023). These alluvial conglomerates contain rounded pebbles from the

Wadi al-Hijr watershed, including igneous rocks such as ophiolites and gabbros, phenocrystalline igneous rocks, and basalts (Minoux & Jaujon 1986).

Despite its steep slope, Rakhat al-Madrh has a gentler topography than Settlement Slope. The hills form a series of ridges that are easily accessible to livestock. Numerous faults, the concavity of the relief due to the folding of the Hawasina nappe, the regressive erosion of a valley head, and wind deflation are certainly factors whose combination led to the formation of this depression (Shaw & Bryant 2022). Indeed, the southeast–northwest orientation of the depression broadly follows that of the faults that constrain Wadi al-Hijr.

This depression is therefore a valley whose floor has been covered with sediments brought by the wind and by the floods of Wadi al-Hijr. The bottom of the depression is extremely flat, covered with khabra-type deposits (clay-silt deposits[8]) but without a salt layer (Al-Dousari *et al.* 2009). These characteristics make Rakhat al-Madrh a dry playa sensu Laity 2009.[9] Salt is not completely absent: halophytic plants are common in the depression, though not predominant. Thus, the khabra deposits of Rakhat al-Madrh can be described as alkaline.

Numerous faults, the concavity of the relief due to the folding of the Hawasina nappe, the regressive erosion of a valley head and wind deflation are certainly the factors whose combination led to the formation of this depression. Indeed, the south-east to north-west orientation of the depression broadly follows that of the faults that constrain Wadi al Hijr.

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5.2.3 RaM 2 Environmental Context

RaM 2 is located southwest of the depression, in a small recess in the hill of the Wahrah Formation, toward the distal part of the colluvial fan, partially on top of the khabra deposits. RaM 2 is surrounded by geologically diverse outcrops: to the east are quartzites, to the south conglomerates, and to the west calciturbidites. It should be

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[8] This term is also sometimes used as a vernacular synonym for *playa* (Al-Dousari, *et al.* 2009).

[9] Dry playa : "system primarily fed by surface flow, with a predominantly smooth clay floor, and for which the groundwater table is usually more than 5 m below the surface […]such that capillary rise of water and dissolved salts do not reach the surface" (Laity 2009).

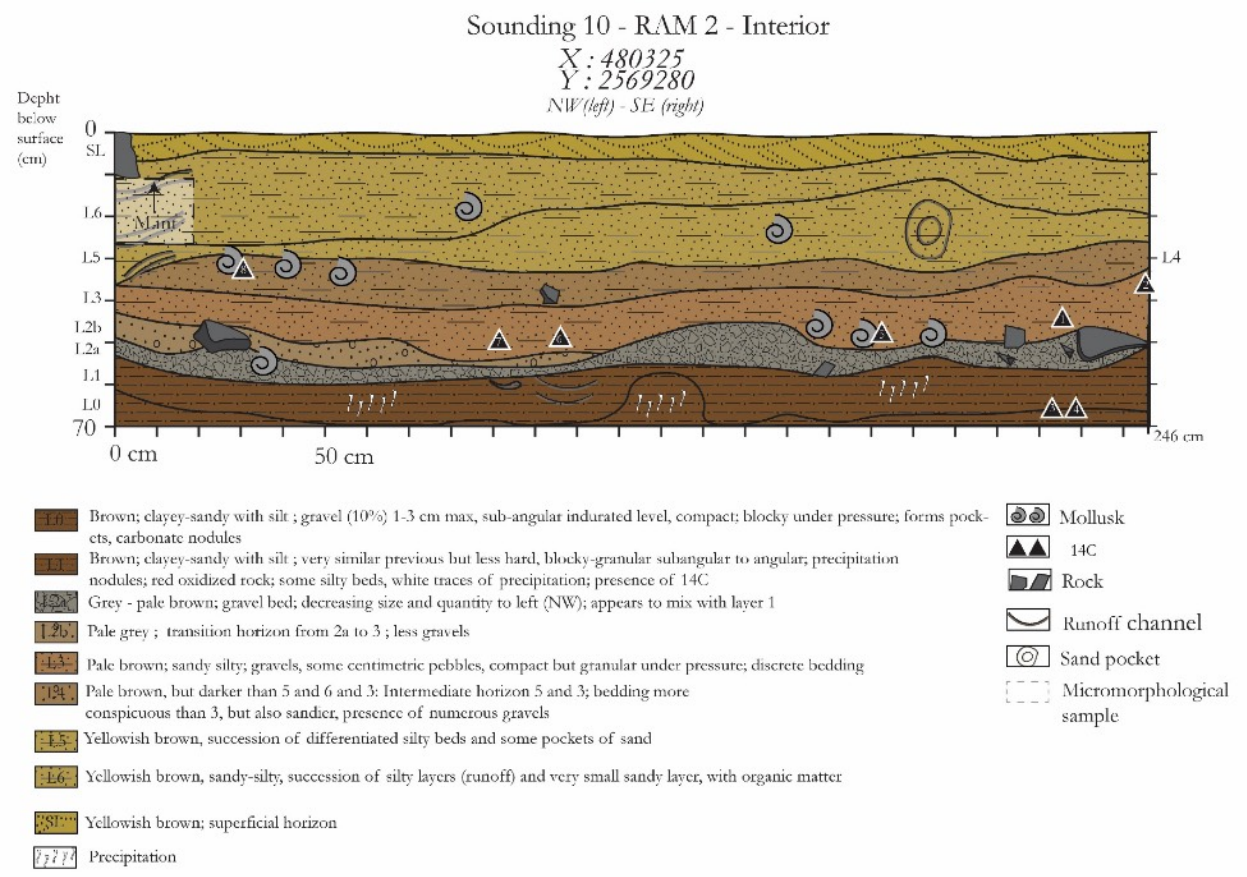


Figure 5.3 - S10 interior survey, carried out inside the RaM2 building, interpreted as an enclosure.

noted that it is also to the west that the 'natural' path taken by animals today, particularly goats, to reach and leave the playa is located. This is not surprising, since, although colluvial, the slope is gentle between the eastern hillocks, which have no tombs, and the western hillocks, which have many. It is therefore easy to walk there. This is also the general direction of Wadi al-Rafesh, whose water table sometimes rises to the surface at the numerous water gaps east of Rakhat al-Madrh (Minoux & Jaujon 1986). Wadi al-Rafesh is not a tributary of Wadi al-Hijr; it is a watercourse discordant with the tectonic structure, passing perpendicularly through the layers of the Wahrah Formation and emerging on the other side of the eponymous Jabal.

5.2.4 Geoarchaeological Questions at RaM 2 - Interior

The aim is to compare natural and anthropogenic processes inside and outside RaM 2. In particular, we are looking for markers of pastoralism or water management, whether for water storage or to protect the building from flooding (Figure 5.3 & 5.4).

To understand the palaeogeography of the site, it was necessary to identify the substrate that preceded human occupation, then to circumscribe the deposits

Figure 5.4 - Orthophoto of S10 interior, based on photos taken by Ruben Hartman.

corresponding to the Early Bronze Age occupation in order to understand the choice of location and the consequences of human occupation on the landscape. These consequences can be seen in the concentrations of chemical elements in the sediments and in the downward trend in the sedimentation rate.

The deposition processes within RaM 2 potentially bear the mark of human activity, insofar as it is located within the archaeological site, which is believed to have been used as an enclosure.

The environmental interest here also extends to biology. Indeed, if the site did serve as an enclosure, it is possible that traces of pastoral activity may be found within it. The animals raised during the Early Bronze Age were sheep, goats, and cattle (Makarewicz 2020).

5.2.5 Geoarchaeological Issues at RaM 2 - Exterior

Compared to the previous survey, this survey is located outside the building. It lies immediately north of the outer wall of the RaM 2 enclosure, slightly offset (1 m) to the east to allow for the opening of an archaeological trench. It is therefore of comparative interest in terms of the differences and similarities between the activities taking place within the RaM 2 enclosure and those in the immediate exterior (Figure 5.5 & 5.6).

It has been found that *tanur*-type ovens were also installed outside the building. Two structures of this type have been found. The shape of these ovens and their depth suggest that they date from the Umm an-Nar period, the main period of occupation of the site.

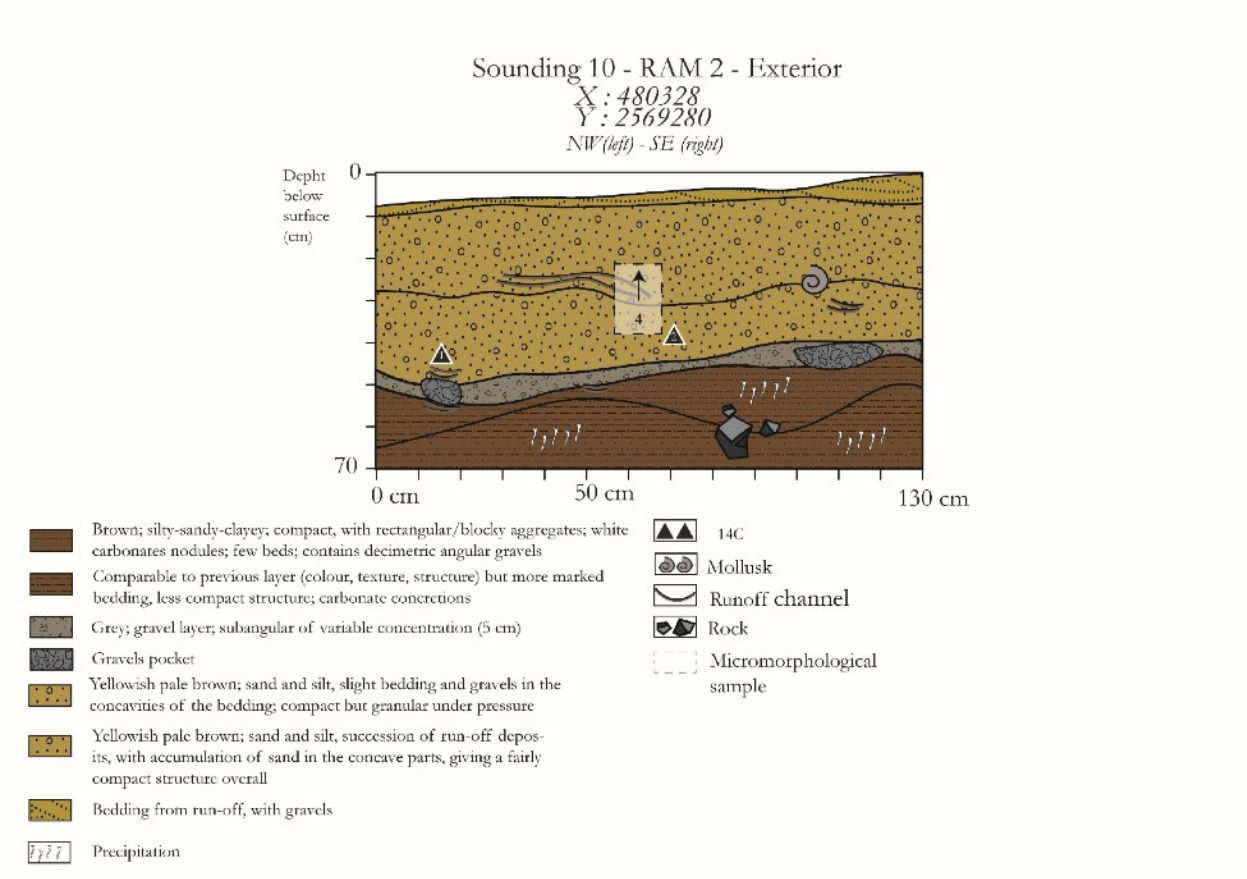


Figure 5.5 - S10 interior sounding, carried out outside the RaM2 building, in the Rakhat al-Madrh depression, near the *tanur* ovens.

Figure 5.6 - Orthophoto of S10 exterior, based on photos taken by Ruben Hartman.

5.2.6 RaM 3 Environmental Context

RaM 3 is located below the colluvial fan and partially buried by khabra deposits. Its location is therefore comparable to RaM 2, although RaM 3 is the site closest to both the outlet and the alluvial cone of Wadi al-Hijr, which extends into Rakhat al-Madrh. A slight protrusion of the calciturbidite slope to the east protects RaM 3 from the effects of playa drainage via the outlet. The site can therefore be considered unaffected by excessive soil erosion, as it is shielded from wind erosion by the shape of the relief and is located at a sufficient distance from the outlet of the depression for its soils not to be carried away by drainage following floods. The lithology of the surrounding slopes is simpler, consisting of mudstone, calciturbidite, and chert, with some magmatic rocks from the eastern watershed trapped in the conglomerates.

During the 2023 excavations, a survey was carried out downstream from RaM 3, in the playa. Charcoals were dated on this occasion and corresponded to the Early Bronze Age.[10] It is possible to attribute the deposit of these charcoals to human activity. Indeed, the low sedimentation rate observed through dating suggests that human societies had an influence on sediment accumulation. In this context, one possible explanation for this low rate of sedimentation could be grazing in Rakhat al-Madrh. Trampling by livestock increases wind erosion, thereby slowing the rate of sedimentation (Laity 2009; Goudie 2008; Reynolds *et al.* 2007). As Rakhat al-Madrh is still used for grazing today, it is not unreasonable to assume that the site was used for this purpose as early as protohistoric times, which would explain the low sedimentation rate at the depth corresponding to the Bronze Age.

The Rakhat al-Madrh sites examined during the 2025 BAP campaign are located in dynamic geomorphological contexts, at the junction between slopes marked by colluvial deposits and low playa areas where alluvial and aeolian sediments are concentrated. This dynamic is explained by the convergence of multiple natural processes, such as alluviation of the wadi, aeolian deposits, and slope deposits. Rakhat al-Madrh acts as a sedimentary trap and preserves the trace of the succession of these processes, making it possible to reconstruct the evolution of the landscape since the Pleistocene. The hiatuses and reductions in the rate of sedimentation are also of interest, as they appear to reflect the increased action of human societies since the Bronze Age.

5.2.7 RaM 3 Geoarchaeological Research Questions

As elsewhere in the Rakhat al-Madrh depression, RaM 3 (associated with trench RaM 11) raises the question of water management and the presence of livestock (Figure 5.7). If some form of agriculture was practiced, it is reasonable to assume that it was

[10] Radiocarbon dating carried out at the Re.S.Artes laboratory in Bordeaux, France.

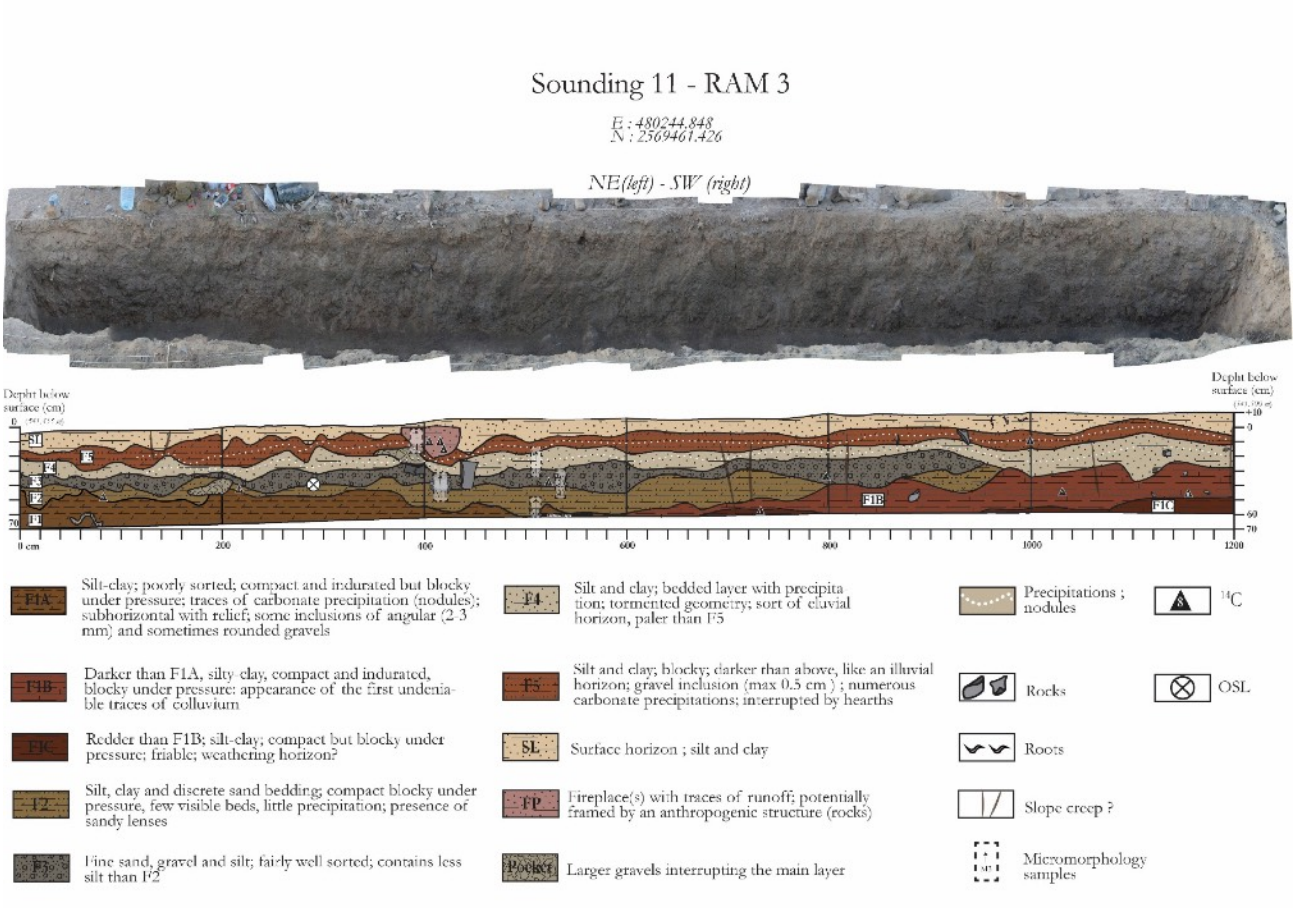


Figure 5.7 - Trench S11 dug immediately to the north-west of the RaM3 building, connecting the slope and the depression.

accompanied by water collection infrastructures, such as the ditches documented at the Hili and Salut sites (Beuzen-Waller *et al.* 2018).

Furthermore, the orientation and location of the site make it possible to observe the colluvial deposits, the deposits adjacent to the RaM 3 archaeological structure, and the alluvial deposits at the bottom of the depression in a single, sufficiently long trench (12 m in this case). The aim is to describe the natural processes by which sediments accumulate and to identify any water catchment structures around the RaM 3 site.

5.3 The Settlement Slope Colluvium: Sounding 2016 alpha and beta

5.3.1 Archaeological Context

The Settlement Slope is part of a renowned archaeological setting. The site is located above the Bat Oasis and the Bronze Age necropolis, which is listed as a UNESCO World

Heritage Site (Swerida *et al.* 2021). At its base are three of the remarkable towers from the Umm an-Nar period.[11]

The Settlement Slope is a particularly important site for Early Bronze Age archaeology in Oman, as it is one of the few preserved settlements from this period and has yielded numerous artifacts. In front of the site lies the Sharjah wadi (seasonal watercourse), which is important for understanding the alluvial and agricultural dynamics of the region (Desruelles *et al.* 2016). This wadi is lined with structures interpreted as water management infrastructure linked to the Bat Oasis (Brunswig 1989).

On the slope, several Early Bronze Age dwellings have been identified, as well as structures resembling terraces or sediment collection infrastructures (check dams). The entire slope is dotted with ceramics, mainly from the Umm an-Nar period. This abundance is rare in the area and offers insights into the diet and socio-spatial practices of Early Bronze Age societies.

The ridgeline of the Settlement Slope is occupied by several tombs from the Hafit period. The geological structure, often visible, breaks down into blocks that are almost suitable for construction in their natural state and have been quarried *in situ* in some cases (Böhme *et al.* 2011).

Overall, the Settlement Slope is an archaeologically complete site. Given the arid environment and the low sedimentation rate, which is not conducive to the preservation of archaeological data, the geoarchaeological approach offers a useful complement to improve understanding of the site.

5.3.2 Environmental Context

The Settlement Slope archaeological site was established on a hill approximately 500 m high, oriented southeast–northwest. The hill belongs to the Hawasina nappe, more specifically to the Wahrah Formation. It is composed of folded layers with a steep dip (50–60° NE), consisting of silicified limestone with shale partings, limestone with abundant chert nodules, limestone and calciturbidites, mudstones, and chert. However, it does not have the abundance of red chert with radiolarites visible on the other side of Wadi Sharjah, in the Bat Oasis (Minoux & Jaujon 1986; Cooper 2001).

The resulting topography is a series of hills several hundred metres long, predominantly beige in color, with slightly convex slopes and a steep, highly colluvial surface. The distribution of colluvium is typical of arid environments, with an upper

[11] al-Rojoom ("Tower 1144"), Kasr al-Khafaji ("Tower 1146") and "Tower 1156" (see Swerida & Thornton 2019b).

part where the bedrock is exposed and a lower part, in contact with the depression, where the colluvium is deposited (Yair 1990).

At the base of the Settlement Slope flows Wadi Sharjah, a tributary of Wadi al-Hijr. The action of the water is clearly visible at the base of Settlement Slope. On the one hand, the valley floor is covered with thick silty clay soil brought by the wadi, typical of oases (Purdue *et al.* 2019). On the other hand, the action of the water leaves clearly visible signs of erosion in the soil on Settlement Slope. On the colluvial slope, gullies are visible, possibly barred by *check dams* to take advantage of the runoff and sediments for agricultural use.

These gullies continue and cut into the accumulated soil at the bottom of the valley and join Wadi Sharjah, which is itself deeply incised. Indeed, Wadi Sharjah has become greatly incised over the last decade, since the construction of a dam levee upstream in Wadi al-Hijr (Desruelles *et al.* 2016). This construction channels the waters of the wadi and accentuates the incision, so that the shape of Wadi Sharjah resembles an arroyo, with a flat bottom, which corresponds to the road, and almost vertical walls of silty–clay alluvium into which Wadi Sharjah cuts (Laity 2009).

This change in dynamics had the positive effect of revealing a stratigraphy rich in information about the early days of agriculture in Oman. Thus, in conjunction with the Settlement Slope, it is possible to reconstruct a logical subsistence system between the sites of the Bat Oasis during the Early Bronze Age (Swerida 2017).

5.3.3 Geoarchaeological Issues

The Colluvium section (Figure 5.8) corresponds to a potentially artificial structure. It blocks a gully and could therefore have been used to capture sediments or channel water. Conducting a survey beneath a water management infrastructure believed to date from the Bronze Age aims to confirm its artificial nature and clarify its function. The study of soils and precipitation processes, and their content, can help achieve this second objective, while the first can be achieved provided that datable materials are found — which fortunately was the case. In addition, the study of the colluvium at the base of the section provides an opportunity to understand the natural functioning of the slope and thus measure the extent of the consequences of human action.

The Wadi Sharjah section was studied in detail by Desruelles *et al.* in 2016. Numerous analyses were carried out on this section, with the exception of phytoliths. The BAP now has the means to carry out these analyses. It was therefore appropriate to resample the section studied in 2016 in order to enrich and re-evaluate the results previously obtained in light of the information provided by the phytoliths.

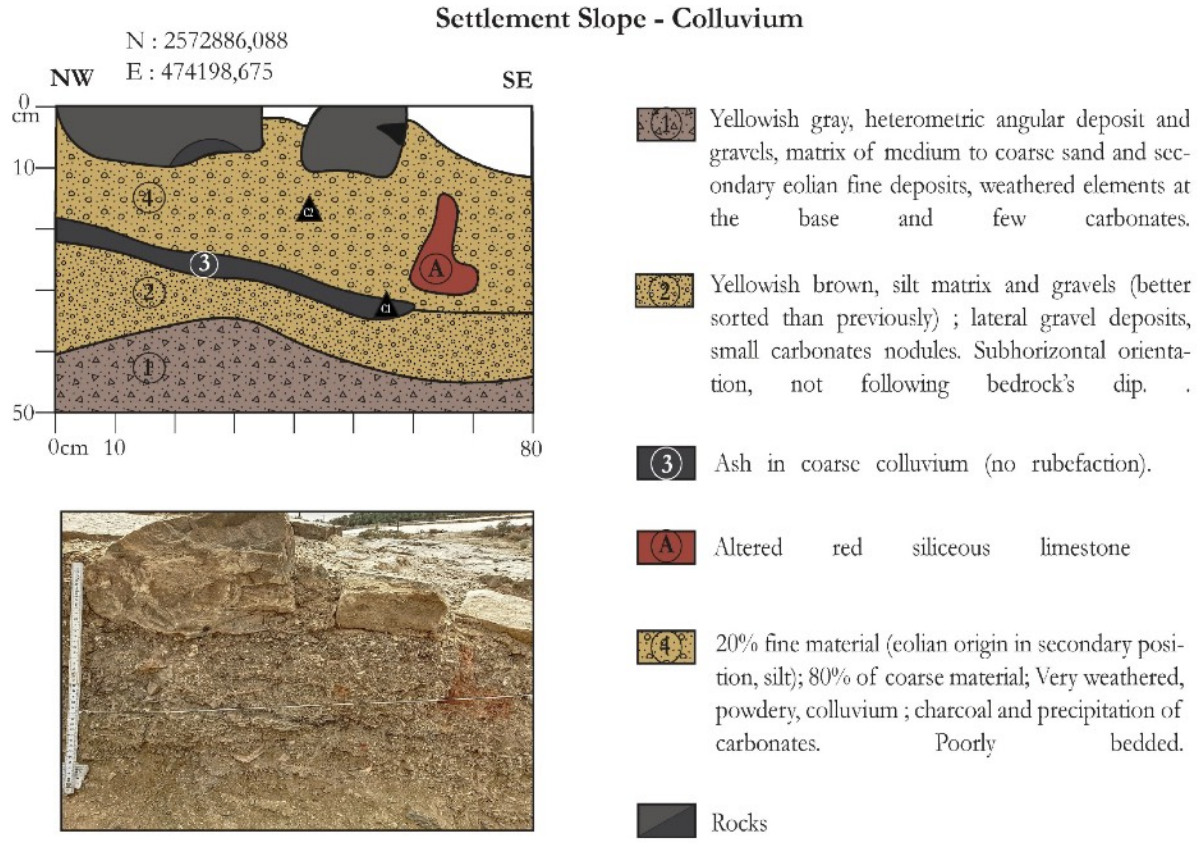


Figure 5.8 - Colluvium section, under a potential check dam linked to agricultural activity.

The Wadi Sharjah incision has continued. In nine years, the profile recorded by Stéphane Desruelles *et al.* has changed significantly (Figures 5.9–5.11). To ensure consistency between the samples taken in 2016 and 2025, two sections were made on the wall: 2016 Alpha near the road and 2016 Beta a few meters further away.

5.4 Soundings Zebah III and Zebah IV

5.4.1 Archaeological Context

Zebah is located to the northwest, upstream from the Bat Oasis. It is a small settlement (150 m by 200 m) (Döpper & Schmidt 2014), situated on an alluvial terrace dating to the early Holocene (OSL dating: 10,830–890 ka; obtained at the Re.S.Artes laboratory). Zebah is smaller than Bat and certainly occupies a peripheral position in the spatial organisation of the sector (Döpper & Schmidt 2014). Nevertheless, Zebah remains a remarkable settlement, with its own houses and potentially a tower (Döpper & Schmidt 2014). Zebah is also distinguished by the presence upstream, in a small side *wadi*, of a major water management structure described as a dam. Zebah must therefore have been

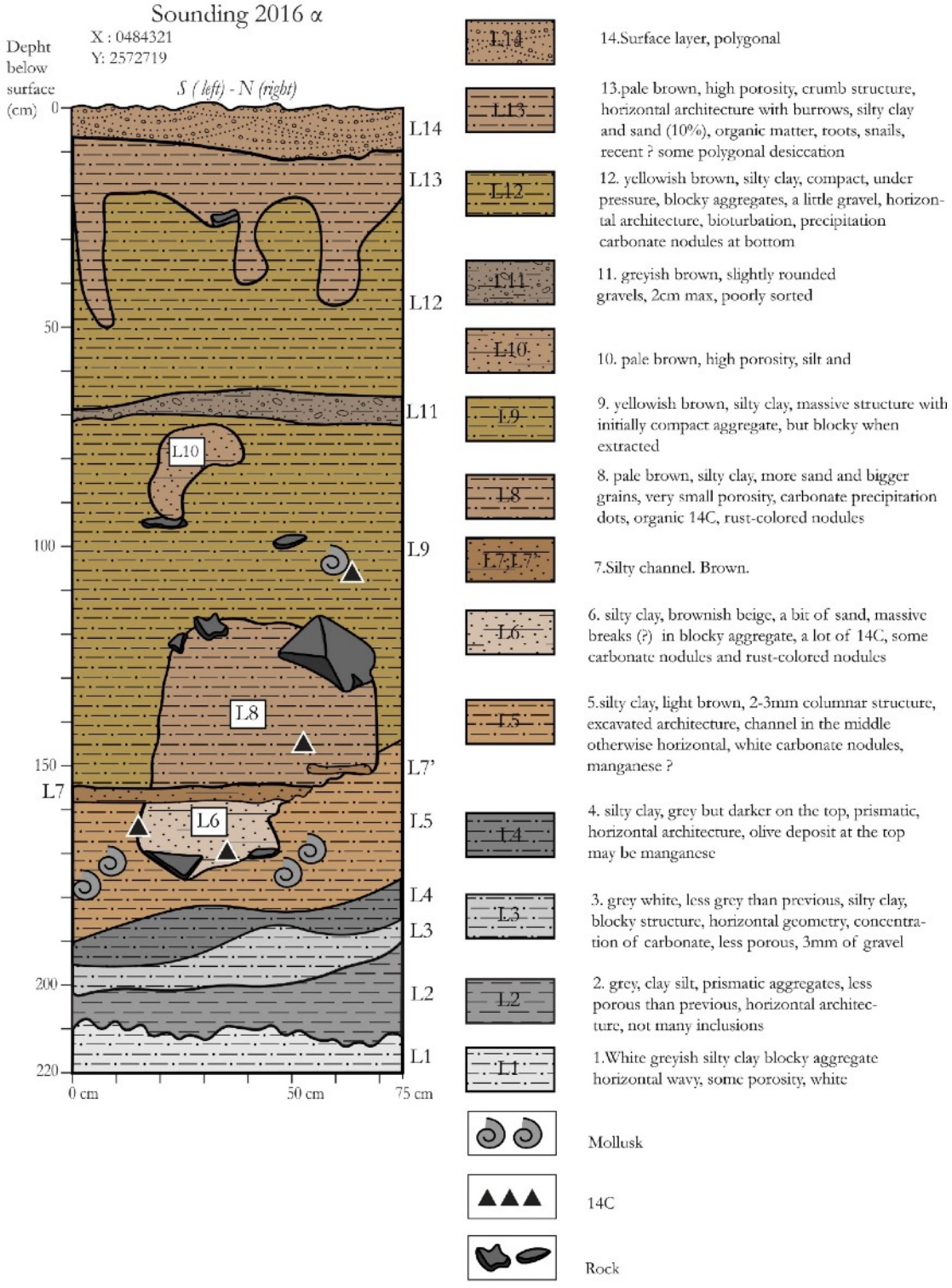


Figure 5.9 - Section taken from the section studied by Desruelles *et al.* in 2016 and sampled for phytolith analysis by Alessandra Dominguez.

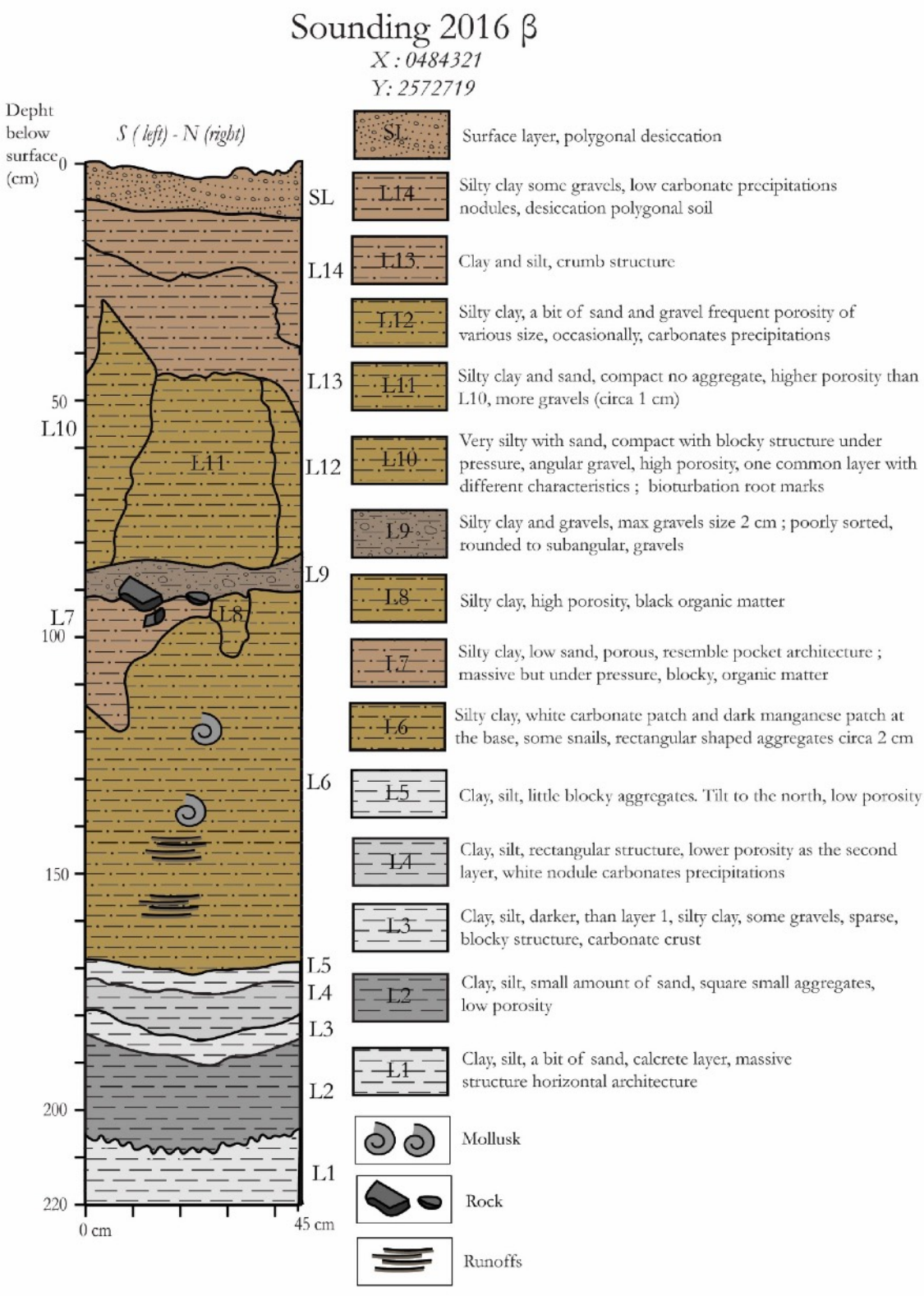


Figure 5.10 - Section 2016 beta taken from the section studied by Desruelles *et al.* in 2016 and sampled for phytolith analysis by Alessandra Dominguez.

a peripheral site, occupied seasonally by populations described as nomadic or semi-nomadic. Zebah raises questions about mobility, trade, and the spatial organization of the area around the Bat Oasis.

Figure 5.11 - Orthophoto of section 2016 alpha. Made by Ruben Hartman.

5.4.2 Environmental Context

Zebah is located on an alluvial terrace dating to the early Holocene (Figure 5.12). This terrace is high enough to avoid flooding, which explains the quality of its preservation from both archaeological and palaeoenvironmental perspectives. The alluvial plain is bordered to the west by rocks of the Al-Aridh Formation, dating from the Middle Triassic to Late Cretaceous periods, as well as exotic limestones. To the east are the ophiolites of the Muqniyat Block Nappe. At the base of the Al-Aridh exotics are copper salts, probably malachite, set in what appears to be basalt (Prosperini, field observations in 2024 and 2025). The terraces of the Zebah alluvial plain are stabilised by denser vegetation than elsewhere in the Bat region. The water table lies relatively close to the surface, and wells attest that this resource is still used today.

To the north of Zebah, the Muqniyat alluvial plain likely also provides abundant water during wet periods. Overall, the area around Zebah is a vast pastureland. This is evidenced by the numerous small private farms in the area, as well as the herds of goats and camels that frequent it. The wadi dammed upstream to the west of Zebah is remarkable for its length and the scale of the blocks used. This is undoubtedly a check dam, whose role is to capture fertile silt rather than store water.

5.4.3 Geoarchaeological Questions at az-Zebah

There is still no consensus on the role of Zebah in the Bat region or the ways in which the site was inhabited. A major point of contention is whether the inhabitants were

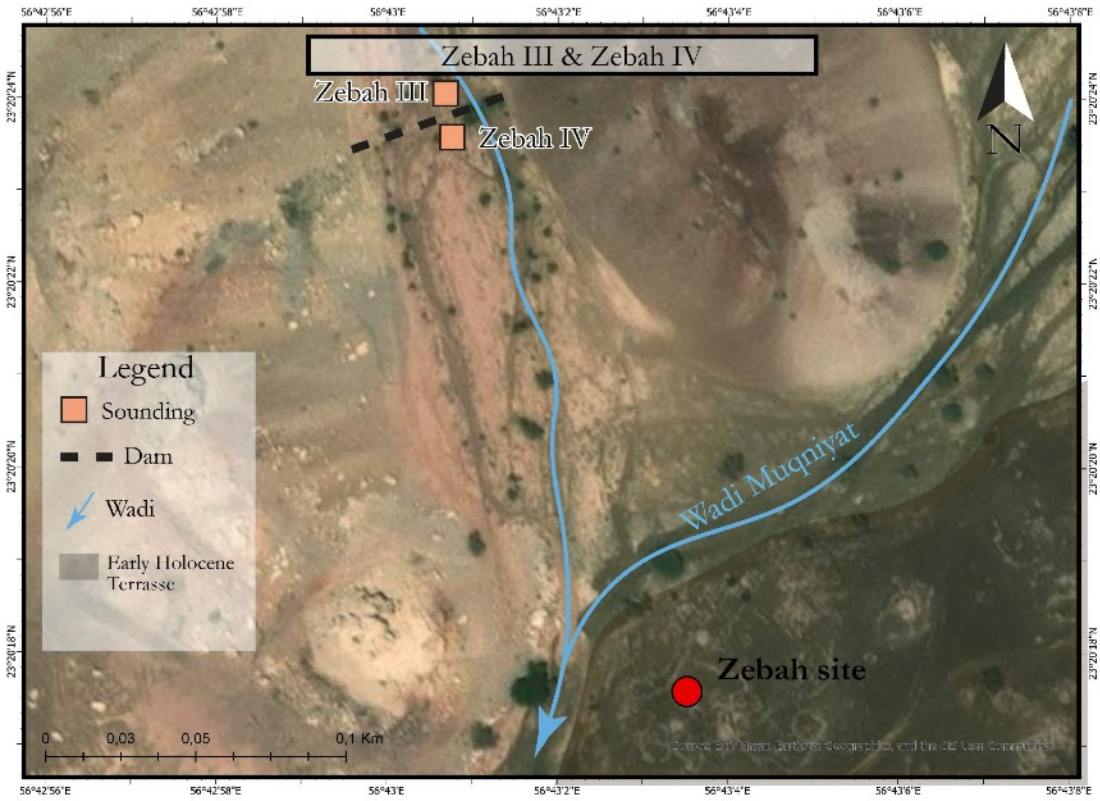


Figure 5.12 - Zebah III and IV soundings, upstream and downstream of the check dam associated with the Zebah site (south of the map, on a terrace dating from the early Holocene).

nomadic, sedentary, or somewhere in between. In this respect, the dating of the potential dam upstream from the site is important for placing it within the site's history. Two test pits (Figure 5.12), upstream (Figure 5.13) and downstream (Figure 5.14) of the dam, should enable us to determine what type of agriculture it might have been associated with, and whether this agriculture corresponds to a sedentary or a nomadic society.

Water Samples

As part of the BAP 2025 field mission, 18 water samples were taken in the Bat and Sint sectors (Figure 5.14). These samples were analyzed for the concentration of major elements (ion chromatography) at the METIS laboratory (UMR 7619).

The aim of this sampling was to improve understanding of the natural dynamics of the Bat catchment and the distribution of water resources exploitable by human societies. Particular attention was paid to salt concentration, which is highly variable and strongly dependent on the nature of the local geology. Given the complexity of the geology in the Hajar Mountains, concentrations can vary substantially even within the

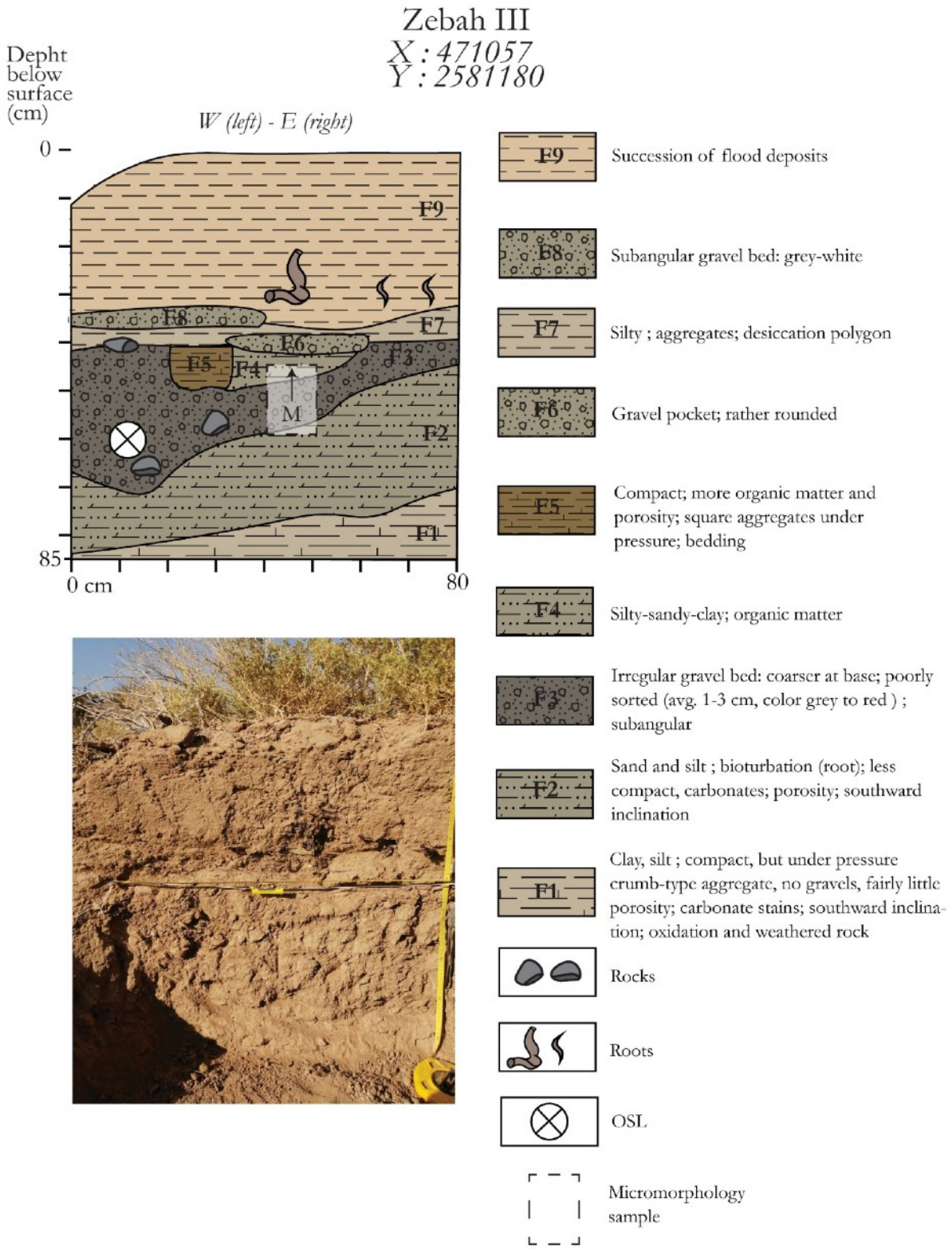


Figure 5.13 - Zebah IV survey downstream of the Zebah check dam, also carried out in a silty bar.

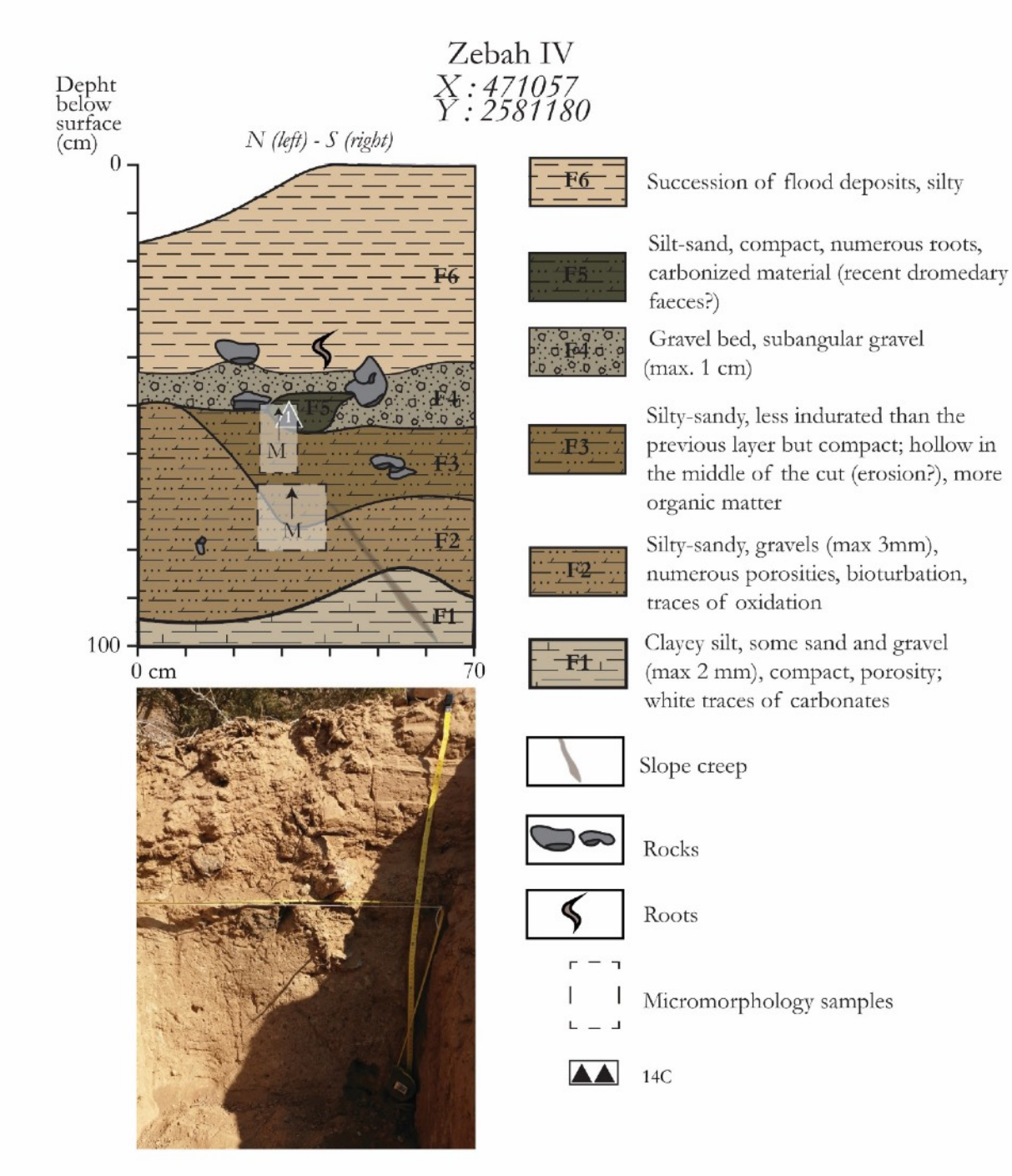


Figure 5.14 - Zebah IV survey downstream of the Zebah check dam, also carried out in a silty bar.

same catchment. Thus, analysis of the main elements provides information about the properties of the rocks surrounding the aquifers, the distribution of certain plants, and the formation of landscapes typical of desert environments, such as sebkhra. Other

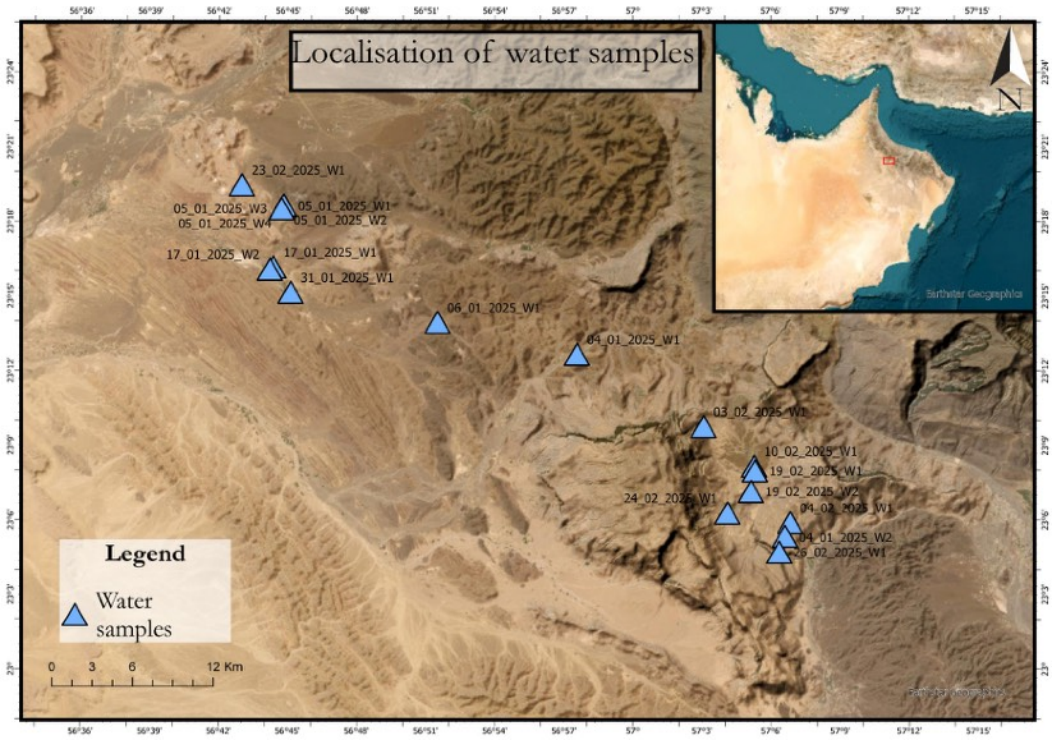


Figure 5.15 - Location of water samples in the Bat and Sint watersheds.

elements contained in the water are of particular interest, notably sulphur, whose presence may help explain the formation of gypsum in the Bat watershed.

Sampling was carried out opportunistically whenever water sources were available. The areas can be classified into two major categories: natural springs and artificial springs. Natural springs are outcrops of groundwater, karstic resurgences, or hollows where rainwater collects. Artificial springs are boreholes or wells. The water points sampled are geolocated and accompanied by descriptions and rock samples to aid in understanding the local geology.

6. Archaeobotanical Study

Alessandra Dominguez[12]

6.1 Introduction

Research goals for the BAP 2024-25 season included: 1) building a flotation tank for macrobotanical recovery, (2) collecting modern plant samples from around the Bat oasis, (3) and collecting soil samples for micro-archaeological analysis. The purpose of these goals is to contribute to the broader research concerning the modern and archaeological oasis landscape at Bat. Other projects at Bat, such as the geomorphology initiatives, focus on reconstructing past environmental conditions and landscape formation processes. The data collected and to be analyzed provides important information regarding these areas of interest and compliment other projects that are currently underway.

The samples collected are made up of soil/geological and of live plant material. The live plant materials remain in a climate-controlled storage unit in Oman. The soil samples were transported to Philadelphia, Pennsylvania (USA) for further analysis. These analyses include phytolith extraction and identification, FTIR (Fourier transform infrared spectroscopy) analysis, and soil profile testing (carbonates, Total Organic Content, etc.). The samples are stored in a USDA-approved archaeology laboratory at Rutgers University in New Brunswick, New Jersey. Additional analysis will also occur at the Paleoecology Laboratory and Center for the Analysis of Archaeological Materials (CAAM) at the University of Pennsylvania in Philadelphia.

6.2 Floatation Tank

Archaeobotanical recovery occurs in two primary ways: the flotation tank and dry-sieving. Flotation operates by suspending carbonized organic material (like seeds) in water, separate from the soil matrix. At Bat, flotation is the preferred method of recovery and has been undertaken through bucket flotation. The bucket flotation is a laborious and inefficient technique but is inexpensive and does not require excessive water. The flotation tank is superior to bucket flotation, but requires specific parts and water, which are not always accessible in the field.

This year, BAP built a manual bilge-pump flotation tank (after Shelton & White 2010), which was inexpensive and uses a boat bilge-pump to recycle water, thus avoiding excessive water waste (see Figures 6.1 & 6.2). The tank will provide the project with a water and time efficient method for recovery of archaeobotanical material, primarily seeds.

[12] Department of Anthropology, University of Pennsylvania

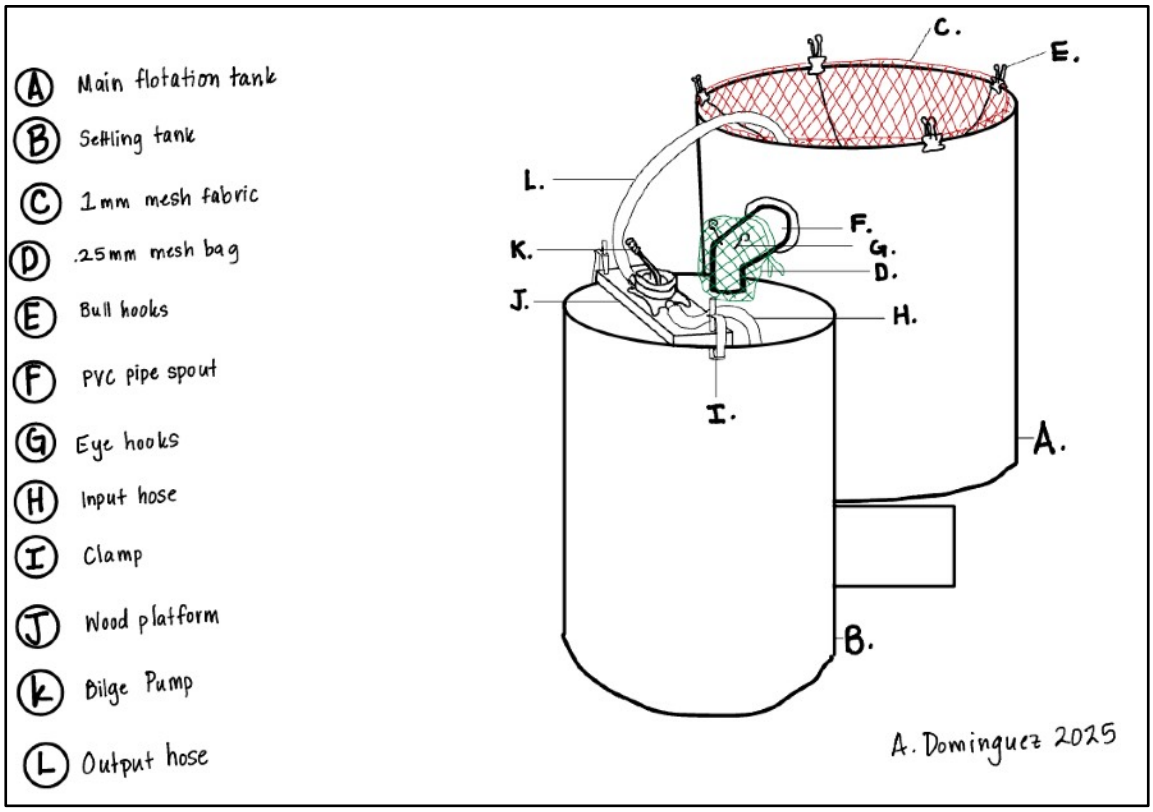


Figure 6.1 - Plan of BAP manual bilge-pump floatation tank (after Shelton & White 2010).

Figure 6.2 - Image of of BAP manual bilge-pump floatation tank.

The other method of recovery, dry-sieving, uses geological sieves (sieve aperture measurements: 4mm, 2mm, 1mm, .5mm, pan) to collect botanical remains. Rather than using water to suspend the botanical material from the soil, dry-sieving separates the soil particles and their inclusions through particle size. Where flotation dissolves the extraneous soil particles, dry-sieving maintains the entire original matrix. This reduces the potential for the botanical material to be destroyed in the recovery process, which is a concern with flotation. Despite this benefit, dry-sieving takes significantly longer to analyze, which is why it is not a favored recovery process. Regardless, we employ both dry-sieving and flotation to determine which process is the best for the preservation of the botanical material at Bat.

The floated and sieved botanical material has been stored in Oman and awaits export. The laboratory at Rutgers University holds a soil permit, which extends to Oman. The permit has been renewed as of the past month and the lab is prepared to receive the samples.

6.3 Modern Plant Samples

In reconstructing the environment at Bat in the third millennium BCE, we must understand the modern Bat oasis landscape. This includes recording the flora of the interior and periphery of the oasis. These samples were collected, pressed, and mounted on a sheet for a preliminary herbarium database (see Figure 6.3). Although preliminary identifications were made with the aid of botanical guidebooks, official identifications by a state-recognized botanist are further required. Once identified, clippings from the samples will be exported to the United States for further analysis. These clippings will specifically be used to create a modern phytolith assemblage. The assemblage is necessary for phytolith analysis because it offers site-specific comparisons, rather than relying on regional databases. This initiative is especially important considering that the only regional database of modern phytoliths available comes from the Dhofar region, which differs dramatically in its vegetation and environment.

Figure 6.3 - Scan of Calotropis procera, recovered near the archaeological site of Sint.

The plants that make up the assemblage were collected from various environmental settings including the interior of the oasis, in gardens, around archaeological sites, and within the wadi channels. Plants were collected based on their frequency and plant type. Specifically, grasses were prioritized because they yield the most phytoliths. Each specimen collected has GPS-associated points and basic field descriptions. The specimens were dried and pressed for 72 hours and mounted on acid-free paper using herbarium tape, and/or stitching when necessary. There are 65 samples total. If the plant had fruits, the seeds were removed from the fruits and stored to create

a modern seed assemblage. The specimens are currently stored in a climate-controlled space in Oman.

6.4 Modern and Archaeological Soil Samples

There are two types of soil samples that were collected this season. Firstly, the archaeological samples, which come from archaeological contexts, were collected while excavation was undertaken at Rakhat al-Madrh (RaM).

The modern soil samples were collected, like the modern plant assemblage, to create a comparative assemblage. This assemblage provides us with significant information regarding the modern oasis soil, which then will aid in our capacity to determining if the soil we are excavating in is paleo-oasis soil. These samples were collected randomly and at my discretion depending on landscape shifts. Firstly, I collected at the heart of the oasis at various locations (ie. Around the falaj, near the Tower, along the road). I then began to move outward and collected as the oasis landscape diffused into the rocky piedmont. I attempted to collect along these axes; however, I had to adapt when a collection point was obstructed or inaccessible.

Each sample has a GPS-associated point and a basic soil description. The soil samples were brought back to the United States and are kept in a USDA-approved laboratory at Rutgers University. Phytolith extractions and other soil analyses are currently in progress.

6.5 Preliminary Results

There are a variety of different varieties of samples that were collected. Primarily, the samples were either soil or floral and will be used for different analyses (Figure 6.4). The current analyses undertaken include phytolith extraction and FTIR. A comparative analysis between the dry-sieved and floated botanical material will occur once the recovered material is shipped from Oman to Pennsylvania. The current analyses have been undertaken at the Rutgers University Department of Anthropology Laboratory for MicroArchaeology (ALMA). These analyses are supervised by Dr. Dan Cabanes with assistance from Marc Ramrekha (Rutgers Anthropology PhD Student).

Phytolith extractions were performed using the Rapid Extraction protocol (Katz *et al.* 2010). Out of the extracted samples, one sample produced a productive amount of phytoliths. Primarily, the phytoliths are melted and are indistinguishable, thus, I can count their presence but not document their morphotypes. Some identifiable phytolith bodies do remain, particularly spheroid echinate morphotypes, which are indicative of the Aceraceae family (Figure 6.5). Preliminary analysis suggests that the non-rapid method may be necessary but is more time and product consuming. Currently, we are continuing to perform extractions on the samples and developing a specialized protocol to remove the clay material, which is not thoroughly removed enough causing the phytoliths to be obscured when adhering to the exact extraction method. Other types of identifiable material are diatoms, which are indicative of the presence of water (Figure

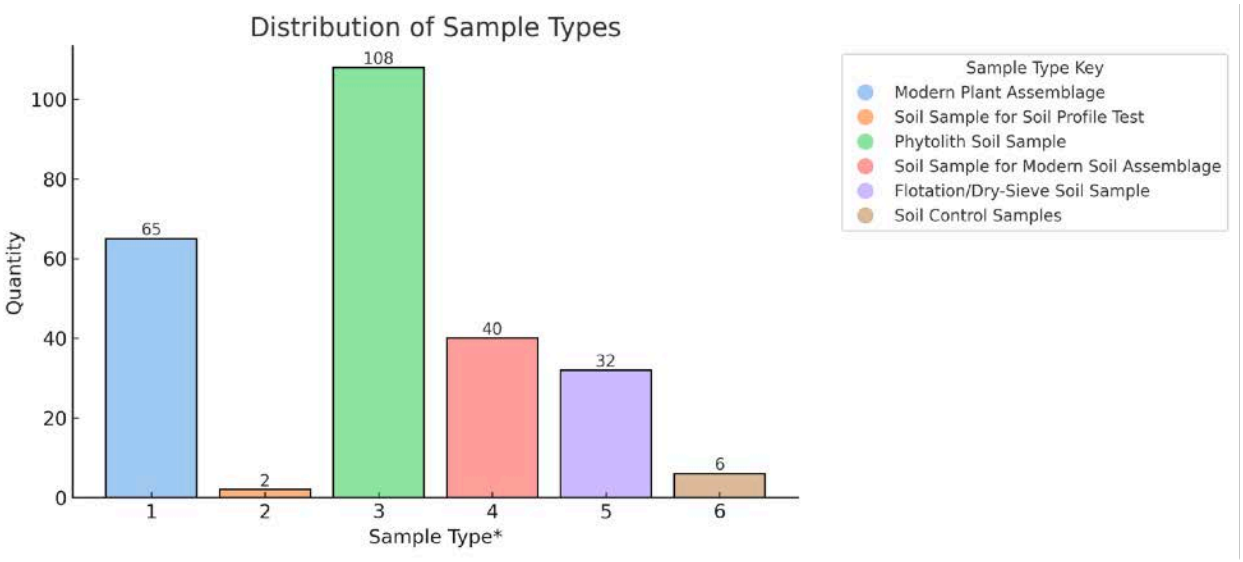


Figure 6.4 - Bar graph showing quantity of samples collected. This graph represents the sample collection up until January 17, 2025. Samples continued to be collected by the team after this date, therefore, this graph may not represent the total assemblage of samples collected following January 17th. *The sample type number is associated with the Sample Code.

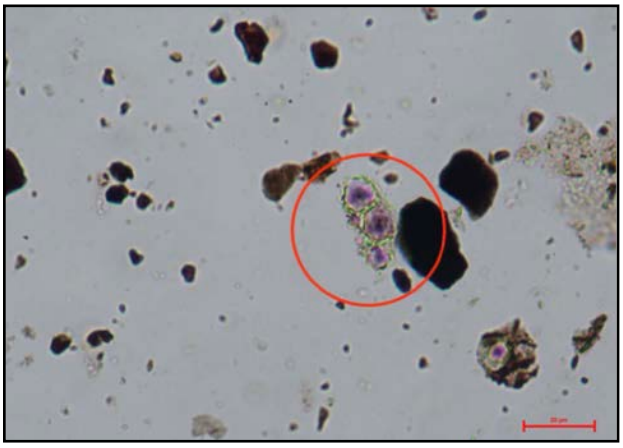


Figure 6.5 - Image of spheroid echinate multicell, indicative of palm (Aceraceae) taken under compound microscope (magnification 400x). Sample K-3-24.

Figure 6.6 - Image of possible diatom (genera and species presently unknown) taken under compound microscope (magnification 400x). Sample K-3-24 from RaM.

6.6). These fossilized sponge bodies can provide information on ancient wetlands and changes in salinity over time. Further classification of these entities is required.

In addition to the phytolith analyses, I am running FTIR analyses, which permits us to ascertain the mineral composition of the samples and identify important signatures, such as organic material like burned bone. FTIR will also aid in identifying

which samples are high priority for phytolith extraction because they can identify both organic and inorganic material within the sample matrix.

6.6 Conclusions and Future Directions

The research conducted during the Bat Archaeological Project's 2024/2025 seasons has made progress in collecting data to better understand the modern and ancient oasis landscape at Bat. The construction of a flotation tank has provided a more efficient system for archaeobotanical recovery, reducing labor intensity while also optimizing the retrieval of macrobotanical remains. Additionally, the collection of modern plant and soil samples has established the beginnings of a comparative dataset that will enhance interpretations of past environmental conditions and agricultural practices.

Preliminary analyses, including phytolith extractions and FTIR spectroscopy, have yielded promising results. While phytolith extraction has faced challenges due to sample composition, ongoing refinements in the extraction protocol will improve the recovery capacity. The identification of spheroid echinate phytoliths suggests the presence of palm species, while diatoms provide potential insights into past hydrological conditions. Additionally, FTIR results are expected to clarify mineralogical compositions and organic signatures within the soil matrix.

Future work will focus on completing the comparative analysis of flotation and dry-sieved botanical material, refining phytolith extraction techniques, discerning site-specific morphotype sheets, and expanding the modern plant database for more precise identifications. The integration of these datasets with ongoing geomorphological and environmental reconstructions will provide a multi-modal perspective on landscape change and human-environment interactions at Bat. Ultimately, these efforts contribute to a more comprehensive understanding of the ecological and cultural history of the oasis, informing broader discussions on sustainability and adaptation in arid landscapes.

7. Ḥiṣn al-Wardi

Jennifer Swerida, Ruben Hartman[13], & Aila Santi

7.1 Introduction

The Ḥiṣn al-Wardi is a mudbrick fortress located in the heart of the modern Bat oasis (Figure 7.1). The fort appears to date to the 15th century AD and is constructed on the foundations of an Umm an-Nar period monumental tower. While no longer a functional fortification, the Ḥiṣn remains an important cultural centerpiece for the Bat community. Additionally, the site has significant potential as a focal point for visitor interest and demonstrates the continuity of such oasis spaces throughout human history in southeast Arabia. BAP is committed to supporting the Bat community and MHT in documenting, researching, and protecting this monument.

Figure 7.1 - Photograph of the Ḥiṣn al-Wardi showing its precarious state of preservation (January 2024).

[13] Faculty of Archaeology, Leiden University

7.2 Site Access and Monitoring

While it is extremely important to protect Bat's archaeological remains, it is equally important to ensure that site development is to the benefit of the modern Bat community. The community is the first line of defense for the site. It is essential that they be invested in the well-being of the archaeology as collaborators and not feel that it is a source of limitations.

Figure 7.2 - Photographic documentation of structural risks to mudbrick architecture at the Ḥiṣn Al-Wardi.

Regarding the mud brick village and Ḥiṣn al-Wardi, these spaces have historically been and remain at the living heart of the Bat community. They are spaces that are regularly used for both public and private activities, which are important access points for community identity and cohesiveness. As a result, they are highly valued and enjoyed by the community. However, mud brick buildings and oasis spaces are expensive to maintain and increasingly vulnerable due to the effects of climate change. The current state of disrepair in the Ḥiṣn al-Wardi is the result of continued use without regular maintenance or repair. BAP is currently undertaking a process of annually documenting the structural integrity of the Ḥiṣn al-Wardi through computational modeling and risk assessment and we are happy to support MHT in expanding this effort to support a formal conservation program (Figure 7.2).

In order to protect the Husn and support the Bat community, the MHT should provide guidelines and support for continued use and maintenance of the space.

Guidelines should include:

- Instructions for best practice annual maintenance to the Husn al-Wardi, the Sheikh's house, the old mosque, and surrounding buildings, especially those used in community activities;
- Organization of regular cleaning of rubbish from the oasis and mud brick village by community members who participate in activities in the oasis;
- Incentives to avoid further cinderblock construction within the oasis.

If at all possible, the MHT should provide professional and financial support to restoring and maintaining the mud brick and oasis. Craftspeople familiar with mud brick construction and maintenance at historic sites such as the forts of Bahla and Nizwa can be consulted for guidance on best practices. It is important that this guidance come from specialists in Omani heritage, rather than from other regions where mud brick traditions may differ. BAP is happy to facilitate these connections and conversations. This support must be contingent upon the Bat community abiding by the guidelines.

Only select portions of the mud brick village should be made available to tourists. The location of these areas should be mutually agreed upon by the MHT, residents of the mud brick village, and leaders of the Bat community. All tourist areas and walking paths must be clearly marked and maintained. Privately owned and farmed areas of the oasis should not be open to tourism except at the express invitation of the owners.

7.3 Documentation and Research

In the the 2024-25 field season, BAP continued our commitment to document and monitor the preservation of the historic Ḥiṣn al-Wardi in the Bat oasis. The *ḥiṣn* and mudbrick town of Bat is located in the heart of Bat oasis, on the remains of a Bronze Age tower, on the highest spot above the *wadī*'s bend (Figure 7.3). Although nowadays sparsely inhabited, it still stands as the symbolic core of the oasis and a unique point of encounter between Bat's most ancient past, Medieval and early modern history.

On an annual basis, BAP will create a 3D model of the *ḥiṣn* using photogrammetry. This documentation process is a time and cost-effective means of monitoring the state of the monument, as well as a non-intrusive means of gathering detailed architectural information for study and analysis. We aim to provide the MHT with annual 3D models of the *ḥiṣn* and risk assessments. We recommend a sustainable development approach to preserving the Ḥiṣn al-Wardi that will support the dignity of local residents and offer sustainable employment/income-generating opportunities. Opportunities include:

- Practical courses in mudbrick restoration;
- Partnership with local and international universities;
- Opportunities for local artisans to teach and practice Omani heritage.

Additionally, in the 2025-26 season BAP will begin a systematic documentation of the mudbrick architecture in the Bat oasis for future multi-disciplinary study. This work is a multi-year program that will involve:

- Constructing 3D models of the *ḥiṣn* and the mudbrick houses composing the core of the village in order to record and for future teaching and tourism purposes;

Figure 7.3 - Example of an in-progress photogrammetric model of the Ḥiṣn al-Wardi.

- Documenting and cataloging the building fabrics, techniques, and materials attested in the village;
- Carrying out a survey aimed at mapping and documenting other fortified mudbrick buildings in the area in order to contextualize the *ḥiṣn* of Bat in its broader medieval and early modern landscape;
- Systematic research, collection and study of historical Islamic written sources mentioning the *ḥiṣn* of Bat, its oasis, and/or the surrounding area;
- Excavation of trenches in strategic points of the *ḥiṣn* and its surrounding meant to investigate the earliest historical levels of the fort and obtain precise information about the chronology of its building;
- Implementing tourism promotion plans in order to include the oasis of Bat in a broader tourist itinerary offering a comprehensive picture of the long history of the area.

The proposed project is intended to address the issues related to the foundation of the *ḥiṣn* and the mudbrick settlement and investigate the earliest phases of the site's occupation in Islamic times.

8. Community Outreach & Engagement

Selin Nugent[14], Jennifer Swerida, & Nora al-Aati

8.1 Introduction

Building on successful community outreach and engagement programming developed during previous field seasons, the Bat Archaeological Project developed a new heritage program in community-based research and engagement to enhance the relevance of our archaeological work. The new research program was trialed during the 2023-2024 field season. The purpose of this program is to systematically, and regularly monitor our impact and relationship as a foreign-led project with the Bat community to better integrate resident's voices and preferences in how we conduct and communicate research on their heritage. This data will be used to continue developing relevant engagement and outreach activities and responsively align our archaeological research strategy and scholarly communication with local interests and needs.

8.2 Community and Cultural Engagement Events

During the 2024-2025 season, the BAP team continued to present opportunities for Bat residents to engage with archaeological field research in line with our approach in

Figure 8.1 - Photograph of BAP 2024-25 Welcome Day event for men.

[14] Centre for AI, Culture, & Society, Oxford Brookes University

previous years. This year, with the organizational support of Ms. Sumaia al-Marmarri, we organized three community-focused events:

- Two "Welcome Day" events, one for men and one for women, at the beginning of our research campaign. These events informed the community of BAP's research plans for the season and invited visitors to the excavations on certain days.
- One "Open Day" event at the end of our research campaign. This event shared BAP's results with the Bat community and invited all community members to celebrate Omani heritage with food and games.

Figure 8.2 - BAP 2024-25 Welcome Day brochure.

8.2.1 *Welcome Day Events*

The Welcome Day events were composed of a brief presentation by project director Jennifer Swerida detailing BAP's research plans for the 2024-2025 season (see Figure 8.1). Translation services were provided by Mr. Ahmed al-Jabri and Ms. Asma al-Jassassi. A brochure was provided to all attendees listing the locations of project excavations and best dates for community visits to each location (Figure 8.2). Precise GPS points for research locations were provided via QR code.

Following the presentation, Dr. Jennifer fielded questions from the attendees about BAP's work and the archaeological remains at Bat. A brief written survey was also distributed to attendees. Participation in this survey was voluntary and anonymous. Open survey questions consisted of:

١-ما رأيك باهداف عملنا لهذا الموسم؟
٢ - هل لديك أسئلة أخري حول أهداف هذا الموسم؟
٣ - كيف ترغب أن يتواصل الفريق مع سكان بات بشأن أهدافه الأثرية؟
٤ - هل هناك أسئلة أثرية محددة ينبغي أن يوجه الفريق اهتمامه إليها؟
٥ - هل لديك أي مخاوف بشأن مشروع الفريق الأثري في بات؟

Open day events were attended by approximately 25 men and 7 women. Survey responses were collected from both groups and will be integrated into future BAP plans.

8.2.2 *Open Day Event*

At the conclusion of the 2024-2025 field season, BAP hosted an Open Day event for all members of the Bat community. The event consisted of a brief formal presentation by Jennifer Swerida summarizing the preliminary results of BAP's archaeological research for the season (Figure 8.3), followed by information presentations and activities. The event was attended by approximately 75 community members — men, women, and

Figure 8.3 - BAP 2024-25 Open Day presentation.

Figure 8.4 - BAP 2024-25 Open Day participants.

children (Figure 8.4). Separate seating was provided for men and women. Informal activities included:

- Presentation of artifacts recovered in the BAP 2024-2025 excavations (Figure 8.5);
- Presentation of 3D models of a Hafit tomb and the Ḥiṣn al-Wardi;
- Presentation of heritage photographs from the Danish excavations of 1972;
- Refreshments of traditional Omani food, prepared by the Bat community;
- Traditional games and coloring activities for children;
- Clay working for children (Figure 8.6).

A booklet summarizing BAP's work during the 2024-2025 season and introducing the team members was also distributed to all Open Day participants (Figure 8.7).

Figure 8.5 - BAP 2024-25 artifact presentation.

Figure 8.6 - Bat community children making pots from local clay.

8.3 Summary

In conclusion, BAP, is building on its past success in designing and delivering outreach/ engagement opportunities for the local community in Bat by integrating reflective and reflexive practices that embed community voices into its research and engagement practices, setting a new standard for foreign-led archaeological initiatives in the region. Through systematic community interviews and cultural engagement events, the project has begun to address the longstanding disconnect between archaeological research and the local community. BAP has not only deepened its understanding of the impact of its work with Bat residents, but has also laid the groundwork for future research and outreach efforts that are more responsive and beneficial to the community. As BAP moves forward, it remains committed to refining its practices to ensure that its research positively contributes to Bat's heritage and future plans for tourism/economic development via the Bat Visitor Centre, by aligning with the needs of the Bat community alongside the Oman Ministry of Heritage and Tourism.

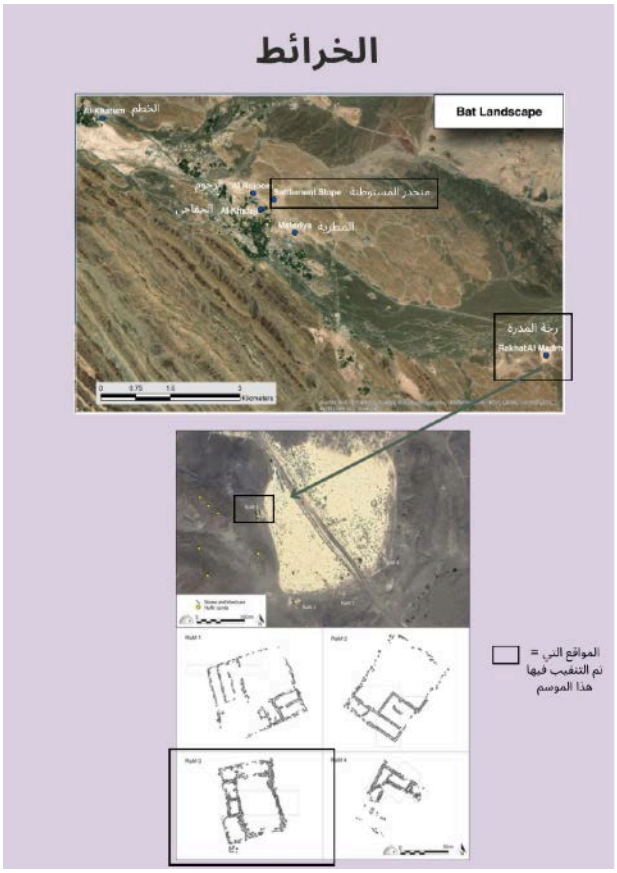


Figure 8.7 - Pages excerpted from the BAP 2024-25 Open Day booklet.

تعرف على بعض أدوات التنقيب المهمة !

مجرفة صغيرة

المجرفة الأثرية هي أداة أساسية يستخدمها علماء الآثار أثناء الحفريات. تم تصميمها خصيصًا للعمل الدقيق والحساس عند الكشف عن القطع الأثرية والمعالم.

ألكسندر يأكل التونة باستخدام المجرفة (ليس بالطريقة المعتادة لاستخدام المجرفة، لكنها مفيدة عندما لا يكون هناك ملعقة متوفرة).

فأس

الفأس مفيد أثناء الحفريات لكسر التربة المتماسكة لتسهيل إزالتها. بمجرد أن تصبح التربة مفككة، يتم جمعها باستخدام مجرفة في دلو ثم تُغربل باستخدام منخل.

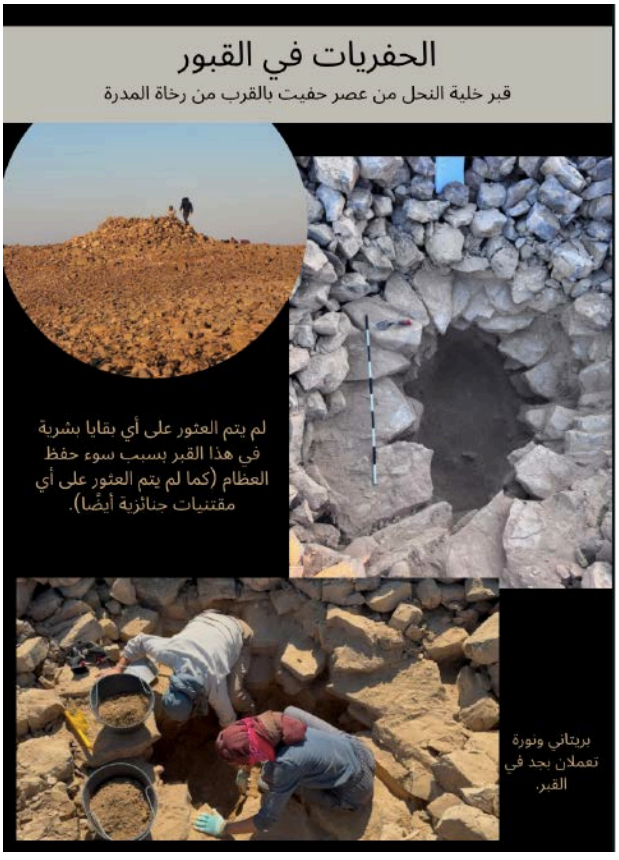
منخل

المنخل هو أداة أساسية في الحفريات الأثرية، يُستخدم لفصل القطع الأثرية الصغيرة والمواد البيئية عن التربة. تساعد المناخل في العثور على العناصر الصغيرة مثل الخرز وشظايا العظام وقطع الفخار والأدوات الدقيقة التي قد تُفقد أثناء التنقيب اليدوي. كما تُستخدم لاستعادة بقايا النباتات والبذور أو الفحم للدراسات النباتية والبيئية.

أفضل الاكتشافات الأثرية لهذا الموسم في رخة المدرة


رأس أداة معدنية من العصر الإسلامي المبكر
صورة من الأعلى
صورة من الجانب
أفضل الاكتشافات الأثرية لهذا الموسم في رخة المدرة
قطعة فخار طينية من عصر أم النار
صورة للجزء الخارجي من الإناء
صورة للجزء الداخلي من الإناء


جرة خزفية مستوردة من وادي السند تعود إلى فترة أم النار (نعتقد أنها كانت تُستخدم لحمل الماء أثناء النقل).
صورة للجزء الخارجي من الجرة
صورة للجزء الداخلي من الجرة
أفضل الاكتشافات الأثرية لهذا الموسم في رخة المدرة
قطعة من العقيق الأحمر شبه المشغول، نعتقد أنها كانت في مرحلة التحول إلى خرزة (الفترة الزمنية غير معروفة ولكن تم العثور عليها فوق طبقة من أواخر فترة أم النار).


الحفريات في القبور
قبر خلية النحل من عصر حفيت بالقرب من رخاة المدرة
لم يتم العثور على أي بقايا بشرية في هذا القبر بسبب سوء حفظ العظام (كما لم يتم العثور على أي مقتنيات جنائزية أيضًا).
بريتاني ونورة تعملان بجد في القبر.


الحفريات في القبور
قبر أم النار في منحدر المستوطنة.
الفخار في موقعه الأصلي
على اليمين، قطعة من الفخار الجنائزي الطيني. على اليسار، قاعدة جرة جنائزية طينية.
لا يمكننا نشر صور لبقايا بشرية احترامًا للأخلاقيات وتقديرًا للأفراد المتوفين.

تعرف على الفريق

بريتاني براون

بريتاني طالبة ماجستير في جامعة ولاية ميسيسيبي، تركز أبحاثها على علم الآثار البيولوجي والأمراض القديمة في شبه الجزيرة العربية. تشمل اهتماماتها من أصولها المصرية والأفغانية، وتشمل الصحة والأمراض القديمة، استخدام المناظر الطبيعية، علم العظام، والممارسات الجنائزية في شبه الجزيرة العربية والشرق الأوسط. تقود بريتاني الحفريات البيولوجية الأثرية هذا الموسم، وهي متحمسة لمواصلة أبحاثها في عمان.

كريستوفر كوتكين

كريستوفر هو خريج حديث من جامعة كامبريدج ويعمل حاليًا كأثري ميداني في مشروع بات الأثري. تشمل اهتماماته تاريخ منهجيات إنتاج الفخار المحلي والمستورد، شبكات التجارة العالمية، والنفسيرات الأثرية للقوة السياسية في الفن. يركز بحثه الحالي على تحليل الفروقات والتشابهات في كيفية ممارسة الحرفيين لصناعة الفخار على المستوى المجهري. عندما لا يكون منشغلاً بالآثار، يستمتع كريستوفر بالخبز والقراءة والتنزه في الأماكن ذات المناظر الخلابة.

أيانّا بلاسمن

أيانّا طالبة علم آثار في جامعة لايدن في هولندا وتعمل حاليًا على بحث الماجستير الخاص بها، الذي يركز على العصر النحاسي في قبرص. ومع ذلك، فإن اهتماماتها البحثية تشمل مناطق شرق البحر الأبيض المتوسط وغرب آسيا.

تعرف على الفريق

جينيفر سويريدا

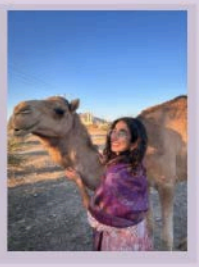
مديرة المشروع

الدكتورة جين هي مديرة مشروع بات الأثري وأستاذة مساعدة في علم آثار غرب آسيا في جامعة لايدن. تعد خبيرة في تاريخ العصر البرونزي المبكر في عمان، وقد أجرت أبحاثًا عن المنازل والآثار القديمة في بات منذ عام 2009. تهتم بشكل خاص بدراسة كيفية عيش الناس في فترة أم النار في بات والمناظر الطبيعية المحيطة بها. هذا الشتاء، قادت الدكتورة جين أبحاثًا أثرية في منحدر مستوطنة بات، وحصن الوردي، والموقع القريب رحاة المدره.

روبرت براينت

مساعد المدير

روبرت يستمتع بعلم الآثار منذ عام 2007 ويركز على المنهجية الرقمية، والمشاركة المدنية، وكيفية تطبيق التلعيب (gamification) على العمل الميداني الأثري والبيانات من خلال علم الآثار المجتمعي. عمل بشكل أساسي في أذربيجان منذ عام 2008، لكنه عمل أيضًا في مجتمع بات لسنوات عديدة، حيث قام بتصوير جوي، ورسم خرائط المواقع، والمساعدة في الحفريات.



نورة العاتي

نورة طالبة دكتوراه من الكويت في سنتها الثانية في جامعة بنسلفانيا. تدرس علم الآثار والأنثروبولوجيا الثقافية. تشمل اهتماماتها البحثية دراسات المتاحف، بناء التراث، الأخلاقيات، وعلم الآثار المجتمعي في شبه الجزيرة العربية. وبالأخص في عمان. تقود نورة برنامج التواصل المجتمعي لهذا الموسم، وهي متحمسة لمواصلة بناء علاقة قوية بين سكان بات والفريق الأثري.

تعرف على الفريق

زوي فان ليتسينبورغ

زوي فان ليتسينبورغ هي طالبة ماجستير بحثي في جامعة لايدن ونجمة من الطراز الأول. تهتم بكيفية تفاعل البشر مع بيئتهم في الماضي، مع اهتمام خاص بالحيوانات. تعمل في عمان منذ ثلاث سنوات، وتأمل أن تواصل المساهمة في تراث بات في المستقبل!

روبين هارتمان

روبين هو طالب ماجستير بحثي في السنة الثانية في جامعة لايدن. يهتم بعلم آثار المناظر الطبيعية والأساليب الرقمية في علم الآثار، ويعمل حاليًا على كتابة أطروحته حول فترة وادي سوق في عمان. كما يستمتع بإنشاء نماذج ثلاثية الأبعاد للأشياء الأثرية والمعالم والآثار، مثل حصن الوردي.

أوليفيا فراسينا

أوليفيا طالبة في السنة الثالثة من مرحلة البكالوريوس تدرس في جامعة لايدن في هولندا. أصلها من المملكة المتحدة، لكنها تحب الانغماس في بيئات وثقافات مختلفة. تستمتع بالحوانب العملية لعلم الآثار وتعشق العمل الميداني. كما تهتم بتطوير معرفتها الجديدة في علم الآثار الرقمي. في وقت فراغها، تحب ممارسة الأنشطة الإبداعية مثل الرسم والخياطة.

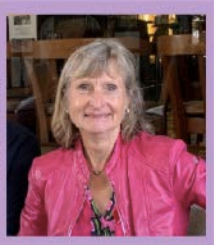
تعرف على الفريق

جورجيا هـ. فانس

جورجيا فانس طالبة دكتوراه في جامعة جونز هوبكنز في الولايات المتحدة. هي عالمة آثار متخصصة في دراسة النصوص والثقافة المادية من الشرق الأدنى في الألفية الثالثة قبل الميلاد لإعادة بناء التاريخ الاجتماعي والسياسي. هذه هي زيارتها الأولى إلى عمان، وهي متحمسة للتعرف أكثر على تقاليد المجتمع المحلي في بات!

ألكسندر بروسبريني

ألكسندر بروسبريني هو طالب دكتوراه في جامعة السوربون (باريس)، متخصص في علم الآثار الجيولوجي. يدرس التفاعلات بين المجتمعات البشرية القديمة (العصر البرونزي) وبيئتها في بات. كانت أول بعثة له إلى عمان في عام 2022. يهتم بكيفية تشكيل المجتمعات البشرية للمناظر الطبيعية والمناخ وتأثرها بهما. لتحقيق ذلك، يركز على بيانات الجيومورفولوجيا والجيولوجيا والجيوكيمياء، مع وضعها في سياق التفسيرات الأثرية.



ريتا كريمر

ريتا درست علم الآثار في جامعة لايدن في هولندا. تخصصها هو العصر البرونزي في الشرق الأدنى، وهي مهتمة بشكل خاص بالأحجار المصقولة والمشظاة. شاركت في العديد من المشاريع الأثرية في عمان خلال السنوات العشر الماضية.

تعرف على الفريق

ليدويين مولينكامب

ليدويين مولينكامب هي طالبة بكالوريوس في علم الآثار بجامعة لايدن. تركز دراستها على آثار جنوب غرب آسيا ومنطقة البحر الأبيض المتوسط. تتمتع بحماس كبير للعمل الميداني، وتستمتع بشكل خاص بتجميع أجزاء الماضي من خلال الاكتشافات والهياكل التي يتم التنقيب عنها. تأمل من خلال الحفريات المستمرة أن تسهم في تعزيز أهمية وتأثير علم الآثار في بات مستقبلاً!

تيم بوكما

تيم بوكما في سنته الأخيرة من دراسة البكالوريوس في علم الآثار بجامعة لايدن، حيث يركز على علم الآثار التجريبي وعلم المعادن. سيواصل دراسته في علم الآثار من خلال درجة الماجستير في جامعة لايدن، مع التركيز على الثقافة المادية. هذا الموسم هو المرة الأولى لتيم في عمان، ويأمل أن يواصل العمل مع فريق بات الأثري لسنوات قادمة. في أوقات فراغه، يستمتع بالقراءة والتنزه في مناظر طبيعية جميلة مع كلبه.

تعرف على الفريق

أكشيتا سوريا نارايان

أكشيتا باحثة ما بعد الدكتوراه في جامعة أكسفورد بالمملكة المتحدة، وتبحث في ممارسات الطعام القديمة خلال فترة أم النار في بات من خلال دراسة بقايا الطعام الموجودة في الأواني الفخارية. هي من الهند في الأصل وتهتم بالتعرف على أساليب الطهي والممارسات الغذائية في عمان. زارت بات لأول مرة في عام 2014 كطالبة، وهي سعيدة جدًا بالعمل هناك مرة أخرى!

أليساندرا دومينغيز

أليساندرا طالبة دكتوراه في سنتها الثانية في جامعة بنسلفانيا، حيث تدرس تاريخ الفن وعلم الآثار في بلاد ما بين النهرين. تشمل اهتماماتها البحثية دراسات المتاحف، المناخ القديم، إعادة بناء المناظر الطبيعية، والأنظمة الغذائية القديمة. تتخصص في علم النباتات الأثري، وهو دراسة كيفية استخدام النباتات من قبل الشعوب القديمة. تهتم بشكل خاص بدراسة إدارة الواحات خلال الألفية الثالثة قبل الميلاد ومراقبة استمرارية هذه الإدارة في واحة بات الحديثة

روشاما أخترسترات

روشاما أخترسترات طالبة في السنة الثانية من برنامج البكالوريوس في جامعة لايدن في هولندا. كان هذا أول تدريب أثري لها. انجذبت إلى سلطنة عمان بسبب مزيجها من التقاليد الثقافية الدافئة والتراث التاريخي الغني. هي متحمسة لتعميق فهمها لعلم الآثار هنا والتعرف عليكم بشكل أفضل! على الرغم من أن رحلتها الأكاديمية لا تزال في مراحلها الأولى، تطمح روشاما إلى التخصص في دراسة انتقال الأمراض القديمة وتفشي الأوبئة، مع التركيز على أنماط الهجرة والتجارة.

9. Future Directions

Jennifer Swerida & Selin Nugent

9.1 BAP Future Research Plans

The results of BAP's 2024-2025 field season presented discoveries in a wide range of areas—geographically and thematically—about Bat's ancient inhabitants. These findings are informing the project's future directions. In collaboration with the Ministry of Heritage and Tourism and sponsorship from Leiden University and the University of Pennsylvania Museum, the project will continue its focus on modeling and understanding the ancient cultural landscape of Bat and the Wadi al-Hijr in 2025-2026.

9.2 2025-26 Fieldwork

The BAP 2025-2026 field season will continue the project's focus on ancient remains from the perspective of cultural landscapes and develop the new phase of research on ancient heritage, memory, and adaptive reuse. The project will pursue the following interlinked research questions:

- (Q1): Where and how did Bronze Age communities choose to create places within the Wadi al-Hijr?
- (Q2): What intersecting lifeways and ritual activities contributed to the creation of cultural places over the course of the Bronze Age?
- (Q3): How has the archaeological landscape shaped the cultural identity and experience of local populations over time?

In 2025-2026, we anticipate our fieldwork to center on six areas: 1) archaeological survey of basin features comparable to Rakhat al-Madrh in the Wadi al-Hirj; 2) expanding excavation at the Bat Settlement Slope; 3) mapping and test excavations at al-Ahliyah; 4) Community Outreach and Engagement; 4) community heritage and technology training through documenting and monitoring at the Husn Al-Wardi; 5) geomorphological and botanical survey of the Wadi al-Hijr; and 6) a follow-up on established outreach and arts engagements program with local communities and groups from around ad Dhahirah, Oman, and the Gulf region to increase access and understanding of Bat's archaeological heritage.

9.2.1 Regional Survey

Building on the results of recent work (see Swerida *et al.* 2024), BAP aim to conduct a regional archaeological survey of the Wadi al-Hijr and its tributaries within approximately 1 day's walk of the Bat oasis to identify locations of past human-environment interactions that will shed light on human resilience in the hyper arid landscape. Using Rakhat al-Madrh as a case study, we will target areas of lingering recourse concentration during and following rain or flood events.

Mr. Robert will direct archaeological survey of the Wadi al-Hijr within a 20km radius of the Bat oasis (see Figure 9.1). The survey will be conducted by walking transects (20x100m) and collecting UAV imagery (50x200m). Walking survey will record evidence of architecture and non-diagnostic material culture (pottery, lithics, other) visible on the ground surface. Diagnostic material culture will be collected for further analysis. A small number of archaeological test trenches will be excavated based on survey results.

Figure 9.1 - Maximum extent of BAP 2025-26 archaeological survey area, with survey targeting wadi channels.

9.2.2 *Bat: Excavations and Mapping*

Expanding on previous research on Bat's Early Bronze Age settlement and paleoenvironment, BAP plans a new program of horizontal excavation at the Settlement Slope in Bat UNESCO zone (Figure 9.2). This excavation aims to connect the refined occupational chronology at the site with BAP's growing Bronze Age environmental profile for the region. Excavation will target two areas, the precise location of which will be determined in consultation with the MHT and an evaluation of surface conditions (see Figure 9.3).

Concurrent with excavations at the Settlement Slope, BAP will complete a program of architectural mapping to document all walling and structural features visible on the ground surface of the Settlement Slope and al-Ahliya hills (Figure 9.3). This mapping will be conducted using Differential GPS unit, providing greater flexibility and accuracy than possible in previous total station-based efforts to map both locations. The resulting maps will be essential in planning future research and tourist development in these densely built archaeological spaces.

9.2.3 *Rakhat al-Madrh: Closing Excavations*

During 2025-26 season, BAP will conduct closing excavation efforts at the Rakhat al-Madrh basing and settlement. Limited excavations will target areas of RaM 2 and RaM 3 structures and their surroundings, where the site's use history remains unclear (Figure 9.4). These excavations will conclude BAP's research at the site.

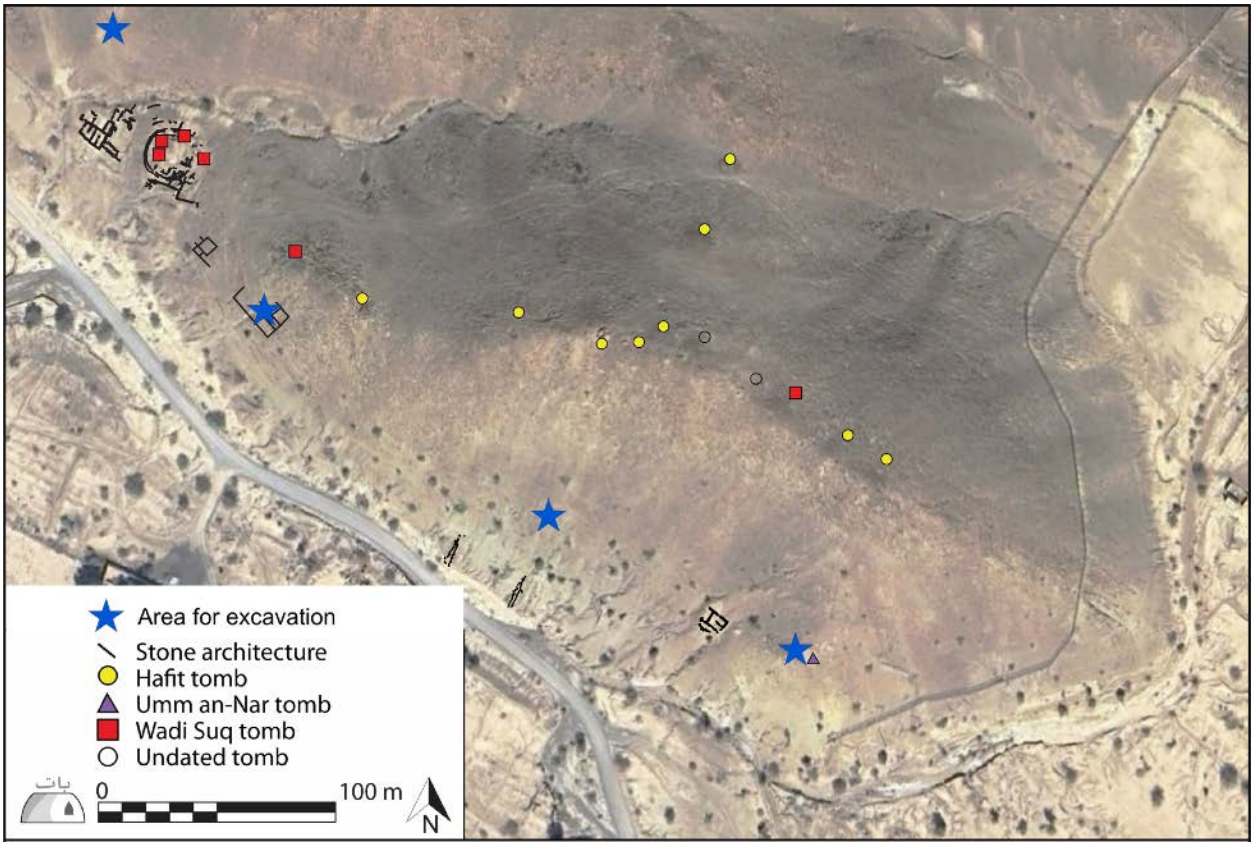


Figure 9.2 - Possible locations for horizontal excavation at the Bat Settlement Slope.

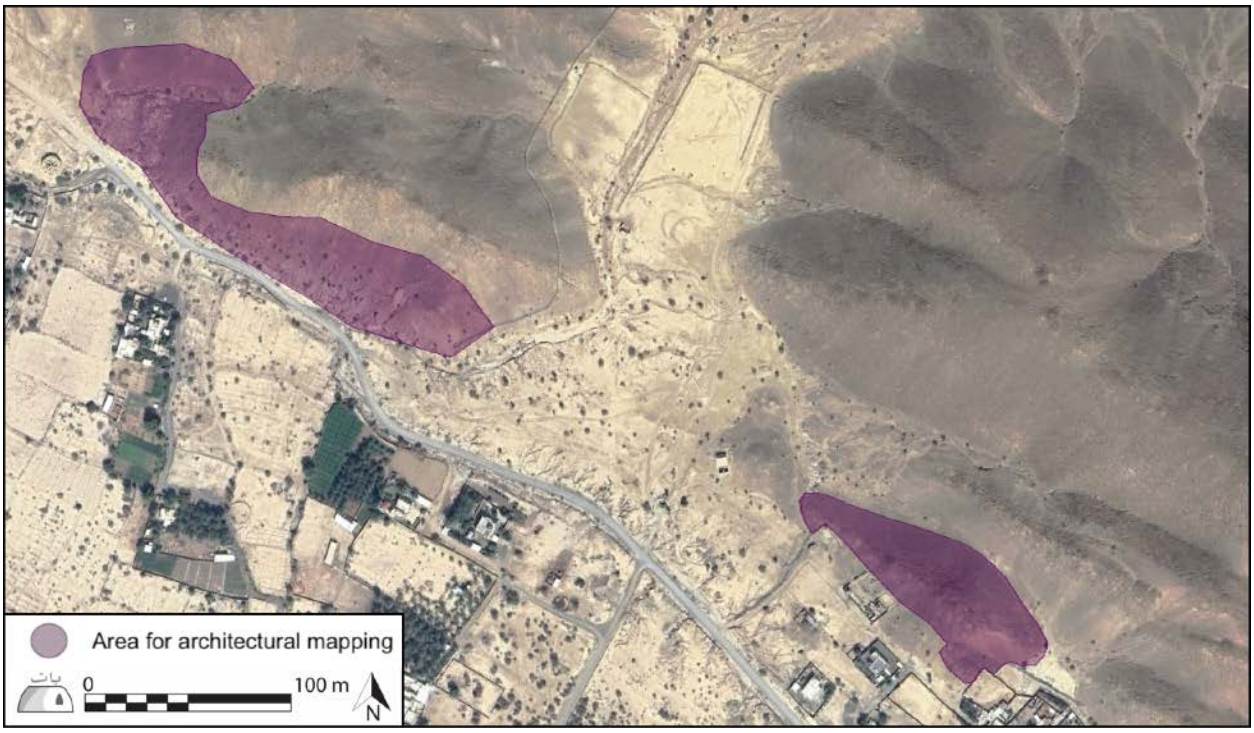


Figure 9.3 - Map indicating the portions of the Settlement Slope and al-Ahilya hills to be mapped.

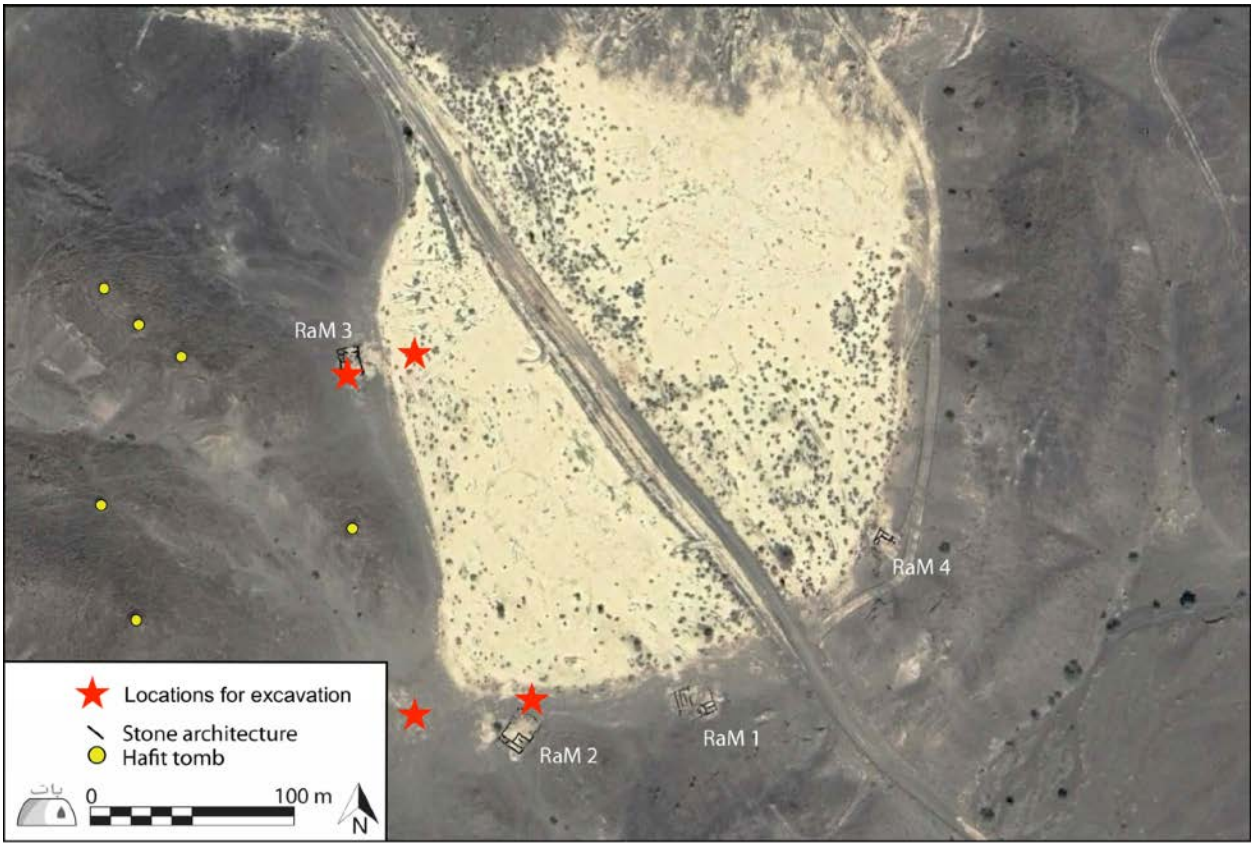


Figure 9.4 - Map of Rakhat al-Madrh indicating the locations of closing excavations and scientific sampling.

9.2.4 Geomorphological and Botanical Survey

During the 2025-26 field season, BAP will continue the multi-disciplinary survey of the Wadi al-Hijr that will work to reconstruct the environmental conditions experienced by the region during the Bronze Age. This research will support two PhD doctoral dissertations by Mr. Aleksandre Prosperini and Ms. Alessandra Dominguez and will be supervised by Dr. Jennifer and Dr. Eric Fouache.

The survey will sample the same are as the archaeological regional survey, and will involve surface collection of plant, soil, and water samples for scientific analysis and the creation of a modern botanical reference collection. Modern samples will support the geomorphological analysis of how the landscape in the Wadi al-Hijr developed over time and the environmental conditions that existed during the Bronze Age. The collection of modern plant samples is especially important for environmental reconstruction through phytolith analysis. Phytoliths are fossilized silica bodies that are resilient against the adverse climate conditions of the Arabian Peninsula. Unlike macrobotanical specimens, such as seeds, or other microbotanical fossils, such as pollen, phytoliths preserve well in the soils around Bat. The analysis of phytoliths will elucidate important information regarding Bat's paleoclimate, paleoecology, and interwoven relationship between the ancient people and their surrounding landscape. Primarily,

phytoliths tell archaeologists what plants were available and economically exploitable for past societies. Additionally, they provide information concerning the ways in which cultural influence modified the landscape and how an environment shapes its human occupants through technological, social, and economic organization (Piperno 2006: 139). Through a comprehensive analysis of Bat's phytolith record, in collaboration with micromorphological data, we can enhance our comprehension of how past humans exercised agency through selective exploitation of economic plant species, in addition to impacting the overall physical landscape. Modern plant samples will serve as a reference guide for ancient phytolith comparison and identification.

Excavation of geomorphological soundings at key locations in the survey area and in Bat will collect soil and archaeobotanical samples from Bronze Age contexts. Possible locations for the soundings include:

- The Bat Oasis — to explore the deep history of oasis settlement and agriculture practiced at Bat. Phytolith and soil analysis will help us understand proto-oasis formation in the Early Bronze Age.
- The Bat Settlement Slope — to connect the environmental indicators studied in Mr. Aleksandre and Ms. Alessandra's PhD dissertations with the long history of cultural activity and hydraulic management previously studied at the site.
- The courtyard immediately south of al-Khafaji tower — to sample the dense domestic debris from the well-dated contexts for paleoenvironmental and archaeobotanical signatures.
- Matariya — to determine Hafit period environmental conditions and probe the potential for agriculture near the tower. This information will complement previous excavations at the site.

All data and outcomes from this research will be made available to the MHT and summarized in the season report.

9.2.3 Community Outreach and Engagement

In response to feedback from Bat residents during community interviews, BAP will adapt how it shares research and designs engagement opportunities over the course of the upcoming field season. We will also adapt our research plans to integrate and focus on areas/features within Bat that residents expressed specific interest in being studied by our team.

Building on the success of this season, we plan to begin the 2025-26 field season with a Welcome Coffee event for Bat residents to meet the team, to learn about our research plans for the year, and to formally welcome everyone to visit and get involved with our work. This event is designed to help the community feel more comfortable engaging in ongoing work and to have the tools and knowledge to be actively involved. We will share informational brochures and give a presentation that highlight our research locations, the types of work taking place at each of those locations, and the dates and times when residents drop by during our working hours.

After documenting the Ḥiṣn al-Wardi in 2023-2024 and 2024-25, we will continue documenting the preservation of mudbrick architecture through 3D photogrammetry, combining drone and photograph-based imagery to model and analyze the integrity of the structure. However, given the prominence of the Ḥiṣn al-Wardi in the local sense of identity in relation to heritage monuments and interest in building employable skills for young people expressed in interviews, we would like to expand this work to involve training of young people in Bat. In this instance, we will invite young people interested in learning about 3D modeling and architectural documentation to observe our team as they document the Ḥiṣn. Depending on the size of the group, there may be opportunities to learn how to take research quality images and how to process images into a working 3D model. The 2025-2026 field season will trial this approach and based on our learnings, we will seek further funding to develop an enhanced training opportunity and dedicated equipment for subsequent years so that students not only learn these digital skills, but are also capable of being citizen scientists who can continue monitoring the Ḥiṣn Al-Wardi independently.

In addition to adapting our research management practices to accommodate community preferences, we will also adapt our research foci to represent archaeological features that are important to the local community in Bat. In addition to our work on documenting the Husn Al-Wardi, we will focus attention on excavating a funerary monument on the Settlement Slope, because more work on the ancient funerary landscape of Bat was treated with a great deal of enthusiasm and personal connection to the heritage site. The Settlement Slope location, situated within walking distance of the Bat village, will provide an accessible means for community members to engage with this content. Excavations of the tomb will be led by Dr. Selin and bioarchaeologist Ms. Mary van de Hoorn. In addition to allowing us to better understand the long-term settlement / use of the landscape at the Settlement Slope, excavating this tomb will also serve as an exciting opportunity to invite Bat residents to witness and engage with tomb excavations.

9.2.4 Ḥiṣn al-Wardi Documentation and Research

In the the 2025-26 field season, BAP will continue our commitment to document and monitor the preservation of the historic Ḥiṣn al-Wardi in the Bat oasis. The ḥiṣn and mudbrick town of Bat is located in the heart of Bat oasis, on the remains of a Bronze Age tower, on the highest spot above the wadī's bend (Figure 7.1). Although nowadays sparsely inhabited, it still stands as the symbolic core of the oasis and a unique point of encounter between Bat's most ancient past, Medieval and early modern history.

In addition to our annual 3D modeling and monitoring of the monument, BAP will continue our effort to systematically document the mudbrick architecture in the Bat oasis for future multi-disciplinary study. This work is a multi-year program that will involve:

- Constructing 3D models of the ḥiṣn and the mudbrick houses composing the core of the village in order to record and for future teaching and tourism purposes;

- Documenting and cataloging the building fabrics, techniques, and materials attested in the village;
- Carrying out a survey aimed at mapping and documenting other fortified mudbrick buildings in the area in order to contextualize the ḥiṣn of Bat in its broader medieval and early modern landscape;
- Systematic research, collection and study of historical Islamic written sources mentioning the ḥiṣn of Bat, its oasis, and/or the surrounding area;
- Excavation of trenches in strategic points of the ḥiṣn and its surrounding meant to investigate the earliest historical levels of the fort and obtain precise information about the chronology of its building;
- Implementing tourism promotion plans in order to include the oasis of Bat in a broader tourist itinerary offering a comprehensive picture of the long history of the area.

This project is intended to address the issues related to the foundation of the ḥiṣn and the mudbrick settlement and investigate the earliest phases of the site's occupation in Islamic times.

9.2.5 Outreach and Arts Engagement

Learning from past experiences, BAP will follow-up with our partners in the MHT and the Bat community concerning the continuation of outreach and engagement programs established in 2023. We are eager to consult with our colleagues in the MHT to facilitate development of long-term outreach programs at Bat, including: ceramics workshops, student field-trips to the site, and training opportunities for university students and MHT personnel. The objective of these efforts is to empower children and their families residing in Bat to become experts and stewards of the archaeological resources at Bat and engage with local and international professional archaeologists working to preserve it.

9.3 2025-26 Laboratory Work

During the 2025-26 field season, BAP will conduct a number of laboratory-based analyses while in the field and requests permission for the export of samples for further analyses abroad.

9.3.1 Artifact Study

The macro-analysis of pottery from the Bat excavations conducted between 2020 and 2025 will be continued. Dr. Jennifer will continue ceramic macro-analysis through the detailed description and classification of pottery sherds from previous excavation seasons. Analysis will consider sherd form, decoration, and ware types to determine chronological and functional patterns. Select sherds will be selected for export for thin-section petrographic analysis by Ms. Lidwien Meulenkamp. Objectives include

identifying mineralogical compositions and sourcing raw materials. Petrographic analysis will provide insights into production techniques and trade/exchange networks of the Early Bronze Age. Select sherds will also be selected for export for microscopic and chemical analysis. All analyses will focus on broken ceramics from bulk excavation contexts without designated artifact numbers.

Lithic artifacts collected during previous BAP seasons will be systematically photographed for detailed documentation and further analysis. High-resolution images will be used to study tool typology and use-wear patterns.

9.3.2 Scientific Sample Analysis

Select samples from surveyed and excavated contexts will be selected for export and analysis. These include radiocarbon (^{14}C), geomorphological, botanical/ archaeobotanical, and bioarchaeological samples. ^{14}C will be used to date excavated contexts and establish a more precise chronology of the site's occupation and usage phases. Geomorphological samples of soil, rock, water will be exported to France for analysis by Mr. Aleksandre Prosperini to understand sediment composition, formation processes, and environmental conditions during site occupation. Ms. Alessandra Dominguez will analyze botanical samples and ancient phytoliths to study ancient plant biodiversity and reconstruct past environments. Finally, Ms. Mary van den Hoorn will examine human skeletal remains from the excavations of the Umm an-Nar tomb at the Settlement Slope. Selected human skeletal remains will be exported for dating and further bioarchaeological analysis.

Results from all analyses will be made available to the MHT and summarized in the season report.

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