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NEW CLUES TO THE DEVELOPMENT OF THE OASIS OF DADAN. RESULTS FROM A TEST EXCAVATION AT TALL AL-ŠĀLIMĪYYAH (AL-‘ULĀ, SAUDI ARABIA)

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SUMMARY

This article presents the results of a test excavation conducted by the team of the Dadan Archaeological Project (CNRS/RCU/AFALULA) in October/November 2019 at a peripheral site of ancient Dadan, in the al-‘Ulā valley (north-west Arabia). The excavation data were processed jointly with the ECOSeed archaeobotanical project and the ArcAgr-AU geo-archaeological project. This multidisciplinary approach provides critical new insights into the development of one of the major ancient north-west Arabian oases. The excavations revealed the earliest safely dated architectural remains in the oasis, associated to the earliest evidence of local date-palm cultivation, in the twelfth–eleventh century BC. The results also enable a reassessment of the earlier archaeological evidence, suggesting a peak in the development of the oasis in the eighth–fifth century BC, at the time of the first North Arabian kingdoms and the rise of long-distance aromatics trade.

Keywords: oasis, north-west Arabia, Dadan, Iron Age, chronology

INTRODUCTION

Located in the al-‘Ulā valley, c.150 km from the Red Sea coast, the oasis of Dadan was one of the major commercial and political centres in north-west Arabia during the first millennium BC (Fig. 1). A hub on the ‘Incense Road’ linking South Arabia with Egypt, the Levant, and Mesopotamia, it is mentioned in seventh- to sixth-century BC biblical sources and appears as the capital of a local oasis kingdom, the kingdom of Dadan, in the accounts of Nabonidus’ conquest of north-west Arabia, in 553/552 BC (Macdonald 1997; Rohmer & Charloux 2015; Rohmer, forthcoming). Sometime after this short-lived episode of Babylonian rule (552–543 BC), in the second half of the first millennium BC, Dadan became part of a larger kingdom ruled by the tribe of Liḥyān, which extended its domination to the oasis of Taymā, c.120 km to the north-east (Hausleiter & Eichmann 2018).¹ As proof of its continuing commercial importance during this period, Dadan also hosted an important trading colony of Minaean merchants, tentatively dated between the fourth and second centuries BC (Rossi 2014; Schiettecatte & Arbach 2020). In the current state of knowledge, it seems that Dadan declined at the end of the first millennium BC in favour of a new settlement located 15 km to the north — Hegra (Rohmer & Charloux 2015). How early this shift occurred is still a matter of debate, but the decline of Dadan was confirmed by the settlement of the Nabataeans at Hegra, in the late first century BC.

Apart from these few, sometimes uncertain historical milestones, very little is known about the early development of the oasis of Dadan and its evolution through time. Excavations carried out between 2003

1 - Contrary to the prevailing narrative, it is not proven that Dadan was the capital of the kingdom of Liḥyān, besides which, the chronology of this kingdom is still debated, with hypotheses ranging from the late sixth–late third century BC to the fourth–second century BC (Rohmer 2021).



FIGURE 1. A map of the Arabian Peninsula showing the location of Dadan and the main ancient trade routes.

and 2019 by the Department of Archaeology of King Saud University (KSU) at the core settlement of Dadan, al-Khuraybah, have revealed a sequence spanning the mid-second millennium BC to the first–second century AD (al-Said & al-Ghazzi 2013: 45–46; al-Theeb 2016: 23–26). A recent reassessment of the pottery finds even suggests moving the beginning of the sequence up to the late third or early second millennium BC (Tourtet, Daszkiewicz & Hausleiter 2021: 52–54). This gives reason to believe that the history of the oasis of Dadan extends beyond the narrow window documented by the historical sources. This would be fully in line with the recent developments of archaeological research in north-west Arabia: at Taymā, Qurayya, and possibly other North Arabian ‘walled oases’, the development of ‘urban’ oases now appears to have started as early as the early third millennium BC (Luciani 2021; Charloux, AlMalki & AlQaeed 2021).

Outside the core settlement of the oasis, al-Khuraybah, only three small sites have been excavated, and to a very limited extent (Fig. 2). At Khayf al-Zahrah, in Wādī Mu‘tadil, domestic, agricultural, and hydraulic or defensive remains were identified and tentatively dated to the mid-first millennium BC (Bawden 1979). Further west, in the main valley, a site spanning the early first millennium BC to the early first millennium AD was identified at the top of a large sand dune known as Tall al-Kathīb (al-Zahrani 2007). South of the latter, archaeological soundings were recently carried out at Tall Sāq, a small tell located on the western bank of Wādī al-‘Ulā, revealing archaeobotanical remains radiocarbon-dated to the mid-/late third millennium BC and the late second/early first millennium BC, but in deposits of uncertain nature (Hausleiter et

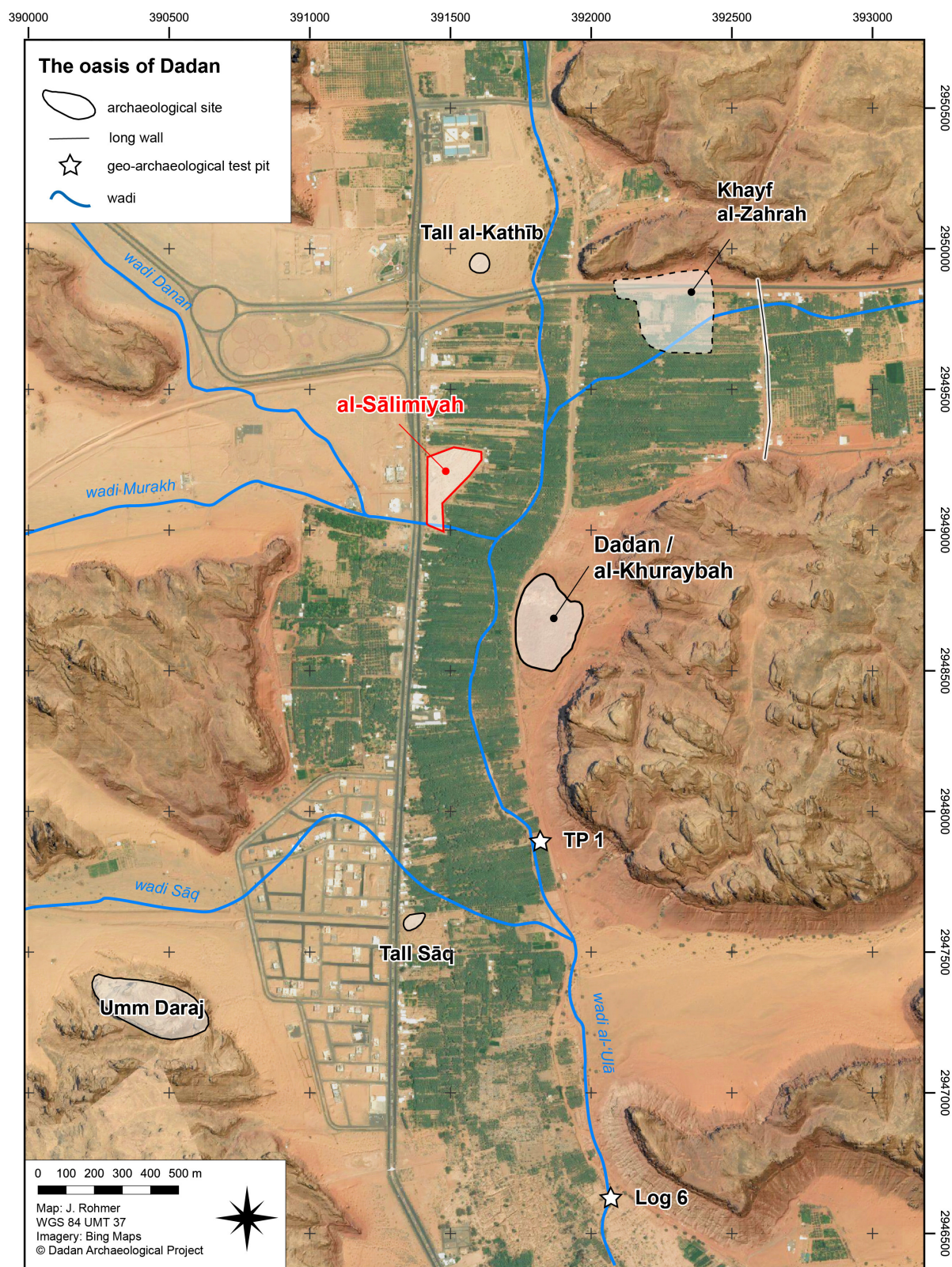


FIGURE 2. A map of the al-'Ulā valley showing the main sites dated to the first millennium BC.

al. 2021). Several other structures and sites possibly dating back to the Bronze or Iron Ages were recorded by Nasif (1988: 25–26) in the al-‘Ulā valley, but they remain poorly documented and undated.² Outside the valley, a funerary cairn linked to a long wall with inner chambers has been excavated in Jabal al-Khramāt, near Hegra, c.13 km north of al-Khuraybah (Abu Azizeh et al. 2020). Its original building phase was radiocarbon-dated to 2113–1892 cal. BC (2 σ), suggesting that at least part of the 276 cairns identified in this area belong to a late third–early second millennium BC horizon. It is so far unclear, however, whether these tombs should be associated to mobile pastoral groups, to an early settlement near Hegra, or to an early phase of the Dadan oasis further south.

Shedding light on the development and organization of the oasis of Dadan is therefore a primary goal of several new projects launched in 2019 by the French National Centre for Scientific Research (CNRS) on behalf of the French Agency for the Development of AlUla (AFALULA) and the Royal Commission for AlUla (RCU): a large-scale excavation and survey project centred on al-Khuraybah and its mountainous hinterland (Dadan Archaeological Project – DAP); a geo-archaeological project aiming to understand the history of the oasis of al-‘Ulā from an environmental and agricultural perspective (ArcAgr-AU project); and an archaeobotanical project focusing on the macro and micro plant archives to understand past agrosystems and plant dynamics (ECOSeed project).

The first opportunity for a collaboration between these three projects was provided by an excavation carried out in October 2019 by the team of the DAP at a small site of the al-‘Ulā valley, Tall al-Sālimīyyah. Although this operation was designed as a short test excavation to locate an ancient pottery workshop, it revealed a site of critical significance for understanding the history of the oasis of Dadan, especially when analysed through the combined lenses of archaeology, geo-archaeology, archaeobotany, and archaeozoology. This article presents the results of the excavation and the study of the excavated material, before discussing their implications for the broader history of Dadan and its oasis.

THE EXCAVATION OF TALL AL-SĀLIMĪYYAH

DESCRIPTION OF THE SITE

The site of al-Sālimīyyah lies in the al-‘Ulā valley, east of the modern asphalt road, c.450 m to the north-west of al-Khuraybah (Fig. 2).³ From a hydrographic point of view, it lies at the confluence of two secondary, lateral wadis flowing from the western plateaux (Wādī Murakh, Wādī Danan) with the main wadi of the al-‘Ulā valley.

The site is surrounded by a modern palm grove to the south, north, and east and is enclosed by a fence installed by the Saudi Department of Antiquities in the early 1980s (Fig. 3). The fenced off area is in the shape of an irregular polygon and covers c.37,000 m². Two main features can be distinguished within this perimeter. The first, to the north, is a row of seven qanat holes oriented north–south. The second, at the western edge of the area, is an oval-shaped shallow mound, c.25 m north–south and 20 m east–west, with a maximum height of 2.50 m (Fig. 4). These two features are separated by a roughly north–south gully which runs at the eastern foot of the tell.

During a reconnaissance made in April 2019, it was observed that the surface material on the tell included a large proportion of painted sherds similar to those found at al-Khuraybah, commonly referred to as

2 - These features are currently being reinvestigated as part of a new survey project (al-‘Ulā Cultural Oasis Project/UCOP).

3 - The site was first recorded by Nasif (1988: 26), who mentions ‘in the area to the north and immediately adjoining the Sālimīyyah lands, (...) several mounds of debris over which a number of sherds are scattered’. It probably corresponds to the ruins that appear on his map 1: d, p. 202. In 2018, the site was recorded as site no. 4215 by the Identification and Documentation of the Immovable Heritage Assets of AlUla (IDIHA) survey project.

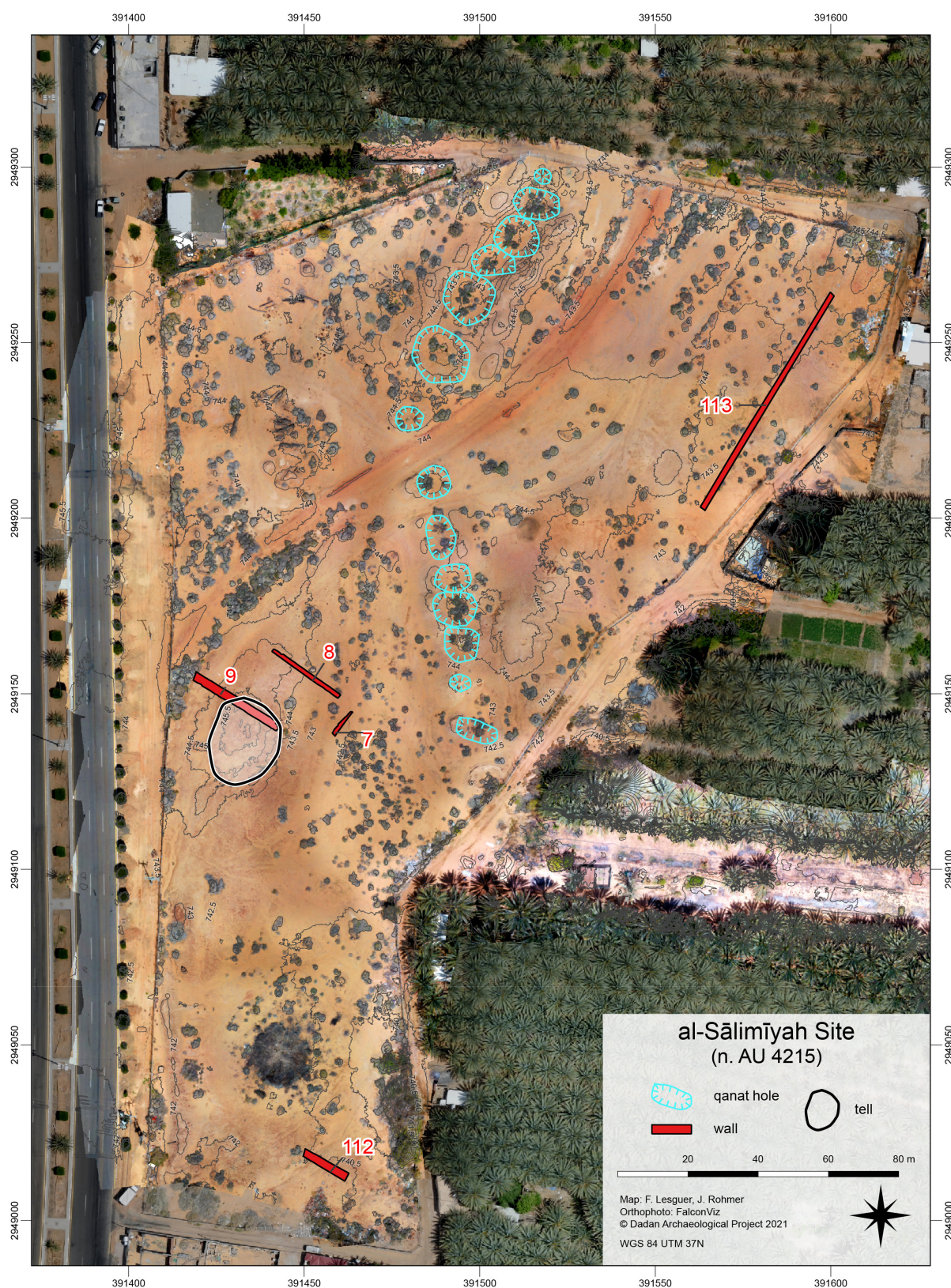


FIGURE 3. An orthophotograph of the site of Tall al-Sālimīyyah showing its main components.



FIGURE 4. *Tall al-Sālimīyyah viewed from the east before excavation.*

al-‘Ulā/Khuraybah pottery (Tebes 2013: 326–328). Furthermore, a small proportion of overfired sherds was observed, suggesting the presence of a pottery kiln at or near the site. This prompted a two-week test excavation from 22 October to 4 November 2019.⁴

PRELIMINARY SURVEY AND EXCAVATION STRATEGY

As a first stage, a foot survey of the site was carried out. It revealed four long, massive walls with rubble core and stone facings (walls 7, 8, 112, 113), located respectively in the southern, central, and north-eastern part of the fenced off area (see Fig. 3). They have coherent north-east–south-west and north-west–south-east orientations despite being distant from each other. Walls 113, in the north-east, and 112, in the south, were the most visible. The former is 1.35 m thick and can be traced for 71 m; the latter is 2.3 m thick and can be traced for 14.4 m.

In a second stage, a systematic collection of the surface material was carried out on and around the tell (2100 m²), following a grid of six squares, to locate potential concentrations of wasters. This was followed by a geomagnetic survey, with the objective of detecting underground structures and looking for specific magnetic anomalies possibly betraying the presence of an ancient kiln.⁵ The results of these operations will be presented later in this article (see below, ‘Assessment of the presence of a pottery kiln’).

By the beginning of the excavation, however, processing of the geomagnetic data and surface pottery was not sufficiently advanced to help define the excavation strategy. Based on the preliminary geomagnetic mapping, no anomaly potentially reflecting the presence of a pottery kiln could be detected. The excavation strategy was therefore defined on the sole basis of the surface remains.

4 - The excavation was carried out by Fabien Lesguer (field director) and Xavier Desormeau (archaeologist) under the scientific supervision of Jérôme Rohmer and Abdulrahman Alsuhaibani.

5 - The magnetic measurements were taken by Rozan Alkhatib Alkontar and Hugo Reiller (Institut de physique du Globe de Strasbourg/CNRS UMR 7516), using a backpack containing the data acquisition system (15F1 and 15F8, designed by the IGPS and developed by DIEFI Ltd) and the DGPS (Trimble R4), and a T-shaped pole with six Bartington MAG-03MC fluxgate magnetometers, spaced 0.50 m apart.

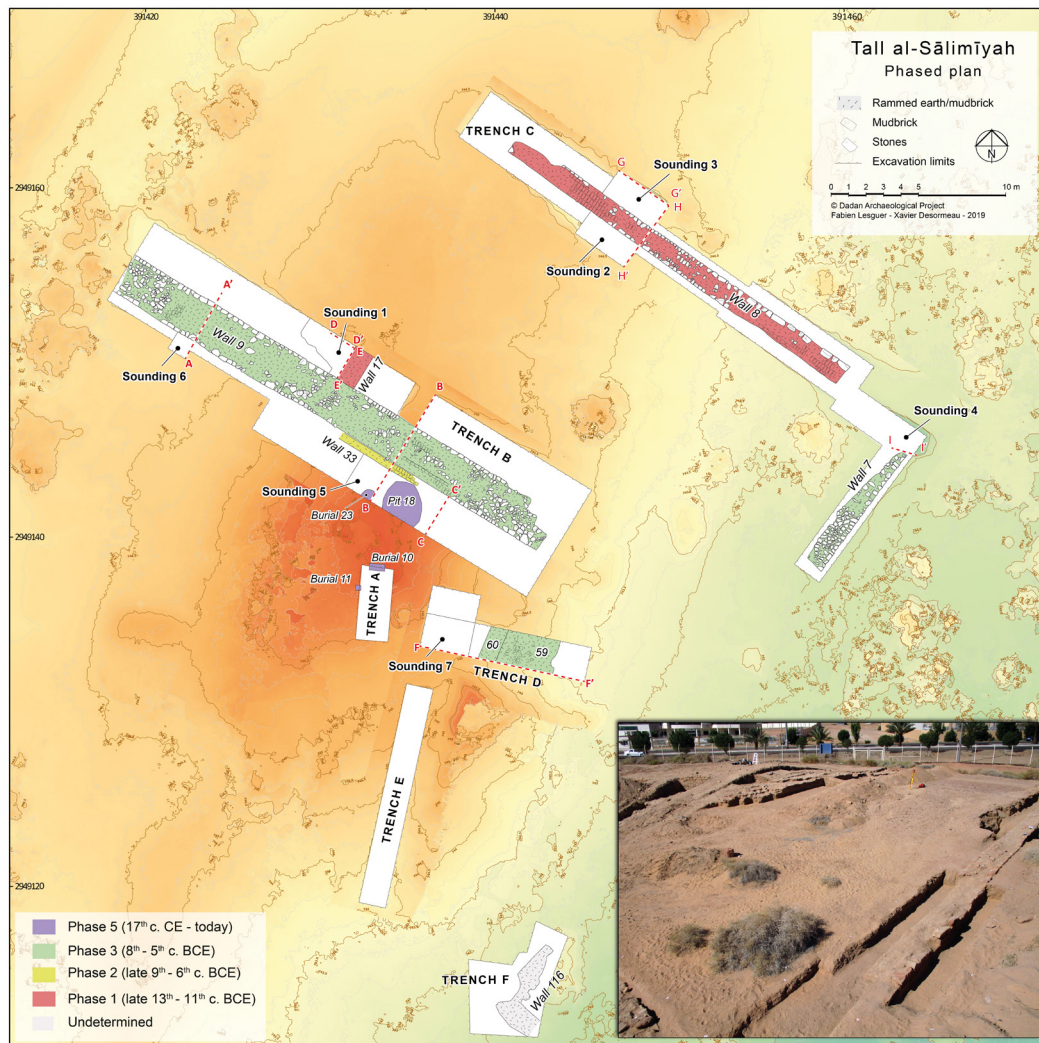


FIGURE 5. A phased plan of Tall al-Sālimīyah, with the location of excavated trenches and documented sections. In the lower right-hand corner, a view of the tell after excavation, from the north-east.

Originally, a long radial trench across the southern half of the tell was planned (Trench A, Fig. 5). Unfortunately, it revealed late Islamic burials, compelling us to backfill it and redefine the excavation strategy. As a result, the excavations focused on the slopes of the tell and the walls which surround it. Five long strip trenches were excavated to clarify the layout of the area, and seven deep soundings were opened in strategic places to date the exposed structures and recover the associated stratigraphic sequences. To recover as much planimetric and stratigraphic data as possible within the short fieldwork period, the excavations were carried out both manually and mechanically, using a lightweight, toothless backhoe bucket.

The strip trenches led to the extensive exposure of three long, massive walls, and the deep soundings revealed an archaeological sequence of five phases, spanning the late second millennium BC to the late Islamic period (Figs 5–6).

THE ARCHAEOLOGICAL SEQUENCE

PHASE 0 (VIRGIN SOIL)

Virgin soil was reached at the bottom of deep soundings 1, 2, 3, and 4. It consists of beds of laminated sand alternating in colour between orange, light grey, and dark grey. They correspond to proximal and distal alluvial deposits originating from the western wadis. The grey colour is due to the presence of

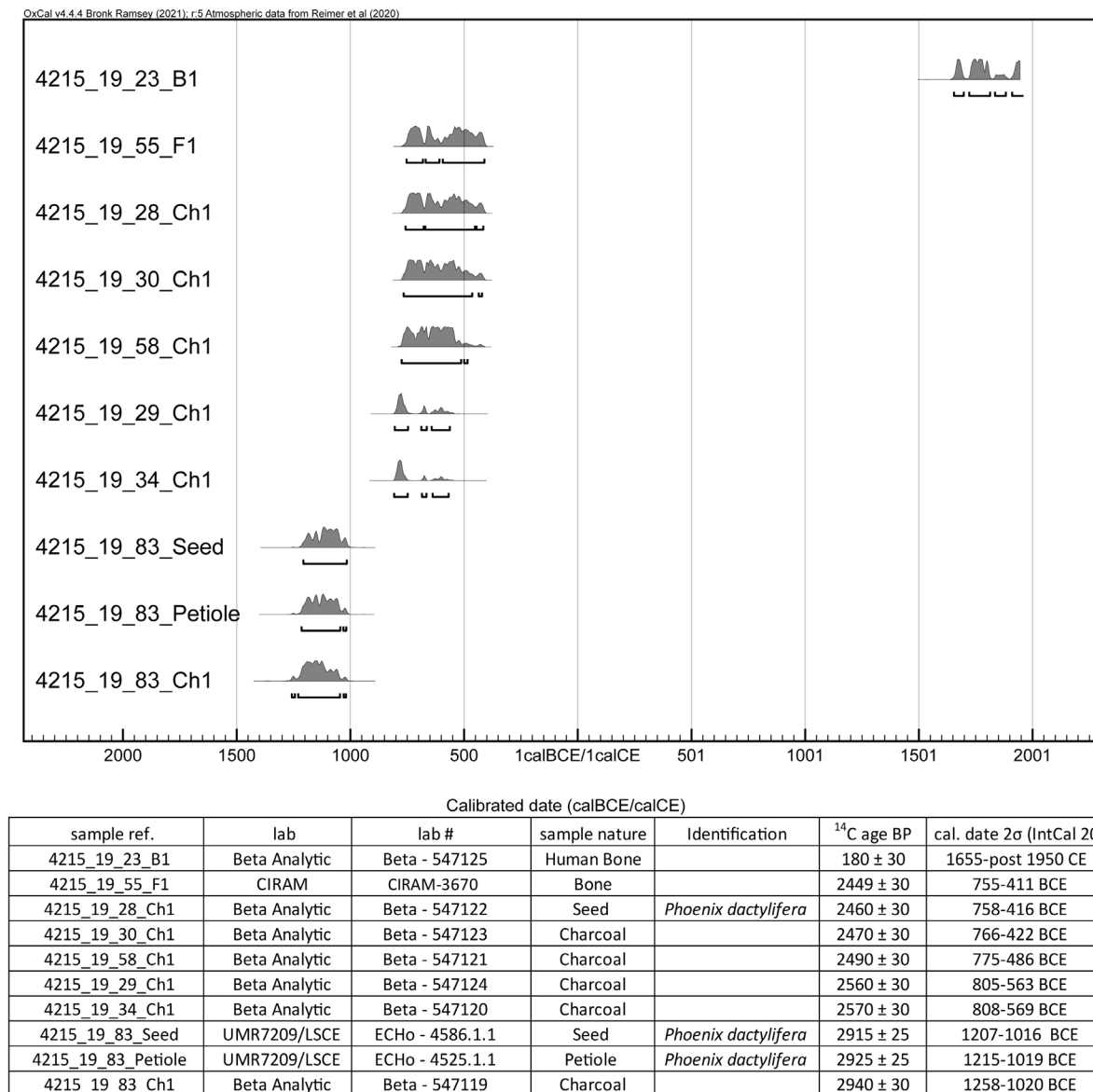


FIGURE 6. Radiocarbon dates from Tall al-Sālimīyah.

basaltic deposits from the basalt fields of Ḥarrat al-ʿUwayriḍ. Recent investigations by the ArcAgr-AU project have shown that these alluvial deposits overlay homogeneous aeolian sands, suggesting the existence of an ancient dune (dating ongoing).

PHASE 1A: EARLIEST STRUCTURES AND OCCUPATIONS (BETWEEN THE LATE THIRTEENTH AND ELEVENTH CENTURIES BC)

The earliest structures were built directly over these natural deposits. They are massive walls, 1–1.2 m thick, made of both stone blocks and mud bricks (Fig. 7) and arranged in an orthogonal pattern following north-west–south-east and north-east–south-west orientations.

In deep soundings 2 and 3, the foundation trench of wall 8 (SU 82) was identified (Fig. 8). It cuts the alluvial layers (SUs 76–79 and 66–67) and was filled with a compact clayey soil (SU 65). The masonry of the wall is heterogeneous. Its northern face is made entirely of roughly squared stones, arranged in relatively regular courses (Fig. 7/a). The lower two courses are made of medium-sized blocks (max. dimensions 0.30 x 0.80 m), whereas the upper three courses are composed of smaller blocks. The southern face, however, is

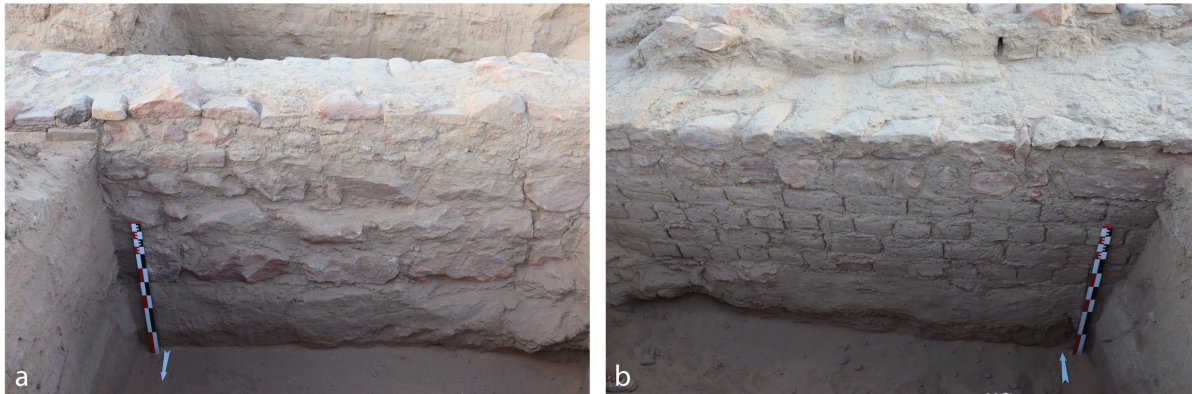


FIGURE 7. Wall 8 (phase 1): a. northern facing; b. southern facing.

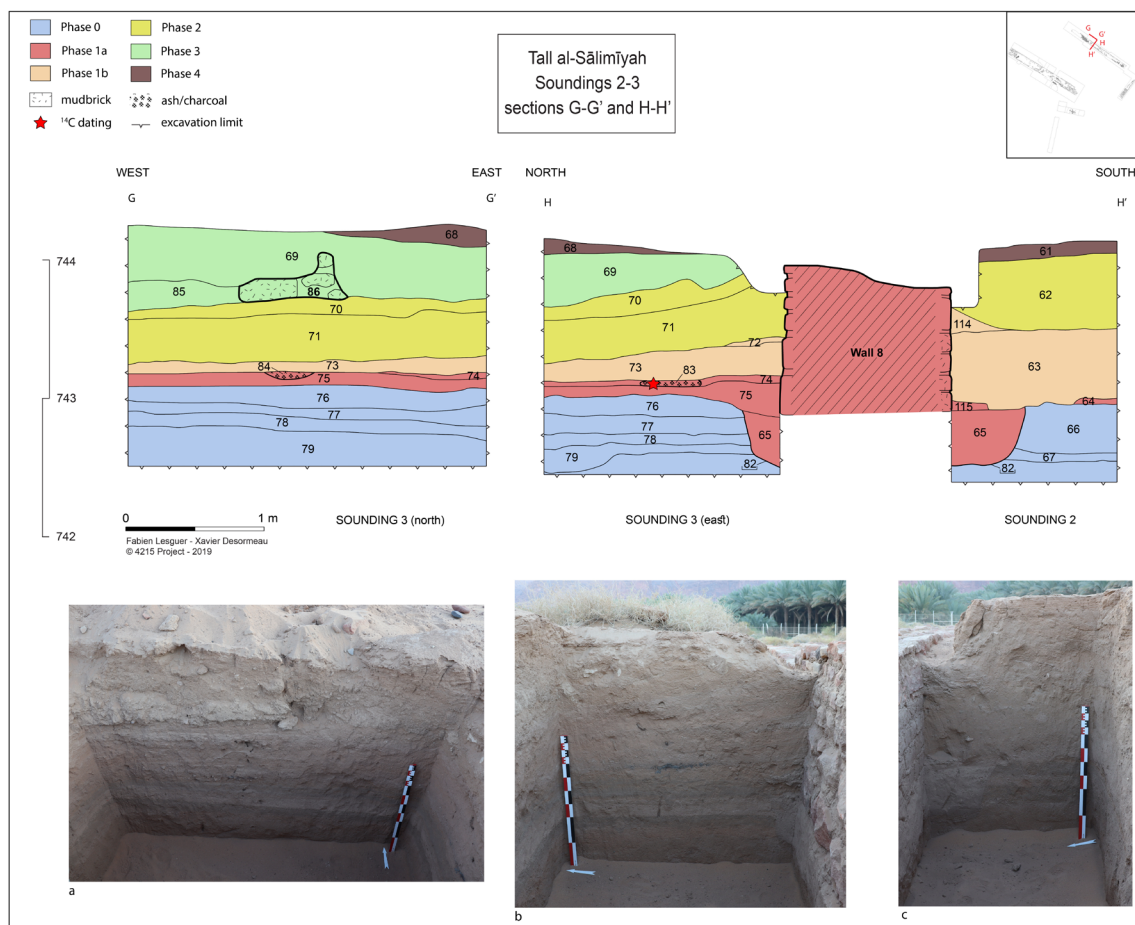


FIGURE 8. Drawing and pictures of section H-H' (northern and eastern section of deep soundings 2 and 3).

made of four courses of mud bricks topped by two courses of small blocks (Fig. 7/b). It is unclear whether these upper courses are original or belong to a later refurbishment of the wall.

On the northern side (sounding 3), the base of the wall is abutted by a possible construction level made of clayey sand mixed with mud-brick fragments (SU 75), followed by an occupation layer of ashy sand (SU 74) containing two small hearths (SUs 83–84). Undetermined charcoal and two date-palm remains (*Phoenix dactylifera*) from SU 83 have yielded consistent radiocarbon intervals ranging from 1258 to 1016 BC (Fig. 6). On the southern side of the wall, a thin layer of lumpy clayey soil overlays the foundation trench, at the base of the wall (SU 115). It may also be related to the construction of the wall. However, no clear occupation layer was identified on this side of the wall.

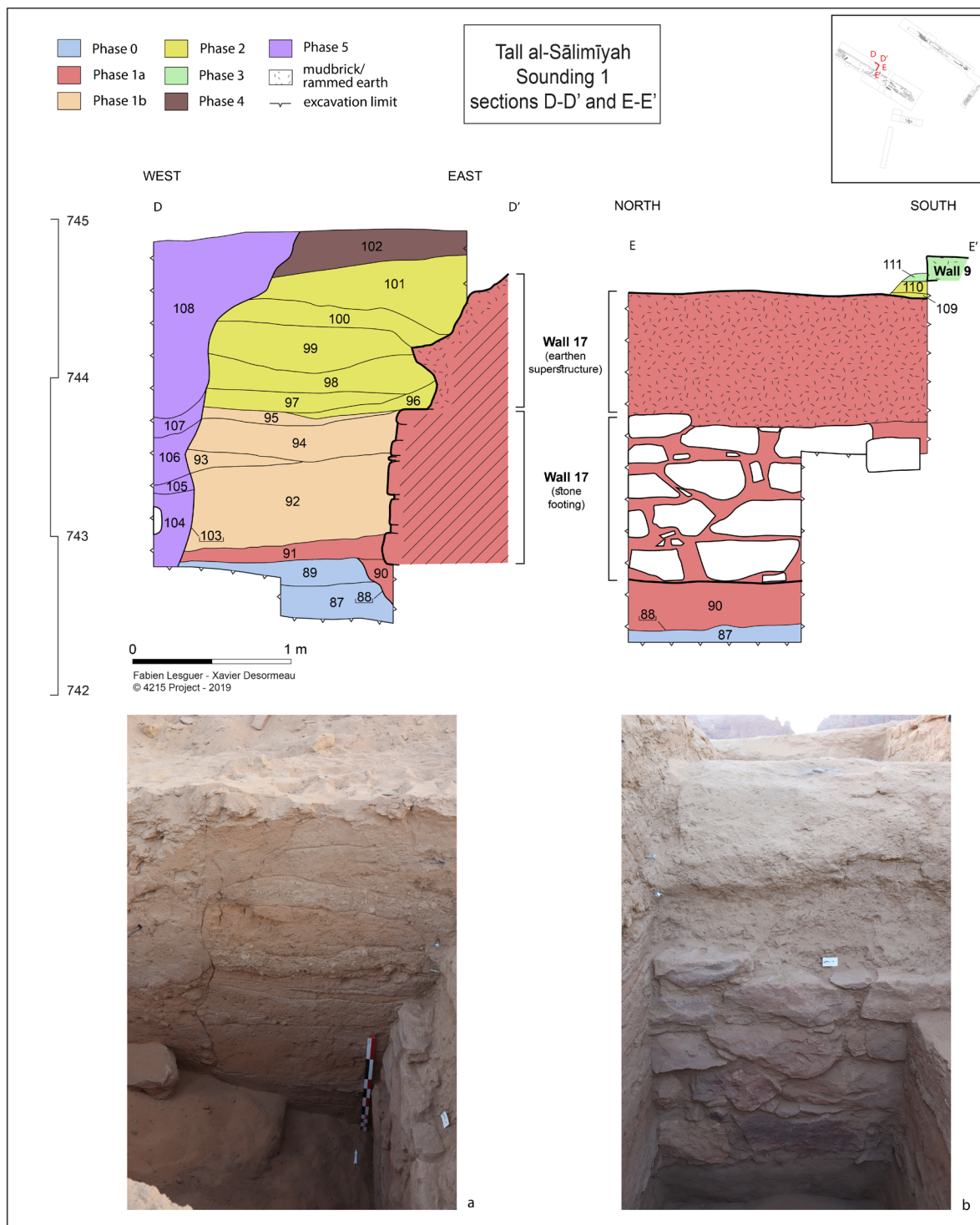


FIGURE 9. Drawings and pictures of sections D-D' and E-E' (northern and eastern section of deep sounding 1).

In deep sounding 1 (Fig. 9), a south-west–north-east wall which was not visible on the surface was uncovered (wall 17). Wall 17 is preserved to a height of 1.83 m and is 1 m thick. This wall has a 1.08 m-high footing made of four courses of rough medium-sized stones (max. dimensions 0.60 x 0.26 m). Over this footing, the wall has an earthen superstructure, apparently made of rammed earth rather than mud brick, preserved to a height of 0.80 m. It is uncertain whether this superstructure belongs to the original state of the wall or if it corresponds to a later reconstruction. The foundation trench of wall 17 (SU 88) was dug directly into the alluvial layers of phase 0 (SUs 87, 89) and was filled with a compact clayey soil (SU 90).

The base of the wall is abutted by a circulation layer made of indurated beige sand and clay (SU 91). No dating evidence was collected for the construction of wall 17, but its stratigraphic position (directly above the phase 0 deposits) and several common points with wall 8 (same altitude at the base \pm 20 cm, same filling of the foundation trench) support attributing it to phase 1a.

PHASE 1B: ALLUVIAL DEPOSITION AND REOCCUPATION

In deep sounding 3, the earliest occupation seems to have been short-lived, since SU 74 is covered with a layer of micro-laminated beige sand corresponding to overflow deposits (SU 73; Fig. 8). On top of this alluvial layer, however, a second occupation layer was observed (SU 72). It is a thin lens of compact dark beige clayey soil, abutting the upper limit of the large blocks in the northern facing of wall 8. It could therefore be linked to a potential refurbishment or reconstruction of this wall.⁶

To the south of wall 8, in sounding 2, the sequence seems different, with no alluvial deposition to be found. Instead, the construction layer of phase 1a, SU 115, is directly overlaid by a 0.50 m thick heterogeneous layer of loose beige sand mixed with gravel and larger stone inclusions (SU 63), which is difficult to interpret. Over this layer, however, a clayey layer similar to SU 72 was found at roughly the same altitude (SU 114). Interestingly, the level of this layer also corresponds to a change in the masonry of the southern facing of the wall (addition of stone blocks over the lower mud-brick courses). It may be a construction level or an occupation layer.

Further south, in deep sounding 1 (Fig. 9), the circulation layer of phase 1a (SU 91) is covered by a succession of natural deposits, possibly aeolian (SU 92) then alluvial (SUs 93–95), characterized by an increased sandstone input. No human activity, however, can be detected within this sequence.

The difference between the stratigraphic sequences of soundings 1 and 3 (which include significant alluvial/aeolian deposition) and 2 (where no alluvial deposit is to be found) may be due to the fact that wall 17 probably continued northwards up to wall 8, thus protecting the area located further east from alluvial/aeolian deposition. Sounding 2 probably corresponds to an interior space, located inside a building or enclosure.

PHASE 2: PARTIAL DEMOLITION, AND FORMATION OF THE TELL (BETWEEN THE LATE NINTH AND THE EARLY SIXTH CENTURIES BC)

In deep sounding 1 the alluvial deposits of phase 1b are covered with a *c.* 1 m-thick sequence of layers alternatingly orange and beige/grey in colour, containing a varying proportion of clay, mud-brick fragments, and small stones (SUs 96–101; Fig. 9). Some thin, intertwined laminated layers are indicative of runoff. All these layers cut into the earthen superstructure of wall 17 and damaged it. The presence of melted clay, mud-brick fragments, and small stones (especially in SUs 96, 98, and 100) suggests demolition, but the laminated nature of these layers seems incompatible with a primary demolition deposit from wall 17. More likely, we are probably dealing with layers of remobilized demolition, either from wall 17 or from another structure located further to the north-west.

Probably during the same phase, however, a new wall was built further south, on the slope of the tell (wall 33). It was exposed in trench B for 4.4 m. It is built in mud brick, with one row of headers and one row of stretchers. In sounding 5, it appears to be preserved to a height of 1.90 m and to have been built at the same altitude as the earthen superstructure of wall 17 and the lowermost phase 2 deposits in sounding 1

6 - Ascribing SU 72 to phase 1b remains hypothetical. It could also belong to phase 2 or 3. The main reason for ascribing it to phase 1b is that it lies only 20 cm above SU 74 (phase 1a), while in sounding 1, the levels from phase 1a and those from phase 2 are separated by *c.* 1 m of deposit. During a reinvestigation of this section by the ArcAgr-AU Project in November 2021, this level turned out to contain a small hearth. The radiocarbon dating of this hearth (still in process at the time of writing) will help determine its phasing.

(743.90 m asl), apparently without a foundation trench (Fig. 10). This indicates that the superstructure of wall 17 (or at least its eastern facing) was still standing unburied when wall 33 was built. It is even possible that the superstructure of wall 17 represents a reconstruction of wall 17 during phase 2.

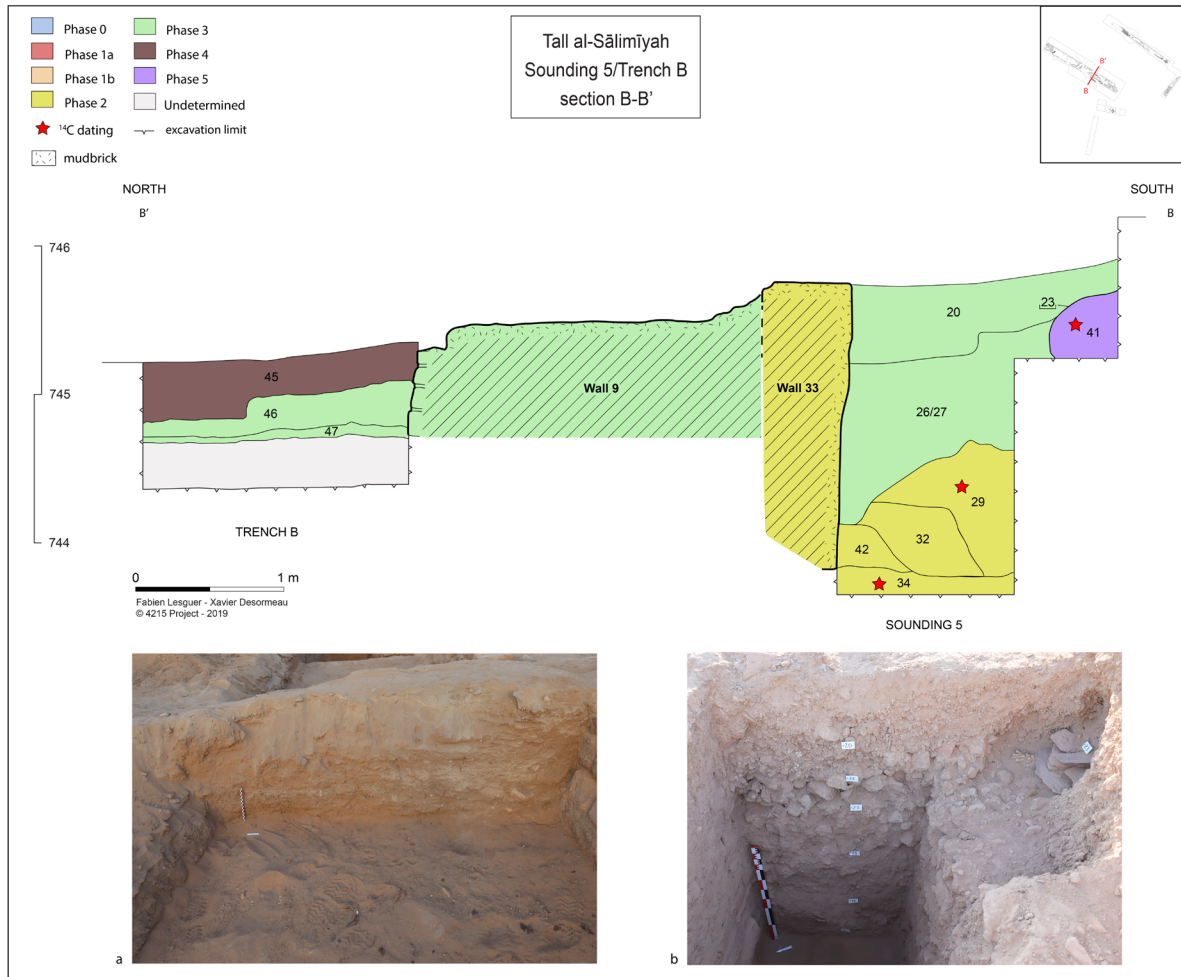


FIGURE 10. Drawing and pictures of section B-B' (eastern section of deep sounding 5).

Wall 33 was built on a layer of slightly indurated yellow/beige sand containing pottery, bones, and charcoals (SU 34). It is so far unclear whether this layer should be ascribed to phase 1b or to the beginning of phase 2 (intentional foundation deposit for wall 33?). However, as it has yielded a radiocarbon date consistent with another phase 2 context (see below), we tend to favour the latter hypothesis. Over this layer, the base of wall 33 is abutted by successive heaps of loose sandy/silty soil (SU 42), compact beige clay (SU 32), and relatively loose, dark beige sandy/silty soil containing small fragments of mud bricks (SU 29). All these layers contained pottery and animal bones, in addition to one metal object and two terracotta figurines in SU 32. One charcoal from SU 34 was radiocarbon-dated to 808–569 cal. BC (2σ), implying that wall 33 was built in the very late ninth century BC at the earliest. Another charcoal, from SU 29, has yielded a similar chronological interval (805–563 cal. BC, 2σ). As wall 33 is the earliest identified wall belonging to the tell itself, the formative phase of the tell should be dated to this late ninth–early-sixth century BC interval.

For lack of stratigraphic connections and radiocarbon dates, no layers from the northern deep soundings can be safely ascribed to phase 2. As a working hypothesis, however, the layers located immediately above the phase 1b occupation layers can be tentatively attributed to this phase (Fig. 8). In sounding 3, one

observes two successive layers of micro-laminated sand (SUs 70–71) corresponding to overflow deposits. The situation is once again different in sounding 2, probably because it corresponds to an interior space. There, one finds a c.55 cm-thick layer of beige sand with very mixed granules and gravel, suggesting human activity or demolition (SU 62).

PHASE 3: NEW CONSTRUCTIONS (BETWEEN THE MID-EIGHTH AND FIFTH CENTURIES BC)

Following phase 2, a new phase of construction took place sometime between the early eighth and fifth centuries BC (see Figs 5–6). Structures and deposits from this phase have been safely identified only on the slopes of the tell (soundings 1, 5, 6, 7).



FIGURE 11. Phase 3 walls: a. bird's eye view of wall 9, from the south; b. wall 9, northern facing, from the north; c. wall 7, from the south.

On the north-eastern slope of the tell, trench B revealed a massive north-west–south-east wall, c.2.50 m thick, with a mud-brick core and stone facings (wall 9; Fig. 11/a–b). It can be traced for c.28 m and is preserved to a height of four courses (c.0.70 m) on its northern side. As shown by the eastern section of sounding 1, it was built above the levelled superstructure of wall 17 (Fig. 9). In the south, it was built against the earlier wall 33, which continued in use from the previous phase (Fig. 10).

The base of wall 9 was reached in several places. On the northern side of the wall (i.e. outside the tell), a circulation layer made of loose beige sand and gravel (SU 47) abuts the base of the wall (Fig. 10). This layer is directly covered with a demolition layer made of melted mud brick (SU 46). Inside the tell, in sounding 6, a comparable sequence can be observed, with a sandy clayey circulation layer (SU 44) buried under a layer of hard clayey sand containing fragments of mud brick (SU 37/38). In sounding 5, a c.0.80 m-thick layer of very compact beige sandy clay containing large fragments of mud brick abuts wall 33 (SU 26/27).

It slopes from south to north. The interpretation and phasing of this layer is difficult. It is uncertain whether it represents the collapse or demolition of a mud-brick structure located further south (at the end of phase 2 or possibly in phase 3), or an intentional fill intended to raise the ground level inside the tell (at the beginning of phase 3). Above it lies a similar layer containing smaller fragments of mud brick, which yielded a particularly large amount of pottery and fauna as well as a fragment of a terracotta figurine (SU 20). This layer belongs more clearly to phase 3, but the same doubt prevails concerning its nature.

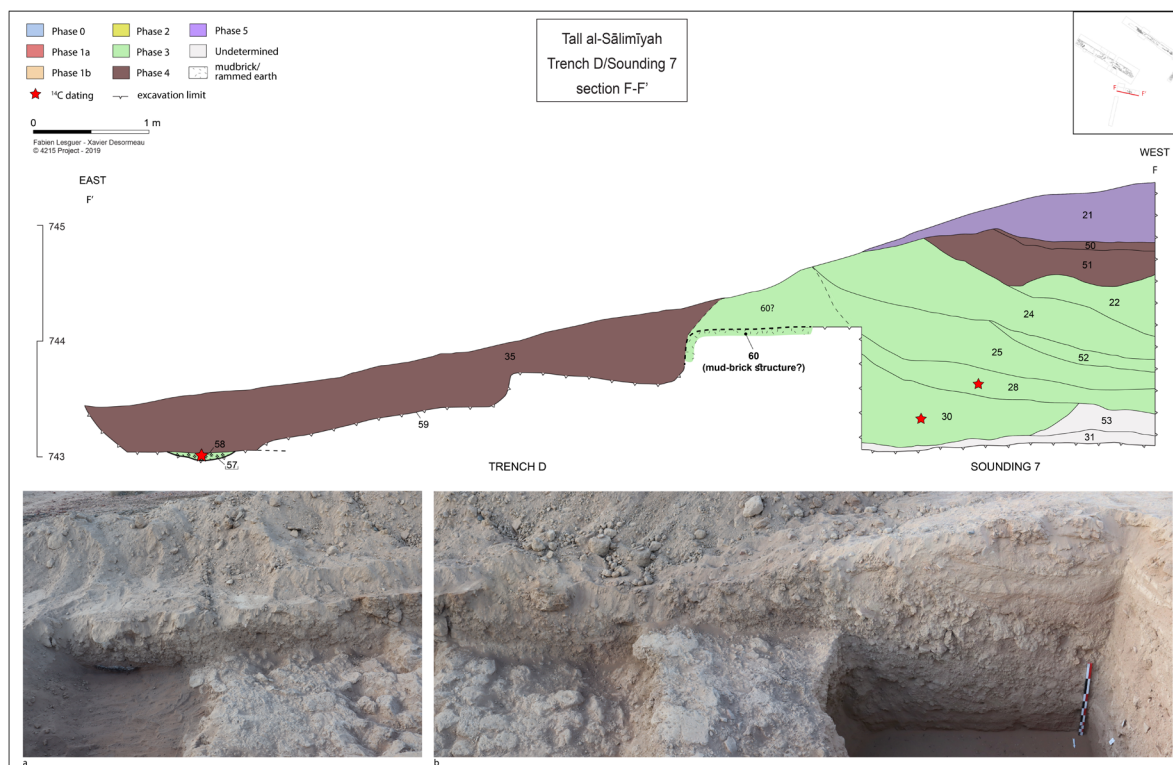


FIGURE 12. Drawing and pictures of section F'-F (southern section of deep sounding 7).

On the eastern slope of the tell, similar layers were identified in trench D and deep sounding 7 (Fig. 12). In sounding 7, the slope of the tell consists of a succession of more or less compact sandy layers containing fragments of mud brick, sloping towards the interior of the tell (SUs 31, 53, 30, 28, 25, 52, 24, 22). These layers yielded three copper alloy objects and three fragments of terracotta figurines. A charcoal from SU 30 and a date seed from SU 28 were radiocarbon-dated to very close intervals, which are later than those of phase 2 — respectively 766–422 and 756–416 cal. BC (2σ). As in sounding 5, it is uncertain whether these layers represent the demolition of a structure located further east or intentional fills. The former hypothesis seems more likely, as they appear to be sloping from a 1 m-wide mass of clay, roughly oriented south-south-west–north-north-east, identified in plan further east in trench D (SU 60). This mass might correspond to the eroded remains of a structure as, at its eastern foot, there is a demolition layer probably resulting from the collapse of a mud-brick facing (SU 59). At the eastern edge of trench D — at the eastern foot of the tell — a small hearth was uncovered (SU 57/58) which yielded a radiocarbon interval consistent with those from the layers of the slope of the tell (775–486 cal. BC, 2σ). In all likelihood, this hearth should be ascribed to phase 3, as it lies under what seems to be the final abandonment layer of the tell (SU 35).

Finally, to the east of the tell, a c.1.25 m-thick south-west–north-east wall perpendicular to wall 8, with facings and a core made of small, roughly squared blocks, should also be ascribed to phase 3 (wall 7; Figs 5, 11/c). Indeed, although it was built directly on laminated alluvial deposits typical of phase 0, an animal

bone from the filling of its foundation trench (SU 55) was radiocarbon-dated to 755–411 cal. BC (2σ). Its preserved top is very flat, suggesting that it might have had a mud-brick superstructure. It was probably connected to wall 8 in the north, but the junction between the two walls has unfortunately been cut by erosion. Its base (above the foundations) lies at 742.20 m asl, or 80 cm below the above-mentioned hearth from trench D, located at the eastern foot of the tell, and c.2.50 m below the base of wall 9 in trench B, on the north side of the tell. This suggests that there was a significant slope on the north-eastern flank of the tell during phase 3.

In the northern soundings, no layers can be attributed to phase 3 with certainty. As a working hypothesis, however, the remains of a poorly preserved small mud-brick wall identified in the northern section of sounding 3 (SU 86) can be ascribed to this phase, together with a layer of melted mud brick which abuts it to the west (SU 85; Fig. 8). These remains are covered with a 0.40 m-thick demolition layer composed of clayey sand with mud-brick fragments and gravel (SU 69). Given the altitude of wall 86, it seems that wall 8 was still standing and partially exposed when it was in use.

PHASE 4: ABANDONMENT, FLOODING, AND EROSION

Following phase 3, it would appear that the site was abandoned for a long period of time, at least until the mid-seventeenth century AD. During this phase, the site was subject to both flooding and erosion.

North of the tell, this phase of abandonment is marked by the deposition of alluvial sand, such as SU 61 and SU 68 in soundings 2–3 (Fig. 8), SU 102 in sounding 1 (Fig. 9), and SU 45 in trench B (Fig. 10). More surprisingly, similar processes can be identified at the top of the tell. In sounding 7, the fill or demolition layers of the previous phase are sealed by a small channel filled with laminated alluvial silts and clays (SU 51 and 50), indicating a low-intensity flow regime.

East of sounding 7, in trench D, both the hearth SU 57/58 and the fallen mud-brick facing SU 59 were covered with a layer of sand and gravel containing fragments of mud brick, probably representing material fallen from the slopes of the tell (SU 35; Fig. 12).

PHASE 5: THE LATE ISLAMIC CEMETERY (BETWEEN THE MID-SEVENTEENTH AND TWENTIETH CENTURIES AD)

The last phase of the site corresponds to the reuse of the tell as a small cemetery. At the beginning of the excavations, two probably Islamic burials were identified at the top of the tell and immediately back-filled (SUs 12-13; Fig. 5). Later on, the foot of a third skeleton (SU 23) appeared in the southern corner of sounding 5 (Fig. 10), but in a slightly deeper stratigraphic position and with a different orientation (north-east–south-west) and burial ritual (body covered with flat stones), suggesting that it might be pre- or non-Islamic. As a precaution, the burial was left unexcavated and backfilled, but a radiocarbon analysis was performed to determine whether it belonged to the end of phase 3 or to phase 5: the results (1655–post 1950 cal. CE; Fig. 6) clearly support the latter hypothesis and provide a broad chronological range for the cemetery. The layers excavated at the top of the tell (SUs 15, 16, 21; Fig. 12) probably correspond to levelling fills associated with the installation of the cemetery. A large pit detected during the surface scraping of the top of the tell, and left unexcavated (SU 18), probably belongs to the same period.

At the northern foot of the tell, a large and at least 2 m-deep pit dug from the current ground level (SU 103) may also be ascribed to phase 5 (Fig. 9). It is filled with a succession of layers of sand, the deepest of which contains a large stone. The function of this pit remains enigmatic. One hypothesis is that it might be a test pit made by the inhabitants of al-‘Ulā in the late nineteenth or twentieth century when trying to locate ancient qanats and renovate them (Nasif 1988: 157–175).

ASSESSMENT OF THE PRESENCE OF A POTTERY KILN

As can be seen from the above, the excavations conducted during the 2019 fieldwork season did not provide an answer to the initial research question which prompted the project: was there a pottery kiln in or around the tell? After the field season, however, a more detailed post-processing of the geomagnetic data revealed a series of broadly linear anomalies oriented north-west–south-east (consistent with the long walls exposed by the excavations) as well as several specific (dipolar) anomalies (Fig. 13/a). Unfortunately, as the area was littered with a high quantity of modern metal waste, it cannot be confirmed whether these specific anomalies result from underground remains or from modern pollution. Moreover, at first sight none of them appears strong enough to fit the definition of an ancient firing structure.

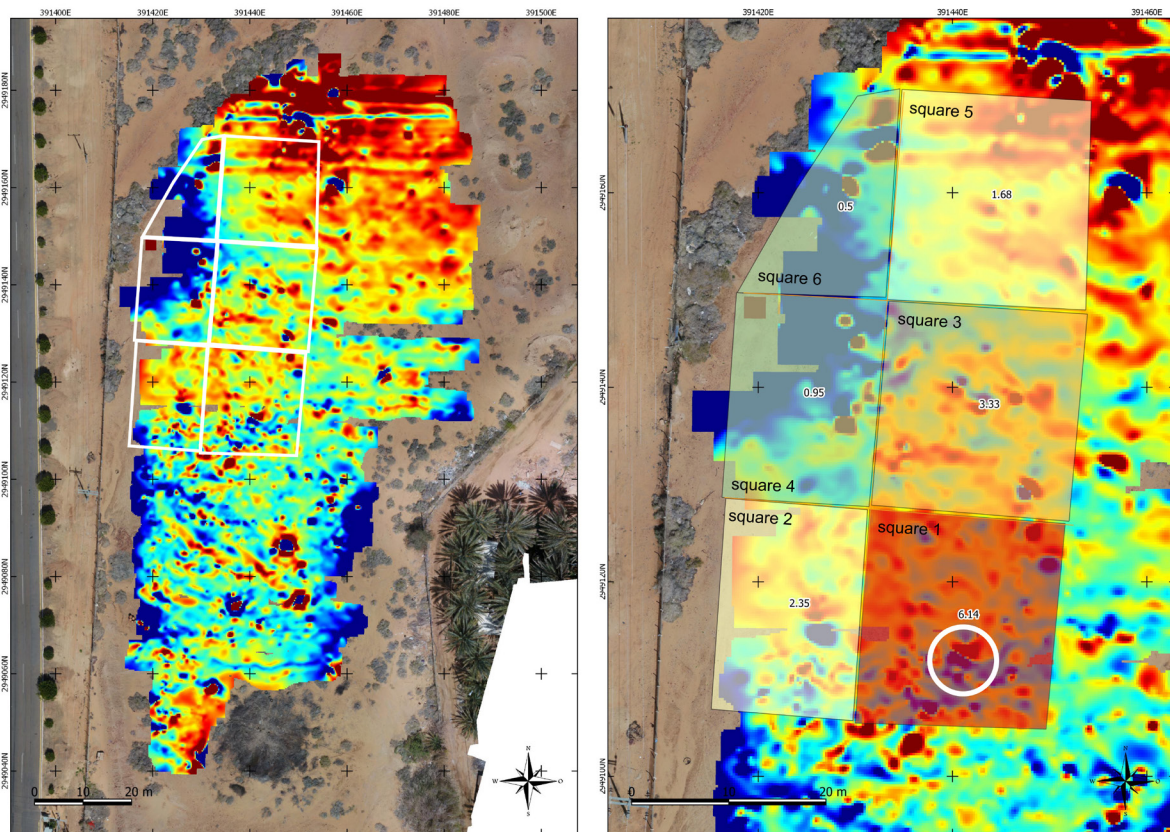


FIGURE 13. Left: A geomagnetic map of the site, with vertical derivative at order 0.25, thresholded at 10 nT (H. Reiller; R. Alkhatib Alkontar); right: a 'heat map' showing the proportion of overfired sherds in the surface assemblage of the tell in each of the survey squares, superimposed on the geomagnetic map. The numbers in black indicate the percentage of overfired sherds in each square.

On the other hand, the study of the pottery collected on the surface of the tell revealed a relatively high concentration of overfired sherds (potential wasters) in square 1, on the south-eastern slope of the tell (6.14% of the collected sherds; Fig. 13/b). Although this percentage is by itself too low to indicate with certainty the presence of a kiln, it concurs to some extent with the geomagnetic evidence, since a strong specific anomaly appears in this square. Assuming that there was a pottery kiln at the site, this area would probably be the best candidate for its location.

In view of these new clues, it was decided to dig a small test trench in this area during the second field season of the DAP, in November 2021 (trench F; Fig. 5). Unfortunately, the trench only revealed the corner of a mud-brick building and a level of demolition.

POTTERY AND SMALL FINDS

POTTERY

During the fieldwork season, 13,009 potsherds were collected (9324 on the modern surface and 3685 from excavated deposits).⁷ The excavated pottery comes exclusively from levels ascribed to phases 2–5. Since phase 4 represents a period of abandonment and phase 5 corresponds to an Islamic cemetery deprived of material, it can therefore be safely assumed that the bulk of the excavated pottery belongs

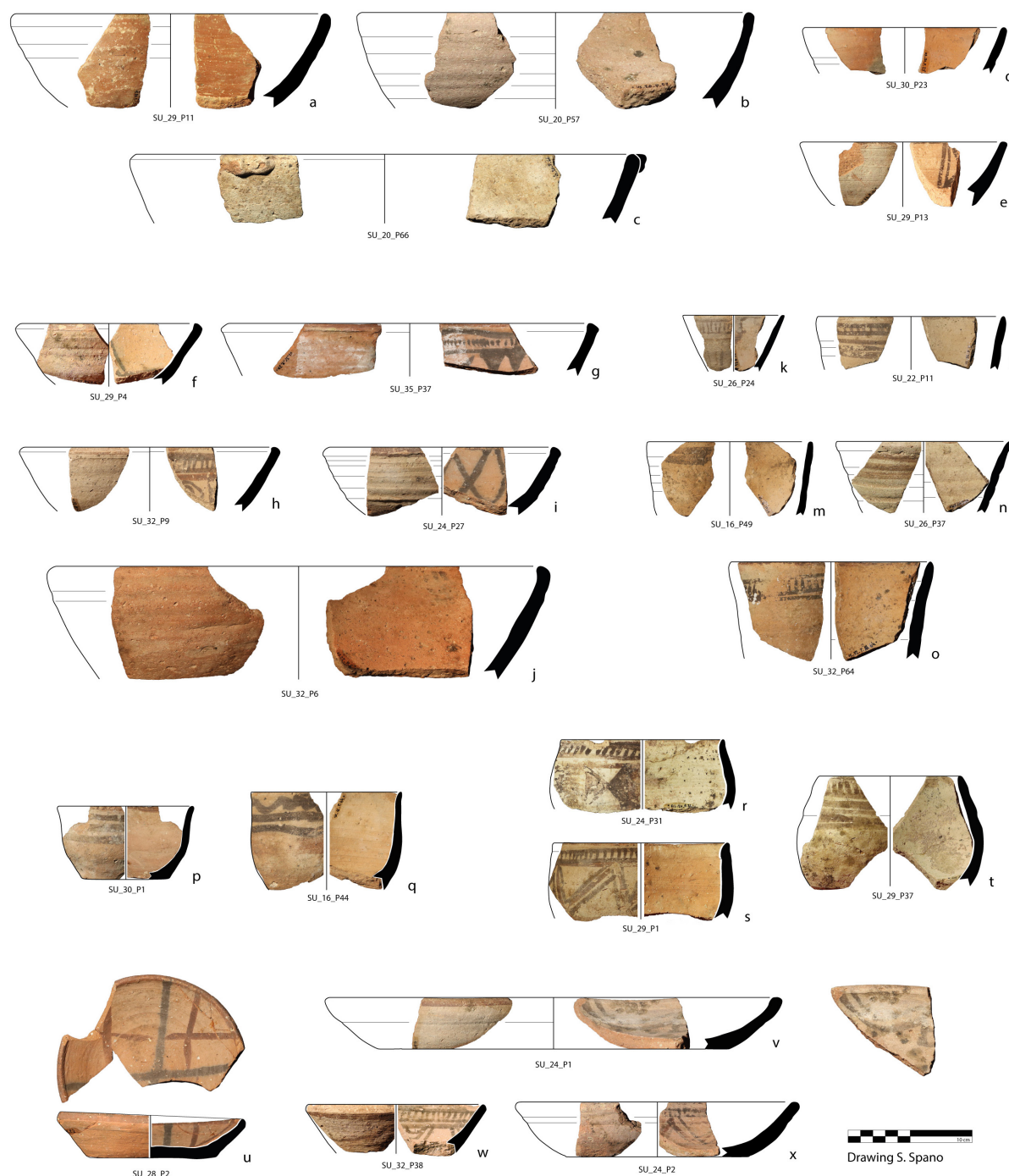


FIGURE 14. Pottery from Tall al-Sālimīyyah: bowls.

7 - The pottery study was carried out by Francelin Tourtet, with subsequent contributions by Jérôme Rohmer and Fabien Lesguer.

to the late ninth- to the late fifth-century interval of phases 2–3 although the presence of earlier residual sherds cannot be ruled out.

The preliminary pottery study focused on the sequences of soundings 5 and 7. In these sequences, 546 diagnostic fragments were isolated and studied.

FABRIC GROUPS

In terms of the macrofabrics, the studied pottery is overall very homogeneous and belongs to one of the main groups identified so far at al-Khuraybah by the DAP. This group represents, in almost every context, between 77 and 90% of the recorded sherds. It is characterized by a probably calcareous matrix, varying in colour from light brown to buff and pink/orange, and by the presence, in varying proportions, of sub-millimetric to millimetric sub-angular white mineral inclusions. It has three variants — one without additional inclusions (Dadan macrofabric 3), one with additional black mineral inclusions (Dadan macrofabric 4), and one with additional vegetal temper (Dadan macrofabric 5). At Tall al-Sālimīyyah, the distribution of these variants does not seem to vary throughout the stratigraphic sequence of the soundings, or between the soundings.

MORPHOLOGICAL REPERTOIRE

The studied assemblage is largely dominated by open vessels (77%). Closed vessels are extremely rare (3%). The remaining 20% correspond to unidentified vessels (mostly bases).

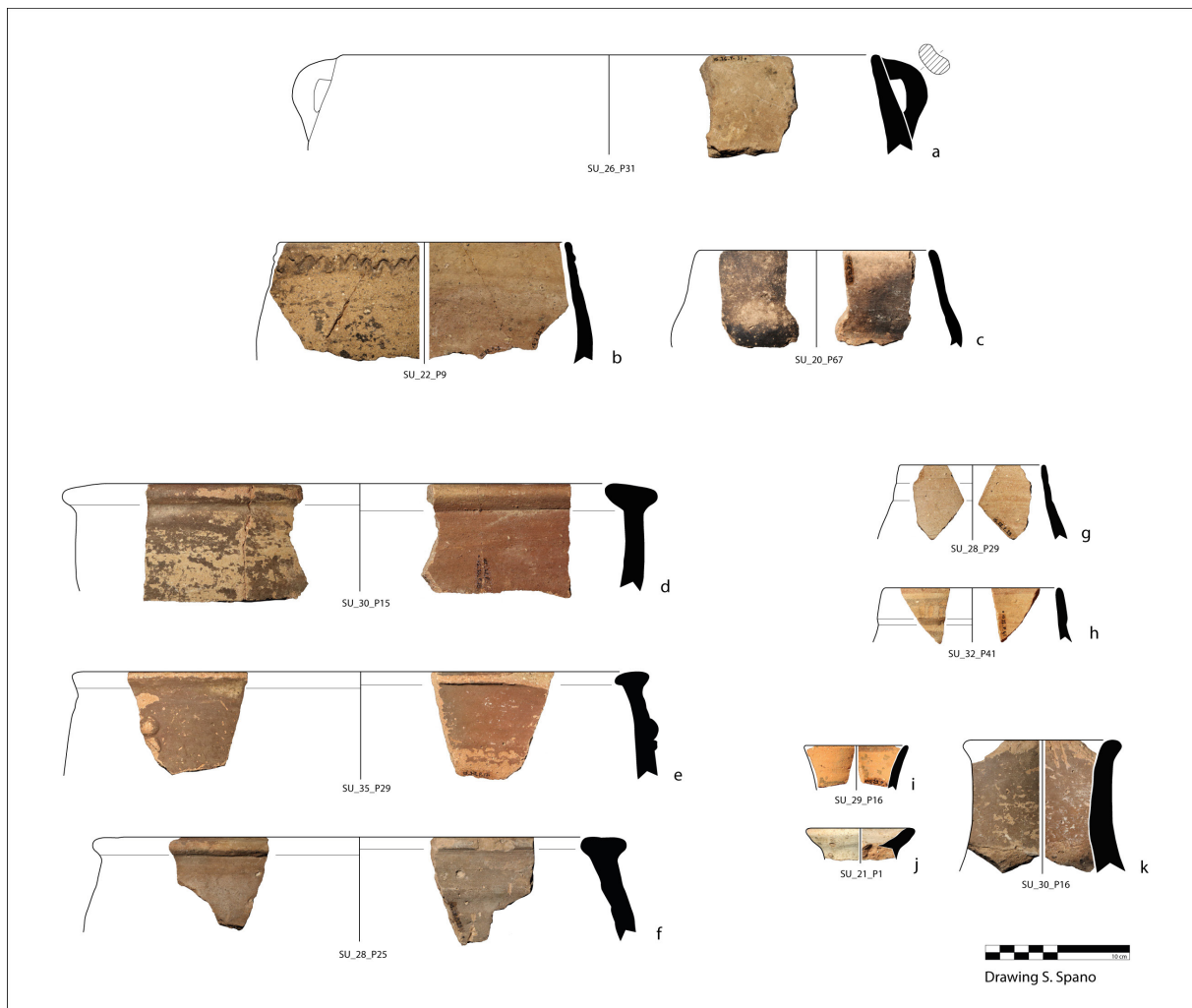


FIGURE 15. Pottery from Tall al-Sālimīyyah: cooking pots, jars, jugs, and large storage vessels.

Among the open vessels, the following types were defined:

— Rounded bowls with a rounded rim (Fig. 14/a–e). Vessels of this type are usually large, ranging from 25 to 40 cm in diameter, but smaller examples, *c.* 15 cm in diameter, occasionally occur (Fig. 14/d–e). They often have ridged walls. Several large specimens have small horizontal lugs on the rim (Fig. 14/c). Similar bowls are known from al-Khuraybah (Parr, Harding & Dayton 1970: fig. 5, nos. 1, 3, 6–7, 9).

— Rounded bowls with a slightly incurved, inwardly pointed rim (Fig. 14/f–j). The vessels of this type vary in diameter from 15 to 41 cm. In the al-ʿUlā valley, such bowls are known from Khayf al-Zahrah (Bawden 1979: figs 46/22, 47/32).

— Small deep bowls with straight thin walls (Fig. 14/k–o). The walls of these vessels are slightly everted, often with broad ridges. Their diameter ranges from 9 to 16 cm. In the al-ʿUlā valley, such bowls are known from Tall al-Kathīb stratum III (al-Zahrani 2007: pls 61/69; 83/112) and al-Khuraybah (Parr, Harding & Dayton 1970: fig. 5/4; al-Shehry 2014: 526, no. 92). They find parallels during the Iron IIC/Persian period in southern Transjordan (Bienkowski 2002: figs 9.30/1–3, 9.32/10).

— Small deep bowls with upright, slightly carinated walls (Fig. 14/p–q). These vessels have relatively thin walls and a rounded or tapering, slightly everted lip. The best-preserved example has a simple flat base. Regionally, such bowls are known from Tall al-Kathīb stratum III (al-Zahrani 2007: pl. 63/73) and al-Khuraybah (al-Shehry 2014: 486, no. 55).

— Small deep, piriform bowls with slightly inverted walls and a pointed or tapering rim, which can be slightly everted (Fig. 14/r–s) or straight (Fig. 14/t). Regionally, such bowls are known from Tall al-Kathīb stratum III (al-Zahrani 2007: pls 63/76; 65/78–79; 73/97). On a larger scale, the variant with straight rim is attested in southern Transjordan during the Iron IIC/Persian period (Bienkowski 2002: fig. 9.32/5).

— Shallow bowls with a large flat base, flaring walls, and a rounded rim (Fig. 14/u–x). Their diameter ranges from 13 to 37 cm.

— Deep pots with inverted walls and a rounded rim (Fig. 15/a–c). At least two of these vessels (Fig. 15/b–c) bear traces of fire on their surface. They may therefore be consistent with cooking pots.

— Large thick-walled vessels with a T-shaped rim (Fig. 15/d–f). These vessels often have slightly convex walls, either slightly inverted or slightly everted. They usually have a grey to brown slip. Their diameter at the mouth ranges from 29 to 52 cm. They correspond either to storage vessels or to very large, deep bowls. A comparable shape, also slipped, but with seemingly thicker walls, was found in Tall al-Kathīb stratum III (al-Zahrani 2007: pl. 75/100).

Closed vessels include:

— Pots or small jars (?) with a slightly inverted neck, often ridged, and a simple rim (Fig. 15/g–h). This shape is attested at al-Khuraybah (Parr, Harding & Dayton 1970: fig. 5/8).

— Bottles or jugs with an upright concave neck (Fig. 15/i–k). This category is rare (less than a dozen recorded vessels) and displays significant variations.

In functional terms, bowls account for *c.* 78.5% of the identified vessels, cooking pots for 7%, storage vessels or large deep bowls for 8%, and small jars and jugs for *c.* 4%.

DECORATION

The proportion of painted sherds is high — between 25 and 78% of the pottery in each context. The painted decoration is either monochrome (black) or bichrome (black and red), and is always applied on a smooth surface or a slip which has a similar colour to the sherd's core. The decorative repertoire

is generally consistent with Parr's and Bawden's observations on the 'Khuraybah pottery' collected at al-Khuraybah and Khayf al-Zahrah: 'simple geometric designs are painted in black, occasionally with the addition of a reddish-brown' (Parr, Harding & Dayton 1970: 213); 'motifs are limited in range, chiefly comprising rows of vertical lines rounded by thicker lateral borders, or cross hatching, some wavy lines also appear' (Bawden 1979: 69).

The decorative syntax, however, appears more complex and may be related to the shapes of the vessels. On small carinated deep bowls, for example, the main decorative element is a group of three black lines, either straight or wavy, on the upper part of the outer wall (Fig. 14/p–q). Occasionally, one finds a second group of black horizontal lines or a broad reddish band on the lower (Fig. 14/p) or central part of the wall (Fig. 14/q). On small piriform deep bowls with inverted walls, the painted decoration also focuses on the upper part of the outer wall, but usually with a vertically hatched band (Fig. 14/r–t). Below this upper element, a second register can be added, consisting of either a series of black horizontal lines (Fig. 14/t) or alternating motifs (a 'butterfly' and a rectangle on Fig. 14/r; three parallel sawtooth lines on Fig. 14/s).

On larger, wide, open bowls the decoration is applied mostly on the inside of the vessels and displays a greater variety of painted decoration, in terms of both the motifs and their organization. In addition to simple geometric motifs, one finds concentric circular elements, either hanging from the upper register (Fig. 14/x) or filling a central register (Fig. 14/h); triangles hanging from the upper register (Fig. 14/g); zigzag sawtooth lines filling a central register (Fig. 14/x); crossed black lines filling the whole inner wall (Fig. 14/u). At least one vessel shows a totally different organization of the decoration (Fig. 14/u): two black lines crossing each other near the centre of the vessel divide the vessel into four quarters, each of which contains a red cross.

Apart from painting, a burnished red slip occasionally occurs on large open bowls (Fig. 14/u), while large vessels with a T-shaped rim often bear a simple brown or grey slip on both sides (Fig. 15/d–f). Other decoration techniques such as grooving (Fig. 15/b) or appliqué are attested, but they are rare.

CHRONOLOGY

No significant chronological difference in the distribution of morphological types and fabrics was observed, either within the stratigraphic sequence of each sounding or between the soundings.

Taken as a whole, the investigated pottery assemblage from Tall al-Sālimīyyah looks very similar to the so-called 'Khuraybah pottery' collected on the surface of al-Khuraybah by Parr's team in 1968, although it should be placed earlier than the Persian/early Hellenistic date proposed by those authors (Parr, Harding & Dayton 1970: 213). As shown by the parallels adduced above, the assemblage is also comparable to that of Tall al-Kathīb stratum III, dated by its excavator to the first half of the first millennium BC. In accordance with these parallels and with the radiocarbon dates obtained, it should be noted that no characteristic productions from the last four centuries BC were observed at Tall al-Sālimīyyah. For example, the imported Attic black-slipped pottery found in the late fifth- to second-century levels at al-Khuraybah (al-Said & al-Ghazzi 2013: 120–124; al-Theeb 2013: 173) and Tall al-Kathīb (al-Zahrani 2007: pl. 54) is totally missing from the assemblage. The ongoing study of the local pottery from al-Khuraybah so far confirms this impression.

THE SMALL FINDS

In addition to the pottery, forty-one fragments of artefacts were collected during the excavations, including ten in stone (fragments of stone vessels, grinders), five in metal (Fig. 16/e), two shells, and one fragment of textile (from the late burial SU 23). The most recurring category of finds, however, corresponds to terracotta figurines, twenty-three of which were recorded. Sixteen of them come from surface layers, but the other seven come from the phase 2/3 fills or demolition layers in soundings 5 (SUs 32, 20), 6 (SU

38), 7 (SUs 25, 28), and trench B (SU 19). Fourteen probably represent animals, including at least two camels (Fig. 16/a). The rest are representation of females, either kneeling, seated (Fig. 16/b), or standing (Fig. 16/c–d). Six figurine fragments show traces of red or black paint (Fig. 16/b, d).

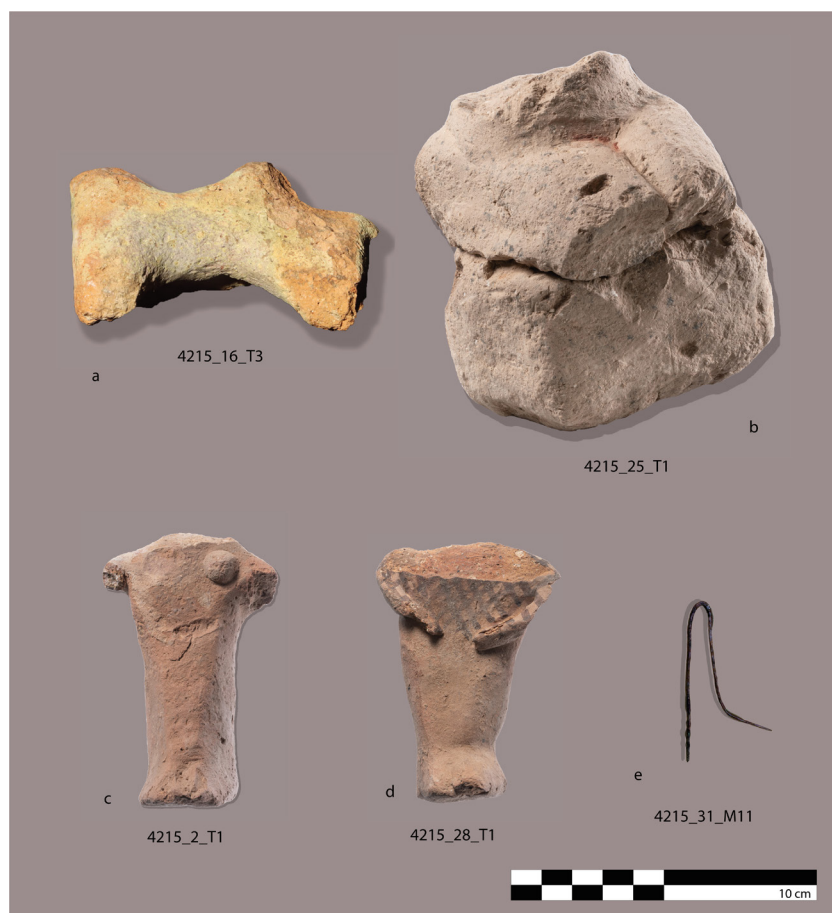


FIGURE 16. A selection of excavated artefacts from Tall al-Sālimīyyah.

THE ARCHAEOBOTANICAL REMAINS

Four soil samples were selected for archaeobotanical analysis by the excavators. One sample comes from the phase 1 hearth SU 83, in deep sounding 3. The other three come from fills or demolition layers of phase 2 (SU 34, sounding 5) and 3 (SU 28, sounding 7), and from a hearth ascribed to phase 3 (SU 58, sounding 7). These four samples represent 16 litres of sediment.

PROCESSING

The samples were exported to the French National Museum of Natural History (MNHN), in Paris.⁸ They were first dry-sieved on a laboratory sieve with a mesh size of 2 mm; then, the fraction below 2 mm in size was wet-sieved on a laboratory sieve with a mesh size of 0.5 mm. Both fractions were sorted using a SMZ 1000 stereomicroscope (with up to 60x magnification). Charcoal fragments, seeds, fruits, and other types of organic material (such as dung or amorphous organic mass) were extracted from the coarse fraction (2 mm), while only seed and fruit remains were sorted from the light fraction (0.5 mm).

8 - The archaeobotanical study was carried out by the team of the ECOSeed project (CNRS/MNHN, UMR 7209 – AASPE), under the supervision of Charlène Bouchaud, with the contribution of Vladimir Dabrowski and Alexia Decaix.

IDENTIFICATION

Fruits and seeds were identified under a SMZ 1000 stereoscopic microscope (with up to 60x magnification) using general reference seed atlases (Cappers, Neef & Bekker 2009; Neef, Cappers & Bekker 2012; Cappers & Bekker 2013), as well as the botanical reference collections of the Middle East (archaeobotanical platform, laboratory AASPE/UMR 7209, MNHN). Whole and fragmented remains of seeds and fruits were counted separately. To obtain a correct evaluation of the original number of whole remains, we estimated the MNI (Minimum Number of Individuals) from the fragmented items. Due to the low number of fragments, the MNI was evaluated with the naked eye.

Only charcoal from the coarse fraction (2 mm) was analysed. At least fifty fragments of charcoal were studied in each sample, and each time a new taxon was identified, fifty more charcoal fragments were added to the study when it was possible. Microscopic identification of charcoal fragments was routinely carried out using a reflected light microscope (Olympus BX51M) with magnifications between 100 and 500x. Taxonomic identification was achieved with the aid of atlases of Saharian and Sahelian (Neumann et al. 2001) and Saudi (Jagiella & Kürschner 1987) woods, as well as the reference collection of charcoal available at the laboratory.

Arabian flora was used to complete the plant descriptions and phytogeographical data (Collenette 1985; Mandaville 1990; Miller & Cope 1996; Kürschner & Neef 2011). The taxonomical nomenclature follows that proposed by APG III and IV (Angiosperm Phylogeny Group 2009; Chase et al. 2016).

RESULTS

All four samples contained charcoal fragments (Fig. 17), but only two contained seed and fruit remains (Fig. 18). All the items were charred, except one nutlet from the Boraginaceae family, which is naturally mineralized.

	Phase	1	2	3	3	
	SU/Sample	83_Bot1	34_Bot1	28_Bot1	58_Bot1	
Taxa						Total
<i>Vachellia</i> sp.			1	8	71	80
cf. <i>Vachellia</i> sp.					9	9
Amaranthaceae		1		13	9	23
<i>Phoenix dactylifera</i> _limb			14			14
<i>Phoenix dactylifera</i> _petiole		6	1	12	5	24
<i>Phoenix dactylifera</i> _stipe		13	17	2		32
<i>Phoenix</i> sp.		2	13			15
cf. <i>Phoenix</i> sp.				3		3
<i>Tamarix</i> sp.		39	1	5	1	46
cf. <i>Tamarix</i> sp.		20		1		21
Angiosperms					5	5
Unidentified			7	7		14
Total		81	54	51	100	286

FIGURE 17. Results of charcoal identification.

In total, 286 charcoal fragments have been examined, of which only fourteen remained undetermined. Four taxa have been identified: acacia (*Vachellia* sp.), tamarisk (*Tamarix* sp.), date palm (*Phoenix*

Taxa	Phase	1			3		
	SU/Sample	83_Bot1			58_Bot1		
	Remains	NR	Fgt	MNI	NR	Fgt	MNI
IDENTIFIED ITEMS							
<i>Vachellia</i> sp.	Integument					4	1
cf. <i>Vachellia</i> sp.	Seed				2		2
<i>Astragalus</i> sp.	Seed				6		6
Boraginaceae	Nutlet				1		1
<i>Phoenix dactylifera</i>	Seed		5	1		1	1
OTHERS							
‘Half-moon’	Undetermined			2	11		11
	Coprolite					2	
	Organic material		3			1	
	Seed					2	
Total			8	1	16	10	18

FIGURE 18. Seed and fruits identification results. NR = number of whole remains; Fgt = fragments; MNI = minimum number of individuals.

dactylifera), and the Amaranthaceae family. The date-palm remains include elements from the stem (or stipe) and from the leaf and the central part of the leaf (petiole).

Charcoal fragments of the most ancient sample (US 83) correspond to tamarisk (NR=59), date-palm petiole and stipe (NR=21; Fig. 19/a), and Amaranthaceae (NR=1). The three later layers (SUs 28, 34, 58) contain the four taxa, with acacia (NR=89) and date palm (NR=67) being dominant compared to Amaranthaceae (NR=22) and tamarisk (NR=8).

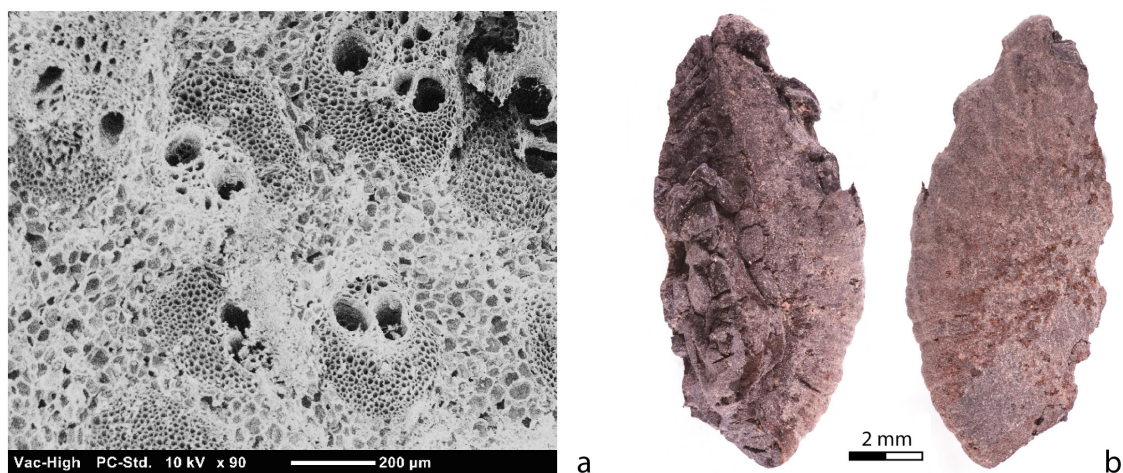


FIGURE 19. Date-palm remains from SU 83: a. transversal section of charred date-palm stipe (SEM photograph); b. charred date seed fragment (*Phoenix dactylifera*): inner part (left) and surface (right).

In addition to charcoal, the sample from SU 83 contained five fragments of date-palm seed (Fig. 19/b) and three fragments of undetermined organic material. SU 58 contained four acacia seed coat fragments and two potential complete seeds, six seeds of milkvetch (*Astragalus* sp.), one nutlet of the Boraginaceae

SPECIES LIST												
SU	CAP	CD	BT	OL	GAZ	AV	LM	SM	IND	TOT	%	W (g)
PHASE V												
SU 15		3							60	63	2.9	45
SU 16	83	5					14		209	311	14.3	832
SU 21	2	2							1	5	0.2	76
SU 36	2	1							6	9	0.4	378
PHASE III (WALL 9)												
SU 9	7	3					1		23	34	1.6	296
SU 19	30	18					13		45	106	4.9	760
SU 37	1						1		7	9	0.4	78
SU 38	9	9							29	47	2.2	356
SU 11	1		1				4			6	0.3	180
PHASE III (SOUNDING 5)												
SU 20	313	51	1				43		395	803	37.0	5280
SU 26	14	6							9	29	1.3	434
PHASE II (SOUNDING 5)												
SU 29	124	13		3	2	1	11		105	259	11.9	1480
SU 32	91	6			3		12		76	188	8.7	582
SU 34	4	3							7	14	0.6	76
PHASE IV (SOUNDING 7)												
SU 22	8	2								10	0.5	486
PHASE III (SOUNDING 7)												
SU 24	60	13					11		34	118	5.4	1482
SU 25	19	4				1			6	30	1.4	730
SU 28	21	4	1				2		13	41	1.9	368
SU 30	14	1					8	2	20	45	2.1	260
SU 31	13	1							4	18	0.8	140
SOUNDING 4												
SU 55	12	1					1		12	26	1.2	284
TOT	828	146	3	3	5	2	121	2	1061	2171	100	14603
%	38.1	6.7	0.1	0.1	0.2	0.1	5.6	0.1	48.9	100	–	–
%NRD	83.9	14.8	0.3	0.3	0.5	0.2	–	–	–	–	–	–

FIGURE 20. A list of the faunal species recovered from Tall al-Salimiyyah (Al-Ula, Saudi Arabia) according to the different chrono-stratigraphic units (SU).

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Key: CAP = caprine, goat/sheep (*Capra hircus/Ovis aries*); CD = Arabian camel (*Camelus dromedarius*); BT = cattle (*Bos taurus*); OL = oryx (*Oryx leucoryx*); GAZ = gazelle (*Gazella sp.*); AV = birds (*Aves sp.*); LM = large mammal; SM = small mammal; IND = indeterminate; W = weight (g).

family, one fragment of date-palm seed, two undetermined seeds, two fragments of coprolites, one fragment of organic material, and eleven ‘half-moon’⁹ elements.

THE FAUNAL REMAINS

The different trenches have yielded a bone assemblage of 2171 remains weighing 14.6 kg (Fig. 20).¹⁰ Species could be identified for 45.5% of the remains. The bones have undergone significant post-depositional fragmentation. However, the bone surfaces are generally well preserved, allowing the observation of cut marks. Some of them show many carbonate concretions resulting from water circulation. Some bones from phase 5 levels show traces of weathering.

The caprine largely dominate the bone assemblage (83.9%). Both sheep and goat are represented. This does not come as a surprise given the importance of these animals in the diet of the inhabitants of the Arabian Peninsula, especially in the Saudi oases (e.g. Monchot 2016; Prust & Hausleiter 2020). These animals were important not only for their meat, but also for the secondary products they provided, especially their milk.

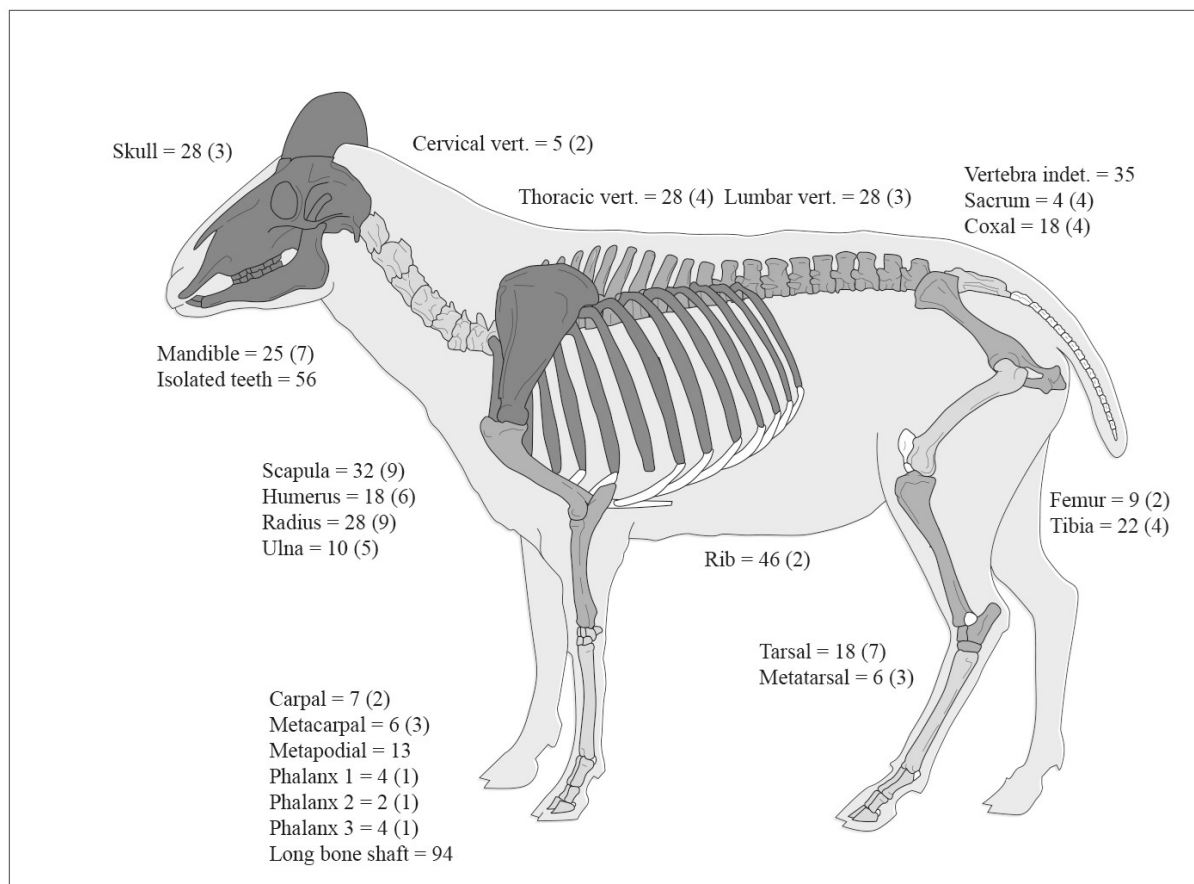


FIGURE 21. Skeletal representation of caprine in sounding 5: the number of identified specimens (NSIP) and the minimum number of individuals (MNI) are given in brackets.

9 - The category ‘half-moon’ refers to charred curved elements from 1 to 5 mm in length, with an irregular surface or cross ribs on the convex part. They could correspond to acacia elements, but a precise identification and nature are yet to be determined (Bouchaud et al. 2021).

10 - The archaeozoological study was carried out by Hervé Monchot (CNRS, UMR 8167).

The anatomical distribution of caprine bones from sounding 5 ($n = 546$, MNI = 9 provided by the scapula and the radius) shows that a wide range of skeletal elements are present at the site (Fig. 21). There is, however, a significant under-representation of the trunk (vertebrae and ribs) and feet (metapodia and phalanges). Long bones are rarely complete and appear as distal, proximal, or diaphysis fragments. This results from several ante-depositional (e.g. butchery technique, culinary practices) and post-depositional (e.g. compaction, trampling, excavation technique) processes. It seems therefore unlikely that entire animals were brought to the site for slaughter and consumption. Conversely, the over-representation of certain skeletal elements is worth noting. For the caprine, it seems that the upper parts of the forelimb (shoulder joint) were favoured. Interestingly, a similar phenomenon was observed at many archaeological sites in the Levant and Central Asia (Monchot, Lorain & Bendezu-Sarmiento 2019, and numerous references).

The Arabian camel accounts for 14.8% of the bone assemblage ($n = 146$) and is found in almost all contexts. From antiquity onwards, it has played an important role in the exploitation of desert regions by man (Monchot 2014; Prust & Hausleiter 2020). As in the case of the caprine, all skeleton parts (i.e. head, trunk, forelimb, hindlimb, and extremities) were identified. Camel bones were also used to make tools or ornaments, for instance in Petra (Studer & Schneider 2008).

Cattle is attested by a fragment of mandible, a proximal end of a phalange 1, and a left third lower molar. Its presence is marginal compared to caprine and camel. This rarity is probably due to its strong ecological requirements (e.g. water and pasture), especially since it can be easily replaced by the camel in arid environments. Finally, oryx is attested by three articulated bones (a right distal tibia, a calcaneus, and a talus), as well as gazelle (two fragments of tibiae, a left proximal metatarsus, a right proximal metacarpus, and a right talus), which suggests that hunting was practised.

DISCUSSION

THE FUNCTION OF THE SITE

In view of the results of the geophysical survey and the additional excavation carried out in November 2021, the initial hypothesis that the site contained a pottery workshop was not confirmed. However, the excavation results open up other avenues of interpretation of the site.

PHASE 1

At the foot of the tell, the survey and the excavations revealed a series of very long, massive walls, organized in a consistent orthogonal pattern and extending over a large part of the fenced-off area (Figs 5, 7, 11). Judging by the excavation results, it seems that at least part of this network of walls was erected during the first phase of the site, between the late thirteenth and late eleventh centuries BC (Late Bronze Age/Early Iron Age). The function of these structures, however, remains enigmatic. No evidence of a domestic use of the area was found: the levels associated with the phase 1 walls are devoid of pottery and artefacts, and the only clear remains of human activity are hearths, apparently located in open-air spaces subject to regular flooding. No agricultural soils were found either: non-anthropogenic deposits are composed of aeolian and laminated alluvial deposits, with weak soil development and no biological activity; while the laminations indicate rhythmic sedimentation, the absence of soil development suggests fast sediment burial.

Given the location of the site at the confluence of two important wadis flowing into Wādī al-‘Ulā, one could put forward the hypothesis that some of the walls of phase 1 might have had a hydraulic function. Indeed, the occurrence of micro-laminated deposits north of wall 8 (in sounding 3) and flood deposits against wall 17 (in sounding 1) indicates that the site was directly impacted by overflow deposition. As there is no connection between the western wadis and the partially incised al-‘Ulā wadi today, this suggests

that there might have been a better hydro-sedimentary connectivity in the watersheds at the end of the second millennium BC, favouring water and soil supply in the core agricultural oasis downstream of the site. It remains impossible to tell, however, whether these walls were intentionally designed to channel or block the flow of water, or if they were subject to unanticipated flooding. Other hypotheses, such as animal pens, can be considered, but in the absence of archaeological or soil evidence, this remains pure speculation.

PHASES 2/3

Phases 2 and 3 correspond to the development of the tell. Unfortunately, as the interior of the tell could not be extensively excavated due to the presence of late burials, its function remains enigmatic. The limited areas which could be sounded inside the tell have revealed only fills or demolition layers. The material found inside these fills, however, is characterized by a large amount of animal bones (representing meal leftovers), the recurring presence of terracotta figurines, and a pottery assemblage dominated by table vessels, with a very low proportion of storage and cooking vessels. This suggests that repeated food or liquid consumption took place at or near the tell — but perhaps not in a domestic context. Moreover, attention should be drawn to the unusual width (2.5 m) of the northern wall of the tell in phase 3 (wall 9): in the al-‘Ulā valley, it is so far paralleled only in the temple of al-Khuraybah (up to 2.70 m in width; see al-Said & al-Ghazzi 2013: 50, fig. 1) and to a lesser extent in the main building of Tall al-Kathīb phase 2, presumed to be of cultic nature (up to 1.80 m, see al-Zahrani 2007: 81, pl. 15). In view of this evidence and pending further excavations, the possibility that the phase 2/3 tell represents a public (cultic?) building should at least be considered.

EVIDENCE OF EARLY OASIS CULTIVATION IN AL-‘ULĀ

Despite the uncertainty about the function of the site, one of the main results of the excavations at Tall al-Sālimīyyah is the identification of an important construction phase in the al-‘Ulā valley at the end of the second millennium BC. The phase 1 walls are the earliest safely dated structures in the valley so far. Combined with ceramic evidence from al-Khuraybah, and possible radiocarbon dates and ceramic evidence from Tall Sāq,¹¹ they suggest a phase of relatively extensive settlement in the northern al-‘Ulā valley at this early stage (see Fig. 2).

Most importantly, this building phase is associated with botanical remains providing new insights on the development of oasis cultivation in al-‘Ulā and north-west Arabia as a whole. Indeed, despite the low amount of botanical remains extracted, the archaeobotanical results attest the combined presence, in a hearth, of date-palm seeds and charcoal fragments of stipe and petiole, several of which have been directly radiocarbon-dated.¹² The fact that these different elements of the date palm appear together makes it very unlikely that they may have been brought from elsewhere. Combined with the presence of significant architectural remains, they strongly suggest the existence of local oasis agriculture during the Late Bronze or Early Iron Age (late thirteenth–late eleventh century BC), with further development during

11 - At al-Khuraybah, a late second-millennium BC occupation is strongly suggested by the recurrent finds, in the KSU excavations, of pottery identified as ‘Qurayyah Painted Ware’ (QPW; Intilia 2016: 188, table 3; 240–241). Although an earlier version of this pottery has now been identified at Qurayyah, the ‘classic’ QPW is now dated to between the fifteenth/fourteenth and the first half of the eleventh centuries BC at Taymā’ (Tourtet, Daszkiewicz & Hausleiter 2021: 55–58). At Tall Sāq, sherds of QPW and ‘late 2nd/early first millennium BC’ radiocarbon dates have been reported but not yet published (Hausleiter et al. 2021: 129). Four sherds from Tall al-Kathīb have also been interpreted as QPW by Intilia (2016: 191, 240–241), based on low-resolution pictures published by al-Zahrani (2007: pls 64–65/77–79; 66–77/82). However, this identification is not consistent with the overall dating of the assemblage (see below, ‘The eighth- to fifth-century horizon in the al-‘Ulā valley’), especially since two of the sherds (al-Zahrani 2007: pls 64–65/78–79) match forms from phase 2/3 at Tall al-Sālimīyyah (Fig. 15/r–s). A late second-millennium BC occupation at Tall al-Kathīb therefore remains very hypothetical.

12 - Besides date-palm remains, the other plant taxa (acacia, tamarisk, and Amaranthaceae) are characteristic of (hyper-)arid environments and indicate plant collecting in the nearby vegetation cover.

the Mid- to Late Iron Age (eighth–fifth century BC). The elements of date palm from SU 83 are the earliest evidence so far of this emblematic plant in the al-‘Ulā valley. No cultivated crops other than date palm have been found, but this does not mean that they did not exist.

Whether this evidence represents the onset of the oasis or a stage in a development that began earlier is as yet unresolved question. In the test excavations carried out in 2019 by Oxford Archaeology in collaboration with the German Archaeological Institute at the neighbouring site of Tall Sāq, cereal fragments originating from secondary archaeological deposits (fills or collapse) were radiocarbon-dated to 2570–2462 cal. BC (Hausleiter et al. 2021). They could indicate the presence of cultivated gardens, although it cannot be excluded that they may have been brought from elsewhere. About 120 km to the north-east of al-‘Ulā, near Taymā’, the presence of pollen from a potential grapevine (*Vitis* type) in pollen spectra from a palaeolake might show the beginning of local oasis cultivation there during the second half of the fourth millennium, somewhat earlier than 3200 cal. BC (Dinies et al. 2016; Dinies, Neef & Kürschner 2018). In addition, AMS-dating of macrobotanical remains from Taymā’ has revealed the presence of potential cultivated plants such as barley (*Hordeum vulgare*), wheat (*Triticum compactum*), grapevine (*Vitis vinifera*), fig (*Ficus* sp.), and pomegranate (*Punica granatum*) during the third millennium BC. Date palm, however, is absent from these early records at Taymā’. It appears later, in the form of seed remains only, at the end of the second millennium BC — at about the same time as the finds from Tall al-Sālimīyyah (Dinies et al. 2016; Tourtet, Daszkiewicz & Hausleiter 2021). Although preliminary, the results from al-‘Ulā and Taymā’ suggest that the earliest agrosystems in north-west Arabia may have appeared in the third millennium BC or even the second half of the fourth millennium BC, relying on cereals, pulses, some fruit trees (fig, pomegranate) and vines — while date palm appeared later, at the end of the second millennium BC. This is so far a different picture from that observed in eastern Arabia, where date palm is one of the earliest plant remains, indicating the emergence of oasis agrosystems from about 3000 BC (Tengberg 2012).

THE EIGHTH- TO FIFTH-CENTURY HORIZON IN THE AL-‘ULĀ VALLEY

Following the Late Bronze/Early Iron Age phase, the second well-attested horizon at Tall al-Sālimīyyah is dated between the late ninth and the late fifth centuries BC (phases 2/3). Although most dated charcoals from these phases come from fills or demolition layers, at least one radiocarbon date from a hearth (SU 58) confirms human activity between 775 and 486 cal. BC at the eastern foot of the tell. Furthermore, as mentioned above, the associated botanical and zoological remains attest to oasis cultivation and animal husbandry during this phase.

Unfortunately, due to the Halstatt plateau, the dating of this horizon remains very broad. For this reason, and because no dating material was found in sub-phase 1b, it is so far not possible to tell whether there was continuity in the occupation of the area between phases 1 and 2, or whether there was an intermediary period of abandonment. Traces of flooding and/or destruction were identified in phases 1b and 2, but they may correspond to local phenomena not necessarily representative of the whole site. The fact that the walls from phases 2/3 strictly follow the orientations of their phase 1 predecessors speaks in favour of a certain degree of continuity at the site.

At the scale of the al-‘Ulā valley, this horizon is represented at several sites, the chronology of which can now be more precisely established thanks to the results from Tall al-Sālimīyyah. Furthermore, it appears in several recent geoarchaeological trenches opened in the al-‘Ulā valley.

TALL AL-KATHĪB

At Tall al-Kathīb, a site located 800 m to the north of Tall al-Sālimīyyah (Fig. 2), the excavator identified three strata (al-Zahrani 2007: 271–272): stratum 3, corresponding to early mud-brick structures (first half of the first millennium BC); stratum 2, corresponding to a large building with thick stone walls and to a

paved room not stratigraphically connected to the latter (fifth to early second century BC); and stratum 1, which was ascribed to the first century BC to first–second century AD, although it corresponds in fact to the demolition layer of stratum 2 (SU 2).

As already suggested in a previous article (Rohmer & Charloux 2015: 309–310), however, this phasing should be reassessed. The material from stratum 3 seems stratigraphically consistent and broadly in line with an early to mid-first-millennium BC date, as is now confirmed by the parallels with the assemblage from Tall al-Sālimīyyah (see above, ‘Pottery’).¹³ Sherds of ‘Sana’iye ware’ (al-Zahrani 2007: pls 86–87), which is the hallmark of ninth- to fifth-century BC contexts at Taymā’ (Tourtet, Daszkiewicz & Hausleiter 2021), further support this dating, as well as a carinated bowl (al-Zahrani 2007: pl. 77/102) reminiscent of a typical Iron IIC/Persian period shape widespread throughout the southern Levant (Beit-Arieh & Freud 2015: fig. 3.4.1: 6–7; Bienkowski 2015: fig. 3.6.6: 3; Stern 2015: fig. 5.1.1: 12–16).

The dating of stratum 2, however, is more problematic. Although most of the published sherds cannot be dated, the dense wheel-ridging found on several cooking pots (al-Zahrani 2007: pls 41/38; 49/50; 51/52) strongly suggests a date after the turn of the era (Hayes 1997: 24). More precisely, a necked cooking pot with triangular rim (al-Zahrani 2007: pl. 41/37) is attested in the first century AD at Hegra (Durand & Gerber 2014: fig. 8/A–B) and between the first and fourth centuries AD at Taymā’ (Tourtet & Weigel 2015: fig. 10/n–o) and Petra (Fellmann Brogli 1996: figs 736–740; 238, n. 756), while a short-necked jar or cooking pot with a deep groove inside the neck (al-Zahrani 2007: pl. 45/44) occurs between the late first century BC and the mid-second century AD at Hegra (Durand 2011: 332 and fig. 13/91011_P01) and Taymā’ (Tourtet, Daszkiewicz & Hausleiter 2021: fig. 14/e). As for the decoration of incised wavy lines found on a jar (al-Zahrani 2007: pl. 45/46), it belongs to a tradition known from the early Roman to Umayyad period in the southern Levant (Wilson & Sa’d 1984: 69–70, figs 270–286) and appears on a ‘Late Roman/Early Byzantine’ open shape at Hegra (Durand 2011: fig. 12/91013_P02). Based on this, it is difficult to contemplate a date earlier than the first century AD for stratum 2. From a logical point of view, it appears that stratum 2 (the occupation of architectural phase 2) is in fact contemporary with, or perhaps slightly earlier than ‘stratum’ 1 (the demolition of architectural phase 2).

In stratum 2, the only sherds which clearly belong to an earlier horizon are two fragments of Greek black-glazed lamps (al-Zahrani 2007: pls 54–55/58–59) datable to 450–350 BC (Howland 1958: 56–62, pls 7–8/209–241), two fragments of Greek red-figure pottery (al-Zahrani 2007: pls 54–55/60, 62) which can generally be dated between the late sixth and the early fourth centuries BC, and a red-burnished carinated bowl (al-Zahrani 2007: pl. 53/55) with an Iron II/Persian period profile (see e.g. Bienkowski 2015: figs 3.6.1/9, 3.6.5/11; Tourtet, Daszkiewicz & Hausleiter 2021: fig. 12/f). All these sherds fit much better with the mid-first-millennium BC horizon of stratum 3, and their presence in stratum 2 is probably best explained by residuality, or by a flawed stratigraphic equivalence between the different excavation areas.

Judging by the published pottery assemblage, therefore, it seems that there is an occupational gap of several centuries between the mid-first-millennium BC horizon of stratum 3 and the post-AD horizon of stratum 2. Tall al-Kathīb seems to have undergone a long period of abandonment probably from the early fourth century BC onwards.

KHAYF AL-ZAHRAH

At Khayf al-Zahrah, in Wādī Mu’tadil, 1 km north-east of Tall al-Sālimīyyah, a field survey and limited excavations carried out by G. Bawden in the 1970s revealed wall foundations over a c.400 x 240 m area, as well as possible field enclosures, a large ‘platform mound’, and a 750 m-long wall spanning the entire width of the wadi (Bawden 1979). Bawden considered that this ‘rural’ site was in use during the mid-first

13 - As mentioned above (n. 11), the existence of a late second-millennium horizon at Tall al-Kathīb remains very hypothetical.

millennium BC and was abandoned by c.300 BC. However, due to the poor quality of the published pottery drawings (no indication of scale, dubious profiles and diameters), this chronology cannot be fully confirmed, and the existence of later occupations cannot be ruled out. Although the published assemblage does include some painted pottery with motifs comparable to those found at Tall al-Sālimīyyah, only a few precise morphological parallels between the two assemblages can be identified (see above, ‘Pottery’) and a large part of the shapes cannot be dated.

TALL SĀQ

According to the preliminary results of the Tall Sāq excavation, ‘Khuraybah pottery’ was found both on the surface and in the test trenches (Hausleiter et al. 2021), suggesting an eighth- to fifth-century BC occupation at the site. Pending the publication of this pottery, however, this dating remains to be confirmed.

GEOARCHAEOLOGICAL SOUNDINGS IN WĀDĪ AL-‘ULĀ

During the 2019 field season of the ArcAgr-AU project, seventeen stratigraphic sequences were studied in the al-‘Ulā valley, ten of which were dated with radiocarbon and/or OSL (Purdue 2020). In two of these sequences (Test Pit 1 and Log 6, located respectively 1 and 2 km south of al-Khuraybah, on the eastern bank of Wādī al-‘Ulā), well-developed, undoubtedly cultivated palaeosoils, were identified and radiocarbon-dated to an eighth- to fifth-century BC interval (see Fig. 2). More dated sequences will however be needed to assess the extent of the cultivated area during this period.

A PEAK IN THE DEVELOPMENT OF THE DADAN OASIS?

In the current state of knowledge, therefore, it seems that the eighth- to fifth-century BC period probably represents a peak in the settlement of the Dadan oasis, at the time of the kingdom of Dadan and/or the first kings of Liḥyān. Interestingly, this period also corresponds to the rise of the long-distance aromatics trade along the ‘Incense Road’ and to a growing interest of the neighbouring empires in north-west Arabia, culminating with Nabonidus’ conquest of the region in 553/552 BC (Eph‘al 1982; Macdonald 1997; Byrne 2003; Rohmer 2020: 434–436).

The available data tend to suggest that this peak was followed by a phase of settlement contraction. While the disuse of Khayf al-Zahrah after 300 BC cannot be confirmed, two important sites of the Dadan oasis — Tall al-Sālimīyyah and Tall al-Kathīb — appear to have been abandoned by the late fifth century BC and the mid-fourth century BC respectively. Although definitive conclusions can hardly be drawn from only two sites, this suggests at least that one or several disruptions or changes occurred in the settlement patterns of the Dadan oasis before c.350 BC — even though the core settlement of the oasis, al-Khuraybah, continued in existence without any interruption until at least the first or second century AD. It is striking to observe that, at approximately the same period (fifth century BC), the core settlement of Taymā’ is thought to have decreased in size by two thirds, while part of its irrigation systems was abandoned (Hausleiter & Eichmann 2018: 20–21, 35). This could indicate a change at the regional scale, perhaps due to environmental, economic, or political factors that remain to be identified. Yet, the whole region would not have been uniformly affected, since the fifth–early fourth century BC also witnessed the emergence of Hegra (Rohmer & Charloux 2015; Rohmer & Fiema 2016). Unfortunately, pending further research, it is probably too early to propose an explanation for these developments and a connection between them.

CONCLUSION

Initially designed as a limited operation to excavate an ancient pottery kiln, the excavation of Tall al-Sālimīyyah eventually revealed an extremely interesting archaeological sequence and critical

archaeobotanical data, both of which shed new light on the early development of the oasis of Dadan. Although the architectural remains of the site are difficult to interpret, a first construction phase, associated with the earliest evidence of date-palm cultivation in the Dadan oasis, started between the late thirteenth and the late tenth centuries BC (end of the Late Bronze Age/Early Iron Age). A second architectural phase, leading to the creation of the tell, took place sometime after the late ninth century BC, and was shortly followed by a third and last one, between the eighth and fifth centuries BC (Mid- to Late Iron Age). As suggested by the reassessed evidence from other sites in the al-‘Ulā valley, and from recent geo-archaeological soundings, the latter period might represent a peak in the settlement and exploitation of the oasis. Further research will however be needed to verify this hypothesis and to gain a better understanding of the settlement cycles and dynamics in both the al-‘Ulā region and north-west Arabia as a whole.

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REFERENCES

- Abu Azizeh W., Delhopital N., Durand C., Fiema Z., Gerber Y., Nehmé L. ... Villeneuve F. 2020. Report on the 2014 and 2015 excavation seasons in some areas at Madā'in Sālih. *Atlat. The Journal of Saudi Arabian Archaeology* 28: 7–45.
- Angiosperm Phylogeny Group. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161: 105–121. doi: 10.1111/j.1095-8339.2009.00996.x
- Bawden G. 1979. Khief ez-Zahrah and the nature of Dedanite hegemony in the Al-‘Ula oasis. *Atlat. The Journal of Saudi Arabian Archaeology* 3: 63–72.
- Beit-Arieh I. & Freud L. 2015. Iron Age IIC: Northeastern Negev. Pages 365–382 in S. Gitin (ed.), *The Ancient pottery of Israel and its neighbors from the Iron Age through the Hellenistic period*. Jerusalem: Israel Exploration Society.
- Bienkowski P. 2002. *Busayra. Excavations by Crystal-M. Bennett, 1971–1980*. Oxford: Oxford University Press.
- Bienkowski P. 2015. Iron Age IIC: Transjordan. Pages 419–434 in S. Gitin (ed.), *The Ancient pottery of Israel and its neighbors from the Iron Age through the Hellenistic period*. Jerusalem: Israel Exploration Society.
- Bouchaud C., Huchet J-B., Faucher T., Redon B. & Noûs C. 2021. Providing fuel, building materials and food for gold exploitation in the Eastern Desert, Egypt: Multidisciplinary dataset of the Ptolemaic site of Samut North (late 4th c. BC). *Journal of Archaeological Science: Reports* 35: 102729. doi: 10.1016/j.jasrep.2020.102729
- Byrne R. 2003. Early Assyrian contacts with Arabs and the impact on Levantine vassal tribute. *Bulletin of the American Schools of Oriental Research* 331: 11–25. doi: 10.2307/1357756.

- Cappers R.T. & Bekker R.M. 2013. *A Manual for the identification of plant seeds and fruits*. (Groningen Archaeological Studies, 23). Groningen: Barkhuis.
- Cappers R.T.J., Neef R. & Bekker R.M. 2009. *Digital atlas of economic plants*. (Groningen Archaeological Studies, 9). Groningen: Barkhuis.
- Charloux G., AlMalki T. & AlQaeed A. 2021. The ‘walled oases’ phenomenon. A study of the ramparts in Dūmat al-Jandal and other pre-Islamic sites in north-western Arabia. *Arabian Archaeology and Epigraphy* 32/1: 256–290. doi: 10.1111/aae.12177
- Chase M.W., Christenhusz M.J.M., Fay M.F., Byng J.W., Judd W.S., Soltis D.E. ... Stevens P.F. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181/1: 1–20. doi: 10.1111/boj.12385.
- Collenette S. 1985. *An Illustrated guide of the flowers of Saudi Arabia*. London: MEPA Scorpion.
- Dinies M., Neef R. & Kürschner H. 2018. Early to Middle Holocene vegetational development, climatic conditions and oasis cultivation. Pages 128–143 in Tayma, NW Saudi Arabia. First results from pollen spectra out of a sabkha, in A. Hausleiter, R. Eichmann & M. al-Najem (eds), *Taymā’ I. Archaeological Exploration, Palaeoenvironment, Cultural Contacts*. Oxford: Archaeopress.
- Dinies M., Neef R., Plessen B. & Kürschner H. 2016. Holocene vegetation, climate, land use and plant cultivation in the Tayma region, northwestern Arabia. Pages 57–78 in M. Luciani (ed.), *The archaeology of North Arabia. Oases and landscapes. Proceedings of the International Congress held at the University of Vienna, 5–8 December, 2013*. Vienna: Austrian Academy of Science Press.
- Durand C. 2011. Pottery study. Pages 362–365 in L. Nehmé (ed.), *Report on the fourth excavation season (2011) of the Madā’in Sâlih Archaeological Project*. <http://halshs.archives-ouvertes.fr/halshs-00671451>
- Durand C. & Gerber Y. 2014. The Pottery production from Hegra/Madā’in Sâlih (Saudi Arabia) during the Nabataean period. Preliminary results, 2008–2011. *Proceedings of the Seminar for Arabian Studies* 44: 153–168.
- Eph‘al I. 1982. *The ancient Arabs: Nomads on the borders of the fertile crescent, 9th–5th century B.C.* Jerusalem: Magnes Press, Hebrew University/Leiden: E.J. Brill.
- Fellmann Brogli R. 1996. VII. Die Keramik aus den spätrömischen Bauten. Pages 219–281 in A. Bignasca, N. Desse-Berset, R. Fellmann Brogli, R. Glutz, S. Karg & D. Keller (eds), *Petra, Ez Zantur I, Ergebnisse der schweizerisch-liechtensteinischen Ausgrabungen 1988–1992*. Mainz: Philipp von Zabern.
- Hausleiter A. & Eichmann R. 2018. The archaeological exploration of the oasis of Taymā’. Pages 2–59 in A. Hausleiter, R. Eichmann & M. al-Najem (eds), *Taymā’ I. Archaeological exploration, palaeoenvironment, cultural contacts*. Oxford: Archaeopress.
- Hausleiter A., Dinies M., Bouchaud C., Intilia A., Schimmel L. & Zur A. 2021. Al-Ula, Saudi Arabia. Archaeology and environment from the Early Bronze Age (3rd mill. BC) onwards. Season 2019. *eDAI-Forschungsberichte* 2021-1: 1–22. doi: 10.34780/b5t2-t686
- Hayes J.W. 1997. *Handbook of Mediterranean roman pottery*. London: British Museum Press.
- Howland R.H. 1958. *Greek lamps and their survivals*. (The Athenian Agora, 4). Princeton: American School of Classical Studies at Athens.

- Intilia A. 2016. Qurayyah painted ware: A reassessment of 40 years of research on its origins, chronology and distribution. Pages 175–256 in M. Luciani (ed.), *The Archaeology of North Arabia: Oases and landscapes. Proceedings of the International Congress held at the University of Vienna, 5–8 December, 2013*. (OREA 4). Vienna: Austrian Academy of Sciences Press.
- Jagiella C. & Kürschner H. 1987. *Atlas der Holzer Saudi Arabiens: die Holzanatomie der wichtigsten Baume und Straucher Arabiens mit einem holzanatomischen Bestimmungsschlüssel*. xx. (Beih. Tübinger Atlas Vorderen Orients). Wiesbaden: Dr. Ludwig Reichert.
- Kürschner H. & Neef R. 2011. A first synthesis of the flora and vegetation of the Tayma oasis and surroundings (Saudi Arabia). *Plant Diversity and Evolution* 129: 27–58. doi: 10.1127/1869-6155/2011/0129-0033
- Luciani M. 2021. On the formation of ‘urban’ oases in Arabia: New perspectives from the north-west. Pages 89–118 in M. Luciani (ed.), *The Archaeology of the Arabian Peninsula 2. Connecting the evidence. Proceedings of the International Workshop held at the 10th International Congress on the Archaeology of the Ancient Near East in Vienna on April 25, 2016*. (OREA 19). Vienna: Austrian Academy of Sciences Press.
- Macdonald M.C.A. 1997. Trade routes and trade goods at the northern end of the ‘Incense Road’ in the first millennium BC. Pages 333–350 in A. Avanzini (ed.), *Profumi d’Arabia: atti del convegno*. Rome: ‘L’Erma’ di Bretschneider.
- Mandaville J.P. 1990. *Flora of eastern Saudi Arabia*. London: Kegan Paul International Limited.
- Miller A.G. & Cope T.A. 1996. *Flora of the Arabian Peninsula and Socotra*. i. Edinburgh: University Press.
- Monchot H. 2014. Camels in Saudi oasis during the last two millennia; the examples of Dûmat al-Jandal (Al-Jawf Province) and al-Yamâma (Riyadh province). *Anthropozoologica* 49: 195–206. doi: 10.5252/az2014n2a03
- Monchot H. 2016. The faunal remains of al-Yamâma: From camels to the spiny-tailed lizard. Pages 259–294 in J. Schiettecatte & A. al-Ghazzi (eds), *Al-Kharj 1: Report on two excavation seasons in the oasis of Al-Kharj 2011–2012 Saudi Arabia*. Riyadh: Saudi Commission for Tourism and National Heritage.
- Monchot H., Lorain T. & Bendezu-Sarmiento J. 2019. From bone broth to kebab: The importance of caprine in the economy of the medieval site of Shahr-e Ghogholah (Bâmiyân, Afghanistan). Pages 285–296 in L. Gourichon, C. Daujeard & J-P. Brugal (eds), *Hommes et caprinés, de la montagne à la steppe, de la chasse à l’élevage: Actes des Rencontres, 16–18 octobre 2018*. Antibes: Éditions APDCA.
- Nasif A.A. 1988. *al-‘Ulā: An historical and archaeological survey with special reference to its irrigation system*. Riyadh: King Saud University.
- Neef R., Cappers R.T.J. & Bekker R.M. 2012. *Digital atlas of economic plants in archaeology*. (Groningen Archaeological Studies, 30). Groningen: Barkhuis.
- Neumann K., Schoch W., Détienne P. & Schweingruber F.H. 2001. *Woods of the Sahara and the Sahel: An anatomical atlas*. Bern: Paul Haupt.
- Parr P.J., Harding G.L. & Dayton J.E. 1970. Preliminary survey in N.W. Arabia, 1968. *Bulletin of the Institute of Archaeology* 8/9: 193–242.

- Prust A. & Hausleiter A. 2020. Camel exploitation in the oasis of Taymā' – caravan or consumption? Pages 95–121 in D. Agut-Labordère & B. Redon (eds), *Les vaisseaux du désert et des steppes: Les camélidés dans l'Antiquité (Camelus dromedarius et Camelus bactrianus)*. Lyon: MOM Éditions.
- Purdue L. 2020. ArcAgr-AU Project. Long-term landscape change, resource availability (soil/water) and evolution of hydro-agricultural techniques in the Al Ula Oasis. First Scientific report – 2020. CNRS; AFALULA; RCU. [Unpublished circulated report.]
- Rohmer J. 2020. *Hauran VI. D'Aram à Rome. La Syrie du Sud de l'âge du Fer à l'annexion romaine (XII^e siècle av. J.-C.-I^{er} siècle apr. J.-C.)*. (Bibliothèque Archéologique et Historique, 217). Beirut: Presses de l'Ifpo.
- Rohmer J. 2021. The Political history of north-west Arabia from the 6th to the 1st century BC: New insights from Dadān, Ḥegrā and Taymā'. Pages 179–198 in M. Luciani (ed.), *The Archaeology of the Arabian Peninsula 2. Connecting the Evidence. Proceedings of the international workshop held at the 10th International Congress on the Archaeology of the Ancient Near East in Vienna on April 25, 2016*. (OREA 19). Vienna: Austrian Academy of Sciences Press.
- Rohmer J. (forthcoming). Dadan. *Thematic dictionary of ancient Arabia*. To be published online.
- Rohmer J. & Charloux G. 2015. From Liḥyān to the Nabataeans: Dating the end of the Iron Age in north-western Arabia. *Proceedings of the Seminar for Arabian Studies* 45: 297–320.
- Rohmer J. & Fiema Z.T. 2016. Early Hegra: New insights from the excavations in Areas 2 and 9 at Madā'in Ṣāliḥ (Saudi Arabia). Pages 281–298 in M. Luciani (ed.), *The Archaeology of North Arabia: Oases and landscapes. Proceedings of the International Congress held at the University of Vienna, 5–8 December, 2013*. (OREA 4). Vienna: Austrian Academy of Sciences Press.
- Rossi I. 2014. The Minaeans beyond Ma'in. Pages 111–123 in O. Elmaz & J.C.E. Watson (eds), *Languages of southern Arabia*. (Proceedings of the Seminar for Arabian Studies 44, Supplement). Oxford: Archaeopress.
- al-Said S.F. & al-Ghazzi A. 2013. *Kunūz athariyyah min Dādān. Natā'ij tanqībāt al-mawāsim al-sab'ah al-ūlā*. (2 volumes). Riyadh: al-jama'iyyah al-sa'ūdīyyah li-l-dirāsāt al-athariyyah.
- Schiettecatte J. & Arbach M. 2020. La chronologie du royaume de Ma'in (VIII^e–I^{er} siècles av. J.-C.). Pages 233–284 in I. Zaytsev (ed.), *Arabian antiquities. Studies dedicated to A. Sedov on the occasion of his seventieth birthday*. Moscow: Oriental Literature Publisher.
- al-Shehry M.M. 2014. *Fukhār Dādān khalāl al-mawṣimayn al-khāmis 1429h wa al-sādis 1430h. Dirāsah taḥlīliyyah*. Riyadh: Saudi Commission for Tourism and Antiquities.
- Stern E. 2015. Persian period. Pages 565–618 in S. Gitin (ed.), *The Ancient pottery of Israel and its neighbors from the Iron Age through the Hellenistic period*. Jerusalem: Israel Exploration Society.
- Studer J. & Schneider A. 2008. Camel use in the Petra region, Jordan: 1st century BC to 4th century AD. Pages 581–596 in E. Vila, L. Gourichon, A. Choyke & H. Buitenhuis (eds), *Archaeozoology of the Near East VIII*. ii. Lyon: Maison de l'Orient et de la Méditerranée-Jean Pouilloux.
- Tebes J.M. 2013. Investigating the painted pottery traditions of the first millennium BC north-western Hejaz and southern Levant: Chronological data and Arabian parallels. *Proceedings of the Seminar for Arabian Studies* 43: 317–336.
- Tengberg M. 2012. Beginnings and early history of date palm garden cultivation in the Middle East. *Journal of Arid Environments* 86: 139–147. doi: 10.1016/j.jaridenv.2011.11.022

- al-Theeb S. 2013. *Al-Khuraybah (Dadan)*, ‘āṣimat mamlakatay Dādān wa Liḥyān. *Al-taqrīr al-awwalī li-l-mawṣim al-thāmin 2011*. Riyadh: al-jamaʿiyyah al-saʿūdiyyah li-l-dirāsāt al-athariyyah.
- al-Theeb S. (ed.). 2016. *Dadan. ‘āṣimat mamlakatay Dādān wa Liḥyān. Natāʾij al-mawṣim al-‘āshir 2013m*. Riyadh: King Faysal Center for Research and Islamic Studies.
- Tourtet F. & Weigel F. 2015. Taymā’ in the Nabataean kingdom and in ‘Provincia Arabia’. *Proceedings of the Seminar for Arabian Studies* 45: 385–404.
- Tourtet F., Daszkiewicz M. & Hausleiter A. 2021. Pottery from Tayma: Chronostratigraphy, archaeometric studies, cultural interaction. Pages 43–88 in M. Luciani (ed.), *Connecting the evidence. Proceedings of the international workshop held at the 10th International Congress on the Archaeology of the Ancient Near East in Vienna on April 25, 2016*. (OREA 19). Vienna: Austrian Academy of Sciences Press.
- Wilson J. & Sa’d M. 1984. The domestic material culture of Nabataean to Umayyad period Busra. *Berytus* 32: 35–147.
- al-Zahrani A. 2007. *Tall al-Kathīb bi-l-‘Ulā: dirāsah āthārīyyah muqāranah*. Riyadh: Wizārat al-tarbiyyah wa-al-taʿlīm, wakālat al-āthār wa al-matāḥif.

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