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## A ninth- to tenth-century pottery workshop at al-Yamāmah, Central Arabia

Fabien Lesguer and Jérémie Schiettecatte

### Summary

No area of craft tradition has so far been documented in the Najd. In this respect, the fieldwork conducted by the Saudi-French archaeological mission in the oasis of al-Kharj (Central Arabia, 2011–2017) filled a gap with the discovery and excavation of a pottery workshop at al-Yamāmah — ancient Jaw al-Khaḍārim, capital city of the historical region of al-Yamāmah. To the southwest of the Islamic city, a sounding revealed several pottery kilns in a courtyard connected to a building and several dumps from the ninth–tenth century AD. The content of the dumps made it possible to distinguish between local and regional productions. The stratigraphic sequence, architectural analysis, material study, chemical analysis, and AMS radiocarbon dating all contribute to clarify the pottery production in the Najd during the Abbasid period. Our aim is to present the spatial organization of the pottery workshop and to characterize its production.

**Keywords:** Najd, early Islamic period, Islamic archaeology, pottery workshop, pottery production

### Introduction

The Saudi-French archaeological mission in the oasis of al-Kharj has been studying the human presence and settlement process in a harsh environment, from the Pleistocene to the modern era (Crassard & Hilbert 2013; Crassard et al. 2019; Hilbert et al. 2016; Schiettecatte et al. 2012; 2013; Schiettecatte, Chabrol & Fouache 2016; Schiettecatte & al-Ghazzi 2016; in press).

Within this project, we conducted archaeological excavations on the largest site of the oasis, al-Yamāmah (see most recently Schiettecatte & al-Ghazzi 2016; in press; Schiettecatte, Darles & Siméon 2019). Based on the results obtained in deep Soundings 1 (area N6) and 4 (Area K17), as well as the excavation of the Friday Mosque and its surroundings (Buildings 1 and 3) (Fig. 1), the occupation of the site was characterized during its three periods of occupation as follows: fifth–third century BC, eighth–eleventh century AD, and fifteenth–eighteenth century AD (see below, Fig. 5).

In 2012, the presence of distinctive pottery types on the surface beyond the fence (Area G17) to the south-west, led us to open a 10 × 1 m trench (directed by Michel Mouton), Sounding 3, where kilns were unexpectedly unearthed. The excavation of this area was resumed, extended, and completed in January 2016, under the guidance of one of the authors (FL). Part of a pottery workshop was subsequently excavated and its evolution, spatial organization, and production were characterized and dated to the early Islamic period.

Previous attempts to characterize the early Islamic pottery material from Central Arabia were unsuccessful. In the Layla-Aflāj region, south of al-Kharj, only the late pre-Islamic material was considered (al-Saud 1997). In al-Yamāmah, a tentative pottery typology had previously been established (al-Ghazzi 2010), but the fact that the sample was poorly representative (eighty sherds found in five soundings plus a surface collection), the absence of absolute dating, and the bias in favour of an abandonment of the site in the twelfth century — while most of the upper occupation of the site clearly dates from the fifteenth to the eighteenth century — has forced us to make a reassessment. During our own previous excavations, most of the material was ascribed to the pre-Islamic and late Islamic occupations, therefore the discovery of an early Islamic pottery workshop offered a rare opportunity to identify the local productions of that period.

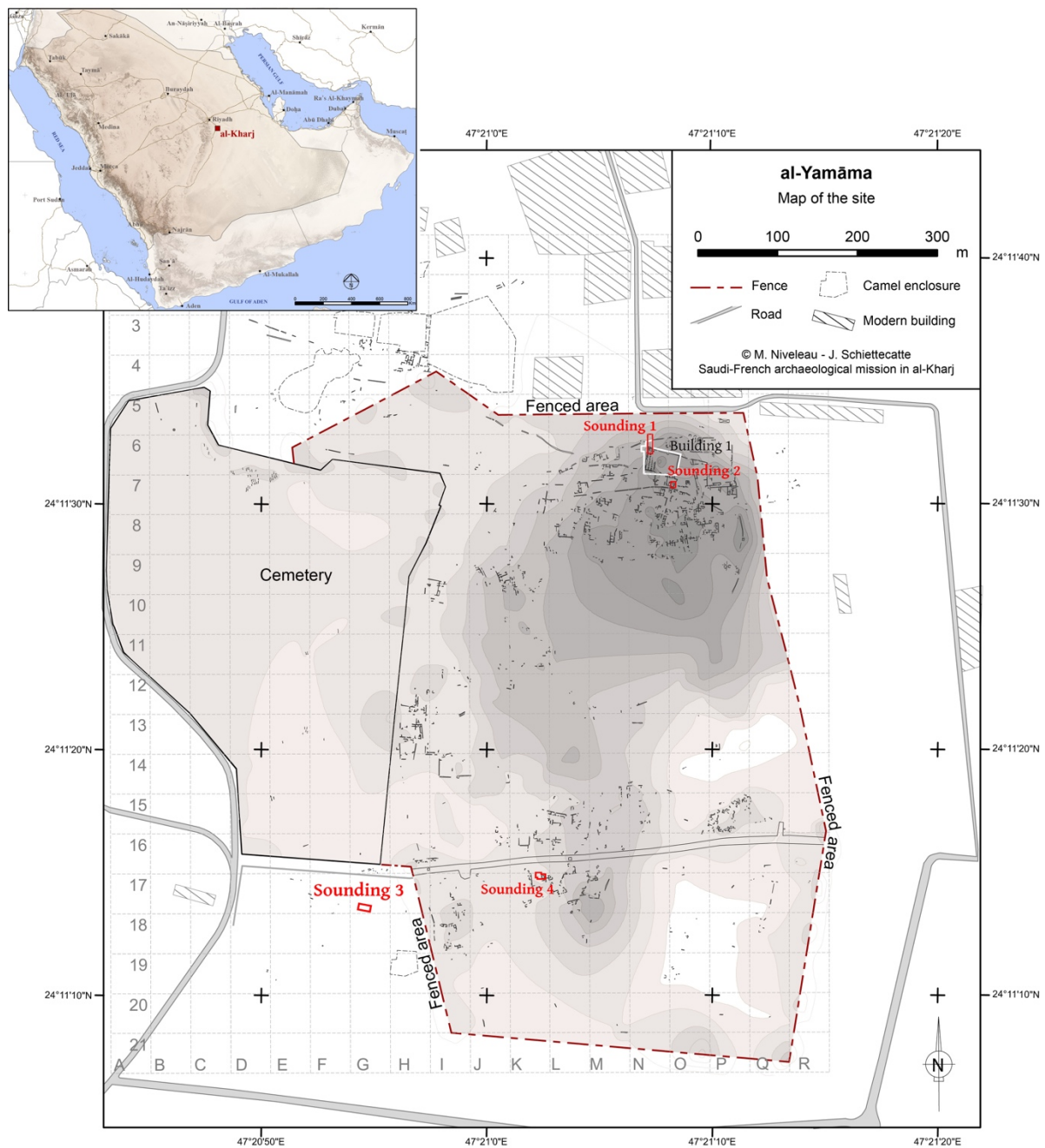


Figure 1. A topographic map of the site of al-Yamāmah (M. Niveleau and J. Schiettecatte, Saudi-French Archaeological Mission in al-Kharj).

### Sounding 3 (Area G17): methodology and general description

Sounding 3 was located in an abandoned palm grove which had been levelled some years ago. The surface altitude was 422.65 m a.s.l. At the end of the excavation, the lowest point was at 420.22 m a.s.l. (bottom of kiln H. 068). Sounding 3, in its larger extent, measured 14 × 5.5 m, or 77 m<sup>2</sup>. A complete photogrammetric record was made at the different stages of the excavation (Fig. 2). The 4685 sherds from the stratigraphic units (UF) were counted and recorded and the 1141 diagnostic sherds were individually registered.

The final plan of Sounding 3 (Fig. 2) comprises four rooms and a courtyard. Rooms R. 368, R. 367, R. 070, and R. 071 form a building. The building material is tempered mud. The courtyard (R. 316) is located to the west and continues beyond the northern and western limits of the trench. Another area (P 378), probably open-air, is located south of the courtyard.

### Architecture and stratigraphy

#### Phase 1: setting up of a pottery workshop

In phase 1, the workshop already comprised a courtyard with kilns and an adjacent building with three rooms. Room R. 367 had not yet been built. Several structures were dedicated to craft activities in the courtyard: two kilns (H. 068 and H. 320), a *tannūr* (H. 317), and a bench (St. 369). Kiln H. 068 is the main structure (Fig. 3). It consists of a firing chamber built above a firebox. The kiln is almost oval in plan and measures 3.1 × 1.8 m. The firing chamber measures 2.1 × 1.36 m and is preserved up to 50 cm. Its floor is perforated with more than eighteen flues. The firebox measures 2.5 × 0.93 m and 1.5 m high (Fig. 3). It is vaulted with five arches of mud bricks fired when the kiln was in use, thus supporting the perforated floor. A 0.4 m-long and 1 m-wide tunnel gives access to the firebox. It is preceded by a wide funnel-shaped working pit (Pi. 318). At the bottom of the kiln, several layers of ashes and charcoals (UF 344, 346, and 347) are covered with a hard, orange silt (UF 345) corresponding to a repair of the firebox (Fig. 3).

West of the main kiln was a second, much smaller kiln (H. 320). It is 1.18 m long and 0.68 m wide. Only the firebox is preserved, at a height of 0.32 m. The inside of the walls is vitrified. The bottom of the firebox was filled in with a layer of compact ashes (UF 361) and sherds. A *tannūr* (H. 317) was located on the edge of the funnel-shaped working pit and against structure St. 369. Measuring 0.76 × 0.6 × 0.38 m, the earthenware *tannūr* is cylindrical in shape, open at the top, set in a rectangular pit, and wedged with a mix of mud and ashes. There is an opening at the base. The bottom of the *tannūr* was filled with loose ashes (UF 357). To the north-east of the courtyard, a levelled, plaster-coated structure (St. 369) leaning against W. 370 was either a working platform or a bench. It measures 2.2 × 0.65 m.

#### Phase 2: continuation of the workshop activity, and refurbishments

Wall W. 376 was built to the east of the courtyard, cutting off the courtyard from the building (see Fig. 2). Between rooms R. 367 and R. 368, wall W. 339 was lowered to make circulation easier. In Room R. 070, the circulation level was raised from 421.97 to 422.35 m a.s.l., with a backfill of green indurated clayey silt (UF 348). Three features were set up for domestic use or craft activity: a shallow plastered basin (St. 305: 0.54 × 0.5 × 0.08 m); a hearth (H. 352: 0.44 × 0.34 × 0.08 m); and a water tank (St. 304) in the south-east corner, containing a complete jar buried in the ground, wedged with stones and sealed in plaster. The tank is 0.74 m in diameter and 0.5 m deep. In the courtyard (R. 316), kiln H. 068 remained active. The fill of the firebox shows a final restoration (UF 343: hard burnt orange silt) covered with several layers of ashes and charcoals (UF 338, 340, 341, 342) (Fig. 3).

As kiln H. 320 was abandoned and levelled, a new, rectangular kiln (H. 069) was built in the south-east corner of the courtyard. It is  $1.26 \times 0.83$  m and preserved over 0.9 m. Although smaller than the main one (H. 068), it was built in the same manner, with a firing chamber separated from the firebox by a floor perforated with flues. The floor is supported by three arches. It is built of tempered mud and the inner sides of the walls are vitrified. The pear-shaped firebox is  $0.9 \times 0.37 \times 0.59$  m. The rectangular firing chamber measures  $0.7 \times 0.6$  m and is preserved over 0.17 m. A tunnel, measuring  $0.24 \times 0.64$  m, gives access to the firebox. The bottom of the kiln was filled with a dense layer of ashes (UF 363). As the old *tannūr* (H. 317) was filled with sandy silt (UF 356), a new *tannūr* (H. 319) was installed next to it, built in the same manner as the previous one. It measures  $0.58 \times 0.5 \times 0.32$  m.

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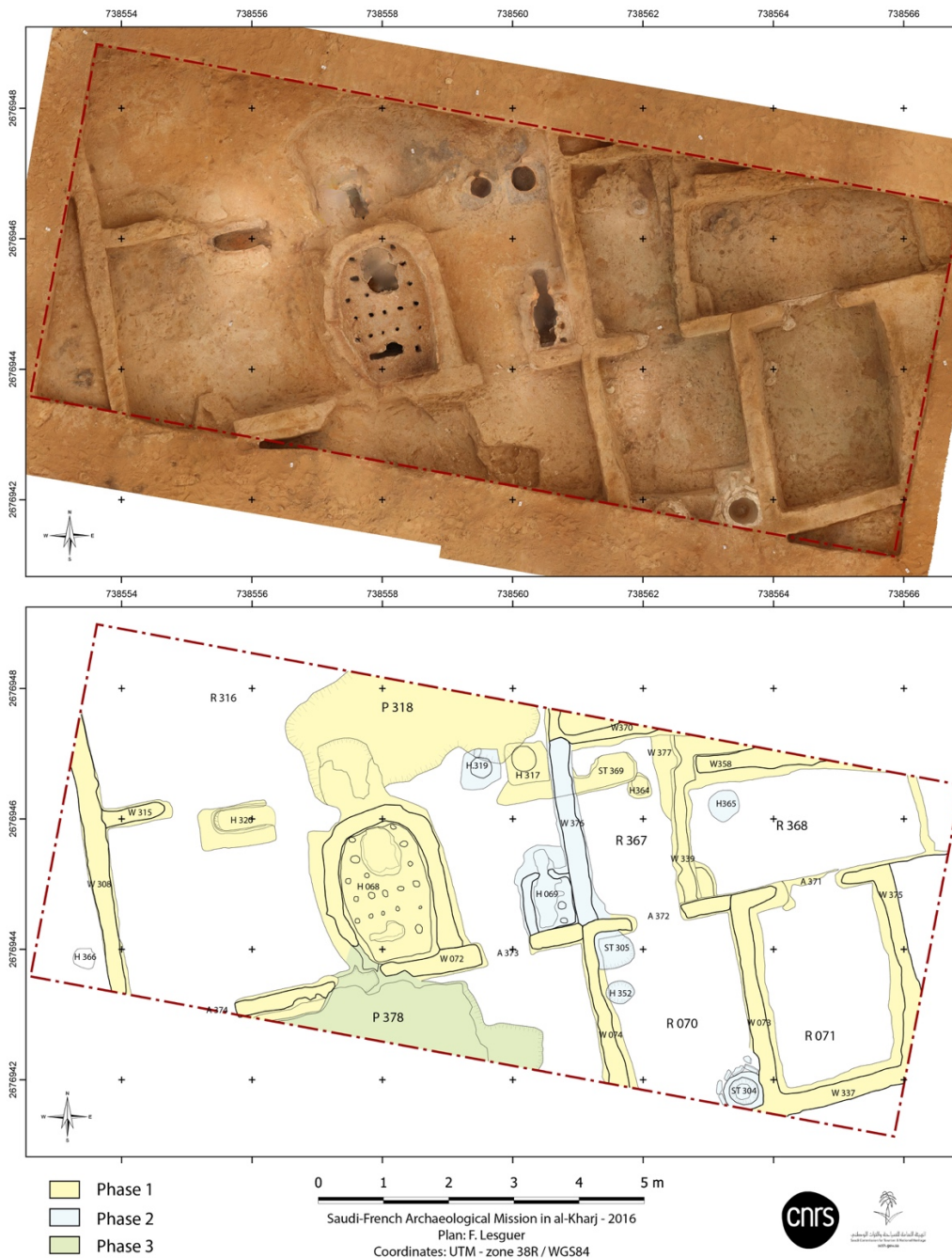


Figure 2. al-Yamāmah: Area G17 — (top) orthophotograph and (bottom) plan of Sounding 3 (F. Lesguer, Saudi French Archaeological Mission in al-Kharj).

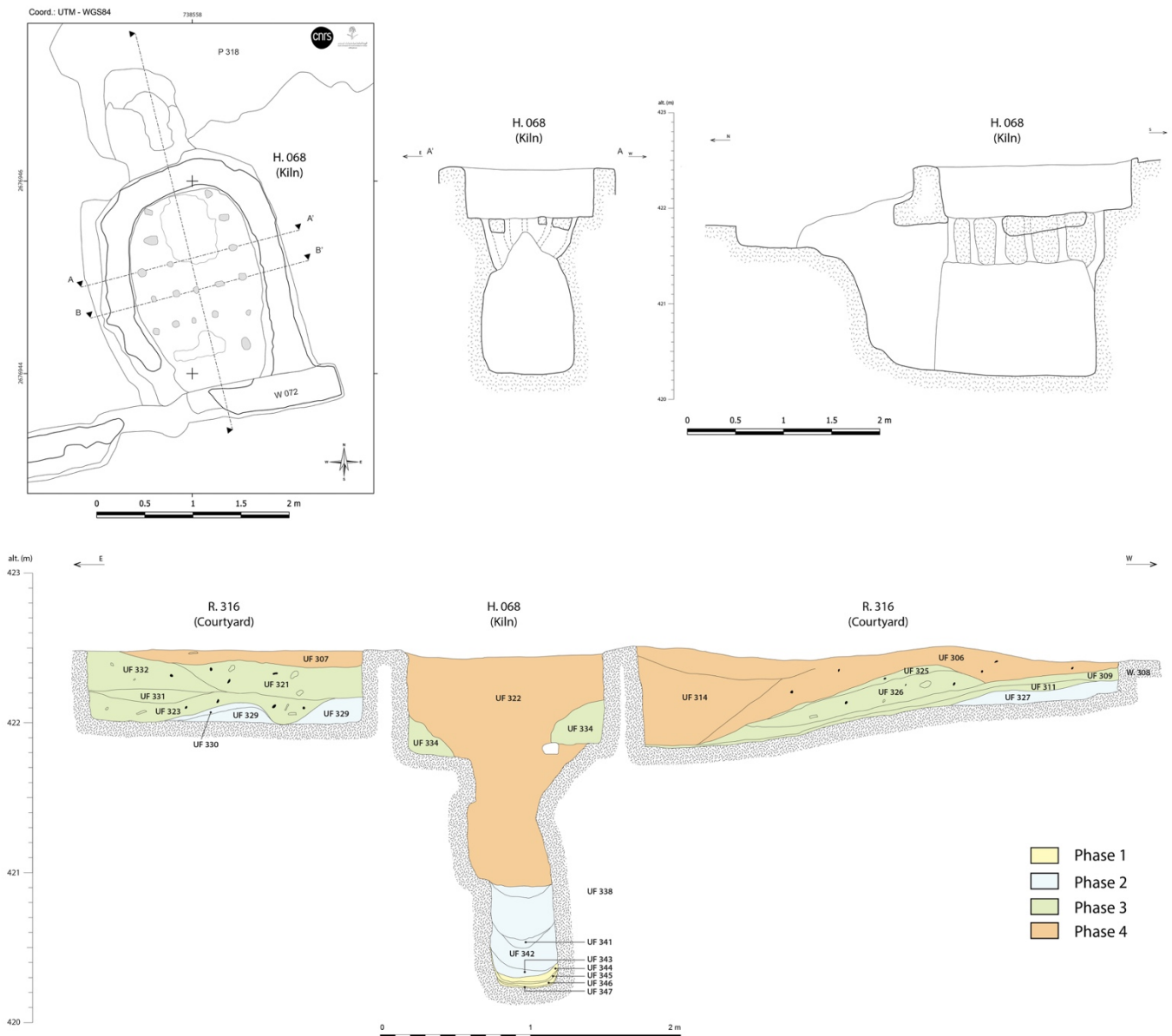


Figure 3. al-Yamāmah: Area G17 — Sounding 3: (top) plan and sections of kiln H. 068; (bottom) east–west stratigraphic section (F. Lesguer, Saudi French Archaeological Mission in al-Kharj).

Phase 3: area turned into a dump for an adjacent production after the shutdown of the kilns

On the floor of the firing chamber in kiln H. 068, numerous fragments of kiln walls and mud brick and 135 pottery sherds were retrieved (UF 334). In the firebox, fragments of earthenware and of a thick plaster disc (Fig. 4/1) show that the kiln was no longer active. The funnel-shaped area in front of the kiln (Pi. 318) was gradually filled in with sandy silt, ashes, charcoals, abundant faunal remains (2.5 kg of animal bones), and 386 pottery sherds (UF 312). Kiln H. 069 was also abandoned and filled with sandy silt, kiln walls, and sixty-nine pottery sherds (UF 206 and 362). *Tannūr* H. 319 was filled with compact ashes. Between kilns H. 069 and H. 068, a backfill of wasters and fragmentary kiln walls had accumulated (UF 321, 323, 331, and 332).

West of kiln H. 068, a succession of levels of destruction and refuse had accumulated (UF 309, 310, 311, 325, and 326). South of the courtyard, a pit (Pi. 378) was dug, in part within wall W. 072 and kiln H. 068. It was filled with hard sandy silt (UF 302, 335) and contained animal bones (1.7 kg) and 922 pottery sherds, including misfired sherds and broken wasters.

Phase 3 layers from the courtyard yielded 55.5% of the pottery sherds from Sounding 3. The fact that they belong to a local production and that they were found together with wasters clearly indicates that with the shutdown of the kilns the area was turned into a dump, while the pottery production continued in the neighbourhood. Rooms R. 070 and R. 071 were connected to this still productive activity: in R. 070, although the water tank was then abandoned and filled with silts and sherds, a small hearth shows that the room was still dedicated to domestic (?) activity; room R. 071 was filled with an 85 cm-thick, very hard layer of clayey marl and a few inclusions and was possibly used as a clay storage space.

#### Phase 4: dump area and abandonment

During this last phase, the whole courtyard and kilns were covered with clayey sand (UF 203, 204, 301, 306, 307, 313, 314, and 322). Kiln H. 068 continued to deteriorate (UF 203 and 314). Silt accumulated in rooms R. 070, R. 367, and R. 368 (UF 205, 303, 328, and 336). The presence of a small hearth (H. 366) in the south-west corner of Sounding 3 and of 1562 sherds in these upper layers (i.e. 33% of the total) could indicate that, while this area was abandoned, production continued nearby. However, the layers of this last phase are disturbed because of the proximity of the surface and ground levelling for agricultural purposes. The topmost layer is a hard and dense hydromorphic and crystallized soil (UF 201, 202, and 300) that includes abundant material (pottery sherds, animal bones), some of which is possibly intrusive.

#### Functional organization

Because of the presence of kilns in phases 1 and 2, the courtyard (R. 316) was obviously the firing area. During these phases, the presence of a small kiln (H. 320 and then H. 069) next to a large one (H. 068) indicates a process of firing that depended either on demand or on the different kinds of products (small vs. large shapes). The nature of the fuel used in the firebox has so far not been determined. The analysis of two charcoals sampled for radiocarbon dating showed the use of *Phoenix dactylifera* stem (kiln H. 068, phase 2) and *Tamarix sp.* wood (*tannūr* H. 319, phase 2). The preparation of the vessels could have taken place here: two stone grinders (Y.349.1) were discovered in phase 1 (Fig. 4/2) and another one (Y.359.1) in phase 2 (Fig. 4/3).

In phase 3, and possibly phase 4, the presence of unfired sherds, refuse, and wasters in the courtyard confirms the change of function; it had become a dump for other workshops in the neighbourhood. This is confirmed by the fact that 97% of the animal bone assemblage comes from phases 3 (39%) and 4 (58%). The fragments of a circular plaster object discarded in the main kiln (Fig. 4.1) in phase 3 have been interpreted as either the turntable of a potter's wheel or the plate supporting the vase on the turntable. In the dump level (UF 321), there are two flat earthenware slabs (Y.321.30 and Y.321.45), which have been interpreted as plates supporting the vase on the turntable or as kiln furniture (*saggar*). Room R. 071 could have been a clay storage space in phases 2 and/or 3: it was almost empty of artefacts and filled with clayey marl. The function of the other rooms cannot be determined precisely, although they are clearly connected with domestic/working activity.

## Absolute chronology

Radiocarbon dating was undertaken on three charcoal samples (Fig. 5).<sup>1</sup> Two samples come from Phase 2 layers: one from the firebox of the main kiln (H. 068), the second from an ash layer of *tannūr* H. 317. Calibrated dates are respectively AD 898–1023 and AD 778–994 (higher probability in AD 863–994). It points to a dominant activity in the tenth century.

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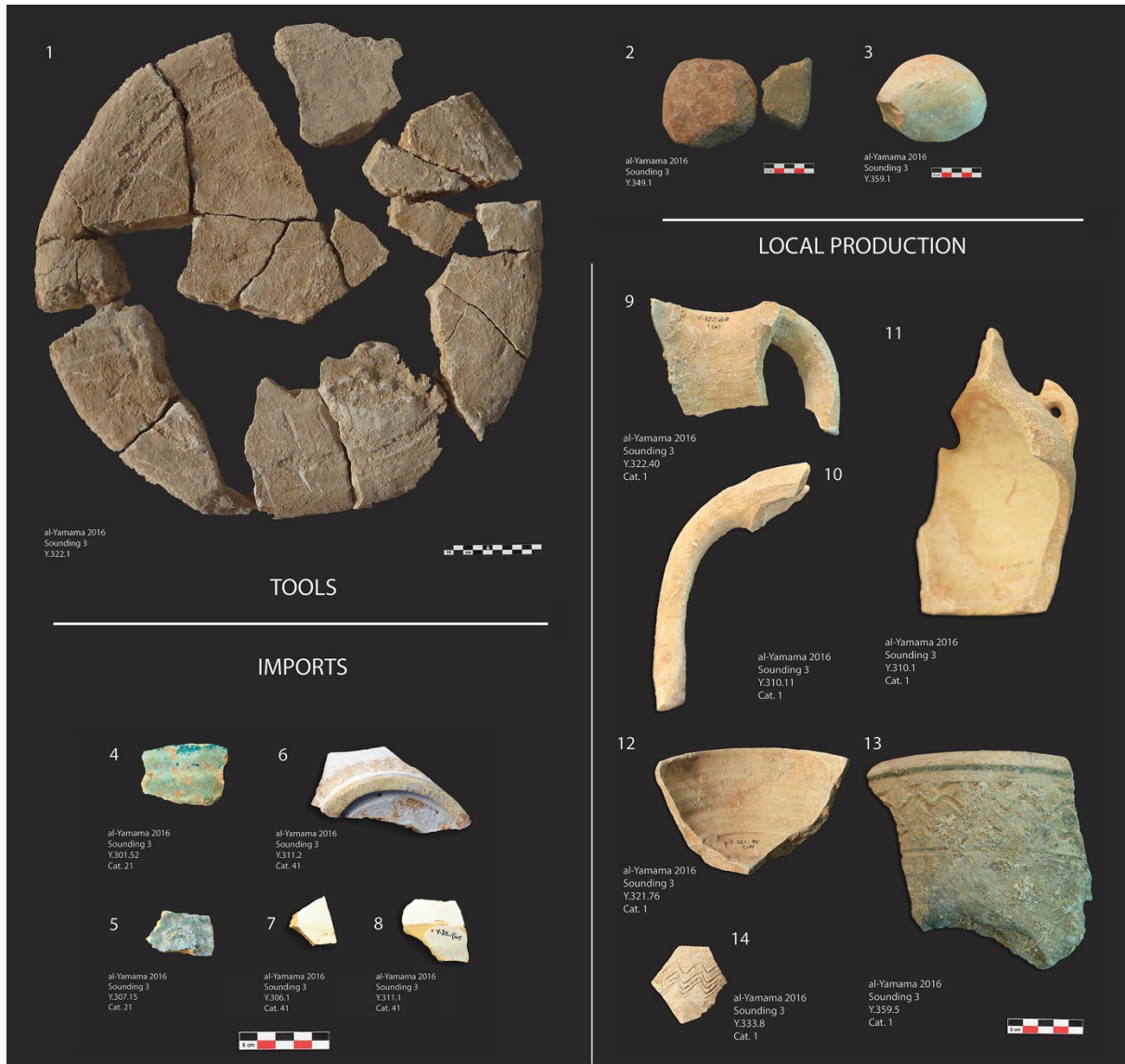


Figure 4. al-Yamāmah: Area G17 — Sounding 3: potter's tools, imported glazed ware, and local production: 1. turntable (?); 2–3. stone grinders; 4–5. imported turquoise-blue alkaline-glazed ware; 6–8. white opaque glazed ware; 9–14. sherds of COMM.BUFF (cat. 1) (F. Lesguer, Th. Sagory, and J. Schiettecatte, Saudi French Archaeological Mission in al-Kharj).

<sup>1</sup> The identification of wood species was undertaken at the Muséum National d'Histoire Naturelle, Paris by Ch. Bouchaud (CNRS, UMR 7209, Archéozoologie et archéobotanique, Paris); sample SacA36383 was prepared at the Centre de Datation par le Radiocarbone (UMR 5138 Archéométrie et Archéologie, Lyon). Others were prepared at the Muséum National d'Histoire Naturelle, Paris by A. Zazzo (CNRS, UMR 7209, Archéozoologie et archéobotanique, Paris). Measurements of <sup>14</sup>C content were taken using the ARTEMIS accelerator (LMC14, UMS 2572, Saclay).



The third sample comes from a phase 3 level and was dated AD 774–967. This result is almost identical to the previous ones, either because the phases were short, because the charcoal sampled in an open-air area might be older residual material, or because of an old wood effect. Be that as it may, these results point to a late ninth- to tenth-century date. Considering the high homogeneity of the pottery production from phase 1 to phase 4, it is unlikely that the workshop was active long before, or remained active long after.

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The very rare imported pottery sherds from Sounding 3 are consistent with this dating. These are five sherds of turquoise-blue alkaline-glazed ware, including one with appliqué decoration (Fig. 4/4–5) and seven sherds of white opaque glazed ware (Fig. 4/6–8), typical ninth- to tenth-century productions from southern Iraq and Siraf (Priestman 2011). These imports were found in layers of phases 1, 3, and 4, which confirms that the activity of the pottery workshop was confined to this period only.

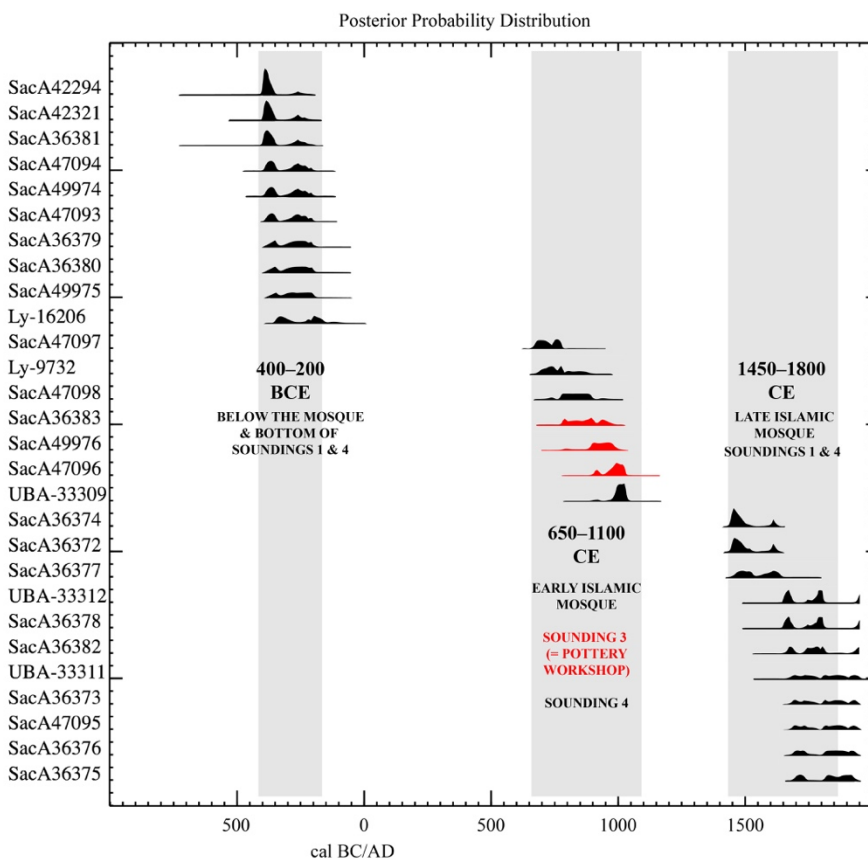


Figure 5. AMS dating on charcoal from al-Yamāmah; samples from Sounding 3 in red, with details in the table below. Calibration programme: Stuiver M., Reimer P.J. & Reimer R.W. 2017 CALIB 7.1 ([www program](http://calib.org)). Available at <http://calib.org> (accessed 19/09/2019). Calibrated with IntCal13 curve (Reimer et al. 2013).

AMS Lab #	Location	Nature	Radiocarbon age (14C yrs BP)	Calibrated date (2 sigma ranges) Start–end (relative area)
SacA49976	Sounding 3 – Phase 2 Tannūr H. 317 (UF 356)	<i>Tamarix sp.</i>	1120 ± 30 BP	AD 778–790 (0.016) AD 809–815 (0.004) AD 826–841 (0.014) AD 863–994 (0.966)
SacA47096	Sounding 3 – Phase 2 Kiln H. 068 (UF 340)	<i>Phoenix dactylifera</i>	1060 ± 30 BP	AD 898–924 (0.145) AD 944–1023 (0.855)
SacA36383	Sounding 3 – Phase 3 Between H. 068 and H. 069 (UF 205)	Indeterminate wood charcoal	1160 ± 30 BP	AD 774–905 (0.752) AD 915–967 (0.248)

### The pottery assemblage

### Distribution

A total of 4685 sherds including 1141 characterized shapes (base, handle, decoration, rim) were collected in Sounding 3. Twenty-five out of the fifty-six pottery categories from the site of al-Yamāmah are present in the layers of this trench.<sup>2</sup> The distribution of the Minimum Number of Individuals (MNI) of vessels per phase and category (Fig. 6) shows that several pottery categories are not statistically representative as they include fewer than eight individuals, often distributed in two or three different phases. Five pottery categories are significant and may have been produced in the workshop and its neighbourhood: the Common Buff Ware with medium to thick grits (cat. 1; COMM.BUFF);

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Category	Code	Description	Conservation	Phase 1	Phase 2	Phase 3	Phase 4	MNI	%
1	COMM.BUFF	Common buff ware with medium to thick grits	Indet. sherds + shapes	4	81	571	273	929	81.4%
2	COMM.RED	Common reddish ware with medium to thick grits	Indet. sherds + shapes		1	2	8	11	1.0%
3	MED.BUFF	Medium fine buff ware with cross-hatch paint in red	shapes				1	1	0.1%
4	MED.RED	Medium reddish ware with medium to thick grits	Indet. sherds + shapes			8	13	21	1.8%
5	FIN.BUFF.SL	Fine buff ware with white and red matt slip	shapes				1	1	0.1%
6	PINK.COOK	Pinkish cooking ware with white exploded grits	Indet. sherds + shapes			2	1	3	0.3%
7	RED.SAND	Medium red-orange sandy ware	Indet. sherds				2	2	0.2%
8	RED.SAND.SL	Coarse red-orange sandy ware with whitish surface	Indet. sherds		1			1	0.1%
9	LAYLA.GREY	Layla ware – well fired grey to deep reddish ware	Indet. sherds + shapes			2	4	6	0.5%
12	FIN.BUFF	Medium fine buff ware	Indet. sherds + shapes			2	6	8	0.7%
15	BLACK&RED	Red ware with grey-black core and abundant chaff temper	Indet. sherds				1	1	0.1%
16	GREY.GRIT	Handmade grey gritty ware	Shapes				1	1	0.1%
21	OPAQ.TURQ	Turquoise-blue alkaline-glazed ware [import]	Indet. sherds + shapes	1			4	5	0.4%
24	OTHER	Others	Indet. sherds + shapes		2	21	14	37	3.2%
26	YELLOW.SAND	Medium yellow sandy ware	Indet. sherds + shapes			3	3	6	0.5%
28	FIN.GREEN	Thin greenish ware	Indet. sherds + shapes			17	4	21	1.8%
29	ORANGE	Well fired reddish to buff orange ware	Indet. sherds + shapes			0	6	6	0.5%
33	FIN.CREAM.SLP	Fine reddish buff ware with cream slip	Indet. sherds + shapes			5	3	8	0.7%
35	MED.CREAM.SLP	Medium reddish buff ware with cream slip	Indet. sherds + shapes		2	24	31	57	5.0%
36	FIN.RED.SAND.SL	Fine red-orange sandy ware with reddish slip	Indet. sherds				2	2	0.2%
37	MED.BUFF.SL	Medium reddish buff ware with black / reddish slip	Shapes				1	1	0.1%
39	OPAQ.YEL	White to yellow glazed ware [import]	Indet. sherds				1	1	0.1%
41	OPAQ.WHIT	Abbasid white opaque glazed ware [import]	Indet. sherds + shapes	1		2	4	7	0.6%
50	LAYLA.RED	Pseudo Layla-ware	Indet. sherds + shapes			1	3	4	0.4%
52	MED.RED.SL2	Hand-made red buff ware with cream slip (variant of 35)	Indet. sherds		1			1	0.1%
<b>TOTAL</b>				<b>6</b> <b>(0.5%)</b>	<b>88</b> <b>(7.7%)</b>	<b>660</b> <b>(57.8%)</b>	<b>387</b> <b>(33.9%)</b>	<b>1141</b>	<b>100%</b>

Figure 6. al-Yamāmah: Area G17 — Sounding 3: distribution of the pottery categories with the MNI for each category per phase (F. Lesguer and J. Schiettecatte, Saudi French Archaeological Mission in al-Kharj).

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three variants of this type, the Common Reddish Ware with medium to thick grits (cat. 2; COMM.RED), the Medium Reddish Ware with medium to thick grits (cat. 4; MED.RED), and the Medium Reddish Buff Ware with cream slip (cat. 35, MED.CREAM.SLP); and another type, the Thin Greenish Ware (cat. 28, FIN.GREEN). These five categories account for 91% of the MNI, COMM.BUFF being much more common than the others with 81.4% of the MNI. The latter clearly dominated production in the workshop. The production consisted of tableware (bowls, basins, plates, cups, jugs, open jars), a few cooking pots, and small storage jars. This daily life assemblage was probably intended for the local market.

### The Common Buff Ware and its variants

COMM.BUFF is a well fired buff to greenish ware, with fine to medium black and red grits, sometimes yellow exploded grits, and rare chaff temper. Walls are medium to thick. There is often a decoration of horizontal and/or wavy lines or hatched patterns (Fig. 4/9–14).

<sup>2</sup> The pottery typology at al-Yamāmah is published in Mouton, Siméon & Schiettecatte 2016 (cat. 1 to 48) and Schiettecatte 2016: 78–83 (cat. 49–56).

The distribution of this pottery type is homogeneous in the workshop. The ratio of COMM.BUFF per stratigraphic unit varies from 0.65 to 0.89. The highest concentration is in kiln H. 068 (Phase 3 levels) and in pit Pi. 318 in front of the kiln, where the ratio varies between 0.89 and 1. The workshop clearly specialized on the production of COMM.BUFF. After the shutdown of the excavated kilns (phases 3 and 4), the neighbouring workshops continued its production.

This type mostly includes bowls (30%), basins (29%), jars (38%), and very occasionally jugs, hole-mouth jars, lids, and cups. In phase 2, when the kilns were active, bowls and basins account for 71% of the identified shapes, and 80% in one of the late firing phase of kiln H. 068 (UF 338). It constituted a major production of this kiln.

There are four kinds of bowls, basins, and cooking pots:

- bowls and basins with a triangular everted rim (Fig. 7/1–5);
- bowls and basins with a thin round/square rim and flat base (Fig. 7/8–15);
- cooking pots with a square rim and horizontal grooves (Fig. 7/16–18);
- bowls and basins with a thin inverted round/triangular rim, some incised with wavy/horizontal lines (Fig. 8/1–16);

There are four kinds of jars:

- jars with a vertical neck, a thickened rim and two vertical handles with a bean-shaped section (Fig. 9/1–4, 9/11–15, 9/21);
- jars with a large vertical neck, a rounded rim, and three rounded handles (Fig. 9/22–24);
- jars with a sloping neck, a rounded rim, and an elongated rounded handle (Fig. 9/16);
- jars with an everted rounded rim (Fig. 9/5–7).

A first variant of this pottery type is the COMM.RED, which is rather similar to COMM.BUFF, but well levigated, red in colour, and with thinner walls. These are mostly tableware (plates, bowls) (Fig. 10/1–3).

A second variant is the MED.RED, a well-fired orange-red to buff ware, with a few thin black and red grits and sandy temper. Walls are thin to medium and surfaces are plane. It mainly includes bowls with an inverted rounded rim (Fig. 10/8–12) and bowls with a thin rounded/square rim (Fig. 10/13–17).

A third variant, MED.CREAM.SLP, is identical to the MED.RED, with a cream slip on the outer side. It is more common, accounting for 5% of the MNI, although most of the sherds come from the phase 4 layers, close to the surface. It is not certain that it was produced in this specific workshop but its abundance in other excavated areas at al-Yamāmah (12% of the MNI in Trench D, Area 6; 20% in the mosque area, Area 6; 5% in Sounding 4, Area K17) and its chemical proximity with COMM.BUFF (see below) probably make it a local production. It mainly includes tableware (85% are bowls) and jugs. These are:

- small to large bowls with a triangular rim and horizontal incisions (Fig. 11/1–4);
- small to large bowls with a thin squared rim (Fig. 11/11–16);
- open bowls with a thin rounded rim and an annular base (Fig. 11/5–8);
- jugs with an everted rounded rim (Fig. 11/9–10).

### The Thin Greenish Ware

FIN.GREEN is a thin to medium, light green ware with a fine mineral temper. The fabric is well levigated and well fired, with a smooth regular surface. It accounts for 1.8% of the MNI. It is absent in phases 1 and 2 and was therefore not produced in the excavated kilns.

Category 1  
COMM.BUFF

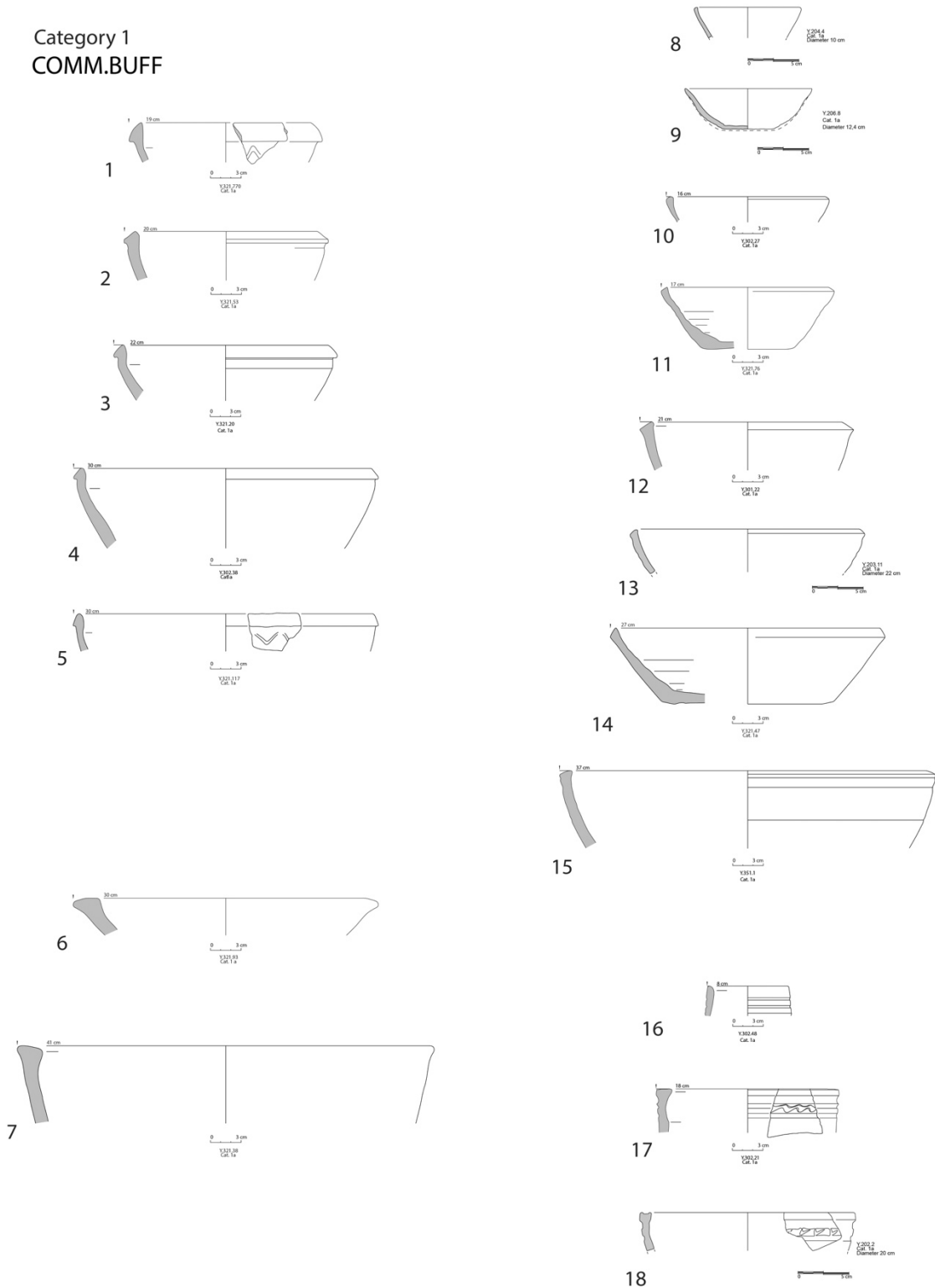


Figure 7. al-Yamāmah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – bowls and basins (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

Category 1  
COMM.BUFF

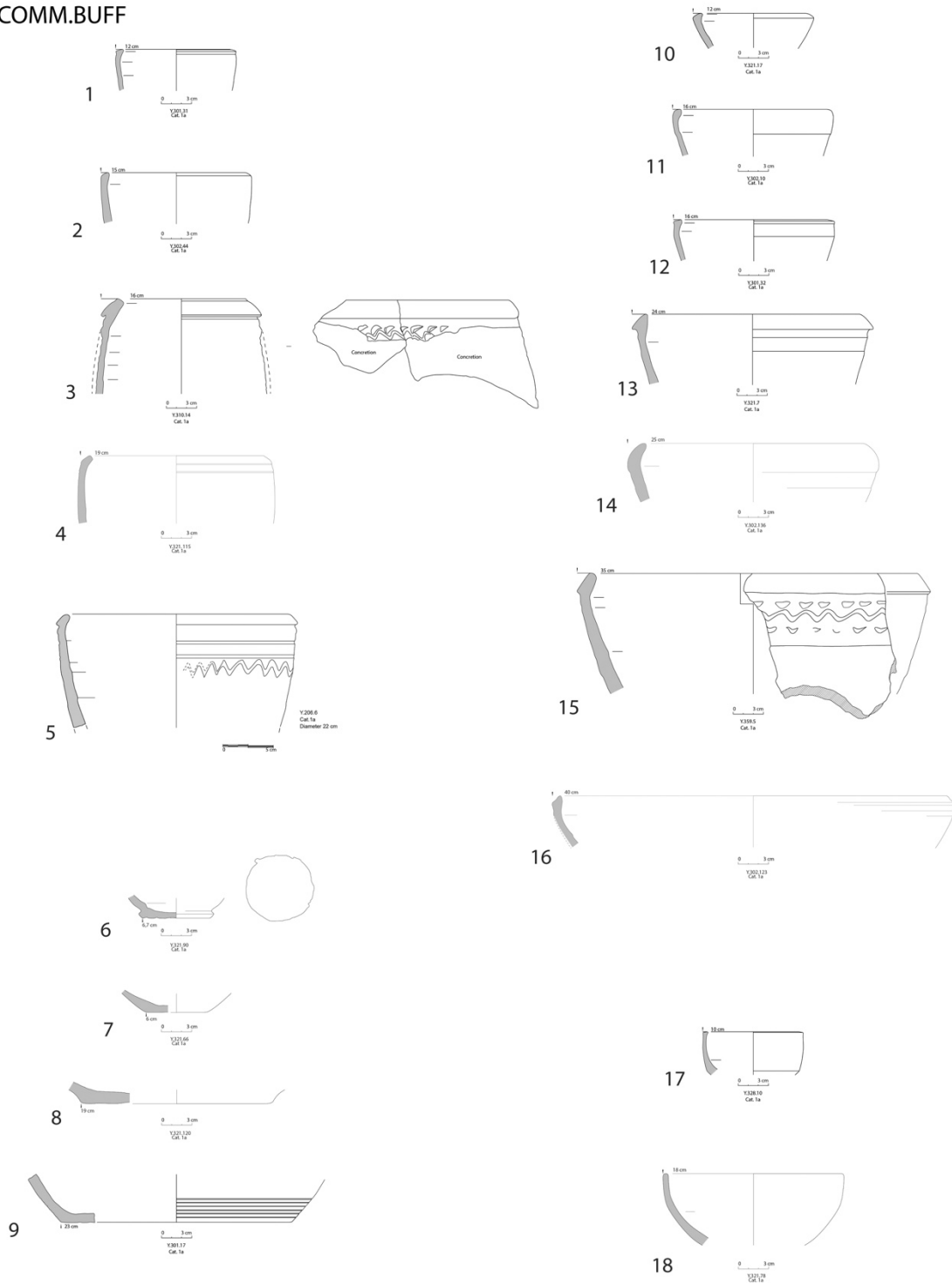


Figure 8. al-Yamamah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – bowls and basins (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

Category 1  
COMM.BUFF

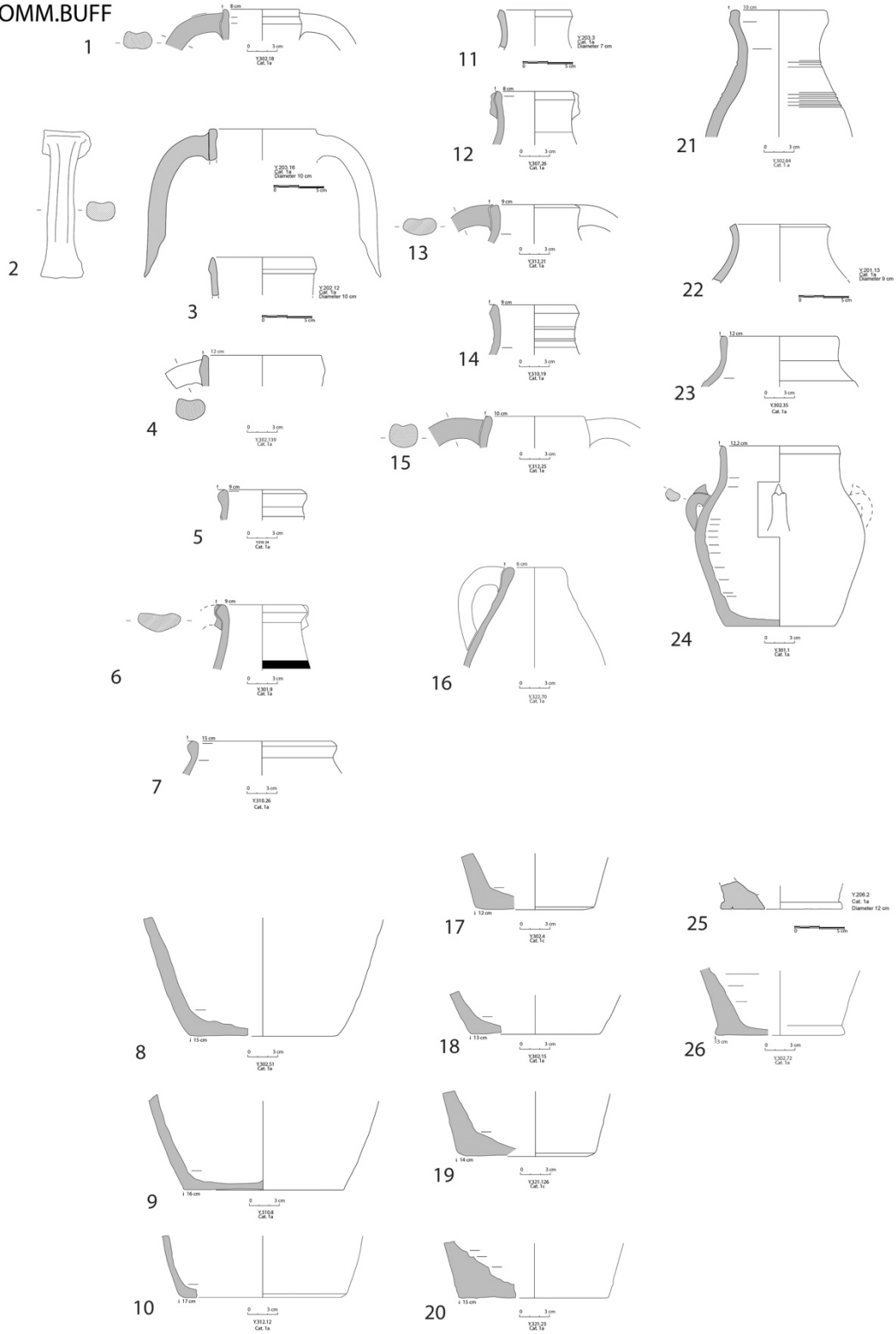
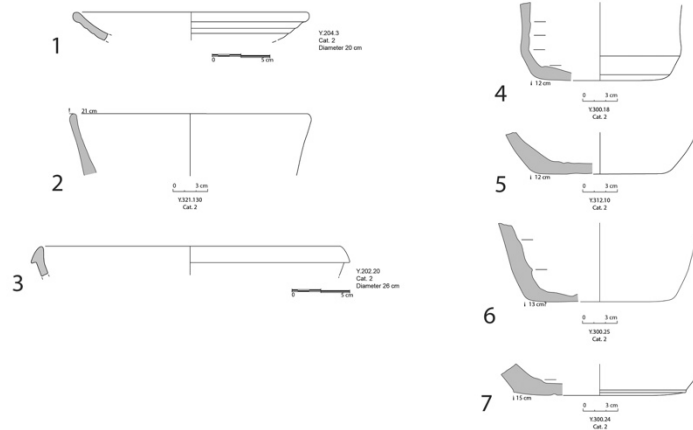
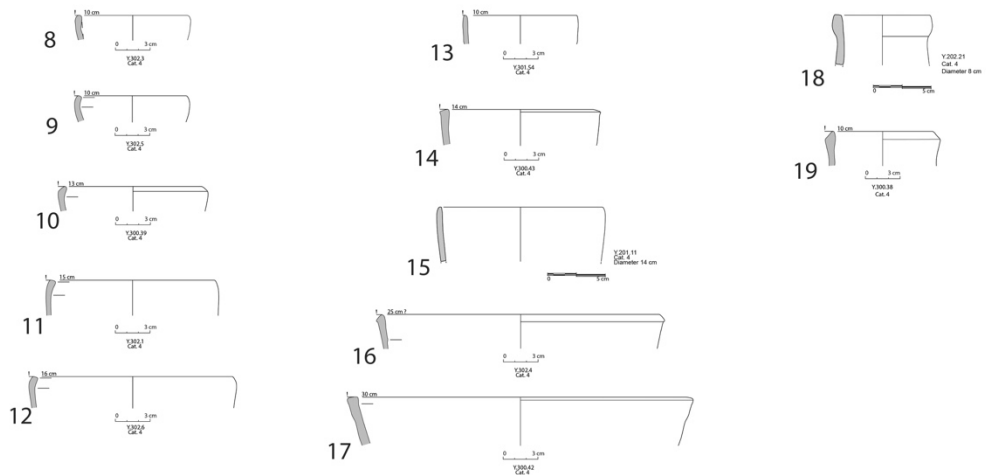


Figure 9. al-Yamāmah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – jars (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

Category 2  
COMM.RED



Category 4  
MED.RED



Category 28  
FIN.GREEN

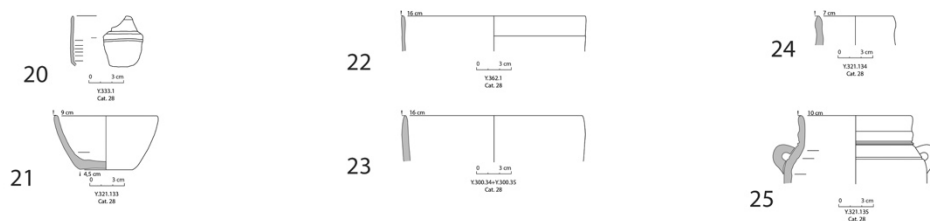


Figure 10. al-Yamāmah: Area G17 — Sounding 3: COMM.RED (cat. 2), MED.RED (cat. 4), and FIN.GREEN (cat. 28) (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

Category 35  
MED.CREAM.SLP

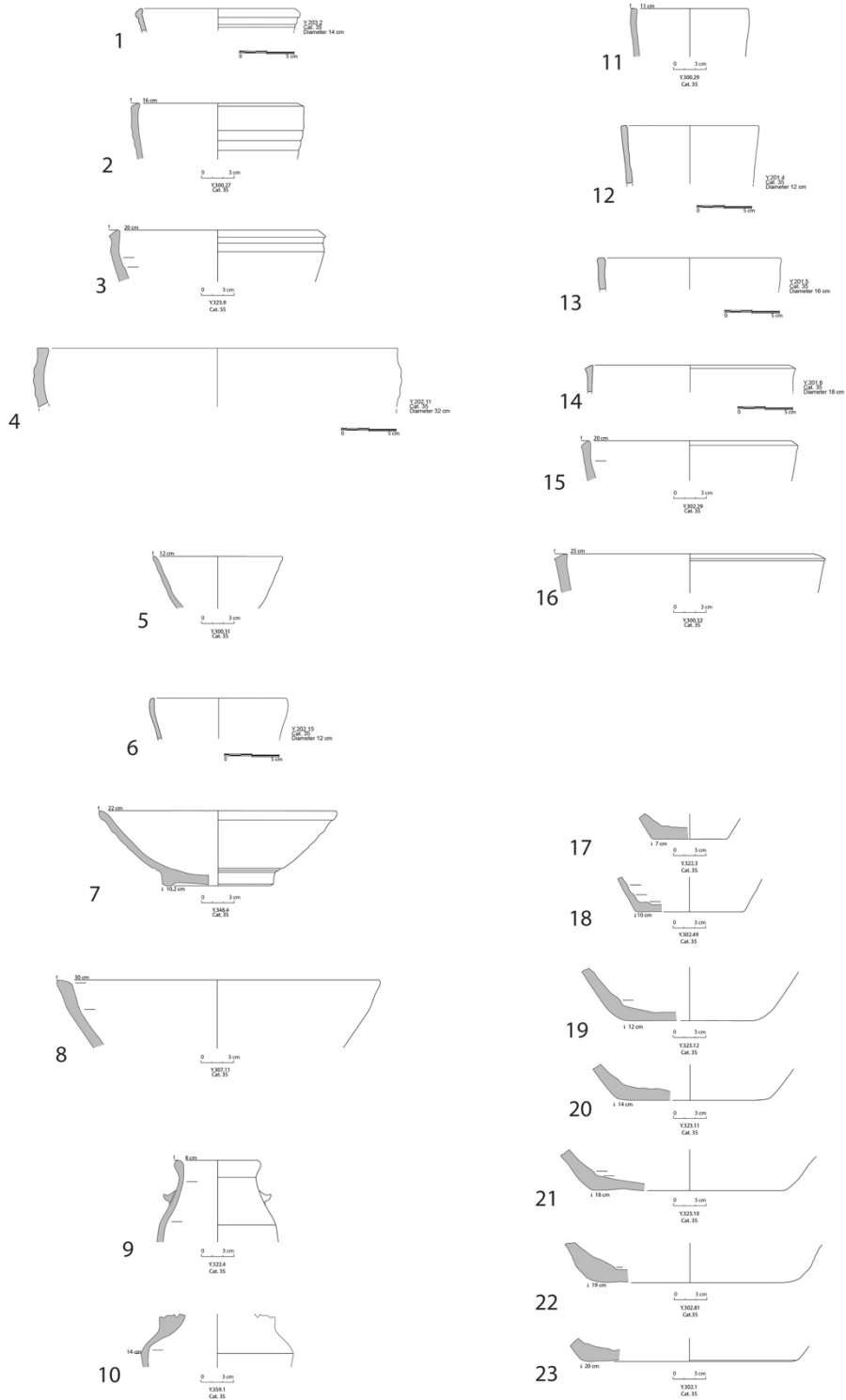


Figure 11. al-Yamāmah: Area G17 — Sounding 3: MED.CREAM.SLP (cat. 35) (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).



Most of the sherds come from the refuse dumps within kiln H 069 and between kilns H. 068 and H. 069. It may have been produced in the neighbouring workshops.

The ware comprises bowls with a thin rounded rim (Fig. 10/22–23), a cup with a rounded rim and flat base (Fig. 10/21), and an open jar with a vertical neck, a thickened rounded rim, and two small rounded handles (Fig. 10/24–25).

## Chemical characterization of the pottery assemblage

### Methodology

A first set of chemical characterizations of the fabrics from al-Yamāmah was established. The purpose was twofold: firstly, to characterize the chemical profile of the local production; secondly, to confirm the proximity of several categories considered as local variants of a similar pottery production.

Major and trace elements were measured on sixteen categories (1, 2, 4, 6, 9, 10, 15, 26, 28, 33, 35, 50, 51, 52, 55, and 56) with twenty-six samples from the whole site. The raw chemical data from the ICP-OES-MS analysis and the process are described in the appendix (see below: 'Supporting information'). Priority was given to the assumed local productions: COMM.BUFF (cat. 1, five samples); COMM.RED (cat. 2, one sample); MED.RED (cat. 4, one sample); MED.CREAM.SLP (cat. 35, three samples); and FIN.GREEN (cat. 28, one sample). For other categories, one or two samples were selected in different areas of the site and different chronological contexts. It allowed for a very preliminary characterization of these categories and the identification of proximity between some of them.

Ceramics is a mixture of one part clay, one part natural carbonated content, and one part sandy content (siliceous or carbonated), natural or added. Clay minerals consist mainly of alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ). The sandy phase is generally siliceous and therefore provides mainly silica ( $\text{SiO}_2$ ) and also titania ( $\text{TiO}_2$ ), zirconium (Zr), and sometimes calcium oxide (CaO). The carbonate phase provides calcium oxide (CaO), strontium (Sr), magnesium (Mg), manganese (Mn), and barium (Ba) (Anna et al. 2011: 69). To improve the determination of the fabric origins with the comparative statistical analyses, a limited number of trace elements were selected: barium (Ba), cerium (Ce), chromium (Cr), nickel (Ni), rubidium (Rb), strontium (Sr), vanadium (V), zinc (Zn), zirconium (Zr). The selected oxides of major elements are CaO,  $\text{Fe}_2\text{O}_3$ ,  $\text{P}_2\text{O}_5$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ , MgO, MnO (Schmitt, Cantin & Thirion-Merle 2009: 134). The  $\text{Na}_2\text{O}$  and La values were not considered due to measurement difficulties (Anna et al. 2011: 75). Different methods of processing multivariate statistical analyses are commonly used for evaluating geochemical data, most often cluster analyses and ternary plots.

### Results and discussion

The cluster analysis of geochemical data allowed for the distinction of two groups and an isolated sample (Fig. 12, top):

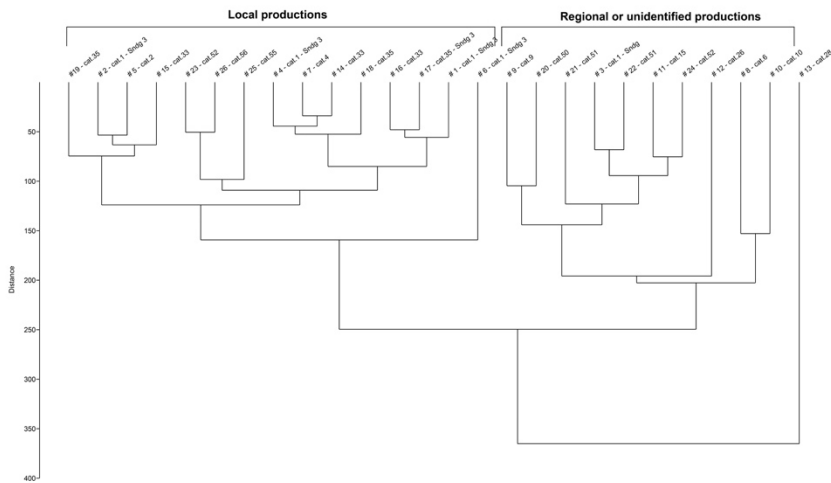
Group 1 includes four out of the five samples of cat. 1 (COMM.BUFF), the sample of cat. 2 (COMM.RED) and 4 (MED.RED), the three samples of cat. 33 (FIN.CREAM.SLP) and 35 (MED.CREAM.SLP), as well as the samples of pre-Islamic categories (52, 55, and 56 — absent in Sounding 3, one sherd excepted). The macroscopic similitude between COMM.BUFF and what we considered to be variants (COMM.RED, MED.RED, MED.CREAM.SLP) is confirmed. The presence in this group of categories well attested in the pre-Islamic layers of other soundings (Trench D, Area N6; Sounding 4, Area K17) indicates probable local pre-Islamic productions.

Group 2 includes sherds from various macroscopic categories: PINK.COOK (cat. 6), a cooking ware more commonly attested in late Islamic contexts; LAYLA (cat. 9, 10 and 50), different variants of the Layla

ware, probably imported from the area of Layla/al-Aflāj; BLACK&RED (cat. 15), a coarse chaff temper ware found in pre-Islamic contexts; and CRUMB.GREEN (cat. 51), also specific to the pre-Islamic occupation. This second group owes its specificity to other regional traditions (e.g. the Layla ware), or to a different provenance of clay and temper with, so far, no possibility of determining whether they were locally produced or not.

In group 2, the presence of a sample of COMM.BUFF (cat. 1) is unexpected. This sample comes from the late Islamic layers of Sounding 1 (Area N6). Although the macroscopic sorting compelled us to register it as COMM.BUFF, it might well be relevant to a different late Islamic pottery tradition, be it local or not.

Cluster analysis after 9 major elements (CaO, Fe<sub>2</sub>O<sub>3</sub>, P<sub>2</sub>O<sub>5</sub>, TiO<sub>2</sub>, K<sub>2</sub>O, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, MnO) and 9 trace elements (Zr, Sr, Rb, Zn, Cr, Ni, Ba, V, Ce)



Ternary diagram according to the values of SiO<sub>2</sub>, CaO and Al<sub>2</sub>O<sub>3</sub>

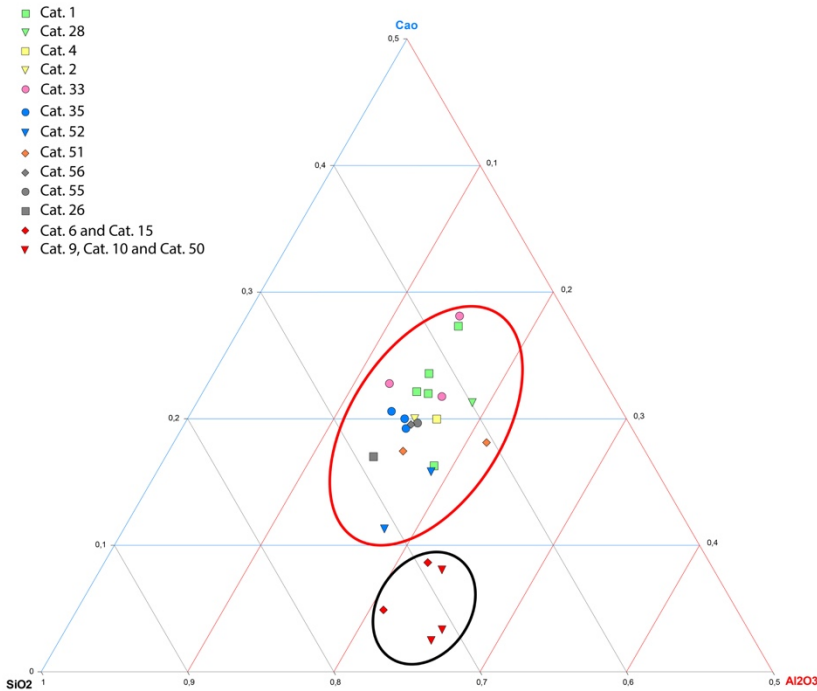


Figure 12. Top: cluster analysis of the pottery samples from al-Yamāmah based on eighteen chemical components: CaO, Fe<sub>2</sub>O<sub>3</sub>, P<sub>2</sub>O<sub>5</sub>, TiO<sub>2</sub>, K<sub>2</sub>O, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, MnO, Zr, Sr, Rb, Zn, Cr, Ni, Ba, V, Ce. Bottom: ternary diagram with the distribution of the pottery samples from al-Yamāmah according to the values of SiO<sub>2</sub>, CaO, and Al<sub>2</sub>O<sub>3</sub> (F. Lesguer).

Finally, the sample of FIN.GREEN (cat. 28) does not fit into any group. This may be due to a high barium concentration (516.36 ppm, i.e. 2.6 times higher than the sample average of 193.50 ppm). Since normal values are comprised between 250 and 1000 ppm (Anna et al. 2011: 70), it cannot be considered as an external pollution (Picon 1985: 29). With just a single sample analysed so far, it is not possible to discuss the geographical origin of this production.

Apart from the cluster analysis, we compared the concentration of the three major elements that show the highest standard deviations in our samples: silica ( $\text{SiO}_2$ ), alumina ( $\text{Al}_2\text{O}_3$ ), and calcium oxide (CaO). They indicate a greater variability between samples which is illustrated in a ternary diagram (Fig. 12, bottom).

The diagram shows two groups, which overlap with those of the cluster analysis. PINK.COOK, LAYLA, and BLACK&RED (cat. 6, 9, 10, 15 and 50) are dissociated. They have a lower concentration of CaO and a higher concentration of  $\text{SiO}_2$ , especially the LAYLA (cat. 9, 10, and 50). Other categories have a higher concentration of CaO. It includes all those significantly represented in the pottery workshop (cat. 1, 2, 4, 28, 35) as well as samples of categories mostly attested in pre-Islamic contexts on the site (cat. 33, 52, 55, 56). These are clearly a group of local productions characterized by a fabric rich in calcium.

## Conclusion

To the south-west of al-Yamāmah, Sounding 3 offered a rare insight into the Central Arabian pottery production of the ninth–tenth century AD. The excavated pottery workshop was active during a limited period of time and specialized in the production of the same fabric and a limited range of shapes — a common buff ware characterized by open bowls and closed jars. Two different-sized kilns were used alternately, according to domestic demand. When the kilns were finally abandoned, pottery production continued in the neighbourhood and the excavated area was converted into a dump (phases 3 and 4).

A quantitative analysis of the pottery distribution and its chemical characterization enabled us to define the profile of the main production in the pottery workshop at al-Yamāmah, the Common Buff Ware (COMM.BUFF). It also showed that the macroscopic variants (COMM.RED, MED.RED, MED.CREAM.SLP), which were the most abundant after the COMM.BUFF, belonged to the same group of carbonate fabric that was produced in the immediate surroundings. The Thin Greenish Ware (FIN.GREEN), which looks unrelated but is well attested, also belongs to this group of carbonate fabrics and was probably produced locally. Together with the Common Buff Ware, the presence of related categories of tablewares, often finer, are probably explained by the existence of several active workshops having their own method of production.

Finally, the chemical characterization also showed that other pottery categories (cat. 33, 52, 55, 56) sampled in pre-Islamic contexts of another area of the site (N6, to the north-east) were very similar to the early Islamic productions and might be considered as pre-Islamic local productions. It also underlined the strong dissimilarity of distinctive wares which were the result of a different pottery-making tradition, possibly imported. This is illustrated by the Layla ware, highly likely brought from the Aflāj region, where the pottery-making tradition and technology were clearly different, the fabrics having a high silicate content and fired at very high temperature.

## Supporting information

Analysis was performed at the Centre de Recherches Pétrographique et Géochimiques — Service d'Analyse des Roches et des Minéraux, Vandœuvre-Les-Nancy. The laboratory practices a  $\text{LiBO}_2$  melting and acid dissolution of samples. Major elements were quantified with an emission spectrometer (ICP-

OES) Thermo Fischer ICap 6500; trace elements with a mass spectrometer (ICP-MS) Thermo Elemental X. Fifty-four chemical elements were determined; the results were expressed in oxide percentages for major components and in parts per million of metal for trace elements. Oxides of major elements are: calcium oxide (CaO), ferric oxide (Fe<sub>2</sub>O<sub>3</sub>), titanium oxide (TiO<sub>2</sub>), potassium oxide (K<sub>2</sub>O), silicon dioxide (SiO<sub>2</sub>), aluminium oxide (Al<sub>2</sub>O<sub>3</sub>), magnesium oxide (MgO), manganese oxide (MnO), sodium oxide (Na<sub>2</sub>O), and phosphorus pentoxide (P<sub>2</sub>O<sub>5</sub>). Trace elements are: arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), cerium (Ce), cobalt (Co), chromium (Cr), caesium (Cs), copper (Cu), dysprosium (Dy), erbium (Er), europium (Eu), gallium (Ga), gadolinium (Gd), germanium (Ge), hafnium (Hf), holmium (Ho), indium (In), lanthanum (La),

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lutecium (Lu), molybdenum (Mo), niobium (Nb), neodymium (Nd), nickel (Ni), lead (Pb), praseodymium (Pr), rubidium (Rb), antimony (Sb), samarium (Sm), tin (Sn), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), thulium (Tm), uranium (U), vanadium (V), tungsten (W), yttrium (Y), ytterbium (Yb), zinc (Zn), zirconium (Zr). Raw data are shown in Figure 13.

## Acknowledgements

Archaeological excavations at al-Yamāmah were made possible thanks to the financial and technical support of the Saudi Commission for Tourism and National Heritage (SCTH), the French Ministry of Foreign Affairs, the French Embassy in the Kingdom of Saudi Arabia, Eveha and the CNRS. Part of this work was carried out under the auspices of the LABEX *RESMED* project (ANR-10-LABX-72) and received financial state aid managed by the Agence Nationale de la Recherche, as part of the programme 'Investissements d'avenir' (ANR-11-IDEX-0004-02). Many friends and colleagues, too numerous to name, from France, Germany, Pakistan, Saudi Arabia, and Sudan took part in the fieldwork and shared both their experience and their enthusiasm as scholars, students, workmen, drivers, and cooks. We thank them all sincerely.

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*See below*

Figure 13. Raw geochemical data from the ICP-OES analysis of major elements, given in percentage per oxide, and from the ICP-MS analysis of trace elements, given in ppm (CRPPM — SARM, Saudi French Archaeological Mission in al-Kharj).

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Table with columns: Sample #, Pottery category, Provenance, SiO2, Al2O3, Fe2O3, MnO, MgO, CaO, Na2O, K2O, TiO2, P2O5, PF. Contains 35 rows of geochemical data.

Figure 13. Raw geochemical data from the ICP-OES analysis of major elements, given in percentage per oxide, and from the ICP-MS analysis of trace elements, given in ppm (CRPPM — SARM, Saudi French Archaeological Mission in al-Kharj).

Table with columns: Sample #, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, La, Lu, Mo. Contains 35 rows of trace element data in ppm.

Table with columns: Sample #, Nb, Nd, Ni, Pb, Pr, Rb, S, Sb, Sn, Sr, Ta, Tb, Th, Tm, U, V, Y, Yb, Zn, Zr. Contains 35 rows of trace element data in ppm.