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Fabien Lesguer, Jérémie Schiettecatte

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Fabien Lesguer, Jérémie Schiettecatte. A ninth- to tenth-century pottery workshop at al-Yamāmah, Central Arabia. Proceedings of the Seminar for Arabian Studies, 2020, 50, pp.203-224. halshs-02924081

HAL Id: halshs-02924081
https://shs.hal.science/halshs-02924081

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This is an original manuscript / pre-print of the article published in the Proceedings of the Seminar for Arabian Studies, Volume 50 2020
Papers from the fifty-third meeting of the Seminar for Arabian Studies held at the University of Leiden from Thursday 11th to Saturday 13th July 2019.
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Lesguer, F., Schiettecatte, J., 2020. A ninth- to tenth-century pottery workshop at al-Yamāmah,Central Arabia. *Proceedings of the Seminar for Arabian Studies* 50: 203-224.

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.

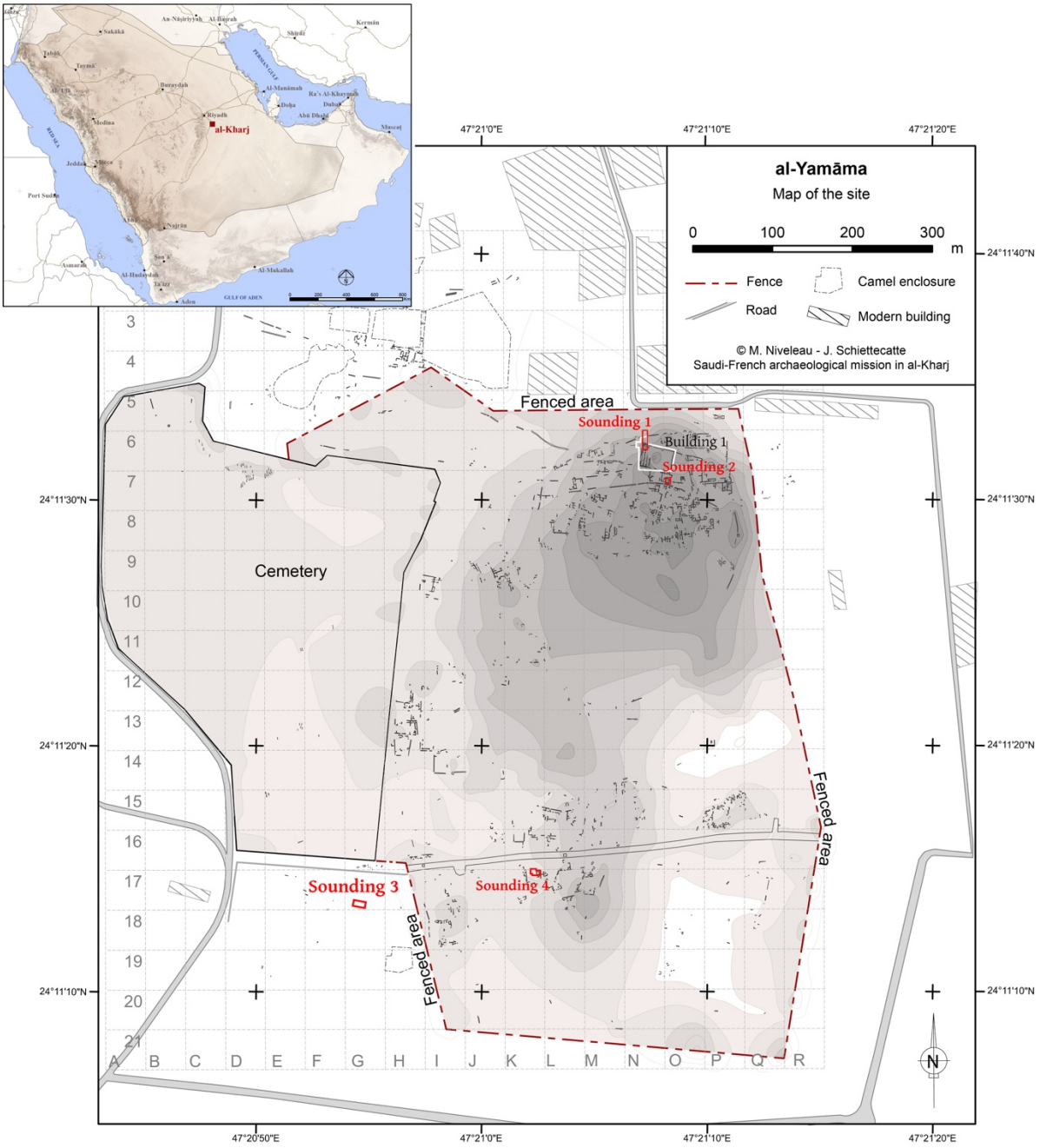


Figure 1. A topographic map of the site of al-Yamāmah (M. Niveleau and J. Schiettecatte, Saudi-French Archaeological Mission in al-Kharj).

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^2. 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 × 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 × 0.37 × 0.59 m. The rectangular firing chamber measures 0.7 × 0.6 m and is preserved over 0.17 m. A tunnel, measuring 0.24 × 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 × 0.5 × 0.32 m.

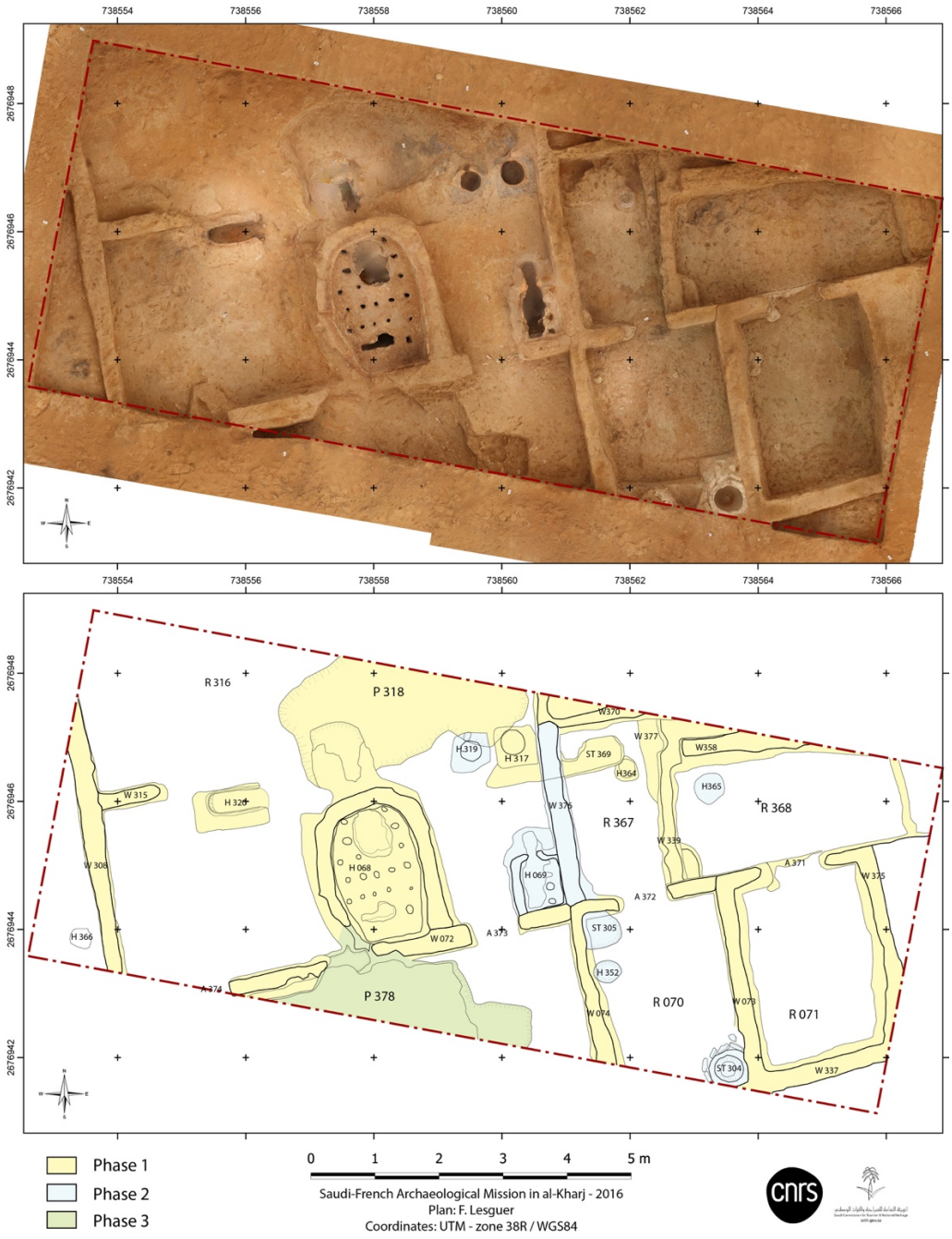


Figure 2. al-Yamāmah: Area G17 — (top) orthophotograph and (bottom) plan of Sounding 3 (F. Lesguer, Saudi French Archaeological Mission in al-Kharj).

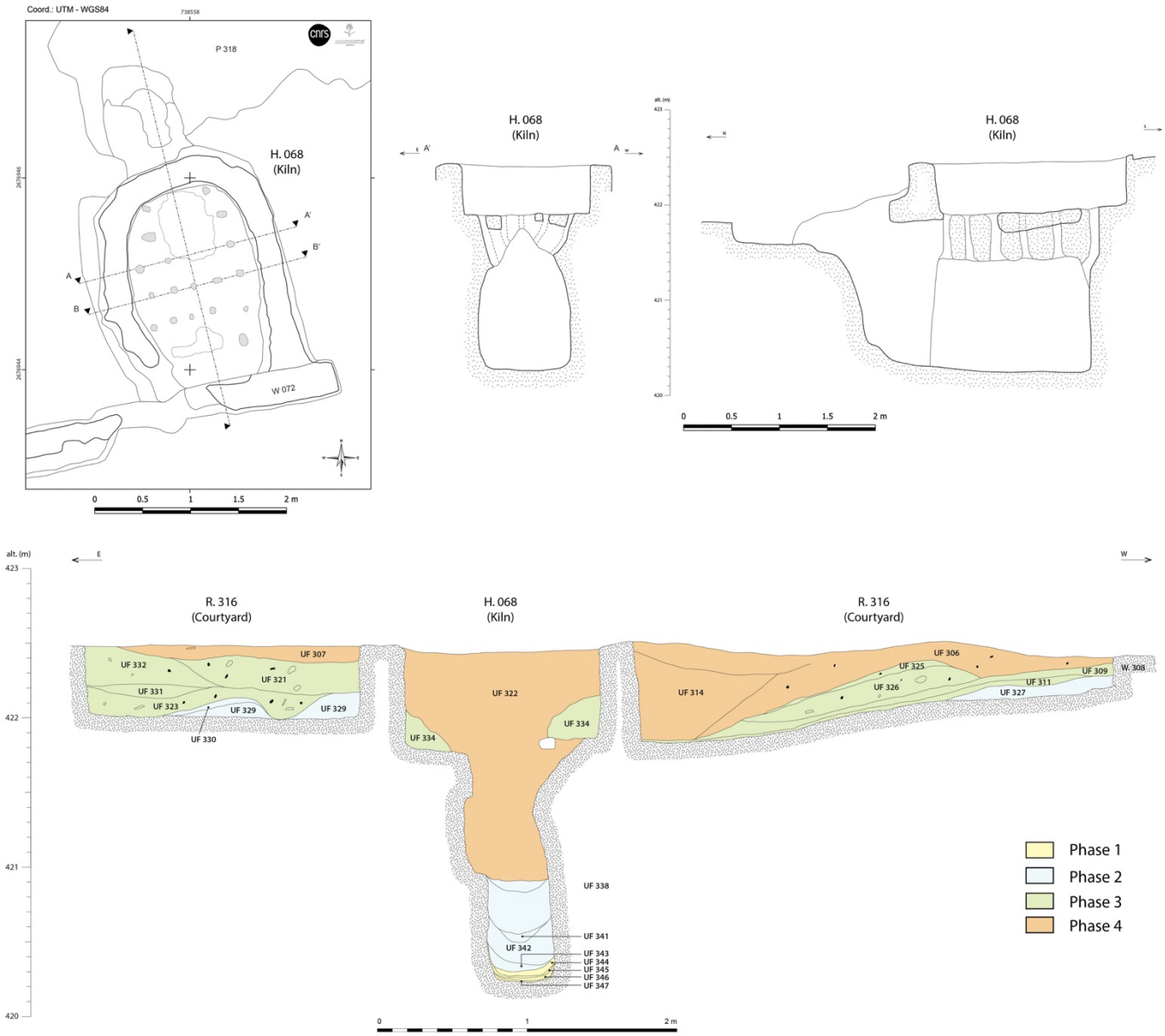


Figure 3. al-Yamāmah: Area G17 — Sounding 3: (top) plan and sections of kiln H. 068; (bottom) east–west stratigraphic section (F. Lesguer, Saudi French Archaeological Mission in al-Kharj).

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).[1] 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.

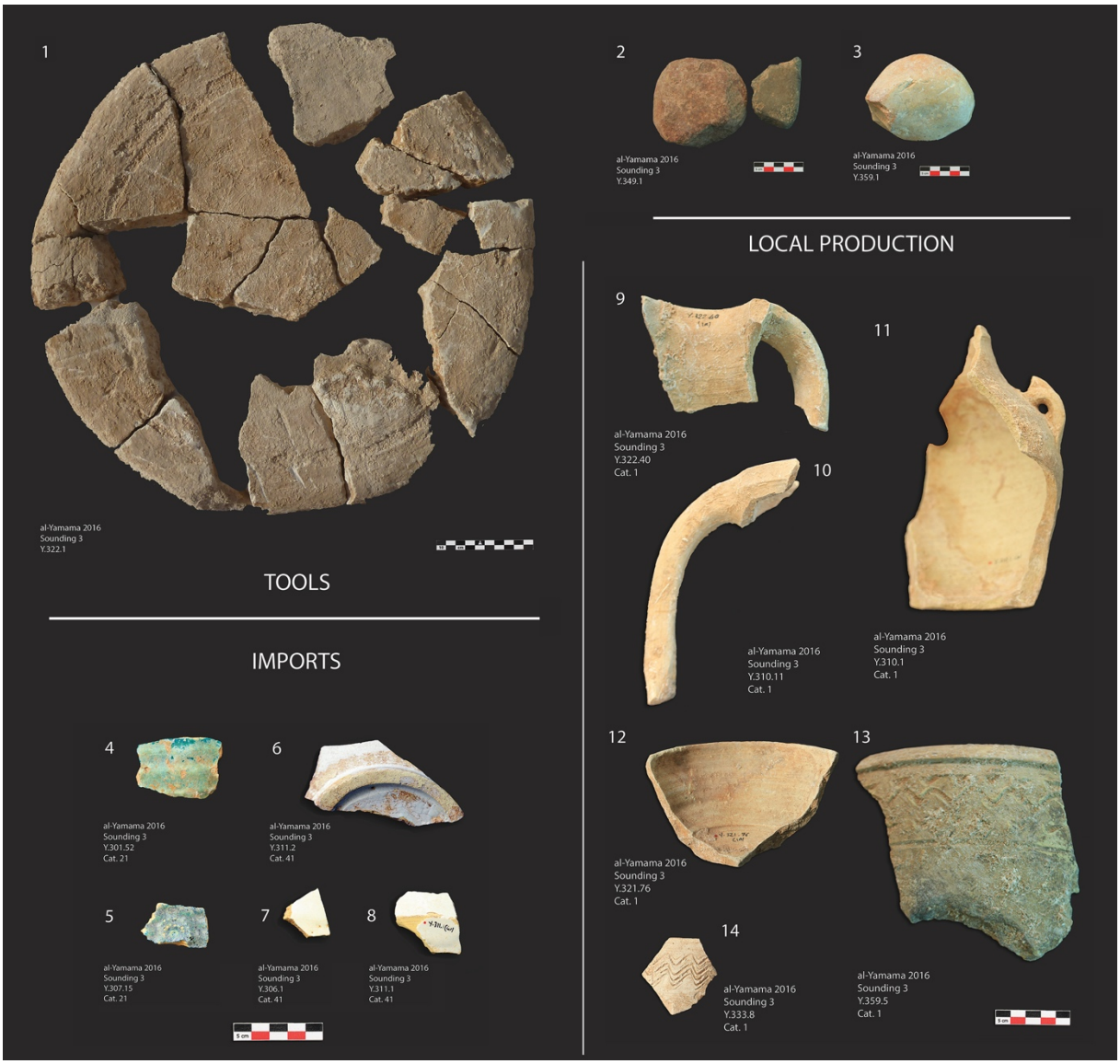
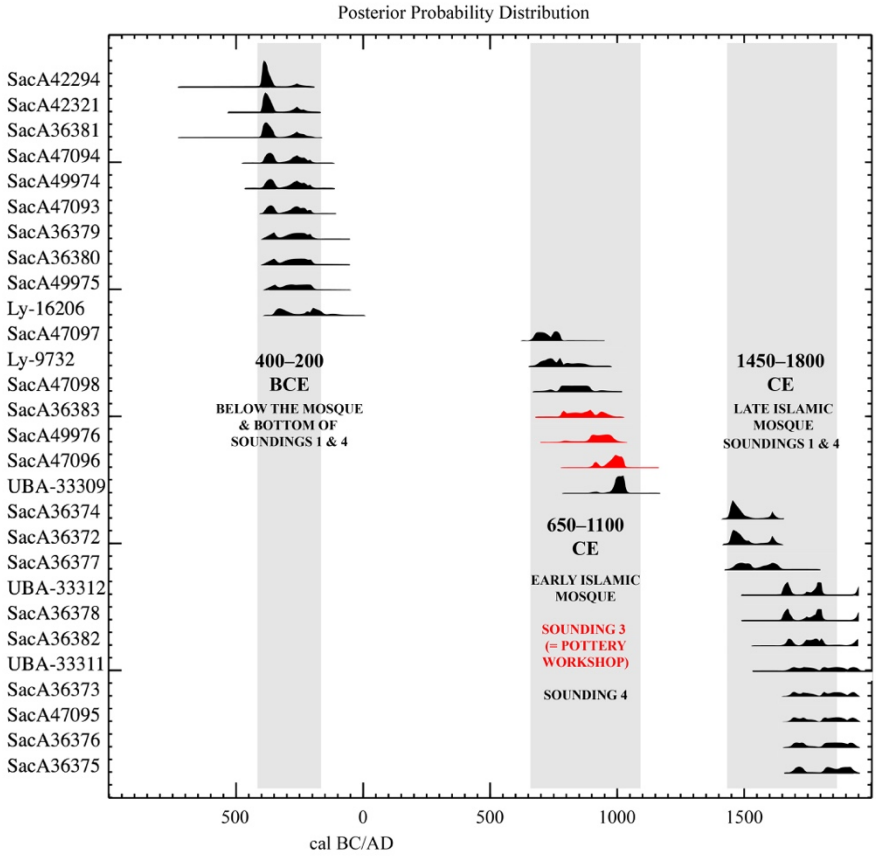


Figure 4. al-Yamāmah: Area G17 — Sounding 3: potter's tools, imported glazed ware, and local production: 1. turntable (?); 2–3. stone grinders; 4–5. imported turquoise-blue alkaline-glazed ware; 6–8. white opaque glazed ware; 9–14. sherds of COMM.BUFF (cat. 1) (F. Lesguer, Th. Sagory, and J. Schiettecatte,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

[1] 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 ^{14}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.

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.



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)	*Tamarix sp.*	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)	*Phoenix dactylifera*	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)

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). Available at http://calib.org (accessed 19/09/2019). Calibrated with IntCal13 curve (Reimer et al. 2013).

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.[2] 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%
TOTAL				**6 (0.5%)**	**88 (7.7%)**	**660 (57.8%)**	**387 (33.9%)**	**1141**	**100%**

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).

[2] 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.

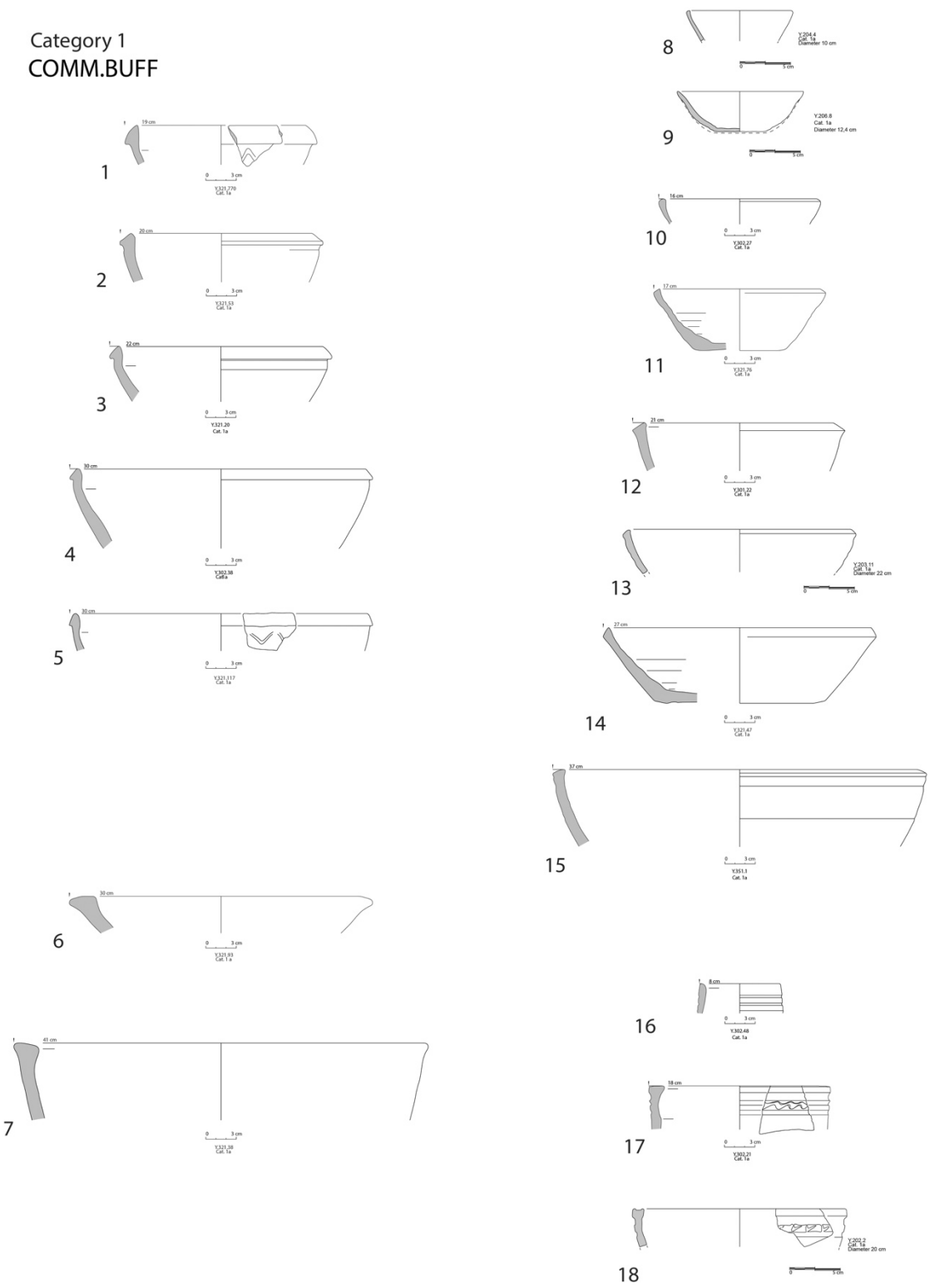


Figure 7. al-Yamāmah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – bowls and basins (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

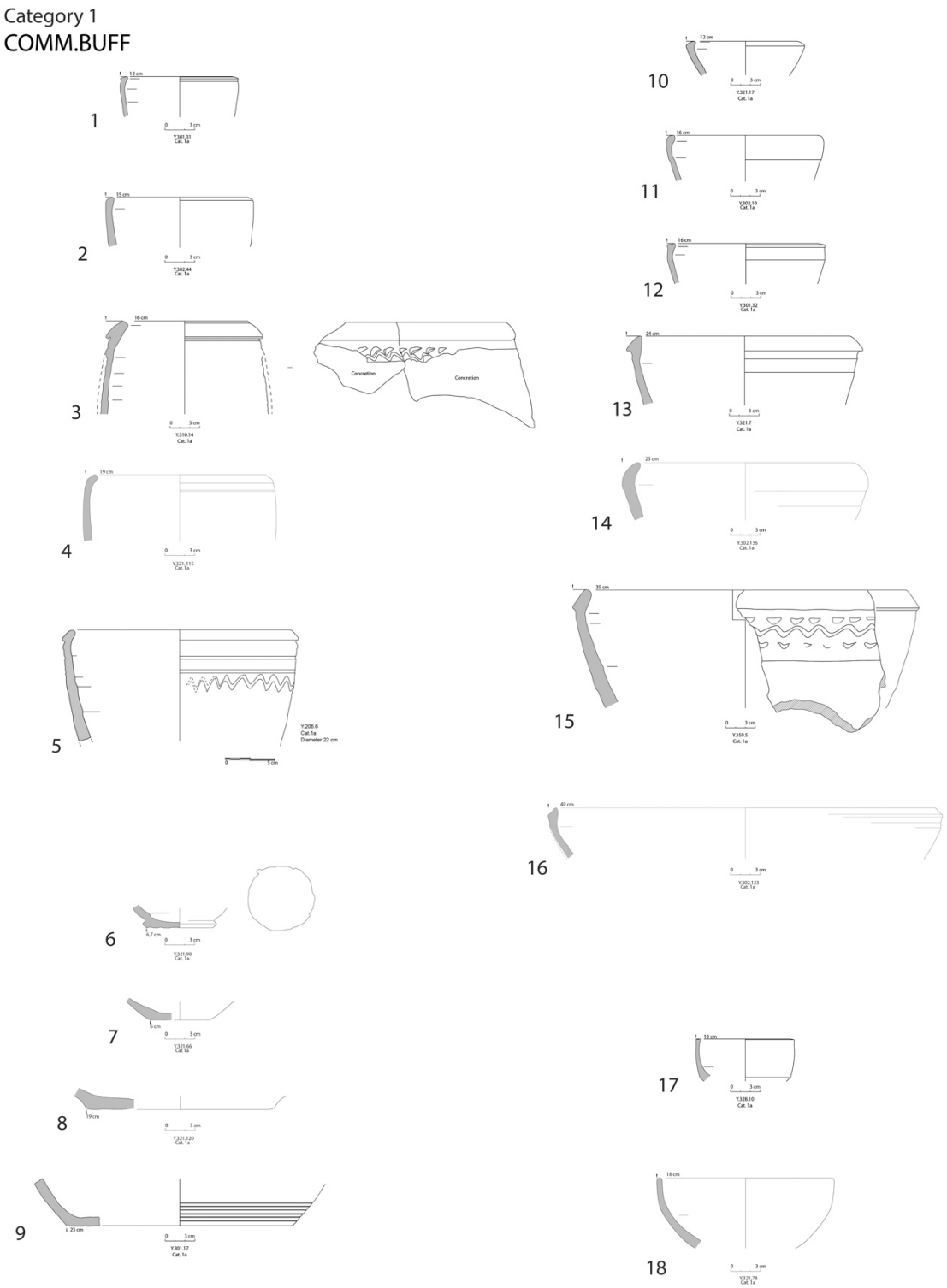


Figure 8. al-Yamāmah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – bowls and basins (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

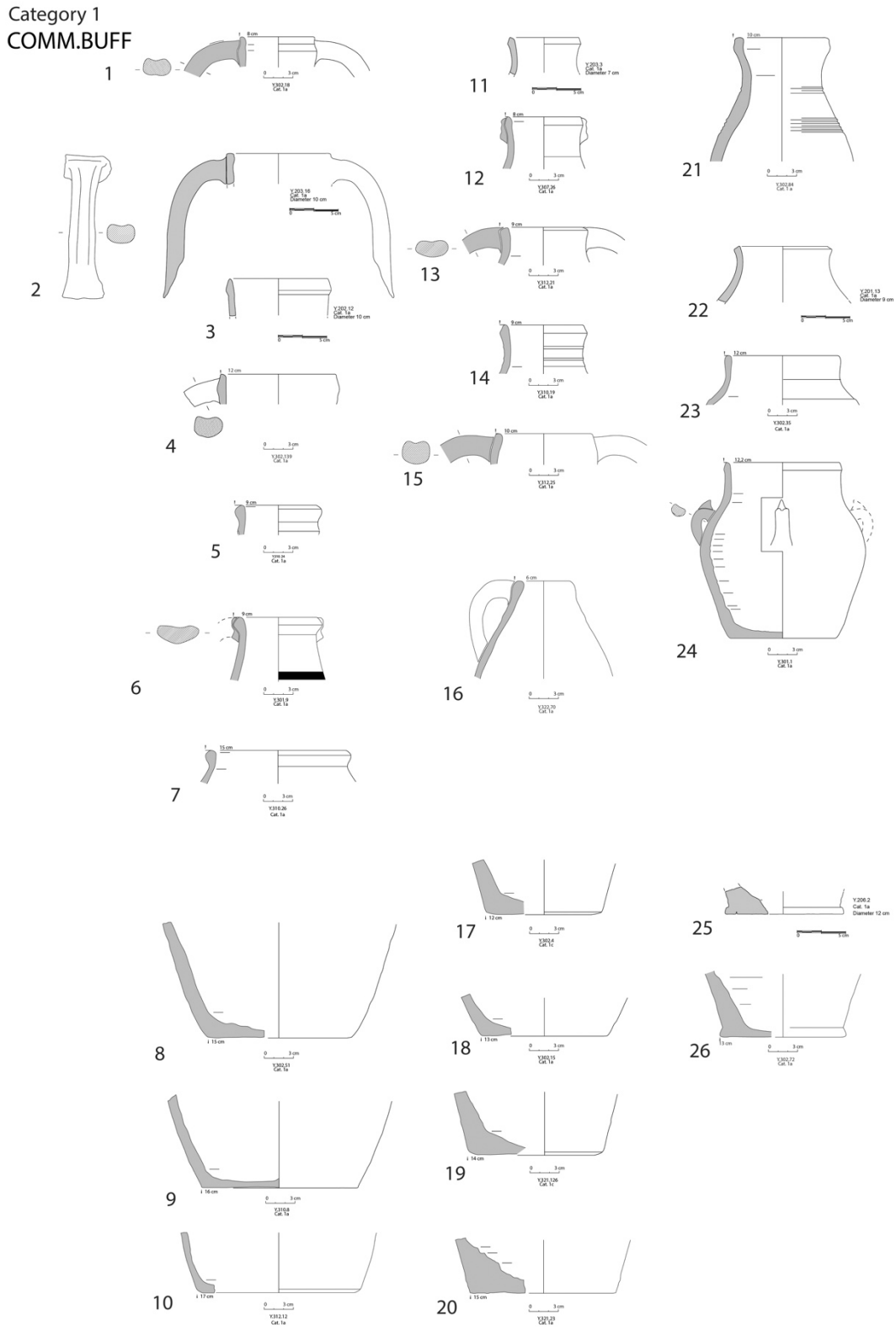
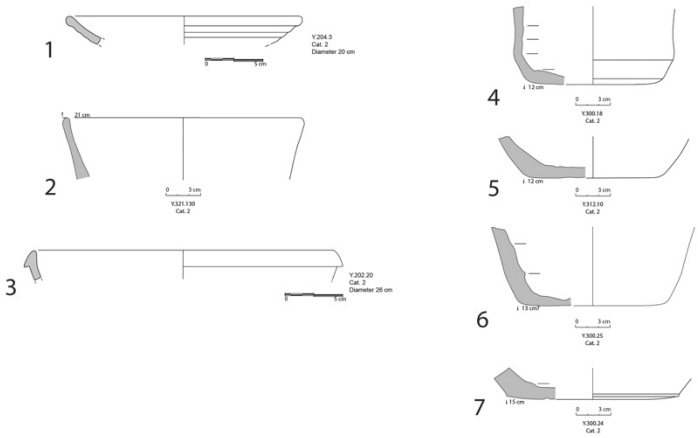


Figure 9. al-Yamāmah: Area G17 — Sounding 3: COMM.BUFF (cat. 1) – jars (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

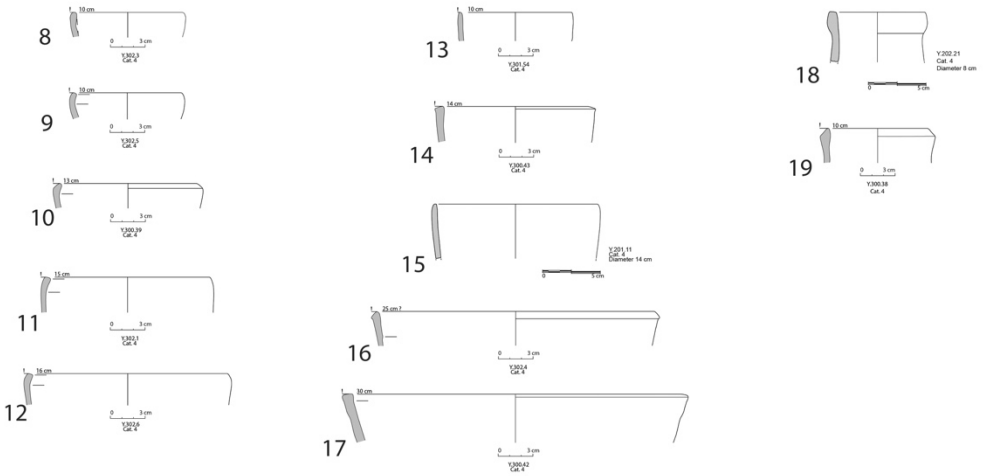
Category 2

COMM.RED



Category 4

MED.RED



Category 28

FIN.GREEN

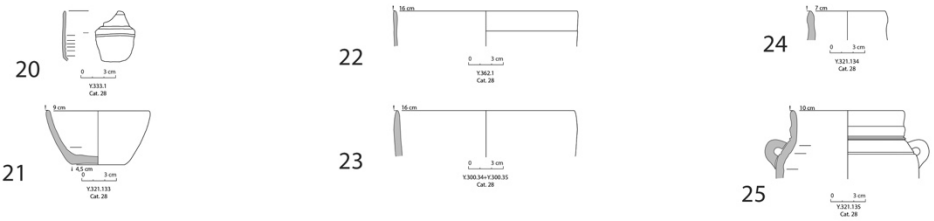


Figure 10. al-Yamāmah: Area G17 — Sounding 3: COMM.RED (cat. 2), MED.RED (cat. 4), and FIN.GREEN (cat. 28) (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

Category 35
MED.CREAM.SLP

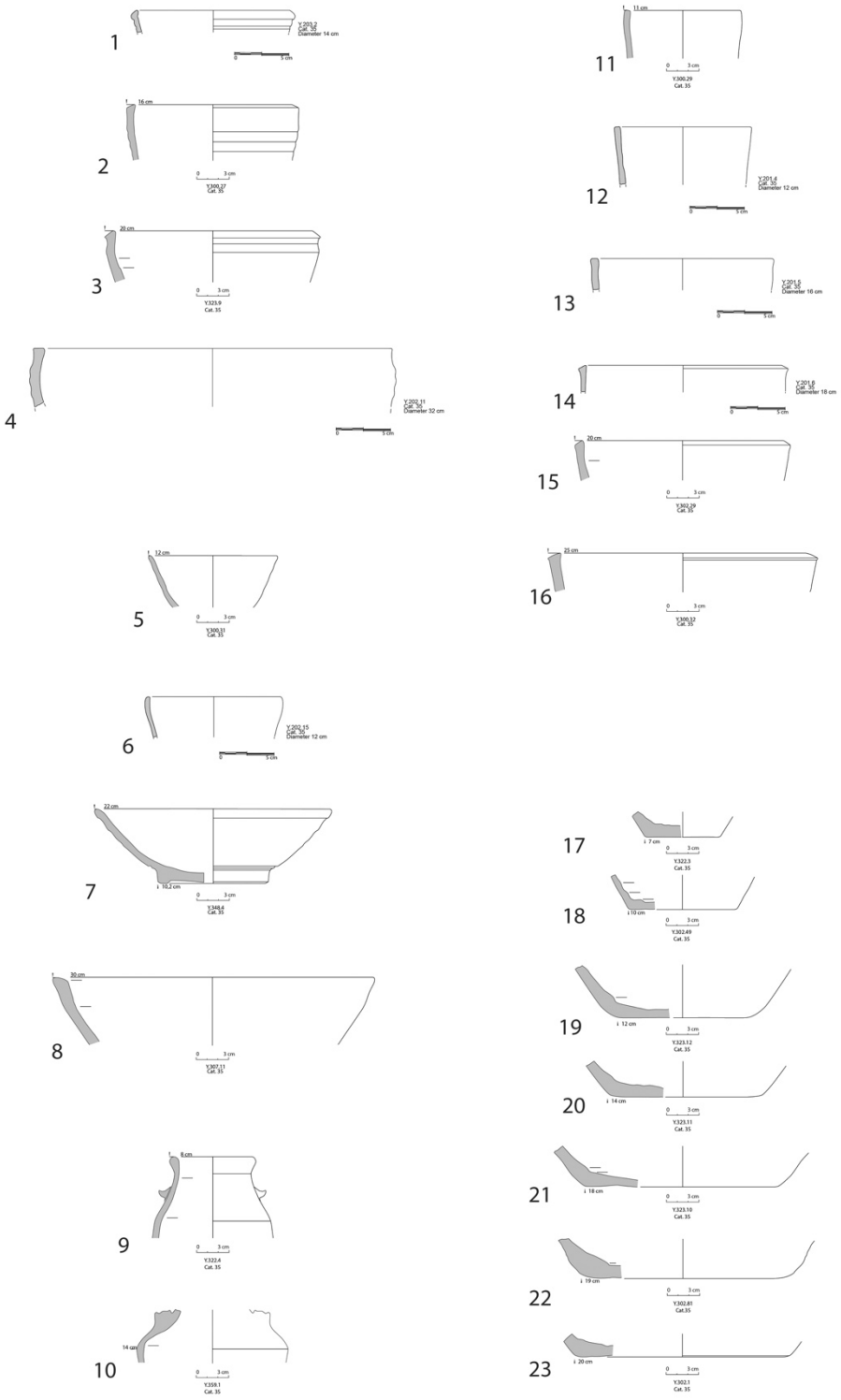


Figure 11. al-Yamāmah: Area G17 — Sounding 3: MED.CREAM.SLP (cat. 35) (L. Munduteguy, Saudi French Archaeological Mission in al-Kharj).

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 (Al_2O_3) and silica (SiO_2). The sandy phase is generally siliceous and therefore provides mainly silica (SiO_2) and also titania (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), nikel (Ni), rubidium (Rb), strontium (Sr), vanadium (V), zinc (Zn), zirconium (Zr). The selected oxides of major elements are CaO, Fe_2O_3, P_2O_5, TiO_2, K_2O, SiO_2, Al_2O_3, MgO, MnO (Schmitt, Cantin & Thirion-Merle 2009: 134). The Na_2O 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.

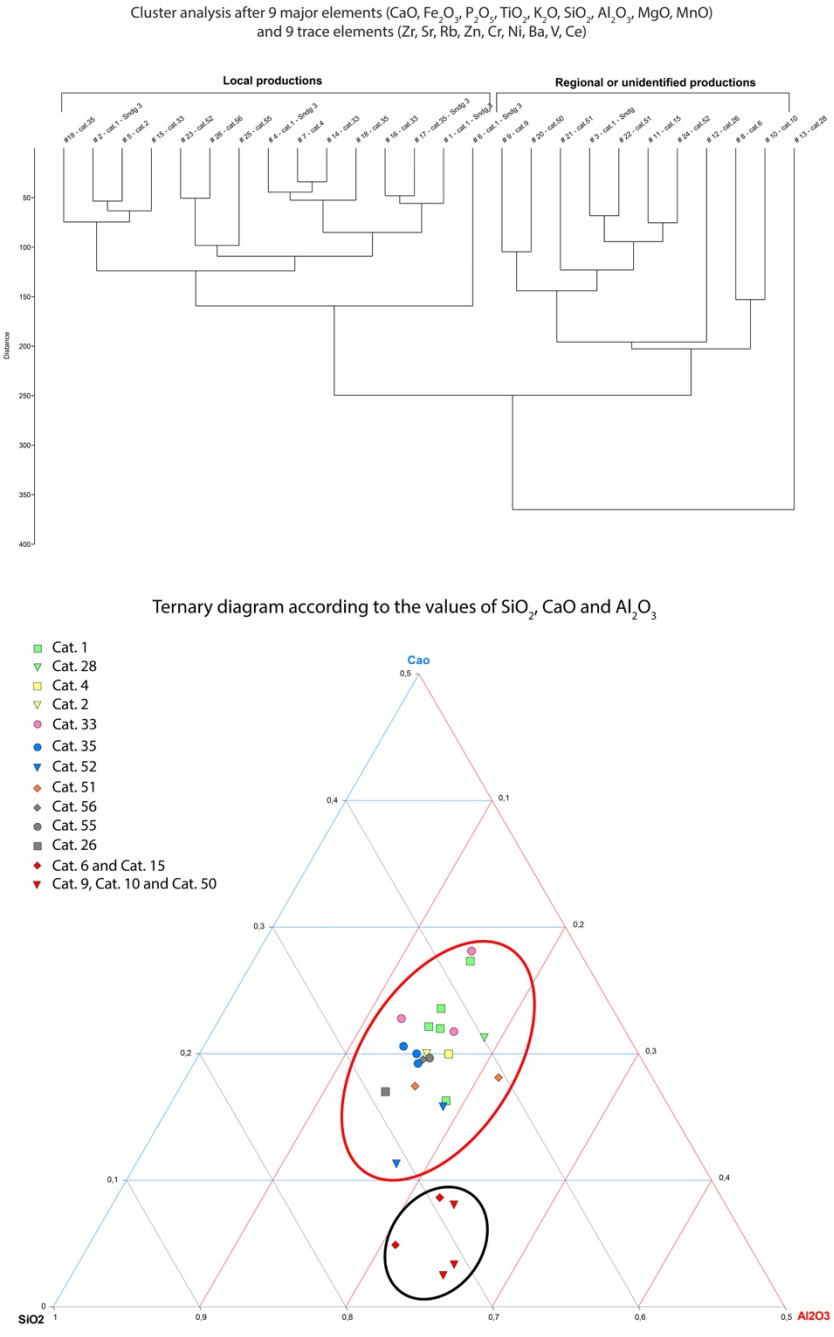


Figure 12. Top: cluster analysis of the pottery samples from al-Yamāmah based on eighteen chemical components: CaO, Fe2O3, P2O5, TiO2, K2O, SiO2, Al2O3, MgO, MnO, Zr, Sr, Rb, Zn, Cr, Ni, Ba, V, Ce. Bottom: ternary diagram with the distribution of the pottery samples from al-Yamāmah according to the values of SiO2, CaO, and Al2O3 (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 (SiO_2), alumina (Al_2O_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 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 $LiBO_2$ 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_2O_3), titanium oxide (TiO_2), potassium oxide (K_2O), silicon dioxide (SiO_2), aluminium oxide (Al_2O_3), magnesium oxide (MgO), manganese oxide (MnO), sodium oxide (Na_2O), and phosphorus pentoxide (P_2O_5). 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),

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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Authors' addresses
Fabien Lesguer, Université Paris 1 Panthéon-Sorbonne, UMR 8167 Orient & Méditerranée, Eveha, 82 boulevard de
Sarrebruck, 44000 Nantes, France.
e-mail fabien.lesguer@gmail.com
Jérémie Schiettecatte, CNRS, UMR 8167 Orient & Méditerranée, 27 rue Paul Bert, 94204 Ivry-sur-Seine Cedex, France.
e-mail j.schiettecatte@cnrs.fr

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).

OXIDES OF MAJOR ELEMENTS (%)													
Sample #	Pottery category	Provenance	SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	PF
1710046	1 - COMM.BUFF	Area G17 - Sounding 3 - UF 302	49,37	11,78	4,47	0,06	5,21	18,85	1,77	1,02	0,65	0,20	6,93
1710047	1 - COMM.BUFF	Area G17 - Sounding 3 - UF 302	41,71	9,63	3,79	0,05	4,79	14,59	2,63	1,83	0,54	0,17	21,20
1710048	1 - COMM.BUFF	Area N6 - Sounding 1 - UF 057	55,54	15,99	4,64	0,04	2,70	13,90	0,76	1,67	0,90	0,20	3,16
1710049	1 - COMM.BUFF	Area G17 - Sounding 3 - UF 302	42,88	11,02	4,66	0,06	4,52	20,24	2,00	1,18	0,63	0,19	12,77
1710051	1 - COMM.BUFF	Area G17 - Sounding 3 - UF 302	49,44	12,22	4,69	0,06	4,82	17,37	1,27	1,38	0,74	0,22	6,83
1710050	2 - COMM.RED	Surface	44,83	10,80	4,06	0,06	4,89	13,90	0,95	2,09	0,63	0,22	16,35
1710052	4 - MED.RED	Surface	48,57	13,15	3,57	0,04	4,05	15,40	0,62	1,45	0,74	0,22	11,84
1710053	6 - PINK.COOK	Surface	65,52	18,51	4,28	0,02	1,33	4,32	1,32	2,00	1,22	0,21	1,48
1710054	9 - LAYLA	Surface	58,65	19,98	8,00	0,02	1,49	6,89	0,56	1,08	1,13	0,21	2,45
1710055	10 - LAYLA.GLOSS	Surface	64,54	22,75	4,95	< L.D.	0,86	2,22	0,44	1,02	1,36	0,13	1,89
1710056	15 - BLACK&RED	Area N6 - Sounding 1 - UF 060	56,24	17,95	5,09	0,03	2,30	7,01	0,87	2,18	0,96	0,25	7,60
1710057	26 - YEL.SANDY	Surface	57,16	11,81	5,11	0,06	2,98	14,12	1,29	1,67	0,73	0,20	4,69
1710058	28 - FIN.GREEN	Surface	51,10	16,07	4,30	0,05	3,44	18,14	0,62	1,25	0,84	0,17	5,19
1710059	33 - FIN.CREAM.SLP	Surface	46,40	12,41	4,27	0,05	4,25	16,34	0,96	2,44	0,71	0,27	12,58
1710060	33 - FIN.CREAM.SLP	Surface	51,17	9,80	3,99	0,06	3,19	17,98	0,64	1,91	0,58	0,19	11,20
1710061	33 - FIN.CREAM.SLP	Surface	39,87	10,11	3,91	0,06	4,16	19,54	1,07	2,04	0,62	0,34	18,35
1710062	35 - MED.CREAM.SLP	Area G17 - Sounding 3 - UF 302	51,53	11,74	4,70	0,06	5,26	15,81	0,93	1,92	0,71	0,19	8,02
1710063	35 - MED.CREAM.SLP	Surface	49,31	10,24	3,74	0,05	2,82	15,43	0,91	2,25	0,63	0,28	14,04
1710064	35 - MED.CREAM.SLP	Surface	53,56	12,53	3,27	0,04	2,25	15,73	0,62	1,51	0,70	0,30	9,08
1710065	50 - PSEUDO.LAYLA	Area G17 - Sounding 3 - UF 300	60,81	22,06	5,83	0,02	0,83	2,86	0,40	0,85	1,31	0,13	5,07
1710066	51 - CRUMB.GREEN	Area N6 - Trench D - UF 502	51,25	18,11	6,33	0,06	4,13	15,34	1,32	1,60	1,00	0,15	0,75
1710067	51 - CRUMB.GREEN	Area N6 - Trench D - UF 502	53,64	12,91	4,87	0,05	4,39	14,05	1,66	1,45	0,80	0,28	5,21
1710068	52 - HAND.CREAM.SLP	Area N6 - Trench D - UF 502	56,08	14,09	3,81	0,04	2,27	8,93	1,12	2,61	0,84	0,19	9,09
1710069	52 - HAND.CREAM.SLP	Area N6 - Trench D - UF 502	53,86	15,43	5,11	0,07	3,06	13,01	0,95	2,86	0,89	0,23	5,42
1710070	55 - GREEN.SCRATCHY	Area N6 - Trench D - UF 502	53,23	13,13	4,45	0,05	4,13	16,23	1,15	1,56	0,79	0,22	5,54
1710071	56 - FIN.SCRATCHY	Area N6 - Trench D - UF 502	53,14	12,69	4,22	0,05	3,93	15,98	0,69	1,80	0,75	0,19	6,97

TRACE ELEMENTS (ppm)																							
Sample #	As	As	Ba	Be	Bi	Cd	Ce	Co	Cr	Cs	Cu	Dy	Er	Eu	Ga	Gd	Ge	Hf	Ho	In	La	Lu	Mo
1710046	2,2052	2,205	164,887	1,221	< L.D.	0,177	50,661	12,519	116,792	1,243	31,716	3,080	1,701	0,994	14,758	3,547	0,832	5,112	0,634	< L.D.	21,288	0,273	0,809
1710047	6,6904	6,690	155,937	0,957	0,121	0,300	41,705	10,951	89,714	1,266	22,729	2,439	1,365	0,746	12,159	2,653	0,842	3,940	0,494	0,036	17,683	0,218	1,355
1710048	5,9461	5,946	206,047	1,589	0,111	0,094	61,997	11,066	130,113	2,352	32,863	4,476	2,411	1,363	20,541	4,792	1,102	6,197	0,905	0,057	26,794	0,373	0,561
1710049	7,6208	7,621	194,310	1,097	0,113	0,142	39,947	12,403	111,504	0,525	20,340	2,755	1,590	0,768	13,922	2,902	0,993	4,765	0,584	0,040	18,063	0,255	0,675
1710051	8,8156	8,816	203,582	1,255	0,132	0,252	66,697	12,946	123,912	1,878	22,793	3,321	1,864	1,062	15,831	3,635	1,078	7,461	0,691	0,047	28,387	0,304	0,999
1710050	14,3784	14,378	197,919	1,155	0,133	0,229	41,138	12,023	91,235	1,945	18,107	3,034	1,748	0,849	13,555	3,080	0,884	4,581	0,635	0,042	18,239	0,281	1,067
1710052	7,3533	7,353	183,325	1,334	0,151	0,166	50,009	9,058	98,398	2,179	20,174	3,644	2,018	1,092	16,302	3,820	0,914	4,355	0,753	0,050	21,342	0,320	1,594
1710053	12,8816	12,882	124,176	1,288	0,079	0,076	49,283	7,757	111,527	2,683	15,622	4,064	2,433	1,158	23,388	3,998	1,022	8,972	0,867	0,048	22,345	0,425	1,093
1710054	5,8816	5,882	170,558	1,773	0,125	0,099	100,016	7,582	131,926	3,013	18,498	5,777	3,249	1,837	26,889	6,224	1,464	8,735	1,190	0,061	43,605	0,523	1,179
1710055	4,078	4,078	148,407	1,956	0,110	0,101	142,909	7,752	132,128	3,045	22,554	11,067	5,618	3,616	29,629	12,382	1,611	7,546	2,183	0,073	61,562	0,776	0,767
1710056	16,7724	16,772	133,508	1,602	0,129	0,144	68,281	9,926	121,364	2,278	19,424	5,355	3,030	1,356	22,431	5,095	1,210	6,114	1,138	0,052	28,539	0,478	1,082
1710057	3,0321	3,032	300,985	1,378	< L.D.	0,043	51,400	12,768	117,641	2,310	22,811	4,242	2,420	1,094	15,986	4,377	1,052	6,602	0,886	< L.D.	23,088	0,379	1,160
1710058	3,0759	3,076	516,362	1,401	< L.D.	0,075	58,243	11,362	131,489	1,652	15,597	3,788	2,127	1,188	20,370	4,250	1,166	5,170	0,777	0,036	25,581	0,341	0,789
1710059	13,5235	13,524	183,231	1,270	0,148	0,295	55,991	11,438	99,474	2,352	24,654	4,274	2,438	1,032	15,443	3,974	0,963	4,646	0,906	0,044	24,029	0,374	0,908
1710060	7,0438	7,044	197,874	1,062	0,120	0,247	36,976	11,671	86,644	1,624	21,650	2,655	1,568	0,722	12,539	2,782	0,872	4,235	0,571	0,037	16,716	0,256	0,737
1710061	12,8582	12,858	187,790	1,031	0,126	0,209	43,317	10,141	100,501	1,002	22,986	3,347	1,891	0,931	13,108	3,522	0,914	4,100	0,696	0,039	18,962	0,289	0,849
1710062	7,4714	7,471	205,432	1,237	0,223	0,186	55,076	12,561	109,378	1,878	23,755	3,084	1,730	0,949	14,130	3,349	1,010	4,949	0,639	0,043	23,207	0,280	1,273
1710063	301,1435	301,144	182,496	1,090	0,105	0,176	43,337	9,741	90,164	1,238	18,465	2,905	1,665	0,872	12,447	3,186	0,926	5,198	0,613	0,036	18,812	0,269	0,852
1710064	8,3524	8,352	244,039	1,337	0,096	0,143	49,585	8,854	90,445	1,933	22,422	3,620	2,027	1,087	15,379	3,937	0,908	4,763	0,742	0,044	21,617	0,323	1,312
1710065	2,9747	2,975	125,149	1,970	0,168	0,146	135,295	9,541	133,071	2,746	31,241	11,384	5,938	3,504	28,641	12,612	1,736	7,718	2,305	0,075	58,151	0,813	0,545
1710066	1,5383	1,538	144,302	2,251	< L.D.	0,122	65,900	14,906	136,841	3,889	15,480	4,559	2,619	1,214	23,681	4,616	1,157	5,147	0,946	< L.D.	30,357	0,425	0,685
1710067	3,7978	3,798	156,184	1,364	< L.D.	0,110	55,251	12,528	114,563	2,463	25,347	4,314	2,310	1,233	16,827	4,483	0,953	5,782	0,864	0,051	23,761	0,335	0,739
1710068	11,3423	11,342	151,478	1,331	0,170	0,152	120,113	8,707	98,003	1,858	21,210	3,380	1,905	1,407	17,860	4,231	1,097	5,421	0,679	0,054	39,194	0,312	1,144
1710069	10,0058	10,006	171,174	1,714	0,216	0,199	56,864	13,936	120,050	3,238	19,152	4,035	2,231	1,127	19,739	4,063	1,020	5,516	0,825	0,056	24,858	0,362	1,345
1710070	3,644	3,644	214,476	1,353	< L.D.	0,071	57,802	11,937	116,956	1,885	24,737	3,035	1,754	0,858	16,657	3,084	0,949	6,402	0,614	< L.D.	25,356	0,290	0,719
1710071	11,3461	11,346	167,580	1,284	0,131	0,142	81,433	10,456	98,853	1,802	21,124	2,710	1,526	0,882	15,564	3,065	1,012	4,792	0,552	0,039	31,754	0,260	0,795

Sample #	Nb	Nb	Nd	Ni	Pb	Pr	Rb	Sc	Sb	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zn	Zr
1710046	9,9348	9,935	21,582	61,120	3,145	5,667	16,348	13,110	0,162	4,308	0,914	603,322	0,828	0,524	5,842	0,261	2,486	97,442	< L.D.	16,236	1,790	60,807	198,954
1710047	8,1055	8,106	17,452	56,792	8,852	4,646	31,766	10,870	0,308	3,417	1,683	472,889	0,669	0,413	4,782	0,207	2,027	80,193	0,811	13,093	1,413	56,313	152,297
1710048	14,1661	14,166	27,221	61,228	28,357	6,980	40,413	18,530	0,434	5,790	2,677	385,319	1,159	0,755	7,374	0,359	2,289	91,332	0,826	22,572	2,474	62,693	239,106
1710049	9,4505	9,451	16,459	62,248	4,593	4,303	16,048	12,400	0,371	3,406	1,949	527,520	0,790	0,458	6,316	0,234	2,289	80,526	< L.D.	15,359	1,649	70,509	183,891
1710051	10,8027	10,803	28,217	65,278	5,700	7,452	26,715	13,880	0,430	4,923	2,341	601,667	0,889	0,548	6,660	0,288	2,642	98,048	< L.D.	18,068	1,991	66,628	300,658
1710050	9,2119	9,212	17,356	51,505	19,238	4,525	43,365	11,830	0,336	3,629	1,923	460,147	0,795	0,499	5,733	0,267	1,774	97,119	0,821	16,865	1,820	61,998	172,944
1710052	11,4646	11,465	21,698	46,244	22,342	5,526	35,817	15,200	0,316	4,485	2,187	531,457	0,951	0,599	5,938	0,302	2,066	83,139	0,881	18,920	2,057	56,422	163,664
1710053	15,1281	15,128	21,959	23,408	12,226	5,466	41,918	19,040	0,361	4,894	3,241	253,286	1,270	0,655	7,981	0,385	2,987	172,079	1,327	21,488	2,722	45,874	350,471
1710054	18,4767	18,477	44,125	39,738	10,171	11,331	40,117	23,120	0,388	8,344	2,960	403,466	1,499	0,957	8,945	0,495	3,447	125,477	1,142	30,315	3,391	54,316	344,429
1710055	16,7929	16,793	69,237	30,947	15,349	17,229	34,786	26,090	0,477	14,982	3,498	171,390	1,375	1,904	8,477	0,804	3,099	136,686	1,207	55,984	5,242	57,706	277,237
1710056	12,1718	12,172	27,846	36,377	11,107	7,542	43,175	18,920	0,336	5,569	3,849	400,945	1,016	0,858	7,417	0,444	2,119	176,004	1,091	28,498	3,098	61,435	233,858
1710057	9,307	9,307	23,508	47,167	28,814	5,934	40,629	13,540	0,397	4,941	1,793	261,217	0,809	0,685	7,412	0,355	1,941	104,423	< L.D.	23,700	2,461	59,126	253,424
1710058	12,3943	12,394	25,428	61,076	5,004	6,472	33,002	17,920	0,271	5,189	1,976	470,547	1,055	0,639	7,087	0,311	2,292	112,655	< L.D.	20,262	2,203	54,603	196,071
1710059	10,5228	10,523	23,090	59,700	16,824	6,056	44,864	13,970	0,393	4,465	2,273	533,769	0,878	0,679	6,146	0,348	2,113	107,163	0,944	23,956	2,446	67,093	175,635
1710060	9,0936	9,094	15,422	58,250	9,636	3,992	35,628	10,790	0,332	3,127	1,823	416,880	0,764	0,438	5,126	0,231	1,650	70,708	< L.D.	15,049	1,615	61,667	160,527
1710061	9,6246	9,625	19,229	59,899	21,492	4,916	27,187	11,510	0,388	4,129	1,999	614,522	0,802	0,560	5,608	0,275	2,009	82,222	< L.D.	18,500	1,893	72,331	154,653
1710062	10,6068	10,607	22,550	61,803	10,673	5,899	42,079	13,020	0,390	4,209	2,109	615,408	0,882	0,515	6,039	0,256	2,476	88,987	0,905	16,504	1,809	66,584	190,892
1710063	8,6087	8,609	18,824	46,382	14,089	4,857	30,876	11,590	4,990	3,791	1,824	558,516	0,728	0,493	5,357	0,243	2,125	82,150	< L.D.	16,362	1,711	54,197	204,764
1710064	11,0065	11,007	22,123	39,800	16,835	5,585	34,868	14,190	0,320	4,603	2,067	459,615	0,920	0,606	5,732	0,291	1,996	75,746	0,820	18,797	2,058	56,324	182,849
1710065	17,1728	17,173	65,844	35,020	10,930	16,193	30,605	25,210	0,404	14,178	3,396	333,909	1,421	1,946	8,573	0,827	3,152	121,399	0,999	60,245	5,471	66,324	294,553
1710066	14,7071	14,707	27,012	60,264	2,005	7,142	36,416	18,960	0,173	5,467	0,898	289,127	1,252	0,732	11,361	0,392	2,333	171,754	0,896	24,512	2,668	61,449	188,177
1710067	14,9772	14,977	24,431	54,472	7,799	6,183	18,476	14,990	0,368	5,198	2,551	353,543	1,205	0,697	6,611	0,327	2,462	88,090	< L.D.	22,890	2,218	72,938	224,932
1710068	11,7129	11,713	53,401	39,965	18,992	13,738	36,452	15,780	0,409	7,638	2,968	488,673	0,974	0,575	7,637	0,282	2,142	124,147	1,008	17,804	1,983	59,231	201,663
1710069	12,816	12,816	23,501	56,320	13,563	6,081	68,014	16,780	0,396	4,818	2,705	369,233	1,065	0,635	8,316	0,330	2,169	138,755	1,169	20,851	2,284	61,040	208,038
1710070	11,4911	11,491	22,342	60,404	7,767	5,993	24,810	14,500	0,197	3,962	1,111	514,520	0,976	0,481	6,955	0,259	2,397	119,189	< L.D.	16,588	1,840	59,541	248,926
1710071	10,3784	10,378	30,468	53,152	9,548	8,453	37,599	14,060	0,354	4,630	2,110	499,406	0,855	0,444	6,409	0,229	2,162	113,390	0,853	14,621	1,604	53,693	184,580