I. A Chalcolithic kiln in the Bora Plain

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This chapter outlines the results of the excavation of a Chalcolithic kiln found in the Bora Plain (UTM 38N 512258 E; 3999222 N), underneath the Iron Age structures of the Dinka Settlement Complex in operation DLT3 (**Fig. A3**). The fieldwork was made possible by a Rust Family Foundation Archaeology Grant awarded to Andrea Squitieri and Mark Altaweel (UCL) and took place between 19 April and 5 May 2019.

I.1 The discovery of the kiln and the goals of the 2019 excavation

Andrea Squitieri & Mark Altaweel

In 2015, during the first fieldwork season of the Peshdar Plain Project whose excavation component targeted Gird-i Bazar, three geoarchaeological trenches (GA40, GA41, and GA42) were opened between Gird-i Bazar and Qalat-i Dinka in order to investigate the geology of the Bora Plain[382]. At that time, these trenches were deemed to be "off-site" as there was no evidence for the existence of archaeological features in the flat area in between Gird-i Bazar and Qalat-i Dinka; the settlement's full extent only became apparent in autumn 2016 after conducting an extensive magnetometer survey[383].

The third of these trenches (GA42) was opened about 400 m southwest of Gird-i Bazar. Excavated by backhoe, it measured about 3×8 m and reached a maximum depth of about 5 m. During its excavation, some archaeological features were intercepted, including a wide burnt area appearing in section, about 1.5-2 m below the surface, that was thought to possibly be a kiln[384]. In autumn 2018, because of the promising Iron Age ^{14}C date retrieved from GA42[385], we resumed excavations in this location by opening a 8×10 m trench (dubbed DLT3), designed to include GA42 (**Fig. I1**). Its archaeological excavation uncovered parts of three buildings (designated Q, R, and S) that are firmly dated to the Iron Age on the basis of pottery and radiocarbon datings[386] (**§A**).

During the 2018 excavations, the GA42 geoarchaeological trench was partially reopened, and the burnt area was re-exposed. We investigated this burnt area from the old 2015 section without removing the Iron Age wall above it. This new work confirmed that the structure was indeed a kiln, with a partially-exposed central column and fills on either side that contained burnt layers combined with collapsed architectural elements[387] (**Figs. I2**, **I3**). It also became clear that the kiln partially cut into a layer of natural pebbles beneath it[388]. Based on preliminary observations made by Jean-Jacques Herr, the pottery collected from the kiln was dated to the Chalcolithic period[389]. Opposite the kiln, a portion of a floor (Locus:226922:055) was intercepted about 50 cm beneath the Iron Age floor of Building R's Room 64[390] (**Fig. I4**). On the floor Locus:226922:055, some pottery was found that was also dated to the Chalcolithic period[391].

The pottery survey conducted by Jessica Giraud and her team in 2013 and 2015 had found Chalcolithic pottery throughout the Bora Plain[392]; however, no structures related to this period were exposed during our excavations at Gird-i Bazar, DLT2, and the operations on the western slope of Qalat-i Dinka. The discovery of Chalcolithic features in DLT3 in 2018 came as a complete surprise.

382 Altaweel/Marsh 2016.

383 Fassbinder/Ašandulesei/Scheiblecker 2017.

384 Altaweel/Marsh 2016, 27, Fig. B2.6.

385 Altaweel/Marsh 2016, 28, Fig. B2.7.

386 Radner/Kreppner/Squitieri (ed.) 2019, 68-93.

387 Palmisano 2019, 75, Fig. E9.

388 This layer had become already visible in 2015 in the section of the test trench GA42 (Altaweel/Marsh 2016, Fig. B2.5), but it was then misinterpreted as a possible floor.

389 Palmisano 2019, 75; Herr 2019, 114.

390 Rohde 2019, 74-75.

391 Herr *et al.* 2019, 114. Initially, the pottery was preliminarily assigned to the Late Chalcolithic period; however, the 2019 excavations have permitted us to update the chronology (see the following discussion).

392 Giraud 2016.

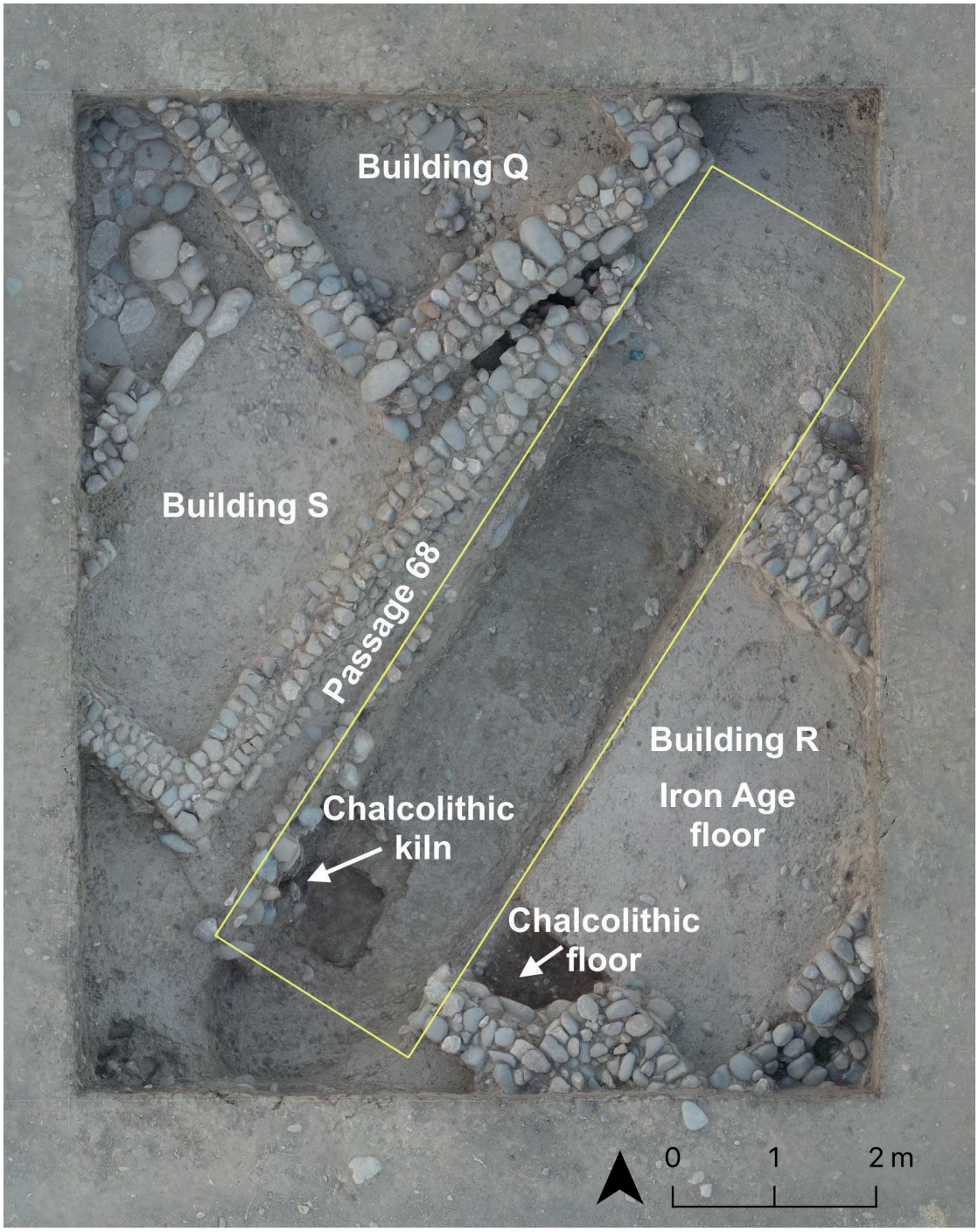

Fig. I1: Orthophoto of the excavation area DLT3 at the end of the 2018 excavations. It shows the Iron Age structures (Buildings Q, R, S and Passage 68), the limits (yellow line) of the 2015 geoarchaeological trench (GA42), and the Chalcolithic features found below the Iron Age remains. Prepared by Andrea Squitieri.

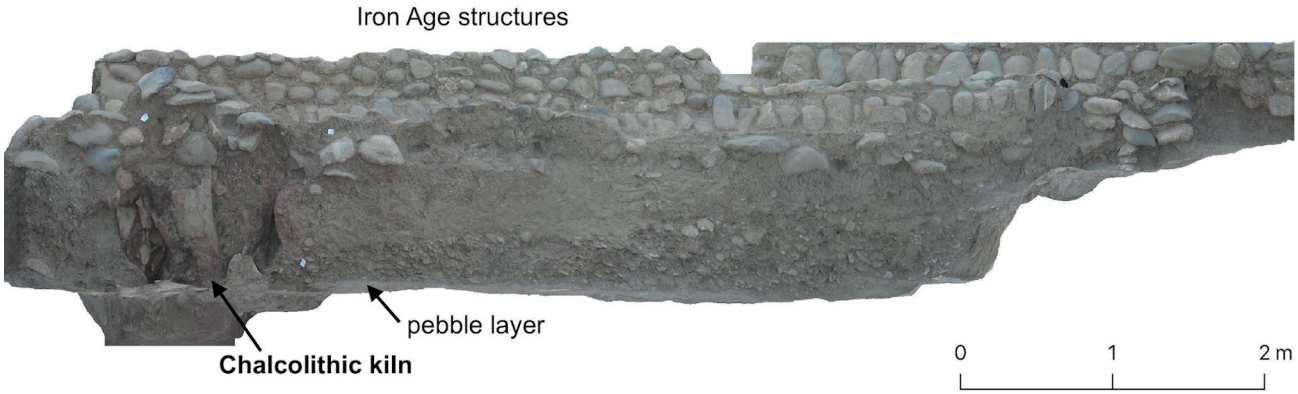

Fig. I2: Orthophoto of the northwestern section of the trench GA42 showing the Chalcolithic kiln at the end of the 2018 excavations, the Iron Age wall above it, and the natural pebble layer into which the kiln had been cut. Prepared by Andrea Squitieri.

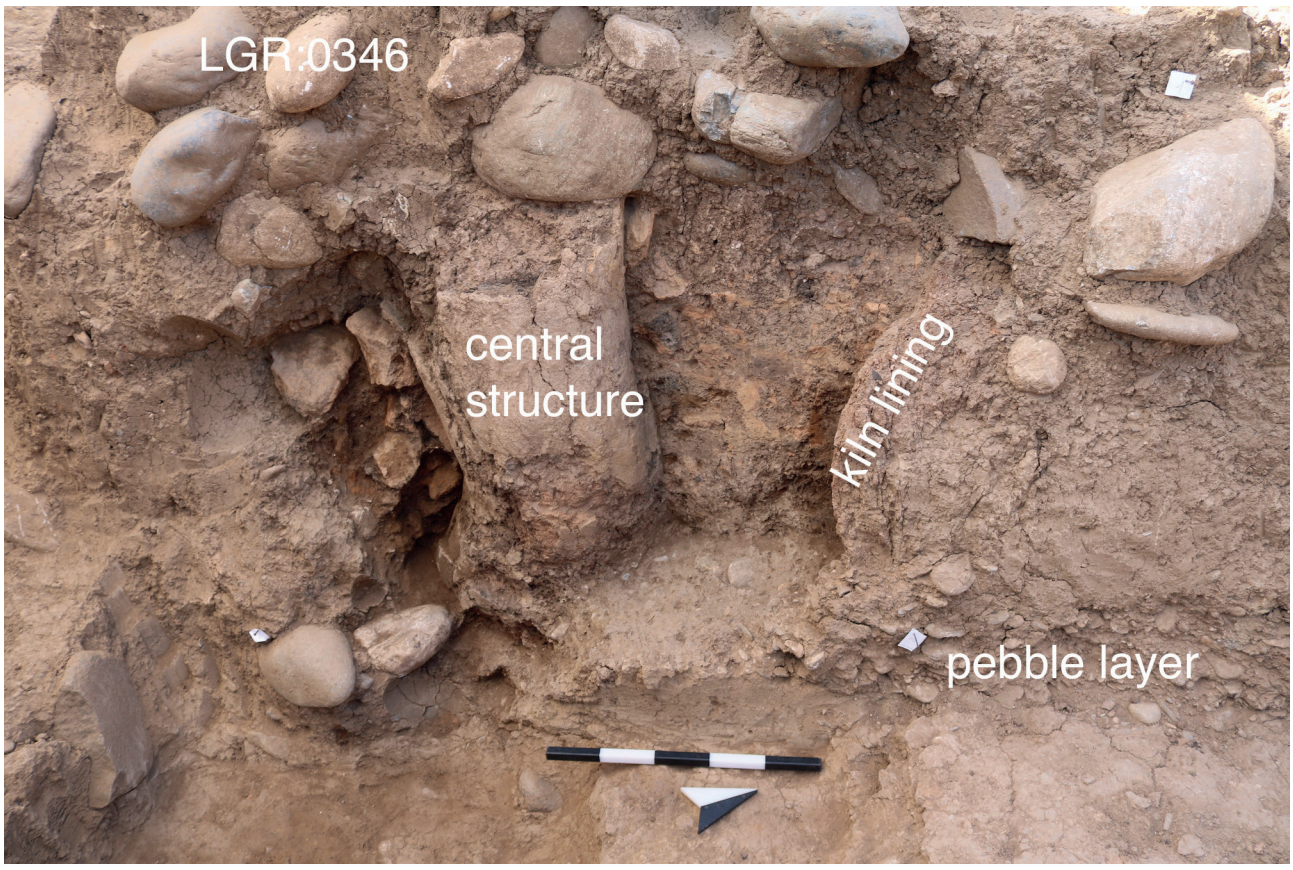

Fig. I3: The Chalcolithic kiln at the end of the 2018 excavations. Photo by Andrea Squitieri.

Fig. I4: The Chalcolithic floor under the Iron Age floor of Building R, at the end of the 2018 excavations. Photo by Jens Rohde.

Without the backhoe trench of GA42 and its exposure of archaeological layers, we would not have had any clue as to the existence of a Chalcolithic settlement in this area since they had been completely sealed by the Iron Age structures above, which were the focus of our 2018 excavation. The discovery of the kiln greatly contributes to our understanding of the Chalcolithic period in the Bora Plain, and more generally in the Peshdar Plain and the Zagros mountains that surround it, and this prompted us to seek further funding to continue the kiln's excavation in the spring of 2019 alongside the already scheduled geoarchaeological fieldwork campaign. The 2019 excavations of the Chalcolithic kiln had the following three goals:

- to excavate the pottery kiln in its entirety to uncover its structure;
- to analyse the pottery retrieved from a morphological and technological point of view through both macroscopic analysis and thin sections;
- to collect samples for radiocarbon dating, micromorphological analysis and archaeomagnetic analysis.

The excavation was continued according to the digital excavation methods established for the Peshdar Plain Project in 2015, entailing:

- the use of a MySQL-based database designed by Christoph Forster (Berlin, www.datalino.de);
- the use of a dGPS to allow 3D measurements of all stratigraphic units as well as relevant find spots (i.e., finds, samples), using the locus-collection registration system according to the Peshdar Plain Project protocol (as summarised in **§C1**);
- the creation of daily orthophotos and Digital Elevation Models by means of a DJI Phantom 4 Pro drone combined with the software Agisoft Metashape (an updated version of Agisoft PhotoScan);
- the creation of a 3D stratigraphy model through the visualisation of each stratigraphic unit (locus) within the Metashape-generated model by means of Autodesk AutoCAD 2018 software[393].

The sections below present a first assessment of the results and the outcome of some of the analyses carried out on the pottery material. Further results of the ongoing pottery, micromorphology, and archaeomagnetism analyses will be published once they have been completed.

I.2 2019 excavation results

Jens Rohde & Sophie Pietsch

In order to proceed with the excavation of the kiln, it was necessary to remove the Iron Age wall that superimposed it, called LGR:0346. This was the south-eastern portion of the wall of Passage 68, a narrow passage between the Iron Age Buildings S and R[394] (**Figs. I1**, **I2**, **I3**). Only about one third of the kiln is preserved, because it was destroyed in the south-west by the cut of the geoarchaeological trench GA42 while to the south it was damaged by an Iron Age disturbance (**Fig. I5**). The preserved structure of the kiln was given the locus number Locus:225922:056. Originally, the kiln consisted of two parts. The upper part was the firing chamber, which would have been above ground, while the lower part, comprising the combustion chamber, was recessed into the ground. The former, however, was not preserved. Only a few of its tumbled remains were found inside the kiln fill. The combustion chamber was dug into the ground from a floor or a surface destroyed by the Iron Age construction. Immediately below this structure, the highest parts of the combustion chamber could be observed. This chamber reaches down to the natural layer of pebbles called Locus:225922:089. Above this layer, there is a dark yellowish-brown soil with some pebbles into which the cut for the kiln, named Locus:225922:057, was dug.

The lining of the combustion chamber consists of heavily fired clay, grey-greenish in colour. At the rear of the

393 Squitieri/Rohde 2019.
394 Palmisano 2019, 75, Fig. E4.

Fig. I5: Orthophoto of the Chalcolithic kiln during the 2019 excavations. Grid with 50 cm spacing, annotated with UTM coordinates (North coordinates on the left, East coordinates on top). Photo by Jens Rohde. Prepared by Andrea Squitieri.

kiln, the lining has a reddish tinge, caused by the heat. The lining extends down almost vertically, only interrupted when it meets the bottom of the combustion chamber. The pebble layer, Locus: 225922:089, surfaces at the lowest part of the combustion chamber. A partially preserved column is found close to the center of the combustion chamber (**Figs. I6**, **I7**). This column has a diameter of about 30 cm and is made of a light-greyish, clayey material with a 3-4 cm thick lining. Its lower half is broken, and it now sits in a slightly slanted position because of destructive processes that occurred after the kiln ceased to be used.

The northwestern portion of the kiln was filled with a dark brown soil embedded with architectural elements from the uppermost construction, labelled LGR:0364 (made up of Locus:225922:049, Locus:225922:080, Locus:225922:082, Locus:225922:083 and Locus:225922:084) (**Fig. I8**). The architectural elements were gathered in several collections[395]. Among these, there were fragments with a plano-convex shape, which are part of the supporting structure located between the kiln edge and the central column (**Fig. I9**). These fragments come in a variety of sizes. There were also fragments that are flat on one side and concave on the other, which probably helped to fix the plano-convex elements between the column and the kiln edge. Some curved fragments were possibly part of the perforated kiln floor (**Fig. I10**). Several thick pieces with a flattish shape probably belonged to the outer construction of the firing chamber. Overall, the kiln fill yielded various architectural fragments belonging to the intermediate zone between the two chambers as well as fragments belonging to the outer edge of the firing chamber. Several samples were taken from the kiln fill for an array of purposes, such as phytolith analysis, micro-debris flotation, pyrotechnology, and micromorphology. There were a few finds in this fill, namely some pottery sherds, and a few flint and obsidian fragments (PPP 225922:080:010, PPP 225922:083:003, PPP 225922:083:005 and PPP 225922:084:003).

Above the kiln, deposit LGR:0365 covered the preserved remains of the combustion chamber. This is a moist, clayey, greyish-brown soil containing a few pottery sherds (Locus:225922:071, Locus:225922:079, Locus:225922:081) representing an intermediate zone that post-dates the

395 Collections: PPP 225922:049:018, PPP 225922:080:004, 009, 011, 013, PPP 225922:082:004, 005, PPP 225922:083:004.

Fig. I6: The structure of the Chalcolithic kiln towards the end of the 2019 excavations, viewed from south. Photo by Jens Rohde.

Fig. I7: The structure of the Chalcolithic kiln towards the end of the 2019 excavations, viewed from east. Photo by Jens Rohde.

Fig. I8: Collapsed architectural elements in the kiln fill, belonging to the kiln's upper structure. Photo by Jens Rohde.

Fig. I9. Fragment of a plano-convex architectural element. Photo by Sophie Pietsch.

Fig. I10: Fragment of the kiln floor. Photo by Sophie Pietsch.

Late Chalcolithic and pre-dates the Iron Age. Pottery from both periods was found in this deposit. In the southernmost part of the kiln an Iron Age disturbance, excavated as LGR:0367 (Locus:225922:074, Locus:225922:085), is responsible for the partial destruction of the combustion chamber. It was filled with dark brown soil, some bones, baked bricks and pebbles. It contained both Chalcolithic and Iron Age pottery. It is possible that LGR:0367 is the fill of a pit that cuts into the combustion chamber. Inside LGR:0367, Locus:225922:087 cuts the debris sloping from the southeast.

In the area above the kiln structure and above the deposit LGR:0367, a cut, named Locus:225922:073, is visible. It was made for the construction pit of the Iron Age wall LGR:0346. Its fill, Locus:225922:072, is composed of a yellowish-brown, clayey soil and contained, in addition to some pottery sherds and charcoal, the cobbles of the Iron Age wall LGR:0346, which had not been uncovered in 2018 (**Fig. I11**). More cobbles from this wall were excavated further to the north, and assigned the label Locus:225922:078. Some of these cobbles were placed directly on top of the kiln structure. Hence, it seems that it was the construction of the Iron Age wall that affected the kiln structure and was responsible for its partial destruction.

Fig. I11: The fill Locus:225922:072 of the cut opened for the construction of the Iron Age wall above the Chalcolithic kiln. Photo by Jens Rohde.

I.3 The kiln's structure and its parallels

Sophie Pietsch

Based on its preserved structures, the kiln had a free-standing, double-chamber updraught construction, with an underground combustion chamber, a central column supporting the kiln floor, and holes positioned between the combustion chamber below and the firing chamber above. The closest match for this type of structure are the "development line V" kilns in Boroffka and Becker's typology[396].

During excavations, the kiln entrance could not be identified. In structures where fire is employed, it is common to place the entrance in a direction that would be protected from disturbing agents such as winds. In the Bora Plain, winds normally blow in a northwesterly direction. Therefore, the kiln entrance is likely to have faced south or southwest, and this is precisely where the kiln structure has not been preserved.

Comparisons for this type of kiln are available at several Chalcolithic sites in Iraq and Iran. In Iraq, two-chamber kilns dated to the 5th millennium BC have been found in Tell Abada in the Hamrin basin. One of them (no. 11) is a close parallel to our kiln as it has a floor with holes supported by vertical structures and a central column; on the other hand, kiln no. 13 from the same site shows two lateral protrusions and a quasi-rectangular shape[397].

In southwestern Iran, parallels to our kiln are known from Darre-ye Bolaghi in the province of Fars where several kilns dated to the late Fars Chalcolithic Period (ca. 5500-4300 BC) were found. Kiln 405 (Site 73) has a quasi-rounded shape like ours, although its middle wall supports the kiln floor rather than a central column. Our kiln more closely matches Kiln 504 (Site 131), which features a kiln floor formed by a platform with holes on the edges, connected to a central column[398]. In the published photograph of this kiln, some plano-convex architectural elements are visible that resemble those found in our kiln's fill. In Kiln 110 (Site 73), these elements form an intermediate floor, which then serves as a stacking platform, leaving gaps for holes. Above this, another clay layer was applied to insulate the construction thoroughly. This double-floor construction is another potential parallel for our kiln.

In central Iran, another close match for our kiln was discovered at the site of Arisman in the province of Isfa-

396 Boroffka/Becker 2004, 219.
397 Jasim 1985, Fig. 35a; Fig. 39.
398 Helwing/Seyedin 2016, 286.

han. There, the late 4th millennium BC levels have yielded a pottery kiln showing a central column connected to the kiln walls by a radial structure that supported the kiln floor[399].

I.4 The Ubaid/LC1 pottery associated with the kiln

Jean-Jacques Herr & Silvia Amicone

Only very few pottery sherds were collected from the kiln fill (24 diagnostic sherds and 83 non-diagnostic sherds). Importantly, the pottery shapes matched those that had been found in 2018, allowing us to securely link the kiln's use with the floors found at the other side of the backhoe trench of GA42[400].

The assemblage includes non-diagnostic sherds belonging to a pot with a flared rim, polished walls and faint traces of red painting (**Figs. I12–I13**). The sherds are made of a fabric that, macroscopically, consists of 15-20% large, shiny, reddish-grey, sub-angular, moderately-sorted inclusions (4.6-8.5 mm long, 2.5 mm wide), 10% small, blue-grey, sub-angular, well-sorted inclusions, and 10% tiny, shiny yellow inclusions. There is a small amount (5%) of planar voids (8.2 mm long, 0.4 mm wide) probably left by the combustion of organic materials. The colour of the surface is heterogeneous, ranging from red to dark brown. The outside wall of this pot presents a shiny topography with almost no visible striations whereas large inclusions are embedded inside the wall of the vessel. This may indicate the use of a textile for polishing the surface in order to give the outside of the pot a hard leathery consistency[401]. Moreover, faint traces of a very thin reddish layer have been found on both the outer and inner surfaces (**Fig. I13.1-2**). Parallels for this type of pot (sometimes described as "angle-neck jar") can be found in the nearby site of Qalat Said Ahmadan (Ubaid layer 1 in Operation E)[402], and in the Shahrizor Plain at Gurga Chiya (Trench E)[403]. Further afield, such containers also occur at Tepe Gawra (Level XII A)[404]. Parallels for the surface treatment can also be found in the Iranian Zagros where the sites of Hajji Firuz Tepe[405] and Dalma Tepe[406] both yielded painted and polished pottery.

Our kiln also contained round and thinned everted rim fragments, made of an orange-coloured fabric with plant tempering (probably chaff, as is also suggested by the results of the ongoing petrographic analysis). These rims most likely belong to deep bowls. Parallels are known from Tepe Gawra (Level XII), including a flared rim pot with plant tempering[407].

Moreover, we found two fragments that together form the complete profile of a small conical bowl with a flat base (**Fig. I12.2.a**, **Fig. I14.1-2**). This vessel was built from four levels of coil segments. The wall was formed by compressing the coils and spreading the clay with an upward movement of the fingers, a technique that obliterated the coil joins. **Fig. I14.2** clearly shows a preferential fracture following the coil joins at the end of the clay accumulation on the first layer of coil. Macroscopically, the fabric of this bowl is composed of 5-10% large, grey, sub-angular inclusions, 5% fine, white, sub-rounded, well-sorted inclusions, and 1% tiny, shiny inclusions. The main temper consists of an abundance of fine plant material (4.3 mm long, 0.3 mm wide). The colour is mostly orange and the firing is semi-oxidizing. Morphological parallels are known from Tepe Marani[408] and Gurga Chiya[409] in the Shahrizor Plain and from Hajji Firuz Tepe in Iran, dating from the "Late Neolithic" to the end of the 6th millennium BC[410]. The vessel from our kiln is not burnished, in contrast to the examples from Gurga Chiya and Hajji Firuz Tepe.

Overall, this preliminary assessment of our kiln's pottery and its known parallels suggest an Ubaid to Late Chalcolithic 1 date[411], ranging from the late 6th millennium BC through the 5th millennium BC[412].

A sample for petrographic analysis was taken from a flared rim pot (PPP 226922:057:001; **Fig. I12.1**) made from

399 Boroffka/Becker 2004, 220; Boroffka *et al.* 2011, 34.

400 Herr *et al.* 2019, 114

401 In an experimental and traceological study, Lepère 2014, 150-151 called this "furbishing".

402 Tsuneki *et al.* 2016, 100, Fig. 2.10.1-2.

403 Wengrow *et al.* 2016, 267, Fig. 12.4-6.

404 Tobler 1950, pl. CXXXVIII, 291.

405 Voigt 1983, pl. 19 and pl. 21 ("red washed and burnished").

406 Some sherds found in Kul Tepe VIII in northwestern Iran show a smoothed and reddish shiny surface designated as "Dalma red-slipped". For comparisons, see Hamlin 1975, 117, Fig. 9.A-D; Abedi *et al.* 2015, 328, Fig. 5. In the material recovered from our kiln, however, no painted motifs (such as the inverse triangular motif or the zig zag pattern) have been observed.

407 Herr *et al.* 2019, 116, Fig. G1.9.1.

408 Wengrow 2016, 273, Fig. 19.1-6, where the description of the fabric is similar to PPP 225922:082:003:001 (Fig. I14).

409 Wengrow 2016 *et al.*, 267, Fig. 12.23.

410 Voigt 1983, 75.

411 For a synthesis of the Northern Ubaid-LC1 chronological framework, see Peyronel/Vacca 2015.

412 We would like to thank Johnny Samuele Baldi (Institut français du Proche-Orient, Beirut) for his help in identifying the pottery and indicating the parallels with Gurga Chiya and Tepe Marani.

Fig. I12. Chalcolithic period pottery: (1) from the fill Locus:226922:057 above the floor excavated in 2018, and (2) from the kiln fill Locus:225922:082 excavated in 2019: (a) diagnostic sherds from a small conical bowl (PPP 225922:082:003:001+002); (b) non-diagnostic bodysherds from a polished and painted pot similar to the specimen shown in (1). Prepared by Jean-Jacques Herr.

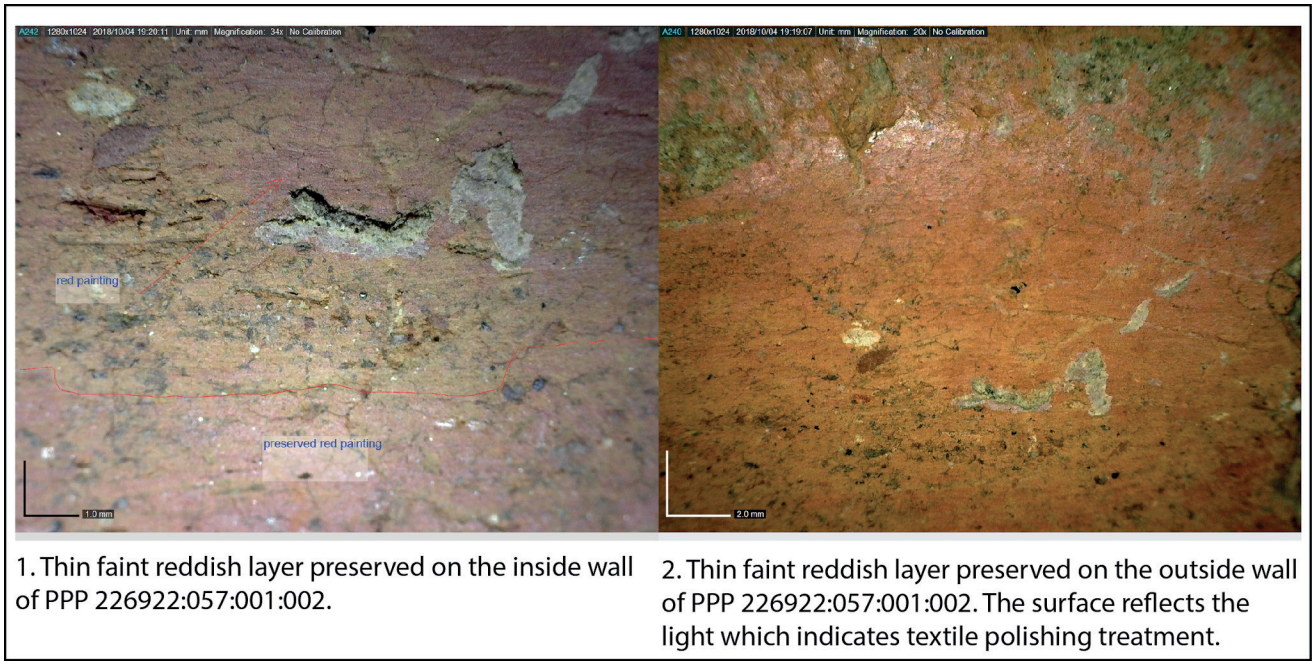

Fig. I13. Dino-Lite microscope images of a sherd belonging to the polished and painted pot of Fig. I12.1, showing the surface treatment on the inside (1) and the outside (2). Prepared by Jean-Jacques Herr.

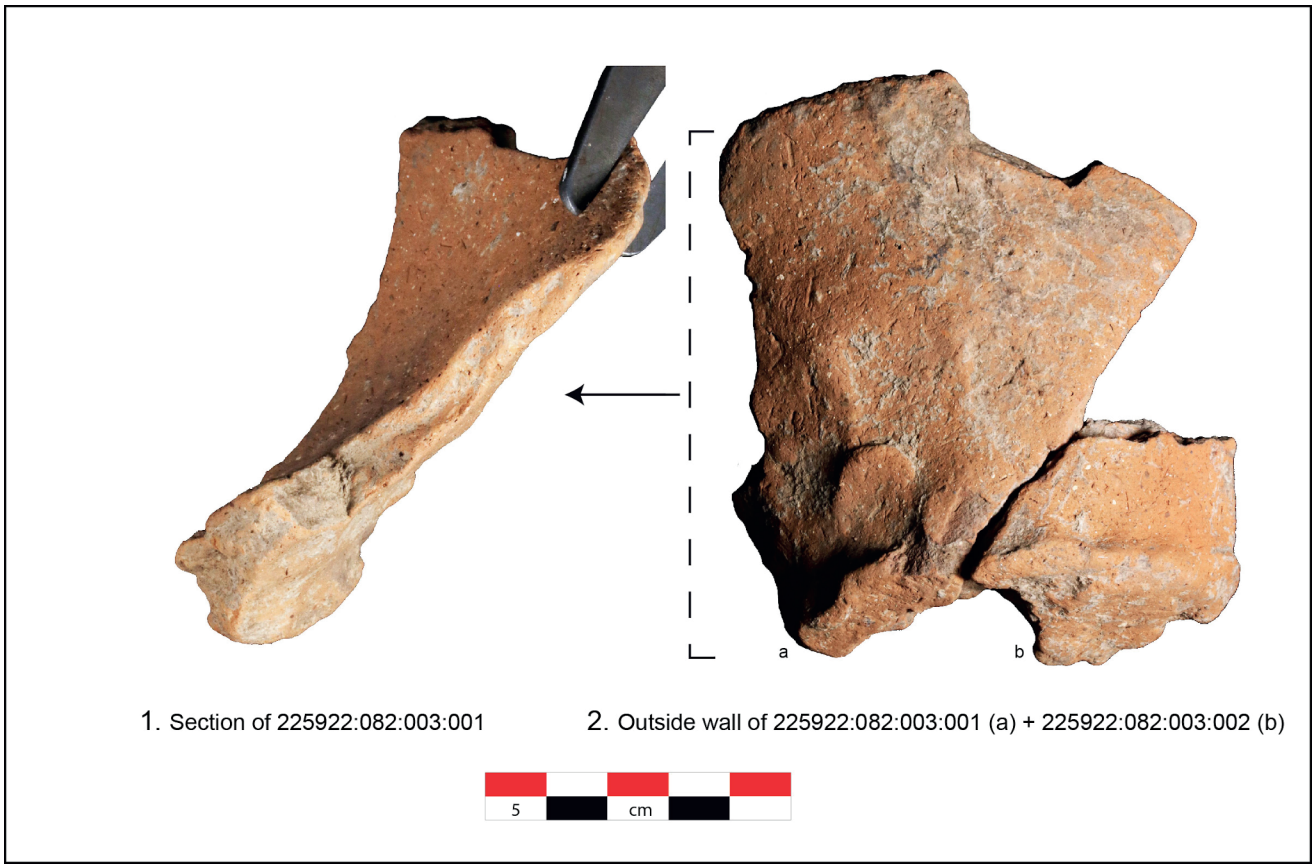

Fig. I14: Sherds PPP 225922:082:003:001 and PPP 225922:082:003:002 from the conical bowl found in the kiln fill: (1) section; (2) outside wall. Prepared by Jean-Jacques Herr.

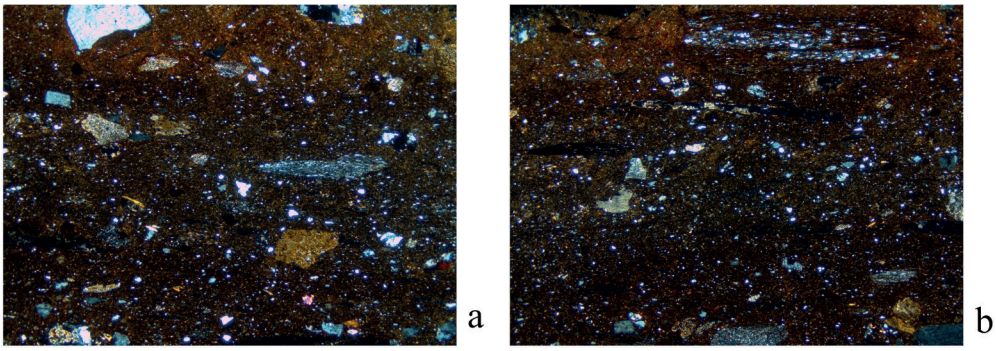

Fig. I15: Thin-section photomicrographs of sample PPP 226922:057:001:001 (= laboratory number PPP 110): (a) with metamorphic rocks and micrite XP; b) with foliated metamorphic rocks composed of quartz and biotite XP. Image width = 6 mm. Prepared by Silvia Amicone.

one of the most common fabrics encountered among the sherds of the Chalcolithic period associated with our kiln. The sample number PPP 226922:057:001:001 corresponds to the laboratory number PPP 110. The petrographic study showed that this sample's fabric features metamorphic inclusions and micritic calcite (**Fig. I15**) and is very similar to Fabric C1, which is characteristic of the Iron Age pottery of the DSC[413]. This suggests that the same local clay sources were in use during both the Chalcolithic period and the Iron Age.

Detailed petrographic description[414]: Quartz (sa.-eq., max=0.30 mm, mode=0.08 mm) and fragments of foliated metamorphic rocks (sr.-el., max=2.8 mm, mode=0.80 mm) composed of quartz, muscovite and biotite are common. Micritic and sparry calcite (wr.-eq., max=2.5 mm, mode=0.85 mm). Few inclusions of plagioclase (sr.-eq., max=0.50 mm, mode=0.20 mm), biotite (sr.-el., max=0.35 mm, mode=0.20 mm), muscovite (sa.-el., max=0.30 mm, mode=0.20 mm) and clay pellets (wr-eq., max=0.65 mm, mode=0.50 mm) were observed. Very rarely epidote (sa.-eq., max=0.35 mm, mode=0.30 mm). The grain size distribution is polymodal. Voids are vesicles and vughs, and they do not show any preferential orientation. The matrix is light brown in PPL and orange to brown in XP. The matrix is non-calcareous, and the sample exhibits low optical activity.

I.5 The kiln's radiocarbon dating and preliminary conclusions

Andrea Squitieri

A charcoal sample was collected from the kiln fill (sample PPP 225922:049:019) and analysed for ^{14}C dating at the Curt-Engelhorn-Zentrum Archäometrie in Mannheim (Germany), producing a date range of 5218–5024 calBC (95.4 % probability) (**Fig. I16**). This date roughly corresponds to Ubaid 3-4 in southern Mesopotamia and "Northern Ubaid" in northern Mesopotamia[415], hence confirming the results obtained from the pottery analysis and also matching the dates assigned to some of the structural comparisons identified for the kiln itself.

The 2019 fieldwork completed the excavation of a Chalcolithic pottery kiln, preserved underneath the Iron Age structures of the Dinka Settlement Complex in the area of the excavation area DLT3. For the kiln's double-chamber structure with a central column supporting the kiln floor, architectural parallels can be found on the Iranian plateau, indicating close links between the Bora Plain and Iran at this time. Based on morphological comparisons, the pottery retrieved can be attributed to the Ubaid – Late Chalcolithic 1 period, and this dating fits well with the radiocarbon date obtained for the kiln fill, which falls into the late 6th millennium BC. Further analysis of the materials retrieved from the kiln is ongoing and will be published in the future.

413 Amicone 2017a; 2018; 2019. See also **§D2**.

414 For the abbreviations and terminology, see **§D2**.

415 Stein/Alizadeh 2014, Table 1.

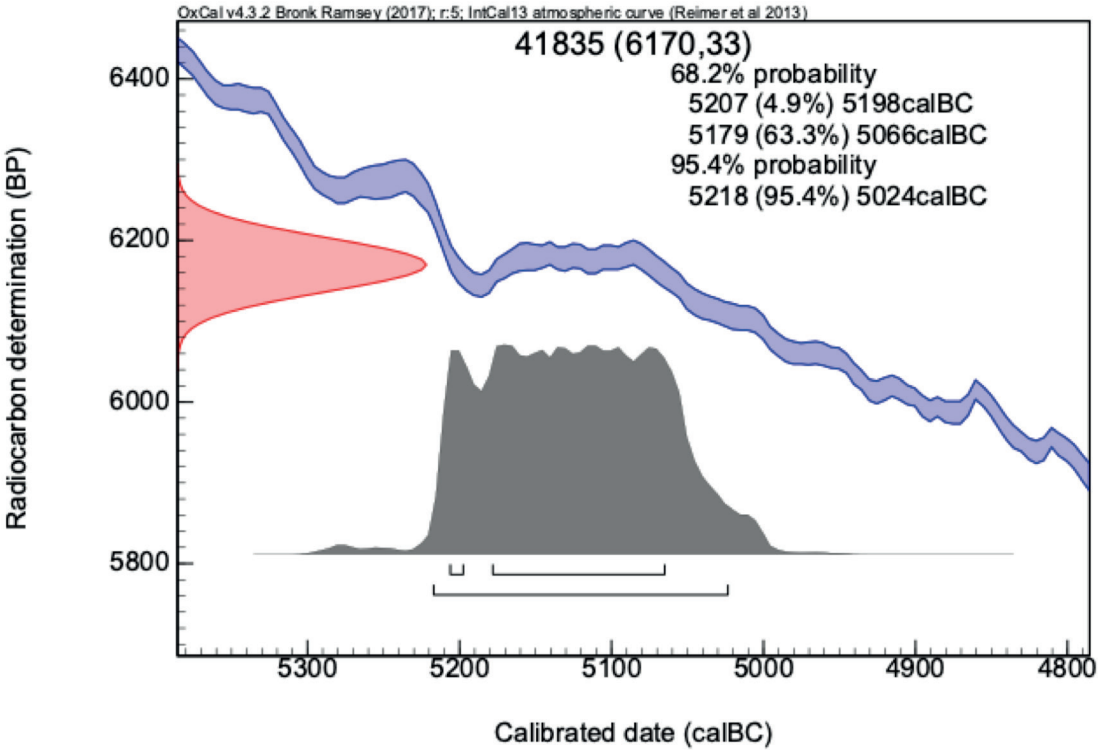

Fig. I16: Calibrated radiocarbon date for the charcoal sample from the Chalcolithic kiln (MAMS-41835). Calibration software OxCal v.4.3.2.