Stone tools, techniques, and spaces for the pottery chaîne opératoire. The case of the pottery workshop of Gird-i Bazar (c. 1200 - 800 BC) in the Autonomous Region of Kurdistan, Iraq

Keywords

Stone tools, pottery chaîne opératoire, RKE, burnishing, Gird-i Bazar (site), Dinka Settlement Complex (site), Iron Age, Iraq, Zagros (mountain range)

Abstract

Although the chaîne opératoire approach was introduced more than half a century ago, it has seldom been employed to reconstruct the techniques and tools involved in the production of Iron Age pottery (c. 1200 - 600 BC) from Iraqi Kurdistan. One of the reasons why this method is so seldomly applied is that only rarely can archaeologists rely on enough contextual information to allow the reconstruction of the specific steps of the pottery production and make inferences about the involvement of specific tools during these stages. In this paper, we present the case study of Gird-i Bazar, an Iron Age site located in Iraqi Kurdistan, where a pottery workshop yielding fixed installations and associated portable stone tools was recently discovered. We will combine context description and macro/microscopic observations on both stone tools and pottery sherds in order to show how the former were used in some of the steps of the pottery chaîne opératoire, and identify the spaces where specific stages of the pottery production possibly occurred. The results from this work will provide comparative material for the technological study of Iron Age pottery from Iraqi Kurdistan and its neighbouring regions in both lowland Mesopotamia and the western Iranian highlands.

1. Introduction

In past societies, making pottery was surely one of the most critical and widespread craft productions, which involved the investment of considerable resources, time, and energy, and occupied a central role in people's economic and social lives (Roux, 2019: 283-292; Rice, 1987: 168-205; Arnold, 1985). The manufacture of ceramic vessels required specific skills, technological choices, and tools that can be investigated through the methodology of the chaîne opératoire (Roux, 2019; Delage, 2017; Gelbert, 2003; Roux and Courty, 1998; Rice, 1987; Rye, 1981; Creswell, 1976: 13). In this paper, we present the case of Gird-i Bazar, in Iraqi

Kurdistan, where an Iron Age pottery workshop has been recently excavated. A wealth of contextual information from this site will be used in combination with micro- and macroscopic analyses of both pottery sherds and stone tools, as well as a distribution analysis of the latter, in order to both reconstruct the involvement of the stone tools in the pottery chaîne opératoire (with a focus on forming and finishing stages) and to identify the spaces where specific stages of the pottery production may have occurred, the so-called "espaces opératoires" (Hasaki, 2011: 24). We will begin by presenting a short summary of the chaîne opératoire method and its implications, before moving to the description of the archaeological context.

The concept of the chaîne opératoire and its methodology were introduced more than half a century ago, and since the 1980s have been widely applied to the study of ceramic technology in both ethnographic and archaeological research (Roux, 2019: 1-3; Gosselain, 2010; Anderson-Gerfaud et al. 1989). A chaîne opératoire can be defined as "a series of operations which transform raw material into a finished product, whether it is a consumer object or a tool" (Cresswell, 1976: 13). A specific technical activity, such as pottery production, can be divided into different chaînes opératoires (Lemonnier, 1983). In pottery production, the selection of clay materials represents the first stage of the chaîne opératoire; the second stage is forming the vessel, during which the roughed-out clay is modelled into the desired shape and finished with decorative motifs and/or surface treatments; and, finally, firing the vessel, whereby the clay properties are modified through heat (Roux, 2019: 3-4). The first two stages leave diagnostic traces on the pottery vessels, which are then fixed and made permanent through the firing process. As archaeologists deal with materials retrieved through excavations, traces visible on both pottery sherds and tools can be interpreted on the basis of both experimental and ethnographic evidence in order to infer the movements, techniques, and tools used by the potters (Roux, 2019; Williams, 2018; Lepère, 2014; Martineau, 2010; van Gijn and Lammers-Keijsers, 2010; Lemonnier, 1992). Subsequently, observations of the recurrences and variabilities of the chaînes opératoires within a social group and among several social groups can then be used to make inferences about the shared technological knowledge, which developed from motor habits transmitted from one potter to another. This transmission process represents the link between technological traditions and social groups (Roux, 2019: 4; Santacreu, 2014; Arnold, 1985). As Roux pointed out, "a technical practice is always the emanation of a social group's way of doing things. It is part of a heritage that develops on an individual (learning) and collective level (transmission), according to biological and anthropological 'rules'." (Roux, 2019: 4). Several ethnoarchaeological studies have

emphasised the complex relationship between the production of material goods and the organisation of social groups (Gosselain, 2010; Gosselain, 2002). Hence, the study of technical practices and technological knowledge allows the researcher to cast light on the way pottery production was organised in the broader economy of a given site (e.g., household production, industrial production; see Costin, 1991), including the identification of spaces where production occurred (Hasaki, 2011; Arnold, 1991).

Despite the wide application of the chaîne opératoire in both archaeology and anthropology, the Iron Age ceramic assemblages of such areas of the Middle East as Iraqi Kurdistan have been rarely approached using this method. Most studies of Iron Age pottery from Iraqi Kurdistan are limited to the presentation of pottery shapes and decoration, with no discussion of the tools involved in their production or any analysis of the spaces where this occurred within sites (Kopanias and MacGinnis, 2016). One of the reasons for this is that only in rare instances have structures, installations and tools been unearthed next to pottery kilns possibly indicating areas used by the potters during the stages of the chaîne opératoire, such as processing the clay, shaping the vessels, and finishing. Notable examples are known from outside Iraqi Kurdistan, from the Late Bronze/Iron Age Middle East: these are the sites of Khirbet Qasrij (Iraq), Tell Sabi Abyad (Syria) and Sarepta (Lebanon) (Duistermaat, 2008; Anderson, 1989; 1988; 1987; Curtis, 1989). In Tell Sabi Abyad, in particular, the distribution study of the movable material culture found in the pottery workshop has allowed archaeologists to reconstruct the use of the spaces in relation to the stages of Late Bronze Age pottery making (Klinkenberg, 2016; Duistermaat, 2008). The Gird-i Bazar pottery workshop represents an ideal case because of the wealth of contextual information that has been retrieved from the site. This has allowed us to apply the chaîne opératoire method by connecting the evidence from the Gird-i Bazar archaeological contexts, the stone tools retrieved from the pottery workshop, and the traces visible on pottery sherds. There are, of course, some challenges in the application of the chaîne opératoire method. In some cases, the tools used by potters were made of perishable materials, which barely survive in the archaeological record. In other cases, the tools employed in making ceramics were multi-purpose devices, used not only in pottery production but also in other forms of craft production, as in the case with recycled potsherds, bone tools, flint, and even stone tools (e.g., Darras and Hamon, 2020). These issues will be discussed below when we present our results. In the following sections, we will show the contexts of the Gird-i Bazar pottery workshop and the traces visible on the pottery sherds that can be connected to the use

of stone tools. Finally, we will reconstruct the stages and the spaces of the pottery making process, taking into account both the evidence from the pottery and from the stone tools.

2. Reconstructing pottery production at Gird-i Bazar

2.1 Gird-i Bazar and the Dinka Settlement Complex

Gird-i Bazar (WGS 84/ UTM 38N 512690 E, 3999290 N) is a low mound about 1.5 ha in size situated in the Bora Plain, a subunit of the much larger Peshdar Plain, which is situated in the Kurdish Autonomous Region of Iraq, on the border with Iran (Fig. 1). Archaeological excavations at Gird-i Bazar were initiated in 2015 by Karen Radner with the interdisciplinary "Peshdar Plain Project" (hereafter PPP) with the aim of investigating the cultural and political transformations that the site's region underwent during the Iron Age, particularly in relation to the expansion of the Neo-Assyrian Empire in the late 9th century BC (Radner, 2016)[1]. The PPP's investigations, coupled with the results of a surface pottery survey directed by Jessica Giraud, revealed that Gird-i Bazar was part of a larger site of about 60 ha (Giraud, 2016), dubbed the "Dinka Settlement Complex", as its ancient name is unknown. This extended site is composed of a lower town (within which Gird-i Bazar lies) extending to the north and north-east of a citadel that is located on a natural rocky outcrop known as Qalat-i Dinka (WGS 84/ UTM 38N 511920 E, 3999140 N). Both the lower and the upper town are bordered to the south by the Lower Zab river.

Since 2015, three archaeological operations have been opened in the lower town, including the one at Gird-i Bazar (Radner et al., 2018; 2017; 2016). Here, the excavation area encompassed about 1050 m^2 situated within a metal fence surrounding a chicken farm that had been built on the site in 2013, thus destroying half of it (Fig. 2). The excavations revealed a central open space (named Outdoor Area 8) located between two distinct groups of buildings, preserved up to the level of the walls' stone bases (Radner et al., 2018: fig. D6).

The basic chronological framework of the occupation at Gird-i Bazar was established thanks to seven short-lived and long-lived radiocarbon samples collected from the floors of the

[1] The Peshdar Plain Project is co-directed by Prof. K. Radner (LMU Munich) and Prof. F. J. Kreppner (WWU Münster), under the auspices of the General Directorate of the Antiquities of the Kurdish Autonomous Region of Iraq, the Sulaymaniyah Directorate of Antiquities and the Raparin Directorate of Antiquities.

buildings. Five cover the period spanning from 1006 calBC to 816 calBC, and the two samples remaining are from the period spanning from 1216 calBC to 1053 calBC (Radner et al., 2018: table D1, figs. D4-5). For the purpose of this paper, it is important to note that no signs of violent destruction have been identified at Gird-i Bazar itself. Hence, we currently assume that the settlement there was abandoned at some point, although it is difficult to establish precisely when based on current evidence. The radiocarbon date of 748-409 calBC, gained from a dismembered human body thrown into the well of one of the buildings, may be associated with a drastic change in the use of Gird-i Bazar's building structures (or parts of them), although the sample's long date range (owing to the so-called Hallstatt Plateau in the radiocarbon calibration curve) cannot help establish when precisely this change happened (for a more detailed discussion, see Radner et al. 2018, 186). Nevertheless, it is clear that after the Iron Age Gird-i Bazar structures were abandoned, the area was reused centuries later as a cemetery during the Sasanian period (224 - 638 AD), and later still, in the modern era, it was once again occupied (albeit sporadically) by squatters (Squitieri, 2020).

This evidence is important for interpreting the mobile material culture retrieved from the Gird-i Bazar buildings, and in particular the tools and pottery remains discussed in this paper. Although the archaeological contexts were not sealed by a destruction layer, the items retrieved from the floors and the fills of the rooms can be safely dated to broadly 1200-800 BC. Moreover, although a selection of objects was likely removed upon abandonment, what was left behind (including stone tools and pottery sherds) still provides a good level of representation for the activities performed at Gird-i Bazar, and their original spatial organisation.

2.2 The spatial organisation of the Gird-i Bazar pottery workshop

The pottery workshop of Gird-i Bazar was identified in the western portion of the excavated area (Radner et al., 2018: 86-99). Here, seven buildings were unearthed, termed Buildings D/E, F, G, H, I, N, and O. Some are fully excavated and some only partially so. They are located to the west of an open area called Outdoor Area 8, and are arranged around two long alleyways, termed Alley 13 and Alley 12 (Fig. 3a-b).

Several building installations were unearthed in this area. In this section, we will focus on those installations that were likely involved in the production of pottery. In Outdoor Area 8, the lower

part of a pottery kiln (Kiln 1) was identified (Amicone, 2017a). It has a roughly circular shape, with a diameter of c. 2 m. The kiln lining was quite well preserved and showed signs of heat exposure (Fig. 4a). The kiln's fill contained its final load of pottery, with some almost complete vessels, as well as fragments of the kiln floor (Amicone, 2017a: fig. D14). The floor had holes to allow heat from the lower chamber to reach the upper chamber. At the bottom of the fill, a thick ashy layer was found. Although most of the upper structure has not been preserved, we can reconstruct it as an up-draught kiln with a combustion chamber located below the ground. Up-draught kilns, roofed or unroofed, are one of the most widespread types of pottery kiln found in the Middle East, particularly in Mesopotamia, and are well attested from the second half of the 7th millennium BC (Hansen Streily, 2000; Delcroix and Huot, 1972). This type of kiln continued to be common during the end of the 2nd and beginning of the 1st millennium BC, being attested in such sites as Ziyaret Tepe (Matney et al., 2009), Khirbet Qasrij (Curtis, 1989) and Assur (Hunt, 2015) in the Tigridian valley, at Dinkha Tepe and Hasanlu in the Urmia Lake basin (Danti and Cifarelli, 2015: 78; Muscarella, 1974: 56) and in the site of Baba Jan in Luristan (Goff, 1977: Pl. Id). Kiln 1 was later disturbed by the Sasanian period (224 - 638 AD) burials, which appear as elongated cuts around the kiln structure.

Another pyrotechnical installation (labelled Pyrotechnological Installation 2 in Fig. 3b) is also located in Outdoor Area 8, to the northwest of Kiln 1 (Fig. 4b). This very eroded installation, measuring 1.7 x 1 m, is sunk into the ground to a depth of about 30 cm and has a lining made of clay, with a brick still in situ placed vertically in the southeastern corner (Radner et al., 2018: 78, fig. D23). The fill was dark red, rich in lumps of burnt clay, and it yielded several pottery sherds. Because of the presence of burnt clay, we interpret this installation as a fire pit used to make pottery. Although its shape is very different from the other pottery kilns found at Gird-i Bazar, pottery kilns in the form of circular pits with vertical bricks on the edges are attested at other Middle Eastern sites and can be seen as parallels to this installation (e.g. at Nippur: McCown et al., 1978: 40, pl. 25C). Admittedly, in absence of additional evidence, the classification of this installation found at Gird-i Bazar as a structure used for firing pottery mainly draws on the overall interpretation of the area as a pottery workshop.

Moving north, we encounter Building D/E, which comprises Courtyard 27, Rooms 19, Rooms 30, 31, and 33. In Room 31, another pottery kiln (Kiln 2) was found, very similar to Kiln 1 in Outdoor Area 8 (Amicone, 2018: 79, figs. D25-26) (Fig. 3b, Fig. 4c). It is roughly pear-shaped in plan view, with a diameter of about 1 m with the narrower part extending towards the west.

The structure has a thick lining made of burnt clay, whose reddish-green colour is the consequence of its exposure to heat. Its fill was rich in lumps of burnt clay, burnt brick fragments, ash, charcoal, and a few pottery sherds. The upper part of the kiln's fill was rich in debris from the collapse of the kiln's upper structure. Kiln 2 can also be reconstructed as an up-draught kiln, with the combustion chamber located below ground. To the west of Room 31 lies Courtyard 27, whose floor was paved with large cobbles (Fig. 3b). A well is located in the southwest corner of this courtyard. The well's opening consists of large cobbles set in a circle with a diameter of about 70 cm. The well was excavated up to a depth of 1.5 m and then had to be abandoned before its bottom was reached (Radner et al., 2018: 86-87). The courtyard was equipped with a drain which served to collect waste water and, running underneath the floor of Room 19, led out to Alley 13.

Beyond Alley 13 and further to the north lies another partially excavated building, dubbed Building F. It consists of Courtyard 21, located at the extremity of the excavation area, and at least four rooms (20, 15, 22, 28) arranged on the southern side (Radner et al., 2017: 97-99), whereas the northern part of the building could not be excavated. Like Courtyard 27, Courtyard 21 has a stone paved floor and a very similar well, which could not be excavated to its complete depth. To the west of the well lies a circular installation consisting of a pit about 70 cm in diameter and about 50 cm deep. At the bottom of this installation, we found a well-worked rectangular stone, with a circular and very smooth depression in the middle with a diameter of about 20 cm. Small pebbles were found around the stone, perhaps to better fix it to the ground (Fig. 5a). Although initially interpreted as the remains of a water-pulling device (in Arabic, *shaduf*) (Radner et al., 2017: 99), this circular installation is now considered the setting for a pottery turntable.

This new interpretation is formulated in light of the discovery of a very similar installation in Courtyard 18 of Building I (Radner et al., 2018: 90-96), which is located to the southwest of Building F and separated from it by Alley 13. The excavation of this building was key to our understanding of the pottery workshop at Gird-i Bazar. Building I comprises Courtyard 18, Room 46 to the north, and Rooms 48 and 49 to the south (Fig. 3b). Room 46 features a stone installation resembling a platform along the eastern wall, and an underground drain covered with stones to the west, whose function was to allow waste water coming from Courtyard 18 to flow out to Alley 13. No evidence beyond its shape is available for the use of the platform, but the most likely interpretation is that it served as a workbench. Next to the platform, a pivot stone was found upside down, which was part of a potter's slow-wheel, described below in

greater detail. Courtyard 18, situated south of Room 46, has a paved-stone floor, with the exception of the north-western corner where a few flat bricks were used as floor paving. The inlet of the drain that crosses Room 46 and funnels waste water to Alley 13 is set against the courtyard's northern wall. In the north-eastern corner of the courtyard lies an installation made of stones set in a semicircle (Fig. 5b). At the centre is a pit lined with stones about 60 cm in diameter and 35 cm deep, with a regularly-shaped square stone, with a smooth circular depression of about 20 cm in diameter, situated at the bottom. This pit closely resembles the pit in Courtyard 21 of Building F and is interpreted as part of the potter's wheel used to shape clay into pottery vessels. A large number of pottery sherds was found on the floor of Courtyard 18, along with a concentration of stone tools. South of this courtyard, a well resembling those in Courtyards 21 and 27 is located in Room 49.

All these installations in Outdoor Area 8 and Buildings D/E, F, and I of Gird-i Bazar can be connected to different stages of pottery production. The pottery kilns belong to the third stage, the firing process, while the two circular pits equipped with a square stone at the bottom can be connected to the second stage: shaping the vessels. The three wells can be connected to the use of water, which is essential for the first and second stages of the pottery production process, for clay preparation and vessel shaping (Roux, 2019: 15-98). It must be noted that other installations were found in the western part of the settlement of Gird-i Bazar that are not connected to pottery making, such as ovens, and also a number of stone tools cannot be connected to pottery production, such as perforated stones (Squitieri, 2019a). On the other hand, some rooms were devoid of installations or objects that would help clarify their primary function. Although, in our interpretation, pottery making was the primary activity that took place at Gird-i Bazar, it may well have routinely overlapped with other everyday activities, such as food preparation and other craft activities.

2.3 Macroscopic and microscopic observations on the pottery from Gird-i Bazar

The technological study of the Gird-i Bazar pottery is based on the study of the macro-traces left by the potters before firing the vessels. The first step of this analysis was carried out on the site, where about 22,000 sherds were collected from floors and closed contexts (e.g., kiln fills). Diagnostic macro-traces, from both inside and outside the sherds' walls, were documented by means of a Dino-Lite Digital Microscope (model AM4113T, with up to 200x magnification). The second step was the classification of the fabrics. This was conducted using thin sections

taken from 77 selected samples analysed at the Competence Center Archaeometry Baden-Wuerttemberg (CCA-BW), at the University of Tübingen. The microscopic analysis further aided the technological interpretations. Some of the results of this research have already been published (Amicone, 2017b; Herr, 2016; 2017), and a comprehensive, in-depth study on the technological aspects of the Gird-i Bazar pottery is on-going. We offer here a summary of the key features of the Gird-i Bazar pottery chaîne opératoire which can be related to the use of stone tools.

The techniques employed to make the Gird-i Bazar vessels were organised by fashioning stages. The first is "forming", which corresponds to the first step in the process after the fabric has been prepared. The second stage is "shaping", during which a shape is conferred to the vessel. The third stage is "finishing", which refers to the final treatment of the vessel. The fourth stage, "decorating", consists of adding decorative motifs to the vessel. In Gird-i Bazar, each fashioning stage was connected to different techniques, and these techniques are associated with specific fabrics (Table 1). The result was the creation of a "techno-stylistic tree", in which these fashioning techniques are hierarchically organised by stage, morphological type and petrographic fabric (Herr, 2017). From both a morphological and a technological point of view, all the pottery from the Dinka Settlement Complex is consistent with that found at Gird-i Bazar (Herr et al., 2019). The shapes attested across the site are carinated bowls, small hemispherical bowls, handled beakers, ovoid cooking pots, and small necked jars all of which are formed with coils, shaped on a slow wheel and then burnished, and lids, trays, and large storage jars which are formed with larger coils and sometimes burnished on the outside wall. For the purpose of the present paper, we present here those stages and techniques which are more commonly attested at Gird-i Bazar and which are relevant for our discussion concerning the involvement of stone tools in the pottery chaîne opératoire (Table 1).

Fashioning stage	**Technique**	**Fabric**
Forming	*Coiling*	A, B, C1-2, D, E
Shaping	Smoothing without Rotative Kinetic Energy (RKE)	A, B?, C1-2, E
	Slow wheel	B, C, D

	Planing	C1
Finishing	Barbotine	C1
	Slip	D
	Burnishing	B, C1, D
	Leather-hard brushing / scraping	B
	Wet brushing / scraping	E
Decorating	Stamped	A, C1
	Modelling	C1

Table 1. Overview of the fashioning techniques identified at Gird-i Bazar. After Herr 2017, Table E1.1, with some modifications. Only the techniques in italics are discussed in this paper.

The first stage, forming, was carried out by assembling coils of different sizes ranging from 0.5 cm in diameter for bowls and small neck jars to 3 cm for large storage jars and lids. Evidence for the use of the coiling technique comes from the observation of preferential horizontal fractures, joins between coils visible in section, and circular distributions of inclusions and voids (Herr, 2017: 111-114) (Fig. 6a-d). Such a circular arrangement of inclusions and voids seems to be the result of rolling the clay on a solid base so as to produce a cylindrical coil (Herr, 2017: 111). Unfortunately, the high fragmentation and erosion level of Gird-i Bazar pottery does not help to identify with precision which method of the wheel-coiling technique was used (see Roux, 2019: 84-86).

As far as shaping is concerned, most of the sherds found at Gird-i Bazar showed traces consistent with the use of Rotative Kinetic Energy (RKE) (Roux and Courty, 1988; Roux, 2009). In particular, traces produced by the use of a slow wheel have been noticed on such shapes as the hemispherical rim bowls, carinated bowls, necked and handled pots and necked jars. These traces consist of sub-parallel fluid striations resulting from continuous pressure made by the potter's hands on the wet walls of the vessel (Fig. 7b, d).

The next stage is finishing. In Gird-i Bazar, a frequent finishing technique was burnishing, which consisted of rubbing the vessel surface with a hard tool when the vessel was of leather-hard consistency (Fig. 7a, c-d). The traces of this technique are easily recognisable and consist of thick striations of 1-3 mm width with an accumulation of clay on the edges. Thus, the surface of the vessels is marked by orientated facets (Fig. 7a, c-d). In Fig. 7a, it is possible to notice the vertical and horizontal burnishing pattern underneath the carination, as well as the non-burnished area of the neck and the horizontal burnished rim. As we will discuss below, we suggest that a particular category of stone tools was used for this stage. As shown in Table 1, secondary shaping and finishing techniques are also attested at Gird-i Bazar (Herr, 2017); however, those described above are by far the most common, hence they better characterise the Gird-i Bazar pottery assemblage as a whole.

As far as the fabrics are concerned, petrographic analyses conducted on 77 thin sections have allowed us to identify at least seven different types of fabric (Fabrics A, B, C1, C2, D, E and F), all made from local clays (Amicone, 2017b). Fabric A is characterised by the use of fragments of metamorphic rocks as a temper, while Fabric B shows the presence of sparry calcite (Fig. 8a, c). Fabrics C1-2 and D do not bear clear evidence for temper as they show naturally occurring inclusions, while chaff temper was observed in Fabric E, and grog temper in Fabric F (Fig. 8b, d).

3. The stone tool kit used in the pottery production at Gird-i Bazar

Excluding pottery sherds, stone tools constitute the majority of the Iron Age finds retrieved from the excavations at Gird-i Bazar, representing 87 examples out of a total of 122 non-pottery finds (= 71%) (Squitieri, 2018: 155-172; 2019a). Overall, these stone tools are portable objects, mostly characterised by an "expedient design" (according to the definition in Adams, 2014: 21): this means that their modifications were mainly due to their use rather than to the manufacturing process.

In previous publications, the stone tools from Gird-i Bazar were divided into morphological categories (Squitieri 2019a) on the basis of stone tool classifications developed by Wright (1992) and Eitam (2009), with some adaptations. The categories identified are pebble mortars, pounders, polishers, pounders/polishers, weights (spherical or perforated), perforated stones, and whetstones. Among these, only pebble mortars, pounders, polishers, and pounder/polishers can be connected with some certainty to pottery production on the basis of their shape, wear-

marks, and spatial distribution, as will be shown below. In addition to these, we will also discuss a pivot stone found at Gird-i Bazar.

The wear-marks on the stone tools which are discussed in this paper have been documented using a 60 mm macro-lense (f/2.8 Macro USM). Their interpretations are based on previous use-wear studies on stone tools (Adams, 2014; Adams, 2013; Dubreuil and Savage, 2014).

Before moving to the stone tool descriptions, it is worth giving some geological information of the area surrounding Gird-i Bazar. The geological identification of the stone tools' raw materials were carried out by naked eye in most cases, while petrographic analysis in thin sections (Fig. 9a-d) has been carried out only for five selected items at the Competence Center Archaeometry – Baden-Wuerttemberg, Eberhard Karls Universität, Tübingen, Germany. The results of the petrographic analysis are summarised in Table 2. The rock types identified are limestone, serpentinite, peridotite/gabbro, and basalt.

Sample ID	**Item ID**	**Rock**	**Rock family**	**Object type**
ST1	PPP 271928:120:006	Limestone	Sedimentary	Pebble mortar
ST2	PPP 267930:036:022	Serpentinite	Metamorphic	Polisher
ST3	PPP 266931:011:008	Serpentinite	Metamorphic	Bowl rim
ST4	PPP 267931:052:008	Gabbro/Diorite	Plutonic	Pounder
ST5	PPP 267931:097:004	Basalt	Volcanic	Weight

Table 2. Results of the petrographic analysis conducted on selected stone tools from Gird-i Bazar.

Overall, they reflect the geology of the area surrounding Gird-i Bazar, which is characterised by sedimentary rocks such as limestone, conglomerate, dolostone, and sandstone (Squitieri, 2019a; Geiger, 2019; Altaweel and Marsh, 2016). Volcanic and metamorphic rocks such as basalt, gabbro, and serpentinite are available further to east, towards the main ridge of the Zagros mountain range (Amicone, 2017b: 128-132). Fragments of these rocks could be easily transported by the small rivers that traversed the Peshdar Plain and flowed into the Lower Zab river that forms one of its boundaries. The Lower Zab is a short walking distance to Gird-i Bazar, and therefore – just like today – such materials could be easily collected from the river banks as pebbles or cobbles, ready to be used as tools.

The use of local rock that could be easily collected from the immediate vicinity matches the "expedient design" characteristic of the Gird-i Bazar stone tools. There was, however, a certain

level of selection, as some raw materials seem to have been preferred over others for specific types of tools: particularly in the case of polishers, which are always made of basalt or serpentinite. In the following sections, we describe the characteristics and distribution of the four categories of stone tools that can be connected to the pottery production of Gird-i Bazar.

3.1 Pebble mortars

Pebble mortars are unmodified or slightly modified disc-shaped pebbles or cobbles, rounded or oval in plan view, into which shallow circular depressions, of varying sections, have been carved (Fig. 10). In some cases, two shallow depressions are present on the opposite sides of the tool. 23 such tools have been found at Gird-i Bazar. Their maximum diameters range from 5 to 20 cm, while their depressions are around 2 cm deep and about 4 cm in diameter. The depressions show several pecking marks and pits on the bottom, left by pounding.

Pebble mortars could be reduced to their shape by means of pecking, flaking, or grinding, and marks of these actions are in some cases visible on the sides of the tools. However, many cases from Gird-i Bazar seem to be pebbles or cobbles collected from the site's vicinity, which were then used as tools, with very few modifications. For this reason, pebble mortars at Gird-i Bazar can be considered expedient design tools subjected to a high level of discard and substitution. Finding suitable raw material for pebble mortars did not constitute any problem as most of them are made of whitish limestone (see Table 2), a rock commonly found in the vicinity of the site.

3.2 Pounders

Pounders are rounded stones with a maximum diameter oscillating between c. 5 and 7 cm, allowing them to fit comfortably in the palm of the hand (Fig. 11a). 10 pounders were identified at Gird-i Bazar, showing pecking marks and pits on their surface, without a preferred direction of use (Fig. 11b). These marks suggest that these tools were used to pound and crush small substances. Like the pebble mortars, pounders are expedient tools that could be easily sourced by collecting pebbles from the surface in the area surrounding the site. They are mostly made of limestone although examples in harder stones such as granite are also attested.

3.3 Polishers

In our classification, polishers serve to polish the surface of objects in a variety of materials, such as metal, stone, or ceramics, by means of rubbing. They are fist-sized pebbles with a maximum diameter between 5-7 cm, like pounders. Polishers typically start out as sub-spherical pebbles that, in the course of being used, develop one, two, or sometimes three very flat, shiny faces (Fig. 12). As a consequence, the shape of a polisher slowly altered throughout its working life, sometimes becoming almost cubic. On these flat faces, tiny striations are visible and, in some cases, a shiny patina. Due to the action of polishing, the working surfaces assumed a darker colour than the rest of the tool. Outside the tool's flat faces, no particular wear marks are visible.

Twelve such polishers have been found at Gird-i Bazar. They are expedient tools deriving from pebbles collected from the surface of the site's surroundings, which required no, or minimal, modification before use. Most polishers are made of volcanic or metamorphic rocks, such as basalt or serpentinite (see Table 2). This shows that a selection of raw material was carried out by the site's inhabitants, who tended to choose harder rocks for polishers as these offered a better polishing effect than softer sedimentary rocks.

3.4 Pounder/polishers

This is a category of tool that shares the same size as polishers and pounders as well as other characteristics typical of both polishers and pounders. Like the former, they feature one to three flat and shiny faces, and like the latter, they show pecking marks all around the working faces and in some cases also across the flat faces (Fig. 13). Because they have characteristics of both these tool categories, they have been interpreted as multi-use tools employed for both polishing and pounding during their life-cycle. Perhaps these two actions did not occur at the same time, meaning that these tools were employed mainly for one action before switching to the other. Seven such tools have been identified at Gird-i Bazar. Like the polishers, they are mostly made of hard volcanic or metamorphic rocks.

3.5 The pivot stone

A circular pivot stone, broken on one side, was found in Room 46 of Building I (Squitieri, 2018: 162). In plan view, it is a circular stone, made of basalt, with a rounded base and a flat and smoothed surface on the opposite side (Fig. 14a). In the middle of the smoothed surface, a

conic protrusion, or pivot, is present, also having a smooth surface and a rounded tip. The maximum diameter of the object is 18 cm, while the pivot is 4.5 cm high. Based on parallels and experimental studies (Powell, 1995), we assume that this object was inserted into a corresponding socket stone. The latter was not found during the excavations at Gird-i Bazar. It would have had the same size as the pivot stone, but a conical depression (socket) in the centre. Once fixed together, the pivot and the socket stones worked as a bearing system (Fig. 14b). By rotating the pivot stone on the socket stone, the level of friction was reduced, thus allowing the rotation of a large wheel attached to the pivot stone base.

This large wheel, called a wheel-head, could be made of clay or wood and would be attached to the pivot stone base by means of bitumen or clay (Powell, 1995; Anderson, 1987: 64, fig. 17). As no traces of bitumen were found on the back of the pivot stone from Gird-i Bazar, it is likely clay was used to bind the wheel to the stone. On top of the wheel-head, the clay object, roughed out in coils, was fashioned into the desired final shape. The rotary movement could be transmitted to the wheel-head simply by hand or by means of a stick (Fig. 14c). The pivot and the socket stones located below the wheel-head guaranteed a smooth rotary movement.
Pivot stones such as the one found at Gird-i Bazar are known from several sites in the Middle East from both the Bronze and the Iron Ages, as well as in Egypt (Bombardieri, 2004; Powell, 1995; Trokay, 1989; Amiran, 1956). The most telling example derives from Sarepta in Lebanon, where remains of unfired clay from the formerly attached wheel-head have been identified (Anderson, 1987: 64, fig. 17). The use of these objects has been investigated and clarified through experiments (Powell, 1995).

Along with the aforementioned pottery kilns, the pivot stone found at Gird-i Bazar constitutes direct evidence for pottery making at the site. Specifically, it suggests the use of the slow wheel system, or tournette, to shape pottery. The use of the wheel shaping technique is confirmed by the fluid subparallel striations left by the potters on the vessel walls.

4. Bringing together the evidence: tools and spaces for the pottery chaîne opératoire

4.1 The distribution of stone tools at Gird-i Bazar

While the pivot stone can be clearly connected to pottery making, the other stone tools may have found use in a variety of activities requiring crushing, pounding, and polishing, and are therefore not necessarily connected only to pottery production. However, we would argue that their distribution across Gird-i Bazar very much points to their involvement in the manufacture of pottery.

Figure 15 shows the distribution of stone tools in the pottery workshop area, as they were retrieved on the floors and found in the fills of the buildings. As mentioned above, material from the fills in Gird-i Bazar can be safely dated to the Iron Age, so no intrusive later material is expected in them. In our distribution analysis, we excluded stone tools found in the topsoil and on the site surface.

Two distribution clusters are evident. Cluster 1 comprises Room 46, Courtyard 18, and Room 49. 13 stone tools belong to this cluster, namely 4 pounders, 3 polishers, 5 pounders/polishers, and 1 pivot stone. The second cluster, Cluster 2, can be observed more to the east. It comprises Courtyard 27, Room 31, and Room 30. Eight stone tools are part of this cluster, namely 5 pebble mortars, 2 polishers, and 1 pounder. These two clusters can be observed in two areas where installations were found that can be directly or indirectly connected to pottery making, as previously discussed. These installations are: a pottery kiln (Kiln 2) in Room 31; wells and drains to manage water supply in Courtyard 27, Room 46, and Room 49; a semi-circular installation in Courtyard 18; and a rectangular platform in Room 46. These two clusters of stone tools may indicate pottery production which was especially concentrated in and around Courtyards 18 and 27. Outside Clusters 1 and 2, stone tools appear to be more spread-out, as they show a non-clustered distribution in Building F and Outdoor Area 8. Nevertheless, as mentioned above, additional areas of production appear to be located in both Building F and Outdoor Area 8. Here, no cluster of stone tools was identified, either because of post-depositional processes which altered the position of the tools, or because of the different distribution of pottery production activities.

In the following sections, we will describe the steps of the chaîne opératoire and their spatial location in relation to the use of specific stone tools.

4.2 Clay tempering

Clay tempering entails mixing clay with other materials, organic or non-organic, with the aim of preventing cracks in the clay during the drying and firing processes of pottery making. As mentioned above, some of the fabrics identified at Gird-i Bazar, in particular Fabrics A and B, are characterised by mineral tempering, while Fabric F is characterised by grog tempering.

We suggest that the mineral temper was prepared by using pebble mortars together with pounders or pounder/polishers in order to crush suitable minerals. Thin section analysis supports this interpretation, as Fabric B is characterised by the presence of sparry calcite inclusions with an angular character (see Fig. 8c); this angular character may have been the result of processing the minerals by crushing (Amicone, 2017b: 135). Moreover, Fabric F, characterised by grog tempering (see Fig. 8b, d), could also have been prepared by crushing small ceramic fragments (grog) to add to clay as a temper. It seems likely that all tempering agents attested at Gird-i Bazar were prepared through crushing. As discussed above, use-wear on both pebble mortars and pounders can be observed as small pits in the pebble mortars' depression as well as on the pounders' surface, which may have formed through intensive crushing and pounding activities. Pounder/polishers, which we have defined as a multi-purpose category of tools, were possibly also involved in preparing the tempering.

It must be noted that the distributions of pebble mortars and pounders placed alongside pounder/polishers does not result in an exact match. While pebble mortars seem to cluster around Courtyard 27, they also show a scattered distribution in Building F, unlike pounders and pounder/polishers. This mismatch in distribution may derive from post-depositional processes; or alternatively, it may indicate that the preparation of the mineral temper through crushing was a mobile activity that did not need to be performed in a specific space within the workshop.

4.3 Shaping

The pivot stone is evidence for the use of RKE at Gird-i Bazar to shape pottery vessels, evidence for which was also provided by the macro- and microscopic analysis of the pottery sherds. Based on our reconstruction of the use of the pivot stone, we suggest that a slow wheel was in use at Gird-i Bazar. The pivot stone was found on the floor of Room 46. However, we assume that it was originally used in the nearby Courtyard 18 of Building I, specifically inside the semi-circular installation located in the north-eastern corner of the courtyard. As discussed

above, this installation shows a hole in the centre, at the bottom of which a fixed rectangular bowl was found with a circular depression, whose surface is very smooth (see Fig. 5b). We suggest that the rectangular bowl was used to support the socket stone (which is not preserved in situ) into which the pivot stone was inserted. This setting would have allowed both the socket and the pivot stones to be well fixed in the ground, anchored there by the rectangular bowl. The advantage of such a more complex setup of the slow-wheel is that the backside of the pivot stone would have reached the floor level, and that the wheel-head, attached to the pivot stone base, could be easily rotated at this level. In support of our interpretation, we can point to the fact that the diameter of the bowl's depression exactly matches the pivot stone's diameter, and hence also of the corresponding, but missing, socket stone. In our reconstruction, pottery shaping activities therefore took place in the north-eastern corner of Courtyard 18.

A similar installation, also featuring a rectangular bowl sunk into the ground, is present in Courtyard 21 of Building F (see Fig. 5a). This installation may also have been used to accommodate a socket stone / pivot stone pairing for a slow wheel. The presence of these installations in Courtyard 18 and Courtyard 21 would indicate that, unlike the crushing of the mineral temper, fashioning pottery was a fixed activity that was performed in specific places. Moreover, the presence of wells near Courtyard 18 and in Courtyard 21 serves the need for a regular water supply in the clay fashioning process, as water must constantly be added to the clay body for shaping the vessel. In both Courtyards 18 and 21, water was readily available, and their paved floors would ensure a level of waterproofing. Based on this evidence, it seems reasonable to suggest that the fashioning of pottery took place at Gird-i Bazar in courtyards equipped with paved stone floors and wells. Another pottery shaping area could therefore have been Courtyard 27, where a well was found surrounded by a paved stone floor, although no slow wheel installation was identified there.

4.4 Burnishing

Burnishing is a step in the finishing stage that consists of rubbing the vessel surface when it has a leather-hard consistency, i.e. after the drying process has already taken place but before firing the vessel (Lepère, 2014: 145; Martineau, 2010; Rice, 1987: 138). At Gird-i Bazar, we suggest that polishers, and to some extent also pounder/polishers, were used for burnishing. Therefore, such tools, when used for this function, can also be described as burnishers. As mentioned above, polishers and pounder/polishers show one or more flat and shiny faces on

which a patina can be seen alongside tiny striations, the latter being interpreted as use-wear left by employing these tools to smooth pot surfaces. Their clustering in Courtyards 18 and 27 would indicate that burnishing routinely occurred near the places where shaping was carried out.

5. Discussion

By combining evidence from the archaeological contexts with the analysis of the macro- and microscopic traces visible on both pottery sherds and stone tools, we have identified the stone tools that were most likely involved in some of the steps of the pottery production at the Iron Age site of Gird-i Bazar. The study of the spatial distribution of stone tools and specific installations has also allowed us to identify the espaces opératoires, i.e. the spaces where specific steps of pottery production may have occurred. In this section we will discuss some key points that have emerged from this study.

The first key point concerns the use of stone tools in the pottery production process and the spaces where this occurred. It seems highly likely that pebble mortars were used together with pounders for the preparation of clay temper, with the former serving as lower stones. The distribution of pebble mortars is scattered across the workshop, which suggests that this was a mobile activity that did not need to take place in a specific place

We have also suggested that at Gird-i Bazar the pottery vessels were shaped by means of the wheel-coiling technique and that the shaping stage took place in courtyards, where specific installations were found that were involved in this stage, in particular wells to provide water and circular pits that could accommodate the pivot stone for a slow wheel. In our spatial reconstruction, this activity occurred in Courtyard 18, Courtyard 21, and possibly also in Courtyard 27. Shaping was, therefore, a fixed activity that occurred in dedicated spaces within the workshop. Finally, we have suggested that polishers (and pounder/polishers) were used as burnishers in the final part of the shaping process to burnish the vessels. In contrast to pebble mortars and in keeping with their interpretation as burnishers, polishers and pounders/polishers show a clustered distribution in courtyards, very close to where the shaping of vessels occurred. Hence, the stages of shaping and burnishing seem to have been both fixed activities occurring in the same spaces within the workshop.

It should be borne in mind, however, that despite the evidence for the use of stone tools for the pottery production seems to be clear at Gird-i Bazar, stone tools, in general, were multi-purpose objects, and in Gird-i Bazar itself, the same tools could have also been used for other, secondary activities. In the other operations of the Dinka Settlement Complex, stone tools of the same type as those found at Gird-i Bazar were unearthed (Squitieri, 2018: 146-154; Squitieri, 2019b), although no evidence for pottery production was found in those excavations. Polishers, for example, by their very nature, can be used for all activities in which surface rubbing and polishing was required (e.g., to polish other tools as well as to flatten beaten earth floors), while pebble mortars and pounders may have been used to crush a range of other types of substances, including seeds and herbs for culinary or medicinal use, or minerals for the preparation of pigments. Therefore, while the small stone tools of Gird-i Bazar cannot be unequivocally connected only to pottery production, their discovery within the pottery workshop makes it very likely that a fair number were involved in the pottery chaîne opératoire.

The second key point emerging from this study is the temporal extension of the wheel-coiling technique. This technique had been attested in the Near East since the second half of the fifth millennium BC (Baldi 2018; Baldi and Roux 2016), and it continued to be in use during the second millennium BC in the Levant (Roux, 2009). Moving to the second half of the second millennium BC and the first millennium BC, some authors have argued that wheel-throwing on a fast wheel became the dominant technique in both Mesopotamia and Syria (Hunt, 2015; Duistermaat, 2008: 378-379; Pfälzner, 1995: 244-245; Rawson, 1954). This technique consists of roughing out and modelling a clay lump directly on a fast wheel (Roux, 2019: 72). However, the evidence from Gird-i Bazar has shown that wheel-coiling was still in use during the Iron Age, at least in the area of the Zagros piedmont. Unfortunately, in-depth technological studies on the Iron Age pottery from other sites in Iraqi Kurdistan are still missing; therefore, we are not able to assess the extent of the use of the wheel-coiling technique in this region. Future regional studies should clarify this point.

6. Conclusion

The discovery of three pottery kilns was, of course, key for determining the presence of a pottery workshop area at Gird-i Bazar, and it places both Gird-i Bazar and the Dinka Settlement Complex at large in a unique position among the Iron Age sites of the region. No other pottery workshop has been unearthed in the area, nor has any technological analysis like

the one conducted on the Gird-i Bazar pottery been carried out on other Iron Age pottery from Iraqi Kurdistan, as yet. This discovery provides some hints about the socio-economic organisation of the pottery production at the Dinka Settlement Complex. Although this site has not been fully excavated, our current evidence allows us to conclude that the production of pottery at this site was carried out with a degree of specialisation as it took place in a dedicated workshop (Gird-i Bazar) in which selected spaces were used in relation to the stages of pottery production. Moreover, the pottery evidence has shown the existence of a technological consistency across the entire site (Herr et al., 2019), which supports the hypothesis that Gird-i Bazar was the specialised area for pottery production within the site. Based on these observations, a supra-household organisation behind pottery production at the Dinka Settlement Complex can be inferred, which could have involved a central organisation of the production and distribution of the products at the site level. However, more evidence from excavations is needed to assess the nature and the extent of this organisation within the site. This study has also shown that the use of wheel-coiling and burnishing, along with temper crushing, can be effectively identified by looking at traces on pottery sherds as well as the distribution and characteristics of stone tools. These results offer the precious comparative material needed for future studies to assess the extent to which the techniques identified at Gird-i Bazar were spread throughout the region, and whether the Gird-i Bazar assemblage of stone tools involved in pottery production was also present elsewhere in the region. Finally, we believe that such an approach, focusing on techniques, tools, and spaces for pottery production, can be a more effective way to assess the level of connectivity among pottery-producing communities in the mountain region of the Zagros.

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Bibliography

Adams J. 2013. "Ground Stone Use-wear Analysis: a Review of Terminology and Experimental Methods." *Journal of Archaeological Science* 48: 129-138.

Adams, J. 2014. *Ground Stone Analysis*. Salt Lake City: University of Utah Press.

Altaweel, M., and Marsh, A. 2016. "Landscape and Geoarchaeology of the Bora Plain." In *Exploring the Neo-Assyrian Frontier with Western Iran: the 2015 Season at Gird-i Bazar and Qalat-i Dinka,* edited by K. Radner, F. J. Kreppner and A. Squitieri, 23-28. Gladbeck: PeWe-Verlag.

Amicone, S. 2017a. "The Pottery Kiln." In *Unearthing the Dinka Settlement Complex: the 2016 Seasons at Gird-i Bazar and Qalat-i Dinka*, edited by K. Radner, F. J. Kreppner and A. Squitieri, 77-82. Gladbeck: PeWe Verlag. Online: https://epub.ub.unimuenchen.de/40252/

Amicone, S. 2017b. "Petrographic Analysis of the 2015-2016 pottery from Gird-i Bazar." In *Unearthing the Dinka Settlement Complex: the 2016 Seasons at Gird-i Bazar and Qalat-i Dinka,* edited by K. Radner, F. J. Kreppner and A. Squitieri, 128-138. Gladbeck: PeWe-Verlag. Online: https://epub.ub.unimuenchen.de/40252/

Amicone, S. 2018. “The Pottery Kiln in Room 31.” In *The Dinka Settlement Complex 2017. The Final Season at Gird-i Bazar and First Work in the Lower Town*, edited by K. Radner, F. J. Kreppner and A. Squitieri, 79. Gladbeck: PeWe Verlag. Online: https://epub.ub.unimuenchen.de/40252/

Amiran, R. 1956. “The Millstone and the Potter’s Wheel.” *Eretz-Israel* 3: 46-49 (Hebrew - English abstract).

Anderson, W. P. 1987. “Kilns and Workshops of Sarepta.” *Berytus* 35: 41-66.

Anderson, W. P. 1988. *Sarepta I: The Late Bronze and Iron Age Strata of Area II, Y.* Beyrouth: Publications de l´Université libanaise, Section des Études Archéologiques.

Anderson, W. P. 1989. *The Pottery Industry at Phoenician Sarepta (Sarafand, Lebanon), with Parallels to Kilns from Other East Mediterranean Sites.* Westerville: The American Ceramic Society, Inc.

Anderson-Gerfaud, P., Inizan, M.L., Lechevallier, M., Pelegrin, J., Pernot, M., 1989. “Des lames de silex dans un atelier de potier harappéen: interaction de domaines techniques.” *Compte Rendu de l'Académie des Sciences de Paris* 308: 443-449.

Arnold, D. E. 1985. *Ceramic Theory and Cultural Process*. Cambridge: Cambridge University Press.

Arnold, P .J. I., 1991. *Domestic ceramic production and spatial organization: a Mexican case study in ethnoarchaeology.* Cambridge: Cambridge University Press.

Baldi, J. S. and Roux, V. 2016. “The Innovation of the Potter's Wheel: a Comparative Perspective Between Mesopotamia and the Southern Levant.” *Levant* 48: 236-253.

Baldi, J. S. 2018. “Between Specialized Productions and Hierarchical Social Organizations: New Data from Upper Mesopotamia and the Northern Levant”. In *Proceedings of the 10th International Congress on the Archaeology of the Ancient Near East,* edited by B. Horejs, C. Schwall, V. Müller, M. Luciani, M. Ritter, M. Giudetti, R. B. Salisbury, F. Höfl mayer and T. Bürge, 247-260. Wiesbaden: Harrassowitz Verlag.

Bombardieri, L. 2004. “Il dispositivo a pivot per tournette: sviluppo e diffusione tra la Mesopotamia settentrionale e l’area egea.” *Orient Express* 4: 96-101.

Costin, C. L. 1991. “Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production”. *Archaeological Method and Theory* 3: 1-56.

Cresswell, R. 1976. “Techniques et culture, les bases d’un programme de travail”. *Techniques & Culture* 1: 7–59.

Curtis, J. E. 1989. *Excavations at Qasrij Cliff and Khirbet Qasrij*. London: British Museum Press.

Danti, M. and Cifarelli. M. 2015. "Iron II Warrior Burials At Hasanlu Tepe, Iran." *Iranica Antiqua* 50: 61-157. DOI: 10.2143/IA.50.0.3053517.

Darras, V. and Hamon, C. 2020. "Indicators of Household Pottery Production: A Case-Study from the Chupicuaro Formative Culture". *Journal of Field Archaeology* 45: 445-463. DOI: 10.1080/00934690.2020.1777371

Delage, C. 2017. "Once Upon a Time… the (Hi)story of the Concept of the Chaîne Opératoire in French Prehistory". *World Archaeology* 49: 158–173.

Delcroix, G. and Huot, J.-L. 1972. "Les fours dits de "potiers" dans l'Orient Ancien." *Syria* 49: 35-95.

Dubreuil L. and Savage, D. 2014. "Ground stones: A synthesis of the Use-wear Approach." *Journal of Archaeological Science* 48: 139-153.

Duistermaat, K. 2008. *Pots and Potters of Assyria: Technology and Organization of Production, Ceramic Sequence and Vessel Function at Late Bronze Age Tell Sabi Abyad, Syria.* Turnhout: Brepols.

Eitam, D. 2009. "Late Epipalaeolithic Rock-Cut Installations and Ground Stone Tools in the Southern Levant: Methodology and Classification System." *Paleorient* 35: 77-104.

Geiger, C. 2019. "A First Geological Survey of the Bora Plain." In *The Dinka Settlement Complex 2018: Continuing the Excavations at Qalat-i Dinka and the Lower Town*, edited by. K. Radner, F. J. Kreppner and A. Squitieri, 21-25. Gladbeck: PeWe-Verlag.

Gelbert, A. 2003. "Reconnaissance des techniques et des méthodes de façonnage par l'analyse des macrotraces: études ethnoarchéologique dans la vallée du Sénégal." In *Pottery Manufacturing Process: Reconstruction and Interpretation*, edited by A. L. Smith, D. Bosquet, and R. Martineau, 67-78. Oxford: BAR.

Giraud, J. 2016. "Surface Survey of the Dinka Settlement Complex, 2013-2015." In *Exploring the Neo-Assyrian Frontier with Western Iran: the 2015 Season at Gird-i Bazar and Qalat-i Dinka,* edited by K. Radner, F. J. Kreppner and A. Squitieri, 29-35. Gladbeck: PeWe-Verlag.

Goff, C. 1977. "Excavations at Baba Jan: The Architecture of the East Mound, Levels II and III." *Iran* 15:103-40. DOI: 10.2307/4300567.

Gosselain, O., 2002. *Poteries du Cameroun méridional styles techniques et rapports à l'identité.* Paris: CNRS Editions.

Gosselain, O., 2010. "Ethnographie comparée des trousses à outils de potiers au sud du Niger." *Bulletin de la Société préhistorique française* 107: 667-690.

Hansen Streily, A. 2000. "Early pottery kilns in the Middle East." *Paléorient* 26 (2): 69-81.

Hasaki, E. 2011. "Crafting Spaces: Archaeological, Ethnographic, and Ethnoarchaeological Studies of Spatial Organization in Pottery Workshops in Greece and Tunisia." In *Pottery in the Archaeological Record: Greece and Beyond. Acts of the International Colloquium held at the Danish and Canadian Institutes in Athens, June 20-22, 2008,* edited by M. L. Lawall and J. Lund, 12-28. Aarhus: Aarhus University Press.

Herr, J.-J. 2016. "The Pottery from Gird-i Bazar, 2015: a Preliminary Study." In *Exploring the Neo-Assyrian Frontier with Western Iran: the 2015 Season at Gird-i Bazar and Qalat-i Dinka,* edited by K. Radner, F. J. Kreppner and A. Squitieri, 80-99. Gladbeck: PeWe-Verlag.

Herr, J.-J. 2017. "The 2016 Season Pottery and a First Catalogue of the Chaîne Opératoire at Gird-i Bazar." In *Unearthing the Dinka Settlement Complex: the 2016 Seasons at Gird-i Bazar and Qalat-i Dinka,* edited by K. Radner, F. J. Kreppner and A. Squitieri, 104-127. Gladbeck: PeWe-Verlag.

Herr, J.-J., A. B. Othman and H. S. Ahmed, 2019. "The 2018 Pottery from the Dinka Settlement Complex." In *The Dinka Settlement Complex 2018: Continuing the Excavations at Qalat-i Dinka and the Lower Town,* edited by. K. Radner, F. J. Kreppner and A. Squitieri, 99-123. Gladbeck: PeWe-Verlag.

Hunt, A. 2015. *Palace Ware across the Neo-Assyrian Imperial Landscape: Social Value and Social Meaning*. Leiden & Boston: Brill.

Klinkenberg, V. 2016. *Reading rubbish: using object assemblages to reconstruct activities, modes of deposition and abandonment at the Late Bronze Age dunnu of Tell Sabi Abyad, Syria (Consolidating Empire Project, volume 2)*. Leiden: Nederlands Instituut voor het Nabije Oosten.

Kopanias, K. and MacGinnis, J. 2016. *The Archaeology of the Kurdistan Region of Iraq and Adjacent Regions*. Oxford: Archaeopress.

Lemonnier, P. 1983. "L'étude des systèmes techniques, une urgence en technologie culturelle." *Techniques et Culture* 1: 11–34.

Lemonnier, P. 1992. *Elements for an Anthropology of Technology*. Ann Arbor: University of Michigan.

Lepère, C. 2014. “Experimental and Traceological Approach for a Technical Interpretation of Ceramic Polished Surfaces.” *Journal of Archaeological Science* 46: 144-155.

Martineau, R. 2010. “Brunissage, polissage et degrés de séchage. Un référentiel expérimental.” *Les Nouvelles de l´archéologie* 119: 13-19.

Matney, T., T. Greenfield, B. Hartenberger, A. Keskin, K. Köroglu, J. MacGinnis, W. Monroe, L. Rainville, M. Shepperson, T. Vorderstrasse, D. Wicke. “Excavations at Ziyaret Tepe 2007-2008.” *Anatolica* 35: 37-84.

McCown, D. E., R. C. Haines, and R. D. Biggs. 1978. *Nippur II. The North Temple and Sounding E*. Chicago: The Oriental Institute.

Muscarella, O. W. 1974. “The Iron Age at Dinkha Tepe, Iran.” *Metropolitan Museum Journal* 9: 35-90.

Pfälzner, P. 1995. *Mittanische und mittelassyrische Keramik: eine chronologische, funktionale und produktionsökonomische Analyse.* Berlin: Dietrich Reimer Verlag.

Powell, C. 1995. “The Nature and Use of Ancient Egyptian Potter’s Wheel.” In *Amarna Reports VI*, edited by B. J. Kemp, 309-335. London: Egyptian Exploration Society.

Radner, K. 2016. “The Peshdar Plain in the Neo-Assyrian Period: the Border March of the Palace Herald.” In *Exploring the Neo-Assyrian Frontier with Western Iran: the 2015 Season at Gird-i Bazar and Qalat-i Dinka*, edited by K. Radner, F. J. Kreppner and A. Squitieri, 17-22. Peshdar Plain Project Publications 1. Gladbeck: PeWe Verlag.

Radner, K., F. J. Kreppner and A. Squitieri, eds. 2016. *Exploring the Neo-Assyrian Frontier with Western Iran: the 2015 Season at Gird-i Bazar and Qalat-i Dinka*, Peshdar Plain Project Publications 1. Gladbeck: PeWe Verlag. Online: https://epub.ub.uni muenchen.de/29236/

Radner, K., F. J. Kreppner and A. Squitieri, eds. 2017. *Unearthing the Dinka Settlement Complex: the 2016 Seasons at Gird-i Bazar and Qalat-i Dinka*, Peshdar Plain Project Publications 2. Gladbeck: PeWe Verlag. Online: https://epub.ub.unimuenchen.de/40252/

Radner, K., F. J. Kreppner and A. Squitieri, eds. 2018. *The Dinka Settlement Complex 2017. The Final Season at Gird-i Bazar and First Work in the Lower Town*, Peshdar Plain Project Publications 3. Gladbeck: PeWe Verlag. Online: https://epub.ub.unimuenchen.de/57255/

Rawson, P. S. 1954. “Palace Wares from Nimrud: Technical Observations on Selected Samples.” *Iraq* 16: 168-176.

Rice, P. M. 1987. *Pottery Analysis: A Sourcebook*. Chicago: The University of Chicago Press.

Roux, V. 2019. *Ceramics and Society: A Technological Approach to Archaeological Assemblages*. Cham: Springer.

Roux, V. 2009. "Le tour au Bronze Moyen II dans le Levant Sud : étude technologique des céramiques de Beth Shean" *The Arkeotek Journal* vol. 3, n. 4. Available from www.thearkeotekjournal.org.

Roux, V., and Courty, M.-A. 1998. "Identification of Wheel-Fashioning Methods: Technological Analysis of 4th-3rd millennium BC Oriental Ceramics." *Journal of Archaeological Science* 25: 747–763.

Rye, O. S. 1981. *Pottery Technology: Principles and Reconstruction*. Washington DC: Taraxacum.

Santacreu, D.A., 2014. *Materiality, Techniques and Society in Pottery Production*. De Gruyter Open Poland.

Squitieri, A. 2018. "The Iron Age Small Finds of the 2017 Campaigns at DLT2 and Gird-i Bazar." In *The Dinka Settlement Complex 2017. The Final Season at Gird-i Bazar and First Work in the Lower Town*, edited by K. Radner, F. J. Kreppner and A. Squitieri, 146-172. Gladbeck: PeWe Verlag.

Squitieri, A. 2019a. "The Iron Age Stone Tool Assemblage of Gird-i Bazar, in the Kurdish Autonomous Region of Iraq." In *Stone Tools in the Ancient Near East and Egypt*, edited by A. Squitieri and D. Eitam, 212-222. London: Archaeopress.

Squitieri, A. 2019b. "The 2018 Small Finds from Qalat-i Dinka and DLT3." In *The Dinka Settlement Complex 2018: Continuing the Excavations at Qalat-i Dinka and the Lower Town*, edited by. K. Radner, F. J. Kreppner and A. Squitieri, 126-136. Gladbeck: PeWe-Verlag.

Squitieri, A. 2020. "The Sasanian Cemetery of Gird-i Bazar in the Peshdar Plain (Iraqi Kurdistan)." *Iran*, DOI: 10.1080/05786967.2020.174900.

Trokay, M. 1989. "Les deux documents complémentaire en basalte du Tell Kannas: base de tournette ou meule?" In *Reflets des deux fleuves: Volume de mélanges offerts à André Finet*, edited by M. Lebeau and P. Talon, 169-175. Leuven: Peeters.

van Gijn, A. and Lammers-Keijsers, Y. 2010. "Toolkits for ceramic production: informal tools and the importance of high power use-wear analysis." *Bulletin de la Société Préhistorique Française* 107: 755-762. DOI:10.3406/bspf.2010.13977

Williams, E. 2018. "Ceramic Ethnoarchaeology in Huácinto, Michoacán, Mexico". *Ancient Mesoamerica* 29, 11-44. DOI: 10.1017/S0956536117000293.

Wright, K. 1992. "A Classification System for Ground Stone Tools for the Prehistoric Levant." *Paléorient* 18: 53-81.

Figure captions

Fig. 1. The location of the Dinka Settlement Complex in the Peshdar Plain in the Autonomous Region of Kurdistan, Iraq. Map created by Andrea Squitieri.

Fig. 2. The Upper and Lower Towns of the Dinka Settlement Complex. In yellow the excavation areas, with the inset showing the excavations at Gird-i Bazar. Drone image created by ICONEM (courtesy of J. Giraud). Annotations by Andrea Squitieri.

Fig. 3a. Orthophoto of the buildings and the installations excavated in the western part of Gird-i Bazar. Created by Andrea Squitieri.

Fig. 3b. Plan showing rooms and installations mentioned in the text. Created by Jean-Jacques Herr, Andrea Squitieri and Laura Tretow.

Fig. 4. Kilns and pyrotechnical installation at Gird-i Bazar: **a** Kiln 1 in Outdoor Area 8 with vessels from the last kiln load. Photo by Silvia Amicone. The inset shows a schematic drawing of an Iron Age up-draught kiln, after Curtis 1989, fig. 20. **b** Pyrotechnical Installation 2 in Outdoor Area 8, possibly a pottery kiln. Photo by Andrea Squitieri; **c** Kiln 2 in Room 33, with the collapse of bricks in its fill coming from the kiln superstructure. Photo by Peter Bartl.

Fig. 5. Pit installations possibly used to accommodate the socket stone of a slow wheel: **a** Pit installation in Courtyard 21. Photo by Zara Hashemi; **b** Pit installation in Courtyard 18 located within a semi-circular line of stones. Photo by Peter Bartl.

Fig. 6. Dino-Lite microscope images showing evidence for coiling. **a** Fracture following the join of two coils in the neck of a jar (PPP 271927:037:001:350); **b** Line of voids visible in the section showing the join of two coils under a carnation (PPP 269929:026:001:001); **c-d** Inclusions and voids organised in circular arrangements (PPP 269929:039:005:001). The red circles highlight the positions of three coils. Photos by Jean-Jacques Herr.

Fig. 7. Slow-wheel shaping technique and burnishing technique commonly found at Dinka Settlement Complex. **a** Photo of a carinated bowl showing burnishing patterns on the outside wall (sherd PPP 271929:039:001:078). By Hero Ahmad Salih; **b** Dino-Lite Digital microscope image showing slow-wheel traces on the outside wall of a carinated bowl (sherd PPP 271927:040:001:310). These traces consist of fluid horizontal sub-parallel striations; **c** Dino-Lite Digital microscope image showing burnishing traces consisting of thick vertical striations

with accumulation of clay on the edges and compact topography (sherd PPP 269929:039:017:001); **d** Dino-Lite Digital microscope image showing thick compact striations of burnishing above horizontal fluid sub-parallel striations made on a slow-wheel (sherd PPP 271929:039:001:016). Dino-Lite images by Jean-Jacques Herr.

Fig. 8. a Dino-Lite Digital microscope image showing the sparry calcite tempering of Fabric B with the sub-angular inclusions (section view of sherd PPP 269929:039:017:001); **b** Dino-Lite Digital microscope image showing the grog tempering of Fabric F with the sub-angular fragments of the crushed ceramics (grog) (sherd PPP 269929:005:006:025). Dino-Lite images by Jean-Jacques Herr; **c-d** Thin section photomicrographs in cross-polarised light of Fabric B showing the sparry calcite inclusions (**c**), and Fabric F showing grog tempering (**d**) (sherds PPP 269929:039:017:001 and PPP 236934:027:011), image width= 8 mm, by Silvia Amicone.

Fig. 9. Thin sections micrographs from selected stone tools from Gird-i Bazar: **a** Limestone (XP, field of view 3 mm); **b** Serpentinite (XP, field of view 3 mm) ; **c** Gabbro/Peridotite (XP, field of view 3 mm); **d** Basalt (XP, field of view 3 mm). Prepared by Silvia Amicone.

Fig. 10. A selection of pebble mortars from Gird-i Bazar: **a** Find PPP 268931:048:003; **b** Find nr. PPP 267931:023:002; **c** Find nr. PPP 271929:007:016; **c** Close-up of the depression of PPP 271929:007:016, showing wear-marks. Photos by Peter Bartl and Andrea Squitieri.

Fig. 11. Two pounders from Gird-i Bazar: **a** Find PPP 266930:010:001; **b** Close up of PPP 266930:010:001 showing wear-marks as small pits on the surface; **c** Find PPP 267930:020:003; **d** Close up of PPP 267930:020:003 showing wear-marks as small pits on the surface. Photos by Kim Thommes.

Fig. 12. Two polishers from Gird-i Bazar: **a** Find PPP 267931:085:040; **b** Find PPP 267930:036:022. Photos by Andrea Squitieri.

Fig. 13. a Two pounder/polishers from Gird-i Bazar: **a** Find PPP 267930:038:001; **b** Close up of PPP 267930:038:001, wear marks; **c** Find PPP 268930:085:038, showing wear marks as pits on the surface.; **d** Close up of PPP 268930:085:038, showing wear marks as pits on the surface. Photos by Kim Thommes.

Fig. 14. a The pivot stone from Gird-i Bazar (Find PPP 267931:064:031) used for a slow wheel. Photo by Andrea Squitieri; **b** Reconstruction of a potter's slow wheel, after Powell 1995: fig. 10.7. Courtesy of the Egypt Exploration Society, London. Annotations by Andrea Squitieri. **c** A man using a stick to rotate a head wheel in an Indian village, photo by Nasir Akhtar, Delhi:

https://pixabay.com/en/potery-old-man-working-in-village-333071/, under CC0 Creative Commons licence.

Fig. 15. Stone tool distribution in the pottery workshop of Gird-i Bazar. Cluster 1: Building I (Room 46, Courtyard 18, Room 48, and Room 49); Cluster 2: Building D/E (Courtyard 27, Room 31, and Room 33). Prepared by Andrea Squitieri.