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How the Uruk Potters Used the Wheel. New Data on Modalities and Conditions of Emergence of the Potter's Wheel in the Uruk World

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ABSTRACT

The phase and the ceramic materials that, in Southern Mesopotamia, go under the label of “Uruk” (after the toponym of the site in southern Iraq) have traditionally been considered the origin for the development of the potter's wheel in the Near East, according to a perspective that associated the emergence of the potter's wheel, the “mass” production of the so-called bevelled-rim bowls and first urbanization. According to recent excavations and ceramic studies it is now clear that this was a narrative based on a priori convictions. However, even if under very different socio-technical conditions, it is true that the potter's wheel made an early appearance in Southern Mesopotamia within the Uruk cultural sphere, and then developed in a widespread and discontinuous way in the Uruk network. Based on recent ongoing fieldwork data from Syria (Tell Feres) and Iraqi Kurdistan (Logardan and Girdi Qala), ceramic analyses have taken into account new criteria to identify the use of the potter's wheel. This paper outlines the chronological and socio-technical scenario behind the adoption of the potter's wheel in the Uruk world, picturing the peculiarities of this cultural environment, as well as the parallels with the emergence conditions of the potter's wheel in northern Mesopotamia and other areas of the Near East.

1. Introduction

1.1 Urbanisation and potter's wheel: from myths to current questions

According to a traditional historical perspective, the spread of the potter's wheel in Mesopotamia – and especially in the southern Alluvium – occurred in the 4th millennium BCE (Abu al-Sooif, 1985; Lloyd, 1948; Laneri and di Pilato, 2000; Butterlin, 2003). This conviction – the result of a linear and teleological vision of history (and essentially of Western history – Childe, 1929) – offered a coherent theoretical and historical framework. This perspective on the potter's wheel matched well with a perception of techniques as neutral human endeavours devoid of specific sociocultural meanings and largely dictated by environmental and functional constraints. As “extra-somatic” strategy of adaptation, a technique – and especially a new one – was assumed to physically respond to the socio-economic goals to overcome the limits imposed by the environment. Therefore, it was rational to associate the diffusion of a new disruptive technology with another

crucial innovation emerging in 4th millennium Mesopotamia, namely urbanization (Mellowan, 1970; Algaze, 1993). The stereotype considering wheel-made pottery as the result of wheel-throwing on the so-called fast wheel imbues the potter's wheel with a series of alleged intrinsic techno-functional attributes enabling efficiency, standardisation, and intensification in pottery production (Haller, 1932; Kalsbeek, 1980). The first cities were considered as social containers gathering large numbers of inhabitants supposedly sharing the same ceramic needs, to which specialized craftsmen necessarily had to respond, in a new, standardized way, with a large-scale production: bevelled-rim bowls (henceforth BRBs – Lloyd and Safar, 1943; Beale, 1978).

However, recent studies on the potter's wheel by Valentine Roux (1994; 2003a; 2009; 2012) and other scholars (Roux and Corbetta, 1989; Roux and Courty, 1995; 1997; 1998; Roux and Mirischedji, 2009; Berg, 2006; 2007; 2008; 2011; Jeffra, 2011; 2013; Roux and Jeffra, 2015; Choleva, 2012; 2018; 2020) have overcome environmental and economic deterministic views on techniques, while knowledge on 4th millennium BCE Mesopotamia has also advanced considerably (Rothman, 2002; Wright, 2001;

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2014; 2016; Pollock, 2001; Frangipane, 2001; 2002; 2018; Schwartz, 2001; Strommenger *et al.*, 2014; Butterlin, 2003; 2018). The southern sector of the plain, occupied by the cultural entity called Uruk (from the eponymous site), is no longer essentialised as the only cradle of social complexity (Butterlin, 2009a; 2009b; 2013; Baldi, 2016a; Iamoni, 2016). For decades, much attention has been paid to the specific organizational features of the independent but equally ancient path to complexity that was developed by the proto-urban formations of northern Mesopotamia (Frangipane, 2009; 2010; 2018; Rothman, 2002; Balossi-Restelli, 2019; Stein, 2001; 2002a; 2002b; 2005; 2012; McMahon and Crawford, 2015; McMahon, 2020). Even the geographical boundaries between these two spheres of influence are no longer regarded as a key factor: “North” and “South” are generally referred to as synthetic labels, evocative categories of different social and organisational systems, but equally hierarchical and far from separate from each other. Clichéd historical reconstructions of the first urbanisation are now completely outdated (Ur, 2010a; 2010b; Algaze, 2018; Benati, 2018; Skuldbøl and Colantoni, 2016; 2018; Emberling, 2015), as also the assumption that bevelled-rim bowls were wheel-thrown (Goulder, 2010; Helwing, 2014). However, one fact remains true: in Mesopotamia, the potter’s wheel was first adopted in the 4th millennium BCE. The focus of current archaeological research is rather on differences, parallels, and connections between north-Mesopotamian Late Chalcolithic (henceforth LC) polities and southern Uruk proto-cities (Marro, 2010; Nannucci, 2012; Butterlin, 2018; D’Anna, 2019; D’Anna and Jaus, 2015). This aims at explaining how reciprocal contacts happened in terms of social dynamics and management

mechanisms framing phenomena such as exchanges, conflicts, migrations, acculturations and shifting cultural frontiers on the basis of respective political economies, identities and ethnicities (McMahon, 2016; Minc, 2016; Minc and Emberling, 2016; Wright, 2016; Balossi-Restelli *et al.*, 2018; Renette *et al.*, in press). Recent literature explores the culture contact between northern local inhabitants and southern Uruk immigrants starting from the so-called Uruk “colonial expansion” (Stein, 2001; 2002a). Actually, the south-Mesopotamian Uruk diffusion has nothing colonial about it (Baldi, 2016b) and is rather a phenomenon of demic and cultural spread (Figure 1), implying the foundation of enclaves, villages and, lastly, Uruk cities in the North and Iran (Stein, 2005; Wright, 2016). The adoption and diffusion of the potter’s wheel is taken into account within this context of intense North-South cultural exchanges.

The appearance of the wheel-coiling technique in the early 4th millennium northern Mesopotamia has recently been documented and compared with archaeological and ceramic evidence from the 5th millennium Levant (Baldi and Roux, 2016). On the other hand, with respect to the Uruk cultural sphere, it is essential to answer two basic questions:

1. What is the chronology and social context of the emergence of this new technique within the Uruk communities?
2. Furthermore, in the framework of the culture-contact between north-Mesopotamian and Uruk people, was the wheel adopted by the Uruk potters as a result of a borrowing, as a local novelty spreading to the North, or rather as an independent innovation characterized by specific features?

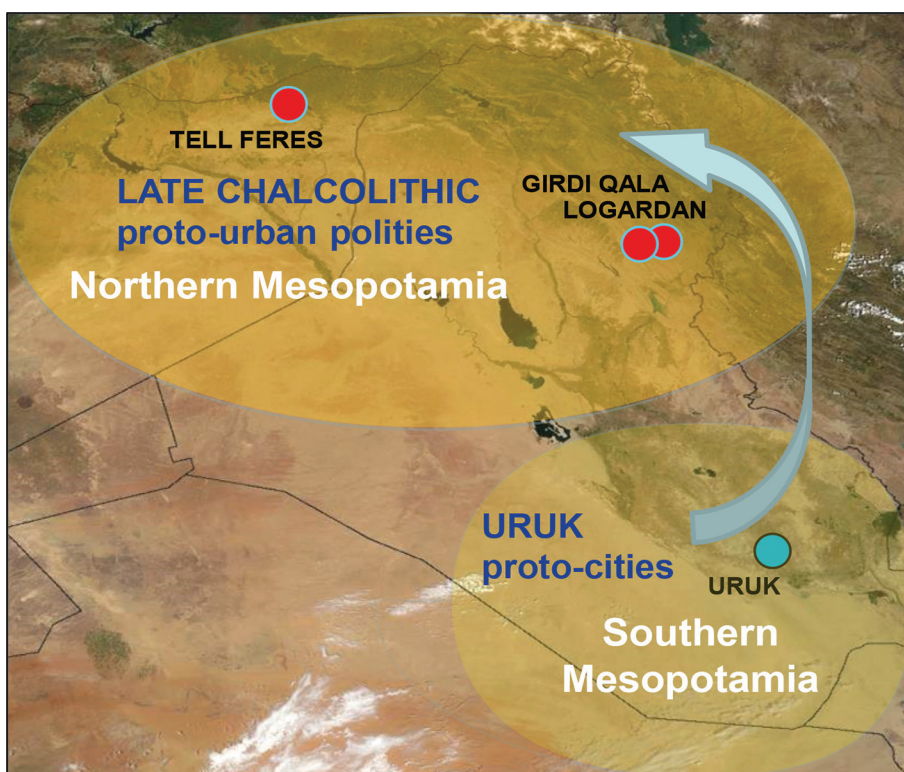


Figure 1. Location of the sites mentioned in the text and outline of the Uruk expansion from southern Mesopotamia into the North during the 4th millennium BCE.

2. Methods

2.1 For a comparative analysis between north-Mesopotamia and the Uruk

Fresh and significant data to answer these questions are offered by the assemblages of sites recently analysed in northern and southern Mesopotamia. These sets of data come from surface surveys (Baldi, 2018), test-trenches (Giraud *et al.*, 2019) or extensive excavations (which are very few in number in the whole Mesopotamian Alluvium – Baldi, 20112a; 2012c; Baldi and Abu Janyab, 2012; Vallet *et al.*, 2017; Baldi *et al.*, 2016). In particular, two case-studies based on recent or ongoing French excavations in different Mesopotamian areas (Figure 1), offered particularly reliable data from well-stratified contexts covering the entire duration of the Uruk cultural phenomenon. Tell Feres al-Sharqi (Hassake Province, northern Syria) is a rural site in the Khabur basin excavated between 2006 and 2010 (Forest *et al.*, 2012). The sites of Girdi Qala and Logardan are located in the Zagros Piedmont (Qara Dagħ area, Sulaymaniyah Governorate, Iraqi Kurdistan) and have been investigated since 2015 by an ongoing archaeological expedition (Vallet *et al.*, 2019). Analyses of ceramics coming from these sites have produced results entirely consistent with those obtained by studying pottery assemblages from other sites and surveys (Giraud *et al.*, 2019). But given the extreme scarcity of well-stratified data on Uruk pottery from southern Mesopotamia (Nissen, 2002; 2018), the case studies of Tell Feres and the Qara Dagħ sites were selected because of the quality of the information they provided. At Tell Feres the excavated area occupied by vestiges from the 4th millennium BCE is about 600 m², while for the Qara Dagħ sites it exceeds a total of 1300 m². This

makes it possible to also examine the characteristics of the ceramics in relation to their contexts of origin. Moreover, both Tell Feres and the Qara Dagħ were areas characterised by intense and diverse interactions between local and Uruk communities. In other words, Tell Feres, Logardan and Girdi Qala have yielded both indigenous north-Mesopotamian and typically south-Mesopotamian Uruk materials and ceramics. Finally, the pace and temporalities of the Uruk south-Mesopotamian presence in the Syrian steppes and in the Zagros Piedmont are not identical, but together the sequences of Tell Feres and the Qara Dagħ sites cover the whole timespan of the culture-contact between north-Mesopotamian societies and southern Uruk communities during the 4th millennium BCE (Figure 2).

All these criteria are necessary to apply a comparative analysis of temporalities and modalities of adoption of the potter's wheel respectively by north-Mesopotamian and Uruk communities.

On the one hand, the study has taken into account the contextual features of indigenous and Uruk ceramics produced using rotary kinetic energy (RKE henceforth), comparing their primary deposition locations. This kind of spatial evidence provides significant information in cases where there is a regular association between a type of *in-situ* material and a specific kind of context (Balossi Restelli, 2019; Balossi-Restelli and D'Anna, 2018; Baldi, 2016b; Baldi and Roux, 2016).

On the other hand, the comparative analysis focused on the physical characteristics of indigenous and Uruk wheel-shaped pottery. Morphology, quantity, and coefficients of variation (CVs) of the rim diameters (one of the most trustworthy indicators for assessing standardisation –

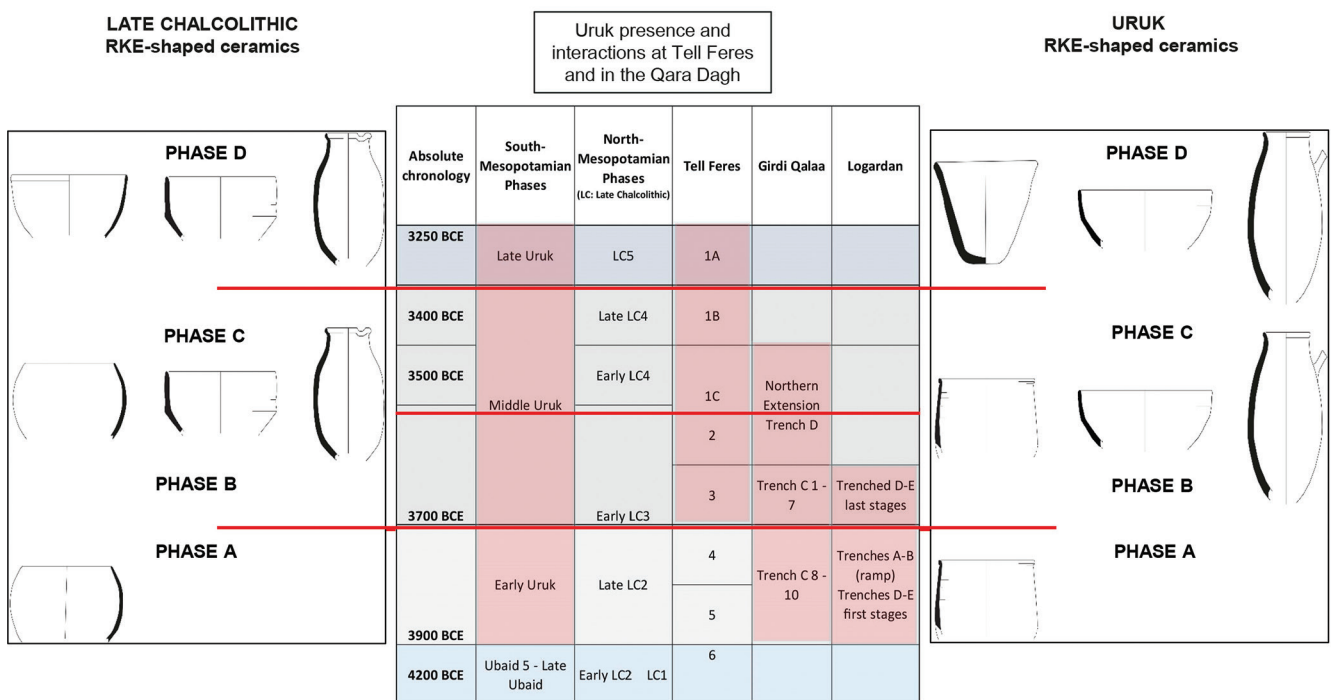


Figure 2. Chrono-stratigraphic and morphological chart of the appearance and evolution of the north-Mesopotamian and Uruk RKE-shaped vessels.

Eerkens and Bettinger, 2001; Kvamme *et al.*, 1996) have been used as parameters for evaluating the degree of specialisation of local and Uruk craftspeople having adopted the potter's wheel. These criteria allow the volume, intensity and standardisation of north-Mesopotamian and Uruk RKE-shaped pottery to be estimated. According to the so-called "standardisation hypothesis", low CVs indicate a high level of control of motor skills, that can be attained only with a high rate of production (Benco, 1988; Blackman *et al.*, 1993; Costin, 1991; 2000; Costin and Hagstrum, 1995; Longacre *et al.*, 1988; Sinopoli, 1988; Stark, 1995; Roux, 2003b). Therefore, low CVs express intense production at the scale of individual artisans, namely specialisation. The number of artisans can be inferred both on the basis of the CVs and the estimated annual production. Hence, low CVs combined with a quite small production suggest a limited number of artisans, since regular practice would have been necessary to develop complex motor habits. Conversely, low CVs associated with high annual rates of production suggest the involvement of a large number of artisans. Standardisation, degree of specialisation, as well as the quantity of craftspeople involved in the production are crucial parameters for the reconstruction of the social and productive context in which the wheel was first adopted by north-Mesopotamian and Uruk potters in order to assess any similarities or differences between the two communities (Baldi, 2012b; 2012c; 2013; Baldi and Roux, 2016).

In addition, technical features of local and Uruk pottery were also compared. Macro- and micro-traces were examined, both with the naked eye and a binocular magnifying glass ($\times 15$), in order to reconstruct how vessels were shaped and when the RKE was involved in the process. Then, the technical gestures and operational sequences distinctive of north-Mesopotamian and Uruk wheel-shaping processes have been reconstructed on the basis of recent reference works framing macro- and micro-features diagnostic of the use of RKE (Roux and Corbetta, 1989; Roux and Courty, 1995; 1997; 1998; Boileau, 2005; Jeffra, 2011; Choleva, 2012; Rückl and Jacobs, 2016).

2.2 A non-formalised experimental protocol

By evaluating both the technical and contextual features of Late Chalcolithic and Uruk wheel-made ceramics, this approach has aimed at assessing whether the potter's wheel was used in the same or in different ways by craftspeople of northern and southern Mesopotamian origin. As macro- and micro-traces observed on the Uruk and north-Mesopotamian wheel-shaped specimens have some different attributes, the issue was whether this variability is the result of different uses of the wheel, or simply a random characteristic. In order to answer this question by an additional evaluation criterion, an experimental protocol was implemented. At first glance, it was therefore a question of testing certain procedures and manufacturing methods on the wheel, to see if they could actually produce macro- and micro-traces compatible with those observed on ancient vessels. This type of approach – the testing of a belief about what is proposed

to have happened in the past by an experience aiming at replicating former conditions and features of past materials (Coles, 1973; 1979; Mathieu, 2002) – corresponds exactly to the definition of an "imitative" experiment (Ascher, 1961, p.795; Coles, 1979, p.1). This test, however, did not involve a mere "simulative" process (Hodder, 1978; Reynolds, 1999, pp.159–160). Although the experimental data set is not very extensive, an "actualistic" procedure (Outram, 2008, p.2; Beyries, 2020, pp.15, 22) was implemented by investigating gestures, postures, conditions and tools that might have been adopted in the 4th millennium BCE, using methods and materials that were probably available at that time. To determine which elements might be characteristic of possibly different uses of the wheel, a crucial point was therefore to control and adjust certain variables (Ingersoll, Yellen and MacDonald, 1977; Roux, 2007b; Outram, 2008) – in particular the shaping tools and the rotational speed – while keeping others stable – such as the size of the pots or the type of clay. The aim was to assess the type of information and analogy from which it could be inferred what technical behaviours might have been at the root of possibly different uses of the wheel. This step of inference is intrinsically questionable: how to reliably test hypotheses on the very facts that gave rise to them? As many scholars have pointed out (Ascher, 1961, pp.808, 810; Giligny, 2010), experimental archaeology is not about inferring a picture such as "if the observable evidence is A, then the gesture that created it is certainly B": there are no automatic or absolutely valid interpretative syllogisms. Moreover, "valid" does not necessarily mean "true", but simply "confirmed by the experimental process". However, determining how to obtain certain results (in this case, certain macro- and micro-traces) by performing certain activities or gestures means identifying a cultural pattern, which is not necessarily a rule, but at least a regularity – because all cultural behaviours (and obviously all *chaînes opératoires*) are patterned (Schiffer and Skibo, 1987; Roux, 2007b; Banning, 2020). Therefore, despite all its epistemological limits, the "actualistic" experimental approach was aimed at suggesting which variables might underlie the differences in macro- and micro-traces observed on 4th millennium north-Mesopotamian and Uruk wheel-shaped pots.

Three experienced potters belonging to different traditions and regions – Nawzi Fakhouri (Rashaya al Foukhar, Lebanon), Roselyn Shelly (Elgin, Scotland) and Gianluca Ricciardi (Montelupo Fiorentino, Italy) – were asked to produce replicas of small bowls according to both north-Mesopotamian and Uruk traditional shaping methods. Pastes used for these experiences were dense, mineral, non-tempered fabrics. Their very fine illitic clay matrix contained goethite and a low quantity of iron-rich mullite, while non-clay materials were essentially fine quartz and feldspar sands, with a small presence of limestone, that is never absent in ancient Mesopotamian fabrics. Each potter made 3 bowls according to the north-Mesopotamian method. A variable number of bowls – between 6 and 9 – were produced by each potter according to the Uruk

shaping technique. The results were then compared to the ancient sherds both in terms of macro-traces and by comparing thin sections of archaeological specimens and experimental replicas. Thin sections came from the lower part of ancient vessels and wheel-shaped replicas. In fact, as R. Thér and P. Toms (2016, pp.40–42) have recently demonstrated for the wheel-throwing technique, in the portions of the walls close to the base the clay-mass undergoes significantly greater deformation. Even though the technique tested for Uruk and north-Mesopotamian pottery was not the wheel-throwing but rather the wheel-coiling, it seemed prudent to observe thin sections coming from the lower part, namely from the area where the RKE has a deeper effect. Thin sections were prepared and observed via digital image analysis at the headquarters of the National Center for Geophysics of the Lebanese CNRS (at Dahr el-Sawwan, Metn region, Lebanon). Each section was a transect approximately 6.5–9 mm wide observed at a magnification of 40× in plane-polarised light. The mineral fabric used by Uruk and North Mesopotamian potters (and, consequently, also by present-day potters asked to shape replicas) was extremely fine and homogeneous, which, even at this degree of magnification, does not help to recognise peculiar traces of manipulations. Therefore, special attention was paid to residual voids in the paste, in particular macro- (wider than 0.05 μm) and mesopores (between 0.05 and 0.002 μm – Borrelli, 1999). In order to make the pores as easily recognisable as possible in plane polarised light, the thin sections were impregnated with a dyed epoxy resin (Quinn, 2013).

However, the purpose was not to establish a reference system associating with certainty technical gestures carried-out by the potters and micro-features of thin sections. As demonstrated by several studies, (Roux and Corbetta, 1989; Roux and Courty, 1995; 1998; Jeffra, 2011) an experimental approach is meant to assess different shaping methods in order to better support the reconstruction of the technical gestures having determined certain traces observed on ancient sherds. But supporting a technical reading of the ceramic material does not imply establishing that a specific configuration of the clay is diagnostic of one particular gesture or sequence. Although useful to suggest some hints, the experimental approach was not based on a normatively formalised protocol. On the one hand, the trials with the three potters were carried out as part of a series of sessions concerning not only wheel-made pottery, but also all the other shaping methods documented at Tell Feres, Girdi Qala and Logardan (Baldi, 2013; Baldi, 2016b). The result is that the experiments on the use of RKE took place over a long period (between 2016 and 2019) and constituted just a part of a larger (and not exclusively wheel-related) experimental project. Actually, in view of the relatively small number of experiments (and, above all, of thin sections), it would be risky or even misleading to determine whether one specific way of using the wheel produces certain micro-traces *under certain conditions*, or whether a systematic correspondence exists (Beyries, 2020, p.4). Basically, correlation does

not imply causation. Therefore, we cannot know whether technical gestures and observed micro-traces are related by a causal relationship or by a mere coexistence.

The experimental approach was rather a means of testing possible implications that different ways of using the wheel might have had in terms of postures and technical complexity for craftspeople belonging to different traditions (Gandon and Roux, 2019).

3. Results

3.1 Similar north-Mesopotamian and Uruk types

Indeed, north-Mesopotamian and Uruk potters were part of very different cultural communities, but they adopted the wheel according to surprisingly homogeneous temporalities and methods.

The Uruk presence in the Qara Dagh area is extremely early, about three centuries older than at Tell Feres, along the Euphrates Valley and in the Syrian steppes. From the beginning it was a massive presence, with an acropolis, stone ramps, monumental buildings, and large production areas, and, later, with the foundation of an autonomous Uruk village at Girdi Qala North (Vallet *et al.*, 2017; Baldi *et al.*, 2016; Vallet *et al.*, 2019). At Tell Feres and in the whole western Mesopotamian sector, on the other hand, relations between indigenous people and Uruk immigrants developed gradually and lasted longer. But in both cases relations between indigenous and foreign inhabitants were characterized by deep social integration (Baldi, 2013; 2016b).

Four main chronological phases are documented, each one characterized by specific ceramic assemblages, both local and south-Mesopotamian (Figure 2).

- A. At the beginning of the 4th millennium BCE (during southern Early Uruk – north-Mesopotamian late LC 2), Uruk materials were not yet attested at Tell Feres. But in the Qara Dagh a large Uruk presence was already documented alongside an autochthonous north-Mesopotamian community. In each of these two assemblages, the use of RKE was restricted to a single shape, in both cases a small bowl.
 1. The local LC2 type was characterized by a globular profile and an extremely thinned rim.
 2. The Uruk shape presented a slightly stretched profile with a beaded rim.

At this stage at Tell Feres and in the whole western Mesopotamia the Uruk expansion had not yet started. But the RKE was employed for the local LC2 globular bowls (the same A1 type documented within the north-Mesopotamian assemblage in the Qara Dagh).
- B. Later (at the very beginning of the Middle Uruk – local early LC3), in the Qara Dagh, types A1 and A2, which had appeared in the previous period, continued to be attested, and two other shapes started being produced by using RKE. For both the traditions these additional

wheel-fashioned forms were tiny bowls (B1-2) and little jars (B3-4).

1. The local variety of bowl had a sharp carination in the lower part of the body.
2. The shallow Uruk cup was slightly carinated towards the middle of the body.
3. The local little jar had a banded rim grooved on the top.
4. The Uruk little jar had a thinned rim and a short spout.

All these shapes were already attested in the previous phase as uncommon types and remain rare even once manufactured by using the RKE in this period.

At this stage Tell Feres was not hosting south-Mesopotamian Uruk immigrants, but some bevelled-rim bowls (clearly produced without RKE) indicate the emerging interactions of the local inhabitants with the Uruk cultural sphere.

C. A little bit later (during the mature Middle Uruk – local late LC3-early LC4), in the Qara Dagh, Logardan was abandoned and south-Mesopotamian Uruk settlers founded a village on the northern mound of Girdi Qala. This phase represents the last stage of the LC/Uruk occupation at Girdi Qala and Logardan, with the same RKE-shaped types (A1-2 and B1-4) as the previous stage (but in slightly larger dimensions).

At Tell Feres, the panorama was now identical, with the same local and Uruk types (and the same sizes) as those observed in the Qara Dagh area.

D. In the Qara Dagh region, as in the whole area east of the Tigris River, there is no Late Uruk/LC5 occupation. Conversely, this cultural phase is attested at Tell Feres and in western Mesopotamia, especially in the Euphrates and Khabur valleys in northern Syria. Local and Uruk repertoires still present three shapes manufactured using the RKE. Both among north-Mesopotamian and southern types, the bowls that first documented the use of the wheel during the Early Uruk/LC2 (types A1 and A2) have disappeared, replaced by two new bowls.

1. The local new type was vaguely carinated with a slightly outstretched rim.
2. The southern Uruk new type of bowl was taller, V-shaped and with an oblique rim.

The evolution of the RKE-shaped vessels takes place at the same pace for both north-Mesopotamian craftspeople and Uruk potters. In fact, both assemblages are characterized by the appearance of closed wheel-shaped containers at the same time. The extension of the RKE to morpho-functional categories other than bowls, with the appearance of carinated profiles and mainly jars, implies a much higher degree of complexity of the technical task (Jeffra, 2011) and, consequently, it indicates the emergence of greater craft skills. The fact that this evolutionary step occurs at the same

time within both indigenous and Uruk communities is not accidental.

3.2 North-Mesopotamian and Uruk pottery produced by similar techniques

Parallels between north-Mesopotamian and southern Uruk wheel-fashioned pottery are even more pronounced with regard to techniques. All the north-Mesopotamian and Uruk wheel-fashioned ceramics are wheel-coiled, namely produced by using RKE for joining, thinning, shaping and finishing the coils of the rough-out (Method 3 of Roux and Courty, 1998, p.748). This shaping technique has been identified on the basis of diagnostic surface features, including horizontal concentric parallel striations combined with fissures, cracks, ridges, wrinkles and bulges matching with coils, and spiral features on the interior surface of the base, as well as by microscopic features revealing junctions of coils.

- At Tell Feres, in the Qara Dagh and in the whole northern-central Mesopotamia, the wheel-coiling technique for indigenous vessels was implemented by assembling a rough-out by overlapping rounded coils of about 2 cm thickness with sub-elliptic section and oblique orientation of the junctions towards the interior side of the container. Then, the shaping and finishing were performed by RKE on a slow wheel (Figure 3).
- Throughout the Uruk sphere, that is in southern Mesopotamia, as well as in the Uruk settlements in the Qara Dagh area and in central-northern Mesopotamia, the wheel-coiling technique was carried out by preparing a rough-out by overlapping flattened 3.5 cm thick coils with sub-elliptic section and alternating oblique orientation of the junctions towards the interior and the exterior side of the container. Then, the vessels were shaped and finished by RKE on a slow wheel (Figure 3).

This means that north- and south-Mesopotamian craftspeople shared a solid common technical basis. The focus on north-Mesopotamian and Uruk methods of assembling the rough-out allows the recognition of a distinction between the two wheel-coiled productions. This differentiation is documented not only at Tell Feres and in the Qara Dagh, but also in other regions (Baldi, 2018) and must have been a peculiarity deeply rooted in the respective technical traditions of indigenous and Uruk craftspeople. However, these are differences related to the coiling technique, while the central question here is how the wheel was used.

In this respect, Uruk sherds, whether they come from Tell Feres, the Qara Dagh sites or other Mesopotamian areas, never have bulges or cracks on their surfaces (Figure 4, right). The appearance of their surfaces is unmistakably more homogeneous, with very little and rare fissures always located next to the sections of the fractures. Therefore, these flaws are visible because of the crushing of the vessel but were certainly not detectable when the small bowls or jars were intact. Moreover, streaks on the surfaces are uniform,

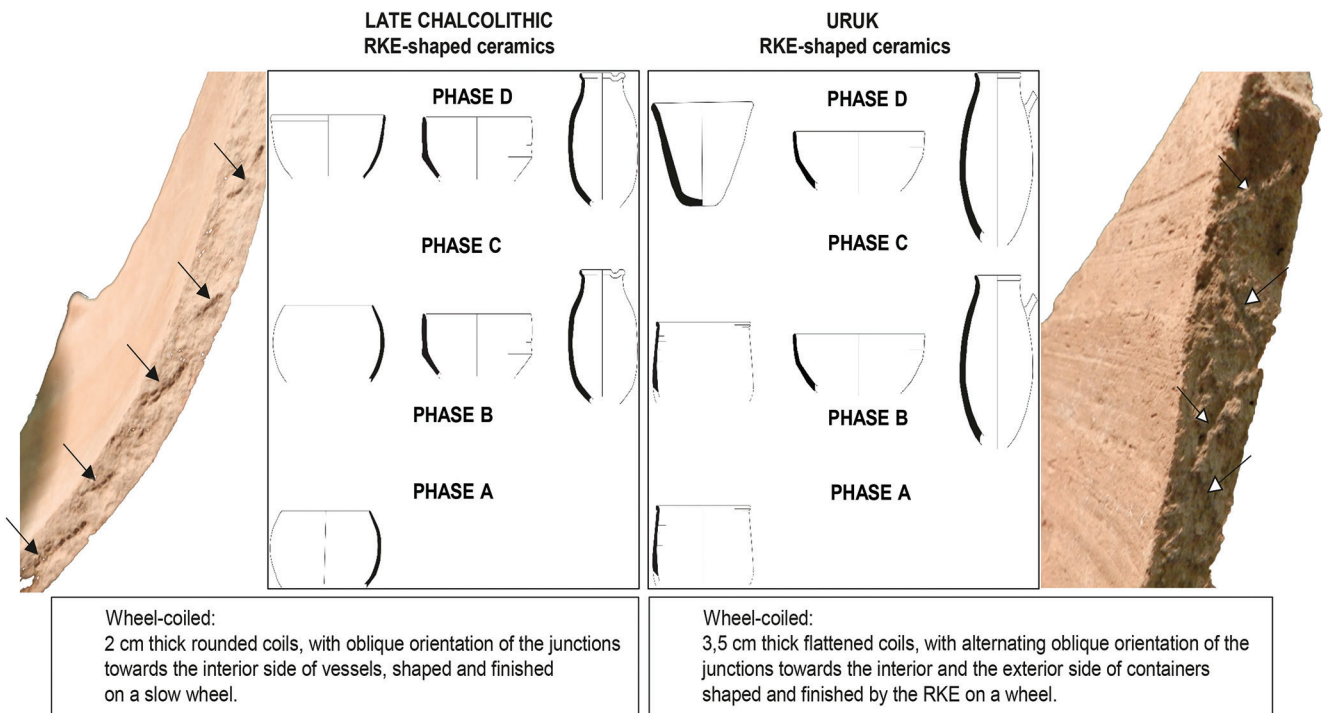


Figure 3. Different ways of wheel-coiling north-Mesopotamian and Uruk containers and respective macrotraces of the joints between the coils.

much thinner than those observable on north-Mesopotamian wheel-coiled productions (Figure 4, left), with no perceptible variations in their respective thickness or distance. The only features that interrupt, at regular intervals, this exceptionally smooth and uniform appearance of the surfaces are small

grooves, slightly deeper and wider than the streaks. These horizontal grooves (arranged according to the direction of the RKE) frame the streaks in bands of regular thickness on the wall of the vessels. These features seem to suggest that the Uruk vessels were shaped on the wheel not by hand,



Figure 4. North-Mesopotamian and Uruk wheel-coiled ceramics, distinct macro-traces probably dependent on different ways of using the wheel.

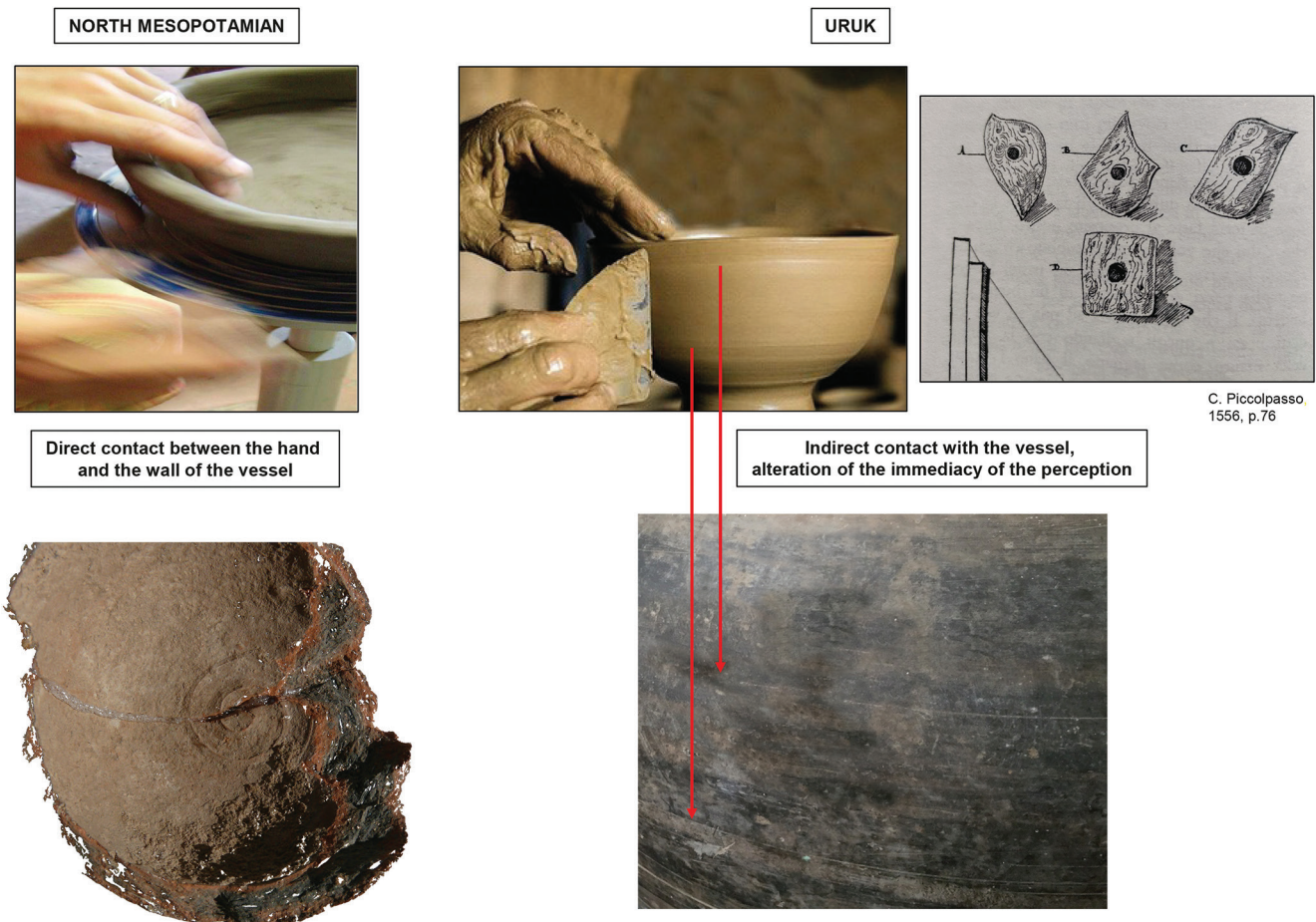


Figure 5. North-Mesopotamian and Uruk wheel-coiled ceramics, reconstruction proposal of different ways of using the wheel according to the respective macro-traces.

but with the help of a tool – probably a hard-matter *lissoir* or smoothing instrument – which gave the surfaces their homogeneous appearance, regularly marked by miniscule grooves corresponding to the points of contact between the edges of this tool and the wall of the vessel (Figure 5).

According to the thin sections (both of ancient Uruk sherds and their experimental replicas), these macro-traces are associated with an interesting microscopic configuration. Although all the north-Mesopotamian and Uruk RKE-shaped pottery is made from dense, fine, low-porous mineral pastes, Uruk containers have much less voids than north-Mesopotamian ones. In addition, once the Uruk thin sections of the sherds are divided into three portions – an internal, an external band and a central core – the few voids are essentially concentrated in the central part. This extremely reduced porosity concentrated in the central band of the walls seems to be the result of forces having affected not only the surfaces but also the inner part of the clay-mass. In other words, this shows that the clay of Uruk vessels has undergone more radical transformations than the north-Mesopotamian specimens (Figure 6).

However, these technical discrepancies are far from surprising for communities with very different cultural, organisational, and geographical backgrounds. These are

therefore characteristics that do not call into question the robust technical basis shared by north-Mesopotamian and Uruk craftspeople. Once again, this is not accidental, but rather the result of social and production contexts that were entirely similar.

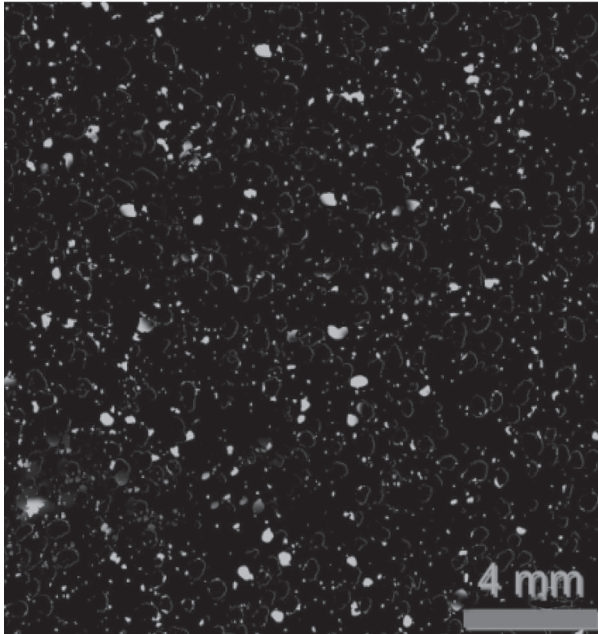
3.3 North-Mesopotamian and Uruk pottery resulting from closely comparable social contexts

In this respect, the spatial distribution of wheel-coiled containers indicates their exceptional value in the Uruk world. The pattern of their distribution is presented below following the chronological order of the four phases identified in the 3.1 section of this article.

- A. In the Qara Dagħ, the appearance of the wheel-coiling technique (during the Early Uruk / local LC2 – Phase A) is documented by 63 fragments of small-sized, round-walled bowls with beaded rims. All these specimens come from very specific archaeological contexts. Many of them (27) come from the basal level (Level 10) of the ceramic workshop at Girdi Qala Trench C and were all concentrated in a multiple furnace. The vast majority of the ceramic kilns brought to light in the Uruk workshops (in the Qara Dagħ as well as in the whole

NORTH MESOPOTAMIAN

Low-porous (between 2% and 5%) fabrics, with regularly distributed voids



URUK

Low-porous (between 2% and 4%) fabrics with voids concentrated in the core of the walls

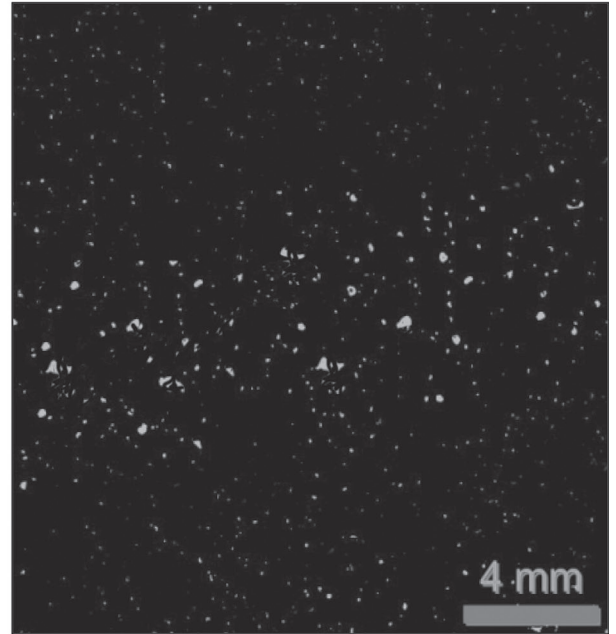


Figure 6. Thin sections of north-Mesopotamian and Uruk wheel-coiled ceramics, differences in quantities and arrangement of pores.

Uruk cultural sphere) are vertical-draught structures, belonging to an architectural and technical typology well attested in Mesopotamia since the 6th millennium BCE (Delcroix and Huot, 1972; Hansen Streily, 2000). Multiple composite kilns constitute a southern-Uruk technology never documented before (Vallet *et al.*, 2017, Figure 13). Several circular structures were connected by internal ventilation channels, as well as by external pipes to evacuate the smoke. The firing installations were similar in shape and size and each one was able to work independently from the others. Nevertheless, their masonries were embedded in each other. Therefore, they were not just associated kilns, but rather conceived and built as a single structure, and indicative of an unsuspected and very sophisticated technology (Figure 7, below).

All the other (36) wheel-coiled Uruk bowls of this initial phase come from the floor of the main hall of the monumental building on top of Logardan (Figure 8). This is a vast complex occupying the edge of the site, with a composite plan, well plastered rooms delimited by about one-metre-thick stone walls, and with the southern façade decorated by large regular mudbrick buttresses. This latter feature, associated with elite houses, temples, or public and communal buildings in 6th–4th millennia BCE Mesopotamia, indicates the special role played by this edifice (Frangipane, 2002; 2009; Butterlin, 2018).

- B.** Later, at the beginning of the Middle Uruk / early local LC3 (Phase B), among the 54 sherds of wheel-coiled containers collected in the Qara Dagħ sites, 3 come from filling layers of the main building at Logardan (which at this stage was transformed into a stronghold), 11 were found in situ in a room to the north of this same complex, while as many as 40 come from two different multiple kilns, respectively in Level IVA of Trench E at Logardan (17 fragments), and in Level 7 of Trench C at Girdi Qalaa (23 specimens – Figure 7, above).
- C.** This same distributional pattern can be observed in the later phase (C), during the mature Middle Uruk in the Uruk village of Girdi Qala North. All the wheel-coiled containers identified for this period (81) come from a large building of Level 3, provided with stone foundations up to 1.6 m in width, pottery pipes for the evacuation of rainwater (Figure 8, above) and typical Uruk sophisticated architectural decorations such as stucco plaques and coloured clay cones.
- D.** Finally, for the later phase (Late Uruk – phase D), the 6 wheel-coiled Uruk ceramic fragments from Tell Feres' tombs were found in the richest burials.

In other words, primary depositional contexts confirm the exceptional value of Uruk wheel-coiled pottery, whose

GIRDI QALA : multiple composite up-draught kilns

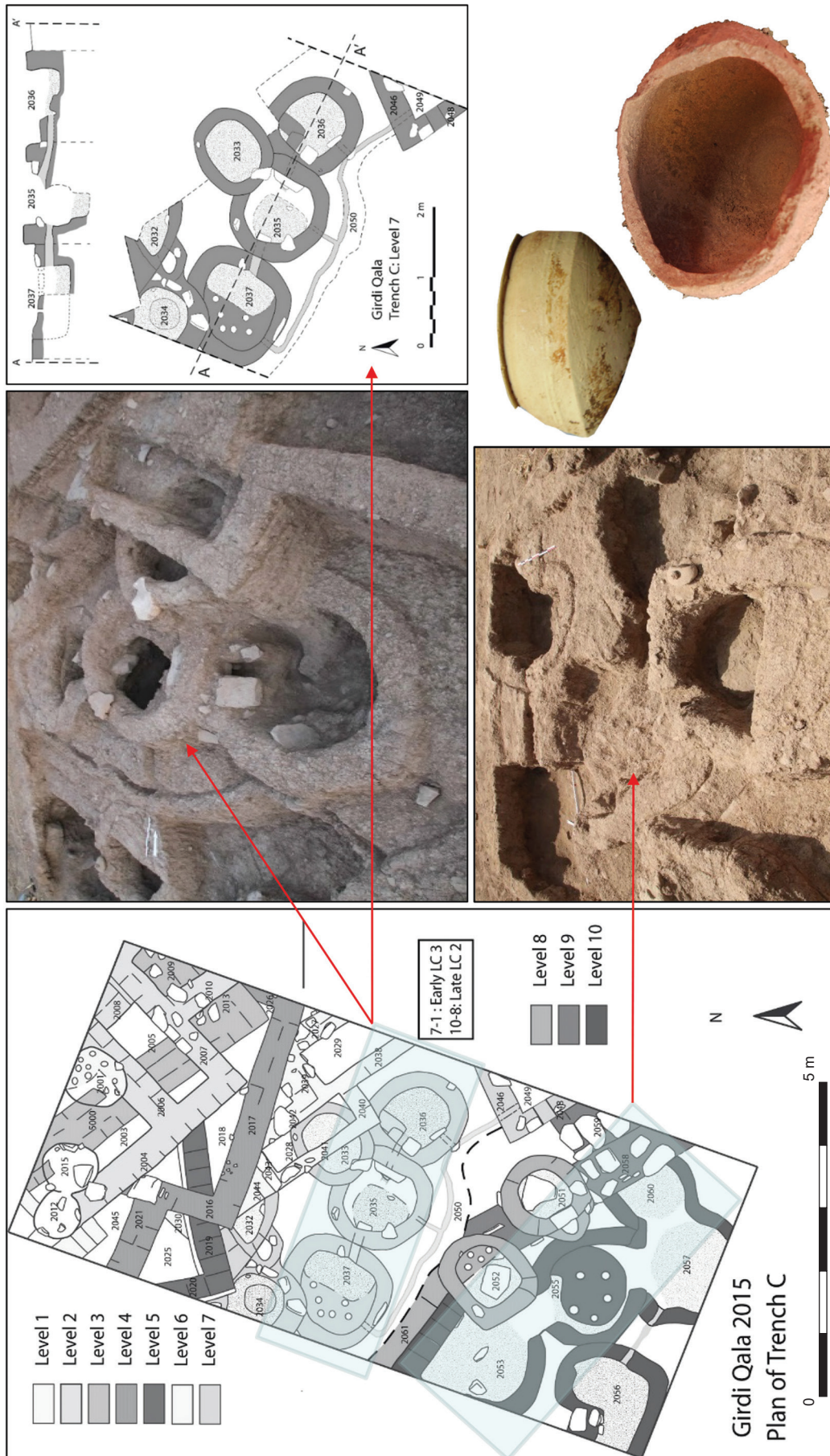
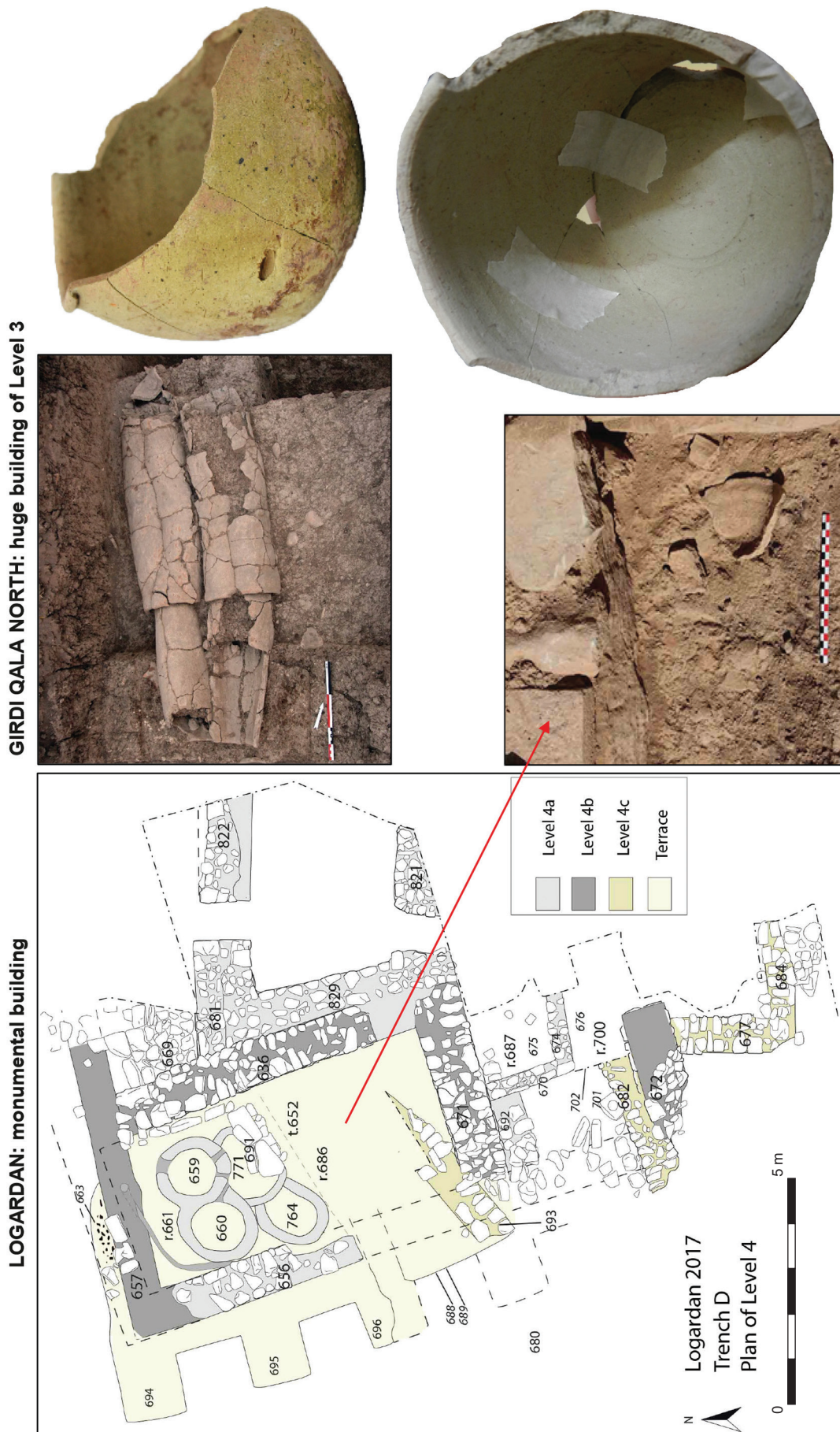


Figure 7. Girdi Qala (Qara Dagh area), multiple composite kilns where wheel-coiled vessels were concentrated.



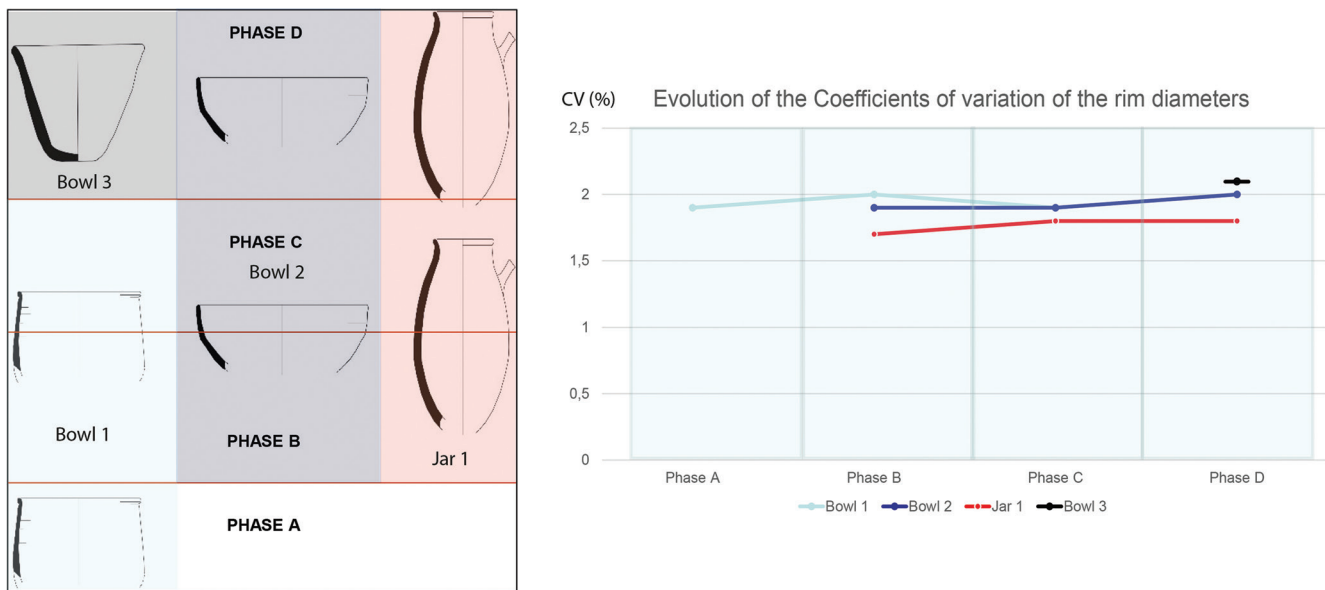


Figure 9. Evolution of the coefficients of variation (CVs) of the rim diameters of the Uruk wheel-coiled shapes (presented by chronological phases).

concentrations indicate that it was used exclusively in specific buildings depending on social elites and produced in working areas associated with special technologies.

Given the extreme rarity of Uruk uninterrupted and reliable stratigraphic sequences, it is difficult to find parallels among other excavations. Nevertheless, it is remarkable that at Warka-Uruk, the eponymous site in southern Mesopotamia, all the specimens of the ceramic shapes usually produced by wheel-coiling come from the deep sounding (*Tiefschnitt*) conducted under the sacred templar area of the Eanna district (Haller, 1932, Tafeln 17–19).

Additional evidence on the social context of production is offered by the degree of standardization of the wheel-coiled containers as established by measuring the coefficient of variation (CV) of the rim diameters. Uruk wheel-coiled containers are extremely standardized (Figure 9), with very low CVs (around 2%). These values of CVs are not only entirely similar for all the Uruk wheel-coiled shapes produced throughout the 4th millennium BCE, but are also closely comparable to the CVs of north-Mesopotamian wheel-coiled containers (Baldi and Roux, 2016, Figure 6).

Hence, the technical and morphological parallelism observed between the north- and south-Mesopotamian assemblages seems to be the result of equivalent social contexts at the basis of the emergence of this new technique.

4. Discussion

4.1 Assessing the importance of differences between two very similar milieux

Although this reconstitution of north-Mesopotamian and Uruk first wheel-coiled ceramics is based on archaeological records from very distant areas, Tell Feres and the Qara Dagh depict an evolution which has nothing specific to these case studies and can be observed everywhere in Mesopotamia.

More generally, as far as morphology is concerned, all these wheel-coiled types have nothing exceptional: they are rare varieties, but well documented not only at Tell Feres and in the Qara Dagh, but both within the north-Mesopotamian repertoire and within the southern Uruk cultural sphere (for morphological parallels see Baldi and Abu Janyab, 2012; Baldi, 2013; Baldi 2016a; 2016b). Even in terms of functional analysis, the similarities between the two horizons are noticeable. All the bowls, both of north-Mesopotamian and Uruk tradition, have thin walls, dimensions unsuitable for eating meals or food rations in daily circumstances, and slightly in-turned profiles, adequate to hold a (perhaps liquid) content that should not be dispersed. The two types of jars (produced from Phase B onwards – Figure 2) have small dimensions, suitable for highly-priced substances, they are equipped with devices to facilitate the slow pouring of a precious liquid, and have restricted profiles difficult to access and easy to cap (with caps, with cloths that can be easily retained by a little rope to be tied under the edge, or with lids to be placed on the grooved or thinned rim, fitting to hold a stopper). Among the shapes produced using RKE, the iconic BRBs are remarkably absent.

This Uruk shape, whose legendary status in archaeological literature has now been deconstructed (including through comparisons with wheel-fashioned bowls in areas as distant as the Aegean – Weiner, 2011) has nothing to do with the history of the wheel in Mesopotamia. If there were still a need, the analysis undertaken here amply confirms this result. Indeed, wheel-fashioned ceramics have completely opposite features compared with BRBs. BRBs are ubiquitous, rough, functionally flexible, very variable in size and serially produced (Baldi, 2016b; Nannucci, 2012; Goulder, 2010; Helwing, 2014), while the wheel-coiled containers are rare (between 0.4 and 0.8% of the assemblage), manufactured with extreme care, extraordinarily standardised, and intended for very specific uses.

The same very striking similarity between the two traditions can be noticed in the size of the wheel-coiled containers, whose rim diameters show a surprising homogeneity. Ethnographic studies suggest that such low CVs, that require highly developed motor skills based on intense repetition of gestures, correspond to contexts of high production rates. On the other hand, if one considers the limited quantity of wheel-coiled Uruk pottery, such low CVs indicate that only a few specialists were in charge of the whole wheel-coiled production. Consequently, the concentrations of wheel-coiled pottery in high status buildings, as well as its function related to special occasions seem to show that, within Uruk communities, the wheel-coiling technique was the prerogative of a restricted number of highly specialized potters, probably depending on emerging socio-economic elites.

Hence, this techno-morphological parallelism is the result of equivalent social contexts at the basis of the emergence of this new technique both in northern Mesopotamia and in the Uruk sphere. Furthermore, all the highlights stressed for the production and use of Uruk wheel-coiled containers have recently been observed for northern Mesopotamia and the Levant (Baldi and Roux; 2016). In the mid-5th millennium Levant, as well as in northern Mesopotamia at the beginning of the 4th millennium BCE, wheel-coiled ceramics were rare, small-sized, initially limited to bowls, with a slow, progressive extension to other functional categories, but still intended for special occasions, as demonstrated by their concentration in spaces connected to elites. Just as in the Uruk world, between northern Mesopotamia and the Levant, wheel-coiled bowls were extremely standardised, with particularly low CVs, due to the work of a few specialists in charge of these highly valuable ceramics.

Based on all these analogies, it might seem logical to speculate that the appearance of wheel-coiling in the Uruk world was a phenomenon linked to the emergence of this same technique in other sectors of the Near East. The chronological coincidence with northern Mesopotamia – supported by archaeological evidence (Baldi, 2013; Vallet *et al.*, 2017) indicating an adoption of wheel-coiling in the early 4th millennium (around 3900–3800 BCE) – would seem to suggest that the first adoption of the potter's wheel implied a technical borrowing between north-Mesopotamian and Uruk potters (whatever the direction of this borrowing). Nevertheless, this hypothesis could be too simplistic.

Although the number of experimental sessions and thin sections is limited, the results seem quite clear. The use of a shaping tool (a wooden platelet, a bone instrument, or a recycled sherd) introduces a completely new factor in the shaping compared to the simple use of hands on the wheel. A potter's gestures, postures and hands position change, because the use of an instrument radically alters the sensorial perception of the pressures applied on the container during rotation. This does not affect the level of detail in the modelling of the smallest features of a vessel, but the tool modifies the immediacy of the sensation of contact with the body of the vase during the potter's work. These “professional” issues

were already approached, from the specific point of view of the potter's work, by treatises dating back to the Italian Renaissance (Piccolpasso (1556), 2006). Neither the texts nor the potters who participated in the experimental sessions consider these tools to be advantageous or disadvantageous, but simply inherent in the different ways of performing the technical task. The use of a tool makes it possible to reduce the visibility of the streaks left by the fingers and, therefore, it gives a very smooth and homogeneous appearance to the surfaces. At the same time, the alteration of the immediacy of contact with the vessel can result in little stronger contacts between the platelet and the wall of the container than those between a hand and the wall itself. However, these applications of greater force on the clay are of very short duration: uncontrolled, more intense contacts immediately leading to pressure relief and not corresponding to deeper action on the matter. So, the use of an instrument during the shaping makes it possible to accurately reproduce the smooth surfaces and small grooves left by the edges of the platelet. But this does not allow a justification for the peculiar configuration of the porosity observed on Uruk samples. The pore distribution remains quite similar to that of the north-Mesopotamian specimens hand-shaped on the wheel, without any concentration of the voids in the central part of the walls (Figure 10). The experimental trials have shown that the use of a shaping instrument was not an effective means to achieve this pore configuration, whereas it seems that a substantially increased RKE could be (Figure 10). The rotational speed of the wheel was a variable adapted by the potters involved in the experiments by its increase and decrease during the various trials, even though a very low speed may be sufficient to regularise the walls of the small wheel-coiled vessels that were replicated. It is a truism to say that, since “slow” and “fast” wheels both use rotary movement, they represent a continuum of speeds rather than a dichotomy (Berg, 2011). Required speeds vary depending on the height and width of a vessel, with higher and wider pots needing lower speeds maintained for a long time, while smaller and narrower pots (as those produced in the 4th millennium BCE) require higher speeds reached in a short time. But this is just a general criterion, given that speeds regularly vary greatly in the making of any single type of vessel. Moreover, a fundamental variable, involving lesser or greater variations in the average speed of a wheel during the work, is its degree of inertia. The absence of data on the type (or maybe types) of potter's wheel in use in 4th millennium Mesopotamia makes evaluations on these aspects quite hypothetical and difficult to verify. However, the fact that there are currently no examples of stone potter's wheel components, such as those known from the 3rd millennium onwards throughout the Near East (Roux and Miroschedji, 2009), suggests that only lighter (wooden?) wheels were used during the 4th millennium BCE, namely “high velocity, low momentum” rotary devices (Powell, 1995 p.334) often called “turntables”, defined as instruments on which the low momentum of inertia prevents them from throwing lumps of clay heavier than 1–2 kg (Roux, 2019, p.49). Although

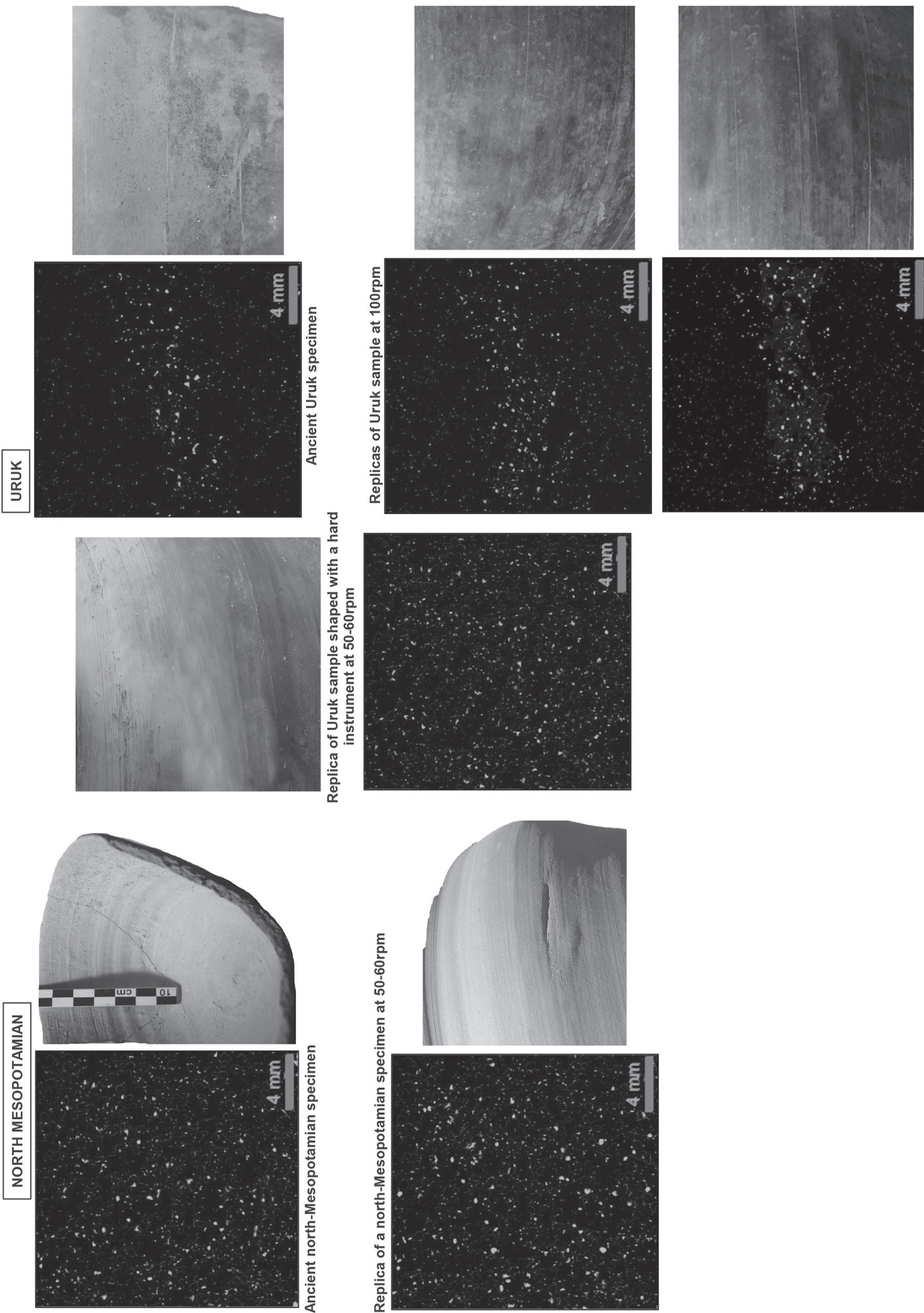


Figure 10. North-Mesopotamian and Uruk macro- and micro-traces (distribution of pores) in archaeological and experimental samples.

4th millennium north-Mesopotamian and Uruk vessels were always wheel-coiled (rather than thrown), the use of these turntables capable of developing a limited speed and RKE is entirely plausible. Experiments conducted by Powell (1995) on turntables characterized by a low momentum of inertia from Bronze Age Egypt have assessed the maximum velocity of these devices to be around 120 revolutions per minute. These results seem to match with what was observed during the experiments to reproduce Late Chalcolithic and Uruk wheel-coiled vessels. According to our experimental trials, it is reasonable to think that wheel-coiled containers of north-Mesopotamian tradition were made at an average speed of around 50–60 rpm, which is a very usual speed of rotation for an expert potter. On the other hand, the experiments carried out to reproduce the macro- and micro-traces typical of the Uruk wheel-coiled containers seem to suggest a much higher speed of rotation, of around 100 rpm, which is almost enough to wheel-throw pots. This does not mean that Uruk craftspeople were able (or almost able) to wheel-throw vessels because the existence of a potential inherent in a device does not mean that this device is being utilized to its full potential. In any case, if this discrepancy in rotational speed were confirmed by further analyses, it would constitute a non-negligible difference between the north-Mesopotamian and the Uruk way of using the wheel.

A technical borrowing does not consist in a mere similarity, and, conversely, the existence of certain differences does not necessarily imply that there could not have been a borrowing of certain technical elements, which could have been adapted during the transfer. A borrowing is not even a somewhat involuntary transmission: it always occurs voluntarily and requires a close and direct relationship between a master and an apprentice (Gelbert, 2003), and thus, in this case, a strong interaction between potters from north-Mesopotamian and Uruk communities. The co-existence, in close contact and during several centuries, of these two groups of craftspeople, as in the Qara Dagh, indicates that the conditions for a technical borrowing existed. At the same time, durable and intensive interactions in no way prove that the wheel was inevitably the object of a technical exchange. In fact, as it was observed both in past and current communities of potters (Baldi, 2016b; Roux *et al.*, 2018), even under favourable conditions, there is sometimes no acceptance and voluntary adoption from a community of technical traits typical of another group. On the contrary, there may be a conscious, quiet rejection, which causes two techniques to exist side by side (Roux, 2007a).

5. Conclusions

Since the experimental tests and microscopic analyses presented here are not based on a formally established protocol, one must consider the possibility that the distribution of pores in the Uruk vessels – with few little voids concentrated in the central band of the walls – is due to other factors, such as a particular way of preparing and

kneading the clay. However, if the possibility of a substantial difference in speeds should be confirmed by further studies, this could have profound implications on the history of the emergence of the potter's wheel in Mesopotamia. Potters working on a slow wheel (and especially on devices with a low momentum of inertia) face serious problems in throwing pots with both hands and spinning the wheel at the same time: they exploit the momentum created in bursts. Often, the help of an assistant is necessary. The only other possible option is represented by a different kind of rotary device, as the double (or kick-) wheel, able to reach very high speeds keeping the hands free. At the moment, in the absence of archaeological evidence, it seems very unlikely that some 4th millennium craftspeople would have had such a device, but it is impossible to know what kind of wheel was used by Uruk potters. On the other hand, it seems perfectly likely that they worked with a wooden shaping tool, implying specific postures and sensations to learn and control in order to apply appropriate pressures on the clay-mass. Therefore, they probably worked with hands even busier than the north-Mesopotamian craftspeople and maybe at higher rotation speeds, which implies a greater need to spin the wheel. Possibly, they were helped by an assistant, or used a wheel typologically and technically different from that adopted by north-Mesopotamian craftspeople.

This indicates that the hypothesis that the potter's wheel was the object of technical borrowing between North Mesopotamian and Uruk potters is not the only possible explanation (and not necessarily the most plausible one) for their contemporary adoption of a rotary device. The possibility of borrowing exists, since the transmission of an operational sequence does not imply adoption without reworking. It has recently been shown (Gandon and Roux, 2018) that experienced potters (as the Uruk potters were) can adapt and use unfamiliar tools: the adoption of a new wheel does not involve significant changes in fashioning skills. Nevertheless, posture and mode of activation appear to be stronger constraints. These constraints have certainly played a role, to the extent that if there was borrowing, it was certainly not a mere transfer of a technological package that one community would have adopted as such from the other. Actually, although the social contexts, the skills required and the ceramic shapes produced were very similar, there is no evidence that the potter's wheel became widespread in 4th millennium Mesopotamia through some kind of borrowing between Uruk and north-Mesopotamian potters, or vice versa. If such a transfer did indeed exist, it occurred by a profound reworking of the wheel-coiling technique, involving a change in the posture of the shoulders, the hands, the tools used, the physical perceptions during the shaping and, maybe, even a change in the speed of rotation of the wheel itself.

This might suggest an alternative hypothesis, that would be interesting to test with further research, namely that the chronological synchronism and technical homogeneity in which the potter's wheel emerges in northern Mesopotamia and the Uruk world may not be the result of borrowing, but

rather of slightly different evolutions of a common technical base. This would lead us to investigate the precursors of the potter's wheel (Baldi and Abu Jayyab, 2012), namely the use of rotary devices throughout Mesopotamia during the Ubaid phase.

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