

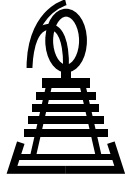
ENKI & PTAH

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in Ancient Egypt and Western Asia

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The workshop area of Level 3b at Logardan, ©FARMQaD, French Archaeological Mission in the Qara Dagh

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Editorial

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It is with great pleasure that we introduce the first issue of *Enki & Ptah. Journal of Technology and Trade in Ancient Egypt and Western Asia*, a new peer-reviewed scientific publication dedicated to the study of technology, scientific knowledge, crafts, exchange in the ancient societies of Egypt, Nubia, the Eastern Mediterranean and Western Asia. Ranging from prehistory to the Hellenistic and Roman periods, the journal offers an interdisciplinary platform for exploring the material foundations of ancient economies and the cultural dynamics that shaped them. *Enki & Ptah* was conceived with the ambition to bring together complementary perspectives from archaeology, history, and philology, and to foster a cross-regional and diachronic approach to the study of ancient technologies and exchange interactions. By placing Egypt, the Eastern Mediterranean and South-Western Asia within a shared analytical framework, the journal highlights the interconnected worlds of technological innovation, craft specialisation and long-distance trade, and the many ways in which these shaped social and economic structures over time. Rooted in the long-standing Italian tradition of Egyptology and Near Eastern studies, the journal aims to serve as an intellectual meeting ground for scholars

investigating the technological, economic and social dynamics of pre-modern cultures, while also fostering methodological innovation and new interpretative frameworks. Its scope embraces a broad thematic and chronological range, inviting contributions on raw-material procurement and processing, production and distribution systems, archaeometric and scientific analyses, as well as textual and iconographic sources on technology and know-how. Particular value is placed on studies that illuminate the transmission of technical knowledge across regions or periods, or that explore the relationship between innovation, environment, agency and local traditions. A defining feature of *Enki & Ptah* is its commitment to interdisciplinary dialogue. The journal encourages the integration of archaeological, scientific and textual evidence, offering a space in which methodological reflection and theoretical perspectives can inform new understandings of ancient technologies and economies. We especially welcome research that challenges disciplinary boundaries or proposes innovative approaches to the study of craft practices and exchange networks. Co-directed by its editors together with a dynamic board of early-career researchers from the University of Milan, *Enki & Ptah* adopts a double-blind peer-review

system and benefits from the guidance of an international scientific committee composed of leading specialists in Egyptology, Assyriology, and the history and archaeology of ancient Western Asia. The journal consists of a section of research articles and a section dedicated to reviews of recent volumes relevant to its areas of interest. Published by the Milano University Press in open access, with print-on-demand options, *Enki & Ptah* reflects the University of Milan's commitment to fostering high-quality, accessible and interdisciplinary research, according to the FAIR principles. This first issue opens with a substantial collaborative article by a team of scholars from the Centre of Excellence in Ancient Near Eastern Empires at the University of Helsinki. Their contribution offers a far-reaching comparative analysis of the relationship between kingship and economic structures in ancient Western Asia, a field of research that has recently experienced a notable revival, enriched by new methodological perspectives. The article presents a systematic diachronic comparison spanning more than a millennium, examining the economic foundations of kingship and, to a lesser extent, queenship, across seven major empires (Neo-Assyrian, Neo-Babylonian, Teispid-Achaemenid, Seleucid, Ptolemaic, Arsacid and Roman). Particular attention is given to the distinction between "state" and "royal" assets and expenditures, explored here to an unprecedented degree. Massimo Maiocchi's article addresses the methodological and historiographical challenges surrounding the study of the earliest writing systems of south-western Asia and northern Africa: proto-cuneiform, proto-hieroglyphic and proto-Elamite. A reassessment of the scholarly debate reveals persistent disciplinary biases and the modern prestige attributed to literacy, which have long

shaped narratives that overstate writing as the primary marker of civilisation. By exposing these ideological assumptions, the study advocates for a more balanced interpretive framework that situates the origins of writing within the broader cultural, technological and social dynamics of the late 4th millennium BCE. The contribution by Padovani and Zingarello examines the mechanisms of control and management of ceramic production during the late Early Bronze Age in northern Mesopotamia, adopting an explicitly archaeological perspective grounded in the analysis of manufacturing contexts, particularly in light of recent discoveries in Iraqi Kurdistan. Focusing on the site of Logardan, the authors present newly uncovered workshops equipped with large and technically sophisticated firing installations. Drawing on fresh spatial, architectural and technological data from ongoing excavations, the study reassesses long-standing assumptions about the political, technical and socio-economic dimensions of pottery manufacture under the first empires of the 3rd millennium BCE, highlighting an incipient trajectory towards proto-industrialisation. Ilaria Sieli's article investigates the relationships between Lower Nubia and Egypt through the analysis of three cemeteries belonging to different phases of the A-Horizon, the earliest cultural horizon of the region. By tracing changes in funerary customs and their implications for Nubian society, and by emphasising regional distinctions within Lower Nubia, the study highlights episodes of contact, tension and divergence with Egypt, as well as instances of creolisation that made Lower Nubia a key interface between distinct cultural spheres. The final contribution, by Ahmed Mansour, turns to the emerging field of ancient Egyptian metallurgy. Despite numerous scientific analyses on metal

composition and technology, our understanding of early manufacturing processes and working conditions remains fragmentary. By examining the written evidence that accompanies Old Kingdom metallurgical scenes, the article integrates textual and visual data to clarify technical procedures, operational stages and the demanding working environment of ancient metalworkers. Together, these sources offer a more accurate and coherent reconstruction of one of Egypt's most specialised industries.

As this inaugural issue brings together diverse perspectives on handicraft production, exchange, and economic systems across ancient societies, we invite our readers and contributors to join us in a shared space where new findings, approaches and ideas may converge, shedding fresh light on the complex interactions and cultural meanings that shaped the procurement, transformation and circulation of materials and products in ancient Egypt and Western Asia.


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An Emerging Proto-Industrial Paradigm: Recent Data on the Organisation of Ceramic Production in Ur III Mesopotamia

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Abstract

While cuneiform sources from the late 3rd millennium BCE Mesopotamia describe labour-intensive and structured economic systems, relations and means of pottery production remain elusive in archaeological evidence. Few studies have explored the organisation of ceramic workshops from this period, and issues related to kiln technology remain poorly addressed. The recent discovery of complex firing systems integrated into large pottery workshops at the site of Logardan in Iraqi Kurdistan, dating to the last centuries of the 3rd millennium BCE, calls for a reassessment of pottery production organisation and practices within the context of the first empires. The site is a ceramic production centre located at the margins of the Ur III empire, featuring large-scale systems of kiln connections through horizontal ducts to enhance firing efficiency and optimisation of fuel and heat. Ongoing excavations provide new sets of archaeological data (spatial, architectural, pottery typologies and techniques), which makes it possible to revise traditional political, technical and socio-economic paradigms about ceramic production. This paper investigates the integration of such mundane craft into the Ur III state economic system, highlighting an emerging path towards proto-industrialisation.

Keywords: Ceramic production, Pottery workshop, Craft organisation, Ur III State, Mesopotamia

1. Introduction¹

1.1. From Sumer to the Zagros: administrative structure of the Ur III state

At the very end of the 3rd millennium BCE, the Ur III dynasty, which ruled over Mesopotamia from 2110 to 2003 BCE

according to the Middle Chronology (Sallaberger and Schrakamp 2015), established a new form of political control, reorganising the economic and administrative system (Steinkeller 2021). During the reign of Šulgi (2092-2045 BCE), the

¹ This article stems from the authors' research – and the PhD dissertation of C. Padovani – on the site of Logardan (Iraqi Kurdistan) in the framework of the Mission du Qara Dagh (2015-2019) led by R. Vallet (CNRS, TEMPS) and FArMQaD (2019-ongoing), the French Archaeological Mission in the Qara Dagh, led by J.S. Baldi (CNRS, Archéorient). The research benefitted from the support of the French National Research Agency (ANR), grant ANR-22-CE27-0003 for the project FACT_WORK – First proto-industrial ceramic FACTories in the 7th-2nd millennia BCE Mesopotamia and Levant. WORK organization from the proto-urban settlements to the supra-regional kingdoms (Project Coordinator J.S. Baldi).

cadastre of provinces created by his father Ur-Namma, including regions from the Susiana Plain to the Diyala Valley, was expanded to include newly incorporated tributary territories east of the Tigris and the Zagros foothills (D'Agostino and Pomponio 2023; Colonna d'Istria and Clancier 2024). This composite domain constituted the basis of a hierarchical economic system overruled by the king. The area controlled by the Ur III state comprised two regions submitted to different tax regulations (Sallaberger 1999). The 'traditional' regions of Sumer and Akkad, the heart of the empire, were constituted of several provinces directed by governors (*ensi₂*, hereafter *ensi*) and overseen by military commanders through a double-entity administration (Lafont 2020). *Ensi* were named by the king and chosen from local elites. They kept relative independence, participating in the political system by paying the *bala* tax to the crown on a rotational basis according to the economic capability of each province. Through this tax, the king was recognised as the owner of the land (Steinkeller 1991; 2021). The 'peripheral' provinces were composed of the newly annexed territories in the Zagros piedmonts, governed by military officials reporting directly to the king. As a rule, they were not submitted to the *bala* tax but were required to pay annual tributes, among which the *gu₂-un ma-da* depending on the payer's military rank (Alivernini 2020). Economic networks during this period were organised in a pyramidal structure, centred around key redistribution hubs that functioned as important knots within the system. One of the most renowned centres was Puzriš-Dagān (modern Drehem), set up by Šulgi in the vicinity of Nippur for collecting livestock tributes and other goods from the northern lands, which were mainly distributed to institutional estates managed by the king (Wilcke 1992; Pomponio

2023). These large institutions were political organs of the society while also playing a significant economic role by cultivating the land and employing a part of the population in their service (Gelb 1965; Pomponio 2023).

1.2. Behind the Ur III administration: kilns and potters in early state systems

The primary sources of information on pottery production organisation in the late 3rd millennium BCE are records from the above-mentioned state-related institutions, including invoices, order receipts and payslips. These texts offer a one-sided, administrative perspective on ceramic production. Their interpretation has sparked a debate on the degree of centralisation and the control established by the empire over all sectors of society's economy (Steinkeller 2004; Dahl 2010). The question is whether state-run institutions and the Ur III king had total control over their specialised workforce in a highly stratified and omniscient economic system providing raw materials and employment or whether the workforce was instead compensated on a per-job basis, keeping freedom and independence. The case of the Ur III economy contributes to a broader discussion on the organisation of production during the late 4th and throughout the 3rd millennium BCE, a period marked by the rise of the first state systems and the development of urban centres. It is generally assumed that in state-run economies, production was centralised in large centres, organised through a division of labour, and controlled by an administrative authority (Childe 1934; 1942; Wright 1977; Tosi 1984; Wailes 1996; Mumford 2019 [1966]). Such organisational structures are believed to have facilitated the development of cities as political and economic centres. In these systems, workers are depicted as being heavily dependent

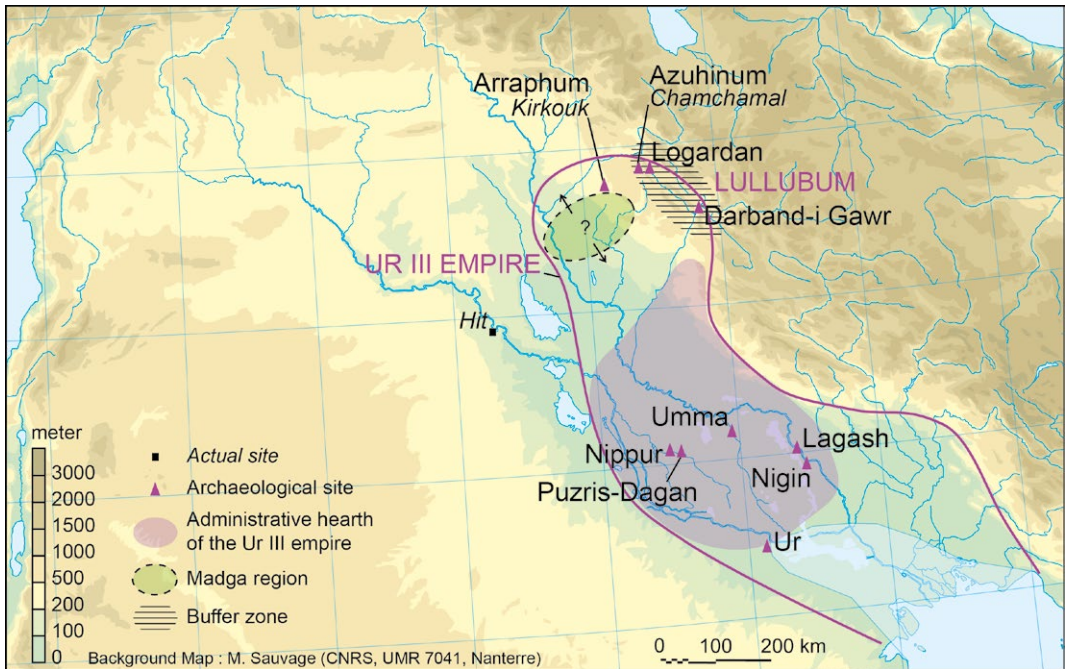


Fig. 1. Map of the Ur III empire highlighting the sites mentioned in the text ©Padovani, Zingarello.

on a hierarchical authority that dictates the economic organisation. However, only a limited number of pottery production sites from this period have been excavated (Padovani 2023b; 2024b). These assumptions are largely based on models derived from ethnographic or modern case studies, which often do not fit well with the archaeological evidence (Rice 1981; Duistermaat 2008; Forte 2019; Amicone et al. 2021). To provide new insights into the organisation of pottery production in early state systems, this paper proposes a fresh interpretation of the scenarios indicated by textual and archaeological evidence available for the Ur III period, through a bottom-up approach. Our analysis examines administrative texts on pottery production from various urban centres in southern Mesopotamia, along with the sole excavated pottery workshops from this period found at Logardan (Trench D, Levels 3a2 and 3a1) in Iraqi Kurdistan.

Logardan is a relatively small site situated at the margins of the Ur III domain, 4 km away from *Azuhinum/Chamchamal*, an important urban centre in the province of *Arraphum* (the present-day city of *Kirkouk*) (Frayne 1999; Ahmed 2012; Baldi and Vallet 2024) (Fig. 1). In Levels 3a2 and 3a1, excavations revealed pottery production installations and innovative firing systems (Padovani 2023a), suggesting the whole site was entirely dedicated to pottery manufacturing during this period. The spatial distribution of pottery types and techniques and the architectural analysis of the operative spaces (such as working platforms, kilns, etc.) provide clues to interpreting how the ceramic production process was handled at the site within the successive workshops of Levels 3a2 and 3a1. Such an approach aims to integrate the perspective from the lower tiers of the social pyramid in a distant province of the empire. Furthermore, this case study prompts

inquiries into the potential emergence of a proto-industrial paradigm during this period. Although the concept may seem anachronistic, archaeologists working on different periods and regions use the term “industry” to describe productive systems that existed in the early stages of human history and were characterised by large-scale output, advanced technical skills (including standardisation and specialisation), technological innovations, and hierarchical management (Van der Leeuw 1977; Costin 1991; Costin and Hagstrum 1995). However, the definition of this term is derived from modern examples and does not accurately suit the reality expressed by archaeological remains. Following Pagès and Verna (2022), based on archaeological evidence, we aim to loosen the concept of industry in the ancient past from the conceptual frameworks that have been heavily influenced by its own history. If the notion of industrialisation can only be applied to the modern era as the result of a complex socio-economic process ultimately including the application of mechanised techniques and methods to a sector or branch of the economy, proto-industrialisation may be polymorphous, taking different forms that equally led to rationalisation and increased productivity to maximise output while minimising costs. Therefore, at Logardan, the large output and structuration of the production – that echoes the batches of pottery recorded in the Ur III administrative order receipts and payslips (Sallaberger 1996) – alongside the considerable size of the workshops, the spatial integration of their productive structures, and the implementation of innovative firing systems, suggest the early groundworks of a proto-industrial organisation.

2. Potters and ceramic production in the Ur III texts

Textual sources about potters from the Ur III period mainly come from the cities of Ur, Lagash, Umma and Nippur, all located in the core of the empire. In general, written evidence from outside this area is very scanty (Molina 2023; Colonna d’Istria and Clancier 2024). The interpretation of data on the job status and social position of potters in Ur III written sources has entailed two opposite views on the organisation of the pottery craft. Some scholars assume that potters were relatively independent and had time to work on their own. However, they were still required to pay an annual contribution to the above-mentioned urban institutions² as either potters or workers employed in other activities (Gelb 1969; 1979; Waetzoldt 1971; Neumann 1987; Postgate 1992; Sallaberger 1996; Steinkeller 1996; 2007). Others suppose that they were an enslaved, moveable workforce obliged to work on the estates of the households depending on their needs (Struve 1954; 1969; Diakonoff 1974; 1987; Dahl 2010). Relying on administrative accounts, what seems to be clear is that potters were subordinated to the city governor (the *ensi*) or military leaders, or they were under the king’s direct authority (Steinkeller 1996). The *ensi* of Umma oversaw the potters who were employed for a set number of days each year by different institutional households related to the temples in the city centre. The same goes for the villages in the Umma countryside, where potters appeared to operate under the governor’s control to fulfil the local ceramic demand (Steinkeller 1996). At Lagash and Umma, potters working as royal personnel, specifically called “royal potters”, seem to

² These large institutions were political organs of society, also holding an important economic role as they cultivated the land and employed a part of the population in their service (Gelb 1965; Pomponio 2023).

belong to a separate category, working directly for the Ur III king's administration and receiving lands as payments. Potters also formed a subsidiary trade linked to different economic entities such as kitchens, breweries and mills (Waetzoldt 1971; Stein and Blackman 1993; Pomponio 2023). For these, they probably produced containers for a variety of purposes, such as preparing, transporting or storing consumables without any specialisation in the manufacture of a specific pottery type (Sallaberger 1996). In this context, a text from Umma states that "In Etena, a mill was built near the pottery" (Sallaberger 1996: 32). The different institutions employing potters did not seem to be concerned with the specific modalities of the potters' work as long as they fulfilled the orders for which they were paid. These institutions did not seem to have any control over the manufacturing process or the organisation of the production chain. They distributed rations to potters (Waetzoldt 1987) and facilitated access to some raw materials. W. Sallaberger (1996) mentions several deliveries of reeds to the Umma potters, often as leftovers from construction and basket-making activities or reed waste from the "sheepfold". Potters could also receive split branches from Euphrates poplars and small shrubbery. On the other hand, clay was probably collected directly by the potters. The soil from which it was extracted may have been part of a private estate, and at times, it was consecrated by the temples. A text from Nippur states that a potter from the temple of Inanna was employed in the clay pit at Iskurs (Zettler 1992). Sallaberger (1996) describes a ritual necessary for the creation of a clay figurine intended to be buried beneath the cella of the temple of Ninsubur: three days prior to making the figurine, an offering was presented to the clay pit in exchange for the material that would have been extracted from it. Institutional control was extended over the distribution of groups of producers across

the workshops and fields they managed (Steinkeller 1996). However, the internal organisation of a pottery crew seems to be a "family affair". We know from the administrative accounts that potters usually worked in groups of relatives, sometimes with their young children (Waetzoldt 1971), following a hierarchical structure. Texts from Umma refer to a group of around twenty potters working for the city governor over a period of almost twenty years. The crew was supervised by potters from the same family, first the elder brother Pešam and, after his death, his sibling Utu-sag, both sons of Ur-Nigar "the potter" (Dahl 2010). Interestingly, each of them possessed his own cylinder seal. At least three sons of these brothers, Ur-Gilgamesh, Erraya and Aba-kala, appear as members of the same work crew. Various texts report similar circumstances for different craft activities, with teams of craftsmen who were generally men from the same extended family (Steinkeller 1987; 1996; Sallaberger 1996; Wright 1998). Administratively, potters could be re-assigned to the same group from year to year unless they were required for specific orders or demanding agricultural tasks (Steinkeller 1996; Dahl 2010). These circumstances likely depended on the potters' skills and possibly also on other social criteria (Wright 1998). Within the work crew, each man had a specific task. Some were responsible for decision-making, while others were in charge of deliveries. At Umma, for instance, Ur-Gilgamesh and Erraya delivered pots to the group supervisors and received reeds (Dahl 2010). Another text from Umma, which includes parts of the same list of workers above (Sallaberger 1996; Dahl 2010), mentions Inim-Šara, the son of Lugal-itida. As superintendent potters, they both had their own cylinder seals, received bundles of reeds, and led a group of workers who responded to institutional orders for vases. Potters were also mobile at the local and regional levels, according to their abilities

and the needs of the time. At the local level, they could be assigned to collaborate with other specialists for specific orders or help with demanding tasks in the institution's fields, such as during the harvest (Neumann 1987). Moreover, they could be sent to distant areas as a backup workforce or to retrieve specific material. Inim-Šara and Lugal-itida of Umma both affixed their seals to documents reporting the departure of a worker from their gang to M^a-da:ga (hereafter Madga) (Sallaberger 1996). According to recent interpretations (Ahmed 2012, *contra* Hempel 2009), the Madga region should have lain between the Lower Zab and the Diyala, likely in a defined area south of Kirkuk. It is known as a bitumen-producing region, particularly during the Ur III period (Forbes 1955; Edzard 1977; Moorey 1994). Within a craft area, bitumen could be used to repair and seal the jars but also possibly as a fuel or at least as a firelighter. Yet, bitumen sources were also accessible closer to southern cities, on the banks of the Euphrates around Hit in central Mesopotamia or in the Khuzestan region in southwestern Iran (Schwartz and Hollander 2016). However, the Trans-Tigridian route was apparently preferred by the potters from Umma. In sum, institutions gathered several groups of highly specialised workers under their control for at least a part of the year. Textual sources highlight a hierarchised and flexible system with different authorities managing the distribution of workers across the territory and local intendants keeping the production organised and operational. Thus, the primary purpose of the institutional households seems to be maintaining a network of workers, sites and economic entities that traded raw materials or finished products with one another. This network appears to have been crucial to the functioning of the Ur III economic system, and at least in the case of the potters, seems to have heavily relied on family ties (Steinkeller 2007).

3. Logardan: An archaeological view from the margins

Toward the end of the 23rd century BCE, the hilltop of Logardan was occupied by a monumental building to be associated with the Akkadian presence in the area, most likely in the framework of the Naram-Suen's military campaigns towards Simurru (Baldi and Vallet 2024). Shortly after, a series of pottery workshops, counting dozens of kilns, were set up on the site's hilltop, reusing the vestiges of the architectural complex. The first of these workshops (Level 3b) is radiometrically dated between 2145 and 2119 BCE (calibrated medians, see Zingarello 2024). It was probably established by local inhabitants of the *Arraphum* province prior to the expansion of the Ur III empire in the region. Two additional workshop levels (3a2 and 3a1) were built on top of Level 3b, reflecting a change in the organisation of the production structures. Chronologically, they both cover the last century of the 3rd millennium BCE based on the pottery material, the more recent level straddling the turn of the 2nd millennium BCE (radiocarbon dating to come). A thick ashy layer was intentionally laid over the Level 3a1 workshop. At the turn of the 2nd millennium BCE, large-scale pottery activities continued to functionally characterise Logardan over a couple of centuries (Levels 2 and 1) until its abandonment. The architectural analysis and spatialisation of pottery shapes and techniques of the levels pertaining to the Ur III period, Levels 3a2 and 3a1, are presented here to highlight the functional organisation of the production spaces and their structural components.

3.1. The workshop of Level 3a2

In the main phase of Level 3a2 workshop, 45 firing structures have been identified so far (Fig. 2). They were set among



Fig. 2. Schematic plan of level 3a2 of Logardan ©FARMQaD.

stone walls and brick benches, and the whole workshop area was provided with extensive mudbrick tiling. Repetitive and intense heating has damaged the latter in some places. Three technical types of firing structures were used at the same time: single-chamber structures, superposed-chamber kilns with vertical draught, and juxtaposed-chamber kilns with horizontal draught. In most cases, only the bottoms of firing structures survived, and the specific type of structure is difficult to identify. The largest structures (k.635, k.638, k.800, k.912, k.926, k.4516 in Fig. 2)

measured more than two meters in diameter and featured internal pillars or platforms, indicating they were possibly superposed or juxtaposed-chamber kilns. Other furnaces measuring less than one meter in diameter (i.e. k.651, k.806, k.807, k.804 in Fig. 2) were certainly single-chamber structures. In the filling of k.912, a block of solid bitumen was found, suggesting the use of this material in the workshop, possibly as a fire starter. The peculiarity of the 3a2 workshop is that firing structures of different types, sizes and construction models were



Fig. 3. Duct below the brick tiling, connecting k.921 and k.924 ©Mission du Qara Dagħ 2018.

gathered in clusters of three, with the chambers of the different kilns connected through internal passages of 10 cm in diameter. These ducts were also found below the brick tiling of the workshop, often hardened and filled with ashes (Fig. 3). Such a ductwork system was used to transfer heat from one structure to the other within a network of heat circulation gathering almost all the firing structures of the workshop (Padovani 2023a; 2024a). Each kiln could work independently, following a classic firing cycle. Nevertheless, it was also part of a larger connection system that enabled the mutualisation of the heat produced and the optimisation of the energy consumption at the workshop level. According to a plausible reconstruction based on the results of a recent experiment (Baldi et al. *forth*), in each kiln cluster, the firing structures were ignited one after the other. A part of the heat produced by the first one was used to dry and pre-heat the ceramic charge of the others. Moreover, when the second and the third structures had been ignited, their

combustion chambers would have been hot enough to allow the optimal combustion of the fuel. Similarly, the mudbrick structure and the ceramic materials that these kilns contained would have been dry enough to start increasing the temperature quickly and consistently (Padovani 2025). Few spaces were left around the firing structure for the various activities involved in the pottery production's operational sequence. However, one-meter-wide brick platforms were set up close to specific clusters of kilns (k.651; k.635-k.634-k.801; k.912-k.922-k.915) (Fig. 4). They might have been used for loading the firing structure or as shaping platforms. Stone tools used for ceramic shaping have been found in kiln fillings and on the platforms. The need for extensive storage space for pot drying is a serious limit in the pottery workshops' setting. Drying clay containers is, in fact, the stage of the operational sequence that requires the most space compared to clay preparation, shaping and firing activities (Kramer 1997; Senior 1998; Hasaki

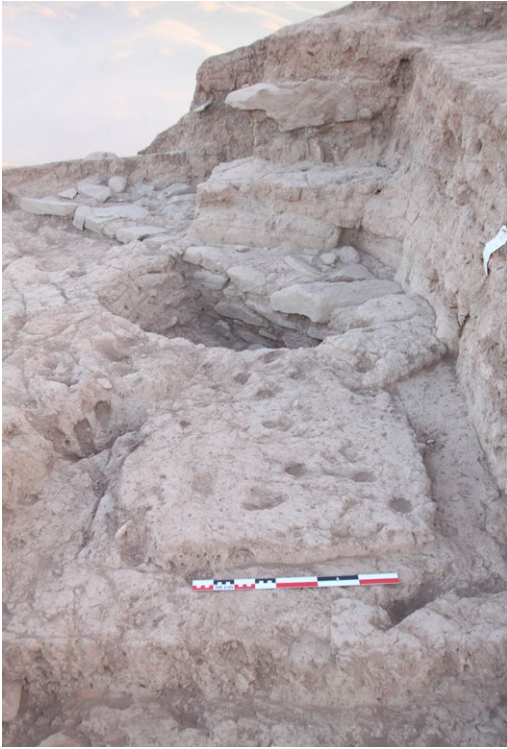


Fig. 4. Kiln 634 built above wall 636 and associated platform in the foreground ©Mission du Qara Dagh 2016.

2011; forth). At Logardan, if clay vessels had been allowed to dry slowly inside the kilns thanks to the large-scale system of heat transfer, the potters would not have needed extensive outdoor drying areas. They could have worked directly next to their kilns and loaded the firing structure as soon as the vessels had been manufactured. In other words, instead of taking place outside, the drying process would have occurred safely within the kilns for most of the required time. When looking at the ceramic material, significant data are revealed by the specialisation of pottery morphology, function, and manufacturing technique. A

preliminary analysis of the distribution of ceramic shapes in relation to the firing structures shows that no kiln-specific pattern in the distribution of material can be distinguished. The most common shapes found in the Level 3a2 workshop are different kinds of carinated bowls, a variety of wide-mouthed, bag-shaped vessels, small to medium in size with or without combed incisions, and medium- and large-sized jars with impressed ropes on elongated or globular bodies. Regular and pie-crust-like stands, cylindrical beakers decorated with incised horizontal lines and small strainers are also quite frequent in this level. Decorated vessel specimens reported as “internal-handled bowls” or trays (Bürger and Miglus 2016), common in Central and Southern Mesopotamia, can be counted among the most peculiar pottery shapes. A rare painted representation of a dancing or praying human figure is attested on a tiny jar with a globular body found close to kiln 638³ (Zingarello 2024: fig. 9b: 7). An unusual medium-sized jar type featuring an internal extension of the rim, possibly related to the handling of liquids, appears restricted so far to Level 3a2 (Zingarello 2018; 2024). Such a wide range of morphologies, decorations and functions of the ceramic material accounts for the diversity and assortment of the assemblage produced in every sector of the firing area. By analysing the clay fabric and the shaping methods of *in situ* potsherds, J.S. Baldi (2023) has identified and spatialised five different technical traditions (*chaînes-opératoires*) used to craft the pots in the Logardan 3a2 workshop. It has been clearly demonstrated that technical traditions embody peculiar ways of doing of distinct groups of producers.

³ An almost identical human representation, probably painted with bitumen, was found during the spring 2024 campaign on a medium-sized jar from a level of Trench E stratigraphically equivalent to Level 3a2 on the southeast side of the Logardan’s hill. This area also includes a series of kilns and probably represents the southern extension of the 3a2 pottery workshop.

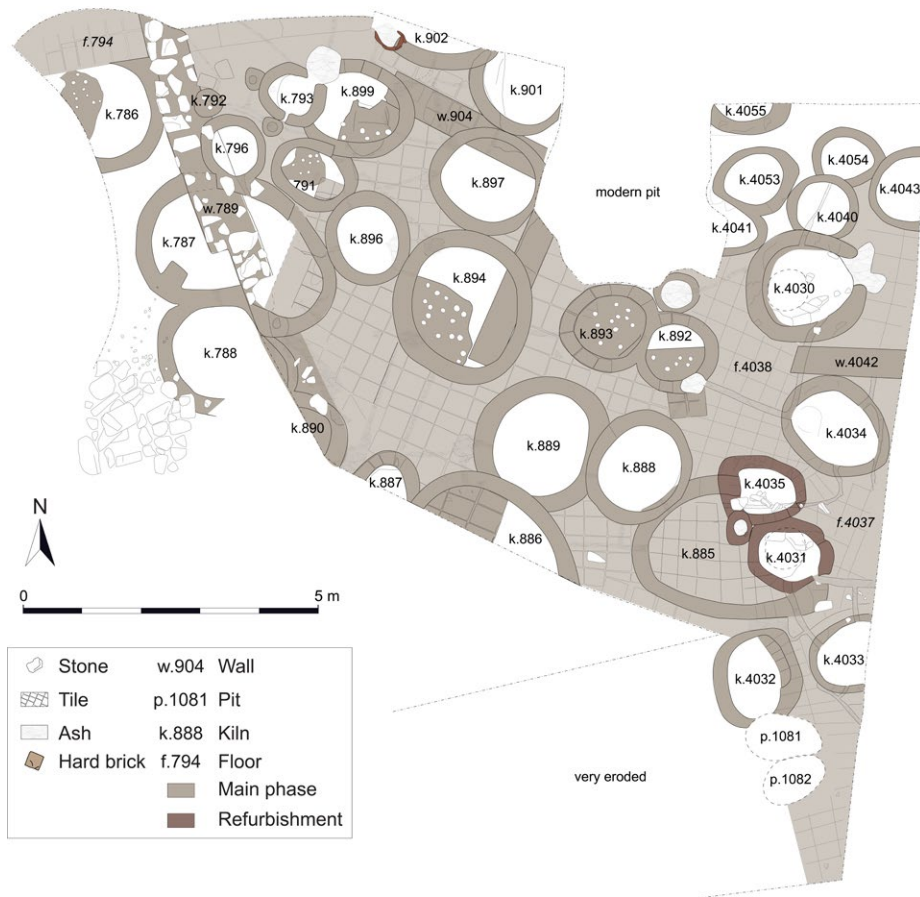


Fig. 5. Schematic plan of Level 3a1 of Logardan ©FARMQaD.

They correspond to the technical identities of the craft communities using specific *chaînes-opératoires* (Baldi 2023 and related bibliography). The distribution of the technical traditions within Level 3a2 appears to fit the clusters of kilns identified in the workshop area. This implies that at least five different groups of producers were active in the excavated part of the 3a2 workshop. Each used diversified shaping techniques to produce the same pottery shapes. Moreover, the potters of each group mastered different firing techniques and were able to cooperate in building connections between

their cluster of kilns and mutualising heat production during the firing process. Interestingly, a cylinder seal was found north of Kiln 638, in the destruction layer of Level 3a2. It is a classic Akkadian seal that probably belonged to a representative of the empire. However, based on an addition to its iconography, C. Paladre (2016) has supposed that the seal may have been reused by a local elite in a later period. Thus, its presence could suggest that the teams of potters were working under the supervision of chief potters owning their personal seals and managing collective work and product orders.



Fig. 6. Superposed-chamber kiln with the mouth to the east and pieces of grates attached to the walls ©FArMQaD 2024.

3.2. The workshop of Level 3a1

There is no period of abandonment between Levels 3a2 and 3a1, but the reorganisation of the workshop is significant (Fig. 5). It is important to emphasize that the entire workshop was reconstructed as a unified structure built on top of the previous one, rather than each group of kilns being rebuilt individually. This suggests a carefully planned construction process. However, the same types of kilns are used as in Level 3a2. Examples of superposed-chamber kilns are k.791 or k.4030, measuring between one and two meters in diameter. A piece of grate was found in the bottom of their combustion chambers (Fig. 6). Juxtaposed-chamber kilns are less numerous than in Level 3a2 and seem to be concentrated in the southern part of the workshop. They are characterised by an ashy and shallow combustion chamber flanked by an internal brick platform. Overall, the kilns are arranged and connected more linearly than in Level 3a2 (Padovani 2023a; 2024a). They were still

organised in clusters, but more structures were connected on an east-west axis. Some east-west oriented ducts were larger than the others (up to 20 cm wide) and used as the main channels to transport heat across the firing area. They constituted the backbone of the system, delivering heat to other kilns through secondary ducts (Fig. 7). The connections between the walls of the kilns and the ducts were protected with hard bricks or stone (Fig. 8). The ducts could have been blocked to allow certain kilns to operate independently and prevent heat loss. A very peculiar stone with a protrusion was found in the southeastern duct of k. 4030 (Fig. 9). It measures 10 cm wide, the size of an average duct and is interpreted to function as a duct plug. In Level 3a1, the ducts are not constructed as kiln extensions that simply connect one kiln to another. They take the shape of a system overcoming the architecture of the firing structures, with connecting points independent of the kilns themselves. The transformation of the connection system to mutualise heat is probably unrelated to the types of pottery produced by the workshop but rather depends on an internal and non-linear evolution of the firing technique. Functional categories of manufactured ceramics did not change in Level 3a1. Small carinated bowls, as well as deep large bowls, medium-sized wide-mouthed, bag-shaped vessels, and medium- and large-sized jars with incised or roped decorations, are still predominant in the assemblages produced. It is interesting to note, however, an increase in pottery types compared to the earlier level. Such greater morphological variety does not seem to be related to discovery chance, particularly considering the relatively poor state of preservation of the 3a1 workshop vestiges due to the later levelling for the construction of the Level 2 craft area. Especially noteworthy is the occurrence of large fragments of *dolia* found in kilns 886, 888 and



Fig. 7. Kilns 4033 and 4032 in the foreground with the 20 cm wide duct, oriented east-west, in the background ©FArMQaD 2024.



Fig. 8. Small duct oriented north-south connecting kiln 4033 to the 20 cm wide duct oriented east-west ©FArMQaD 2024.



Fig. 9. Stone with a protrusion found in the south-eastern duct of k.4030 ©FARMQaD 2024.

889, where they were positioned against the inner walls, apparently used as lining. Baldi (2023) demonstrated that only two technical traditions of pottery manufacturing, already known in Level 3a2, became dominant in the excavated part of the Level 3a1 workshop. Two other different operational sequences remained confined to the north-western part of the craft area. This continuity of technical traditions from Level 3a2 to 3a1 does not imply that the same potters worked in both levels but that potters of the same communities of practice were still operating in the working area. However, they reorganised the production site to fit their more integrated way of firing.

4. Shifting technological and socio-economic paradigms: an emerging proto-industrial Ur III workshop

Both written and archaeological evidence converge on several key aspects: (1) pottery workshops as specific economic entities, (2) the collaborative organisation of potters working in groups, (3) the presence of an internal hierarchy of the potters' crews, and (4) the mobility of workers associated with the pottery workshops. (1) The workshops of Logardan, gathering

several pottery craft facilities in the periphery of *Azuhinum*, an important centre of the Zagros piedmonts, and close to a road circulating toward *Arraphum*, could have formed a "pottery" like those documented in the Umma countryside, as suggested by the written sources (cf. *supra*). The site appears to have been exclusively dedicated to pottery production, as no other working facilities or architectural structures have been identified in its vicinity up to now. The diversity of the pottery assemblage produced at the workshops suggests that its primary purpose was to meet the different needs of people in or around *Azuhinum* or possibly supply the military settlements established by Šulgi in the Zagros Piedmont, attested in written sources. Nevertheless, the possibility that the workshops also manufactured containers for specific contexts of use cannot be dismissed, as a large-scale survey around Logardan has not yet been completed. (2) At Logardan, several groups of potters worked simultaneously, as evidenced by the number of contemporaneous kilns and the distinct technical traditions of ceramic manufacturing identified. Yet, they produced the same pottery assemblages. It is now widely acknowledged that people sharing the same *chaînes opératoires* and manufacturing techniques acquired their skills within a shared learning environment and were probably family relatives (Roux et al. 2017; Baldi 2023). This configuration aligns with the organisation documented in written sources (cf. *supra*). Archaeological data show that potters were not merely passive components of an administrative system but possessed and applied specialised firing knowledge. The ductwork system identified between the kilns in both Levels 3a2 and 3a1 suggests that the different groups of potters were able to collaborate to meet a substantial demand for pottery. In addition, the transformation of the firing system – from

kilns architecturally and functionally connected in Level 3a2 to the individualisation of ductwork for heat transfer linking multiple, architecturally independent firing structures in Level 3a1 – shows an internal evolution in firing techniques driven by the dynamic expertise of the potters and not related to the type of manufactured product. The transformation of the firing processes at Logardan suggests a bottom-up development rather than the imposition of a standardised firing method by a centralised authority to meet production goals. Consequently, the archaeological evidence highlights the agency and adaptability of the potters in refining their production techniques and points to a workshop organisation based on cooperation among potters rather than coercion.

(3) Nevertheless, the planning of the firing area's construction – evident from the simultaneous transformation of the entire level rather than a gradual modification of individual kiln groups – and the presence of a cylinder seal in Level 3a2 support the hypothesis of the existence of a chief potter. As suggested by the written documentation, these supervisors were likely responsible for organising the collection of clay and fuel, coordinating pottery deliveries, and synchronising the firing schedules of the various groups working within the workshop. While the system was designed to be flexible, allowing the firing structures to operate independently through the duct plugs, a hierarchical pressure on potters could only have been effective thanks to an established practice of collaboration among them.

(4) It can be assumed that clay and fuel (dung, shrub, reed) were sourced locally, either around the workshop or, in the case of fuel, potentially from neighbouring agro-pastoral production units that may have also been integrated into the Ur III network. However, the presence of bitumen on pots and in kilns could indicate possible connections

with the nearby Madga region, south of Kirkuk (Ahmed 2012; Schwartz and Hollander 2016). The presence of bitumen at Logardan, combined with textual records, suggests the mobility of some workers associated with the workshop to fetch material necessary for production. Building upon the previous findings, the Ur III workshops at Logardan demonstrate the capacity for large-scale production and, more significantly, the ability to enhance productivity by integrating a collaborative yet hierarchical labour organisation with innovative firing techniques. Meeting large-scale pottery demands can be achieved through various production organisational strategies, such as increasing the number of producers in centralised but segmented workshops (Padovani forthcoming). However, at Logardan, productivity is not enhanced by simply expanding the workforce. Rather, it results from a fundamental shift in the social and technical organisation. This new approach involving collaborative work between several producing units to manufacture the same pottery assemblages and innovation in firing techniques to save fuel, time and energy, is proposed as a defining example of a proto-industrial paradigm. Furthermore, the firing knowledge of connecting kilns, documented as early as the beginning of the 4th millennium BCE (Baldi and Zingarello 2021; Padovani 2023b; 2024b), is the cornerstone of this new paradigm. Running multiple connected kilns represented a significant saving of time and energy compared to operating several isolated structures at the same time. The connecting ducts enabled the transfer of heat from a kiln already in its firing cycle to another kiln still cold, allowing for the gradual preheating of the latter structure and the pots inside (without needing to wait for them to fully dry outside). Considering that the preheating of kilns and the drying of pots are the longest steps of the

ceramic production process, this heat optimisation would have saved fuel by sharing resources across staggered firing cycles. Additionally, this system would have saved time by incorporating the drying phase directly into the firing process. Moreover, the flexibility of the ductwork system enabled rapid response to bigger or smaller orders. In contrast, relying on very large firing structures would have implied more time to fill in the structures and a delay in responding to small commands, as well as more economic risks in case of accident during firing and breakage of the pottery load.

5. Conclusion

In this article, both the archaeological and textual evidence are examined and compared to fully understand the socio-economic mechanisms underlying the labour organisation of the Logardan workshop during the Ur III period and define the proto-industrial paradigm. It is assumed that the potters working at Logardan belonged to local communities that were fully integrated into the Mesopotamian *koiné*. The analysis of the technical and spatial organisation of the workshops shows that the different groups of craftsmen were able to organise themselves together for a coordinated large-scale pottery production. These groups were probably managed by a supervisor working on the site, possibly accounting directly to the state representatives of the imperial power in charge of the Zagros Piedmonts regions. It is not possible to definitely state whether the potters working in the workshop were juridically enslaved people or free men. On the one hand, envisioning a low-skilled workforce recruited outside the stable family-based crews of specialised artisans and assisting them during peak demand periods for fuel gathering or kiln loading and unloading may

not be mere speculation (cf. Dahl 2010). Personnel with varying degrees of labour involvement in craft activities might have been subject to different work obligations and penalties, under the legislation in force. Be that as it may, all these people worked under the Ur III administration, being part of a reticulated economic network more than a centralised production located in urban centres. The analysis here presented recontextualises the role of the state administration, suggesting that its function was not to make decisions at all levels – such as the techniques and methods of production that characterise the proto-industrial paradigm – but rather to oversee the management of the labour force, raw materials and finished products. One should emphasise that the change infiring organisation between Levels 3a2 and 3a1 at Logardan must have been generated internally by the potters themselves rather than being imposed by the central administration, which probably exploited their deep knowledge of coordinating specific firing techniques. The success of this configuration at the end of the 3rd millennium BCE is possibly due to a long-standing southern and north-eastern Mesopotamian tradition of collaborative work rather than to an increasing hierarchisation of an administrative controlling system. Thus, the proto-industrial paradigm appears to be less associated with state influence and more deeply rooted in a long-standing tradition of collaborative labour within specific regions, which fostered the development of firing innovations. We suggest that the bureaucratic framework of pottery production emerged through bottom-up development, driven by the progressive cooperation and integration between groups of potters in Southern and North-East Mesopotamia. The tradition of gathering in shared production areas and working together

using duct connections between a limited number of kilns was already observed at Girdi Qala in Early Uruk contexts at the beginning of the 4th millennium BCE and Ur at the end of the 4th millennium BCE (Vallet et al. 2017; Padovani 2023b). Therefore, we suppose that the different family-based producing groups that were probably in charge of the production for their respective lineages during the 4th millennium BCE – and accustomed to collaborative work under a familial hierarchy – became incorporated into full-fledged economic production units at the service of political institutions during the 3rd millennium BCE. Despite the utilitarian nature of pottery, ceramic manufacturing became an incorporated political factor in the Ur III economic structure, not only in the core area of the empire but perhaps even more so in the peripheral regions. The Ur III workshops of Logardan provide the first archaeological evidence of a specific kind of hierarchy systematically integrated with a central administration in pottery craft activities. Pottery remained a politically *uncharged* commodity (Brumfield and Earle 1987) in this period and, as such, was certainly not fully centralised. One can observe, nonetheless, the overcoming of the city-states' "dual" economy model proposed for the mid-3rd millennium BCE (Stein 2001; Stein and Blackman 1993). This model could be applied to the Central and Southern Mesopotamia workshops, yet to be excavated but already identified in some places such as Tell Zurghul, ancient Nigin (Zingarello 2022). In these regions, the conditions necessary for the emergence of a proto-industrial organisation of pottery production could have been in place at the end of the 3rd millennium. Until these Ur III pottery craft areas from the core of the empire will not reveal hidden differences or similarities, one might imagine a relatively similar labour organisation to that of Logardan.

Credit authorship contribution statement

Claire Padovani: Conceptualisation of the paper, writing – original draft writing – review and editing.

Melania Zingarello: Pottery analysis, writing, review and editing.

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