EXARC JOURNAL
2023 Digest

Where **Archaeological Open-Air Museums, Experimental Archaeology, Ancient & Traditional Technology** and **Interpretation** Meet

FEATURING

Ötzi's Shoes

Anglo-Saxon Beads

A Hall fit for a King

Drawing Wire

Heritage in Times of War

Roman Screw Threads

Leave your Stamp

Peat Burns

Hard Fun

EAC13

ISSN: 2212-523X

EXARC.net/journal

JEXARC JOURNAL 2023 Digest

The leading journal for those involved in experimental archaeology or archaeological open-air museums, featuring the latest developments in fieldwork, academic research, museum studies and living history interpretation (**https://EXARC.net/journal**). This reviewed journal is published by EXARC, the ICOM Affiliated Organisation representing archaeological open-air museums, experimental archaeology, ancient & traditional technology and interpretation (**https://EXARC.net**).

Contact
k.dvorakova@exarc.net

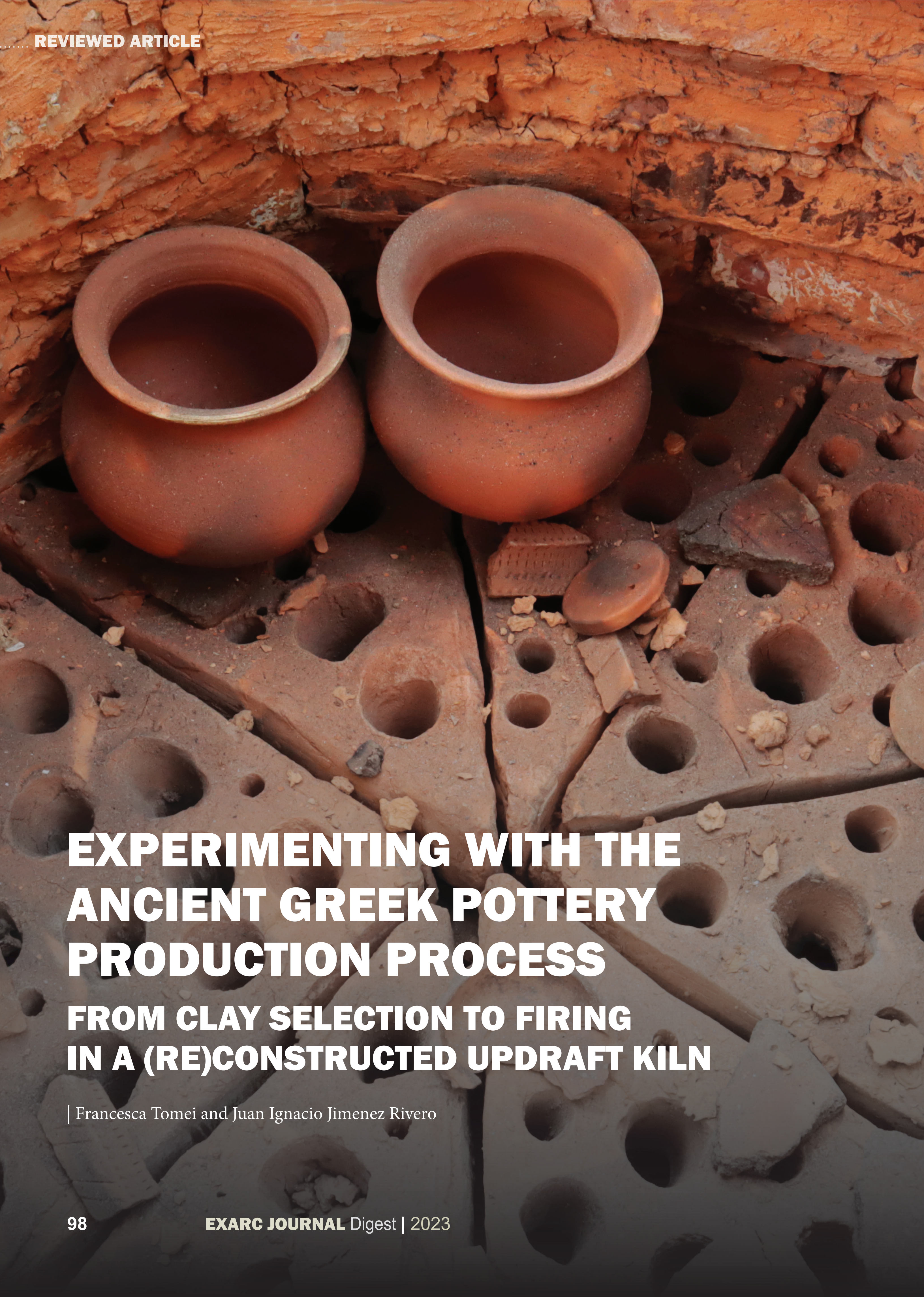
Design: Magdalena Zielińska (EXARC)
Print: DrukWerkDeal.nl

Front cover:
Replica stone matrix for making metal copies based on a 12th century bone plate from Plisnesk, possibly from a folding triptych or a small box from central Europe.

Photo by Oleksandr Didyk, Ancient Plisnesk, Ukraine.

ISSN: 2212-523X

CONTENTS



EXPERIMENTING WITH THE ANCIENT GREEK POTTERY PRODUCTION PROCESS

FROM CLAY SELECTION TO FIRING IN A (RE)CONSTRUCTED UPDRAFT KILN

| Francesca Tomei and Juan Ignacio Jimenez Rivero

This experimental project aimed to reproduce the Hellenistic (fourth-third century BC) Greek pottery production process. We intended to address two main research questions:

1. How did locally available raw materials such as clay, temper, and fuel, as well as the local climatic conditions, impact the decision-making process, the production process, and the successful firing of ancient Greek pottery?

2. How can we improve our understanding of the ancient Greek pottery production process in a suburban context, including the social networks created with the local community?

The experiment took place on Juan Ignacio's private property in Whalley Range, southwestern Manchester. This article provides a chronological description of each stage of the operational process as well as a discussion of the results.

Stage 1: Research and Preparation of the Experimental Project

This experimental project is based on research on kiln technology in the ancient Greek world through the study of the archaeological evidence (Hasaki, 2002; Tomei, 2017). During this chronological period, the Greek artisans used vertical or updraft kilns. We focused on the rural workshop of Sant'Angelo Vecchio in the territory of the Greek city of Metaponto, in southern Italy, as a specific case study (Silvestrelli and Edlund-Berry, 2016). It was a context presenting a wide variety of pottery and ceramic products for everyday-life use in a rural settlement, allowing us to experiment with different shapes and dimensions.

Besides the archaeological remains, the Penteskouphia plaques helped to reconstruct the general appearance of the ancient Greek kilns and the tools used by the potters. It is a large group of votive terracotta plaques (*pinakes*) from a sanctuary located south-west of Corinth that date back to the first half of the sixth century BC (Hasaki, *et al.*, 2022, p. 2). About 100 *pinakes* depict potters at work. They have been an important iconographical source to build the kiln, especially the firing chamber and the dome. In particular, some *pinakes* show an opening in the firing chamber interpreted as a loading door (Hasaki *et al.*, 2022, pp.101 and 106), but most likely it was an opening to take out test pieces to check the firing (See Figure 2).

Fig 1 (Previous page). The perforated floor after the firing. Photo by Tomei and Jiménez Rivero.

Fig 2. Plaque Penteskouphia MNB2858 (Jastrow, 2006, Public Domain)

The creation of a database of ancient Greek kilns for the author's MA dissertation (Tomei, 2017) in addition to Hasaki's catalogue (Hasaki, 2002) allowed us to extrapolate the most common shape and the average dimensions of medium-capacity pottery kilns. We planned a one metre inner diameter kiln with a circular combustion chamber with a central pillar to support the perforated floor (Type Ia: Cuomo Di Caprio, 1971; Hasaki, 2002). The stoking channel is 0.6 m long and wide. The permanent part of the firing chamber is 0.5 m high, and the temporary dome is 0.55 m, reaching a total height of 1.05 m. The shape and size of the dome was adapted according to ethnoarchaeology. Ethnography has been an essential source of knowledge as it has helped us to recreate the different phases of the ancient Greek production process, including how to build the kiln and manage the firing.

Stage 2: Selection of Clay and its Processing

According to ethnographic sources, clay is preferably collected in the proximity of the workplace (Gosselain and Smith, 2005; Tomei, 2022a). Luckily, suitable plastic clay is naturally abundant in the Whalley Range area. We soaked the natural clay in buckets to allow it to soften. Then we filtered the clay. The resulting finer mud settles before the clear water on the top is skimmed off. As pots must stand tensions and changes during firing, we added finely sieved quartz sand.

Stage 3: The Making of the Mudbricks and the Perforated Floor

In most ancient Greek kilns, the combustion chamber was dug into the soil and the walls were covered with mudbricks and clay (Hasaki, 2002). We modelled the handmade mudbricks following the traditional techniques from Valladolid in Northern Castile (González, 1989). In one day, we made ca. 100 bricks and laid them outdoors to sun dry for a couple of sunny days. We also made adobe bricks by tempering clay with lawn grass clippings (See Figure 3). Adobe bricks are important for their insulating properties, and we planned to use them for building the temporary dome and the chimney. Abundant ethnographic evidence confirms the use of adobe bricks as a kiln building material across Spain, such as in Guadalajara (Castellote Herrero, 2006).

The intention was to build the central pillar and most of the kiln's permanent structure with raw handmade bricks. However, we realised that the process costed a significant amount of time and

Fig 3. The adobe bricks made of clay tempered with dry straws. Photo by Tomei and Jiménez Rivero.

Fig 4. The perforated floor completed and dried out. Photo by Tomei and Jiménez Rivero.

energy. Therefore, fired Victorian bricks were a valuable and accessible resource from building sites in the neighbourhood. Their manufacturing process did not differ much from the ancient one (Lynch, 2022). Consequently, we decided to use Victorian bricks to build the permanent structure. The handmade and adobe bricks were used to build part of the stoking channel and the dome.

The second most challenging element was the making of the perforated floor, which is an essential feature of the updraft kiln (Hasaki, 2002). Archaeological finds suggested that the average thickness was between 0.07 and 0.20 m. The diameter of the vent holes usually varied between 0.06 and 0.10 m (Hasaki, 2002, p. 83). The perforated floors from modern traditional pottery kilns in Margarites (Crete) were 0.10-0.15 m thick and the diameter of the holes was similar to the ancient ones (personal observation, 2019). Based on this information, we designed a perforated floor with a 1 m diameter, the same as the combustion chamber, and 0.10 m thickness. Making the perforated floor was a very laborious and time-consuming task, it took up to six months to completely dry it out (See Figure 4).

Stage 4: Wheel-throwing the Pottery

Amongst Sant'Angelo Vecchio's Early Hellenistic assemblage, we selected a representative sample of vessels for everyday domestic use. Before wheel-throwing the pots with a traditional Spanish kick wheel, we carefully studied the published archaeological drawings. To each vase, we added a 10% size to compensate for the average shrinkage of our clay after drying and firing.

Since we selected some Black Gloss wares, we tried to achieve such a surface treatment using a red-coloured slip, which will turn black during the reduction phase of the firing.

Stage 5: Building the Kiln

We adapted an already existing firing pit to make the combustion chamber, based on the archaeological evidence (Hasaki, 2002). Whilst digging the bottom of the combustion chamber, we reached a level of silty clay that we used for making the cocciopesto mix to insulate the walls and the floor of the kiln. Then we dug the stoking channel, leaving a gentle slope towards the firing pit (See Figure 5).

Following the archaeological evidence, we built an arch at the mouth of the combustion chamber as a connection with the stoking channel. We designed a wooden arch-shaped frame on which we placed two rows of bricks. The gaps between the bricks were filled with pebbles to keep the angles. Once the bricks were thoroughly arranged, we carefully pushed out the frame. The structure successfully stood up thanks to the force produced by its own weight (See Figure 6).

Afterwards, we built a provisional central pillar to support the perforated floor and tested its stability by placing two portions of the floor on top of it. However, it proved to be not stable. To solve that structural weakness, we covered the whole perimeter of the combustion chamber with a circular wall of bricks to safely support the outer part of the perforated floor, while all the centre would rest on the central pillar. The central pillar to support the perforated floor in Type Ia Greek kilns had roughly a circular or rectangular shape and it was made of mudbricks or clay mortar mixed with broken sherds, tiles and stones (Hasaki, 2002; Tomei, 2017). However, the humidity of the combustion chamber and the weight of the perforated floor could enhance the risk of collapse during the pre-firing stage. Therefore, we agreed to use well-fired Victorian bricks.

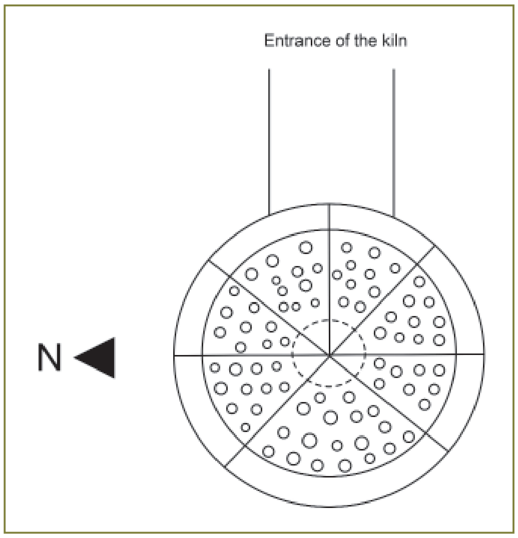


Fig 5. Sketch showing the kiln's orientation. Image by Tomei and Jiménez Rivero.

Fig 6 (Below). Building the arch with a wooden arch-shaped frame. Photo by Tomei and Jiménez Rivero.

After completing the combustion chamber, we built the structures of the stocking channel. Next to the arch at the entrance of the combustion chamber, we made two small columns of bricks and along the ditch we placed two rows of bricks at the same height as the columns, filling the gaps with pressed soil. Then we built the covering of the tunnel using seven arch-shaped flat coils. Once the structure of the stoking channel was dried out and pre-fired, it became strong and stable.

A couple of weeks after we completed the combustion chamber and the stoking channel, we placed the perforated floor. We also filled with clay the gaps between the floor and the combustion chamber and the arch to avoid heat losses. Afterwards, we pre-fired the kiln to dry it out as well as to test the draft. We spent the first three hours to reach 100°C because water trapped within the thick floor modules should be released gently to avoid fractures. This was successful and the perforated floor withstood the thermal change without any damage. We also found that the kiln's draft was excellent.

After pre-firing, we covered the kiln structure for the winter with three layers of tarpaulin fixed to the ground. Nevertheless, the following May we found that soil humidity had caused condensation that made the perforated floor humid and crumbly again. Therefore, we let it dry under the sun and pre-fired it again. After that, we built the firing chamber.

Fig 7. Stacking the firing chamber with the coarses wares at the base and the fine painted vessels above them. Loom weights work as kiln spacers Photo by Tomei and Jiménez Rivero.

Fig 8. The kiln during the first stages of the firing. Four thermocouples monitor the temperature in the kiln. Photo by Tomei and Jiménez Rivero.

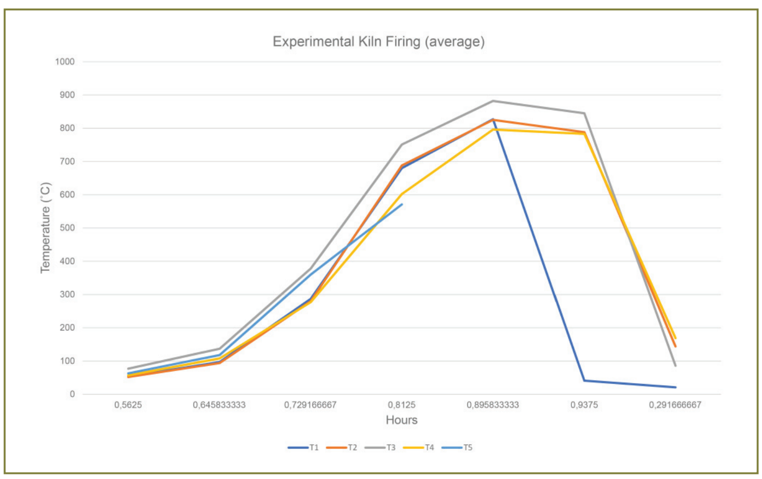
Stage 6: Stacking the Kiln and Building the Dome

We stacked the kiln following ethnographic evidence from different regions in Spain (González, 1989; Castellote Herrero, 2006; García Alén, 2008) and our own experience. We laid the larger cooking vessels at the base of the load with smaller coarse wares at the centre. These vessels rested on small flat sherds so as not to obstruct the vent holes. Above them, we placed finer plain and painted bowls and cups. The basins on top of the load were placed upside down to retain the heat of the ascending gases (See Figure 7). As the pots heap was growing, we built the temporary dome as high as the kiln load required using the handmade raw bricks cemented with natural clay. We completed the dome with a chimney ca. 0.30 m high and wide.

Stage 7: The Firing

The provision of fuel was another essential part of the experiment. The residential area of Whalley Range has many private and public gardens and parks where abundant branches and sticks can be gathered for free, as well as wooden pallets and carpentry leftovers. For this firing, we stored many branch cuttings and planks collected from the surrounding area. Indeed, the collection of fuel shows how traditional pottery production can be part of the local community network. In the rural areas, the use of agricultural waste is documented in antiquity and modern times in the Mediterranean (Tomei, 2022b).

Summer is the most suitable time for firing pottery in the kiln because the weather is warmer and there is less chance of rain. Therefore, we agreed to plan it for mid-July. First, we placed five thermocouples to monitor the temperatures in the firing chamber: four of them on each side of the firing chamber just above the perforated floor and the fifth one at the junction between the firing chamber and the dome on the southern side of the kiln (See Figure 8). The firing team was composed of five people to help gather and add fuel, prepare food for everybody, and monitor the temperatures every five minutes to make sure they increased gently. In addition to the thermocouples, we monitored firing stages and the melting of the sigillata slip using a traditional method. It consists of taking a sample with an iron hook (See Stage 1) through the test window made in the firing chamber.



Graph 1. The graph shows the average temperatures recorded by the thermocouple during the firing day.

We planned the firing based on the ethnographic evidence of rural Spanish potters (García Alén, 2008). As shown in Graph 1, we spent two hours to attain 100°C.

At temperatures above 150°C, we observed that despite spreading the ashes and flames evenly, the temperature measured by the thermocouples diverged quite remarkably and indicated that the northern and western sides of the firing chamber remained colder. These sides of the kiln faced abundant vegetation that kept the soil more humid and, consequently, the kiln temperature lower. After three hours of prudent feeding, we reached a heat above 200°C, so we decided to add more branches and solid logs to keep a constant increase in temperature. As we proceeded, we pushed more and more red ashes with the T-shaped rod - iron-made replica of the tool displayed in the Penteskouphia plaques - into all sides of the combustion chamber. We continued operating in this way for the next four hours until we reached an average temperature of ca. 700°C. After two more hours of intense feeding with small branches, the firing reached temperatures ranging between 800°C and 900°C. At this point, we opened the small test window to take a sample of a small cup and found out with great satisfaction that the sigillata vitrifying slip had already started to become black and the pots turned into an intense orange glowing. We immediately closed the window again and reduced the atmosphere by adding abundant green leaves. After a while, when the temperature went below 750°C, we stopped adding any foliage to allow oxygen to enter the combustion chamber and allow the parts of the pots that had not been coated with sigillata slip to recover their oxidized orange colour. After 10 hours of firing, we sealed off the entrance of the kiln to slowly cool it down. Then we waited 48 hours to open it and check the outcome.

The firing was outstandingly successful as no pot had broken or exploded during firing or opening the kiln. The black gloss came out dark, shiny, and uniform on most vessels, especially the open ones such as the bowls and the Ionic cups. Also, the perforated floor fired well and homogeneously and resisted contact with the flames without any severe crack at all (See Figure 1).

Conclusions

Overall, the combination of archaeological evidence, ethnographic research on traditional Spanish potters and previous pottery-making experience resulted in a successful replication of the Hellenistic Greek pottery-making process and firing. The use of the local clay available for free in the area surrounding the workplace was entirely satisfactory. Similarly, gathering fuel from the neighbours proved to be a very economical and practical way as it offered mutual advantages. The climate is different to the Mediterranean and substantially affected the timing of most of the manufacturing stages. ■

Bibliography

Castellote Herrero, E., 2006. *Alfarería de Guadalajara: una guía para conocerla*. Guadalajara: AACHE Ediciones de Guadalajara (Tierra de Guadalajara, 62).

Cuomo Di Caprio, N., 1971. Proposta di classificazione delle fornaci per ceramica e laterizi nell'area italiana dalla preistoria a tutta l'epoca romana. *Sibrium*, (11), pp.371–464.

García Alén, L., 2008. *La alfarería de Galicia: catalogación arqueológica y artística de Galicia del Museo de Pontevedra*. Ed. facsim. La Coruña: Fundación Pedro Barrié de la Maza.

González, P., 1989. *Cerámica preindustrial en la provincia de Valladolid*. Valladolid: Caja de Ahorros Provincial de Valladolid.

Gosselain, O.P. and Smith, A.L., 2005. The source: Clay selection and processing practices in sub-Saharan Africa. In: A. Livingstone-Smith, D. Bosquet, and R. Martineau ed. 2005. *Pottery manufacturing processes: reconstitution and interpretation. International Congress of Prehistoric and Protohistoric Sciences*, Oxford: BAR Publishing (BAR international series, 1349), pp.33–47.

Hasaki, E., 2002. *Ceramic Kilns in Ancient Greece: technology and organization of ceramic workshops*. PhD. University of Cincinnati.

Hasaki, E., 2022. *Potters at work in ancient Corinth: industry, religion, and the Penteskouphia pinakes.* Princeton, New Jersey: American School of Classical Studies at Athens (Hesperia. Supplement, 51).

Lynch, G.C.J., 2022. *Brickwork: Historic Development, Decay, Conservation and Repair.* [Online]. Available at: <https://www.buildingconservation.com/articles/brick/brickwork.html> [Accessed 6 July 2022].

Silvestrelli, F. and Edlund-Berry, I.E.M., 2016. *The Chora of Metaponto 6 : A Greek Settlement at Sant'Angelo Vecchio*. Austin: University of Texas Press.

Tomei, F., 2017. *Fornaci greche e magnogreche di VIII-VI secolo a.C.* Scuola di Specializzazione in Beni Archeologici. Universita' degli Studi di Padova.

Tomei, F., 2022a. *Ancient Greek pottery workshops in their rural landscape setting. Exploring the intersection between production, environment, society and agrarian economy.* Available at: <https://doi.org/10.17638/03169006>.

Tomei, F., 2022b. Classical and Hellenistic pottery kilns from Greek rural areas in their natural and human landscap., In: A. Brysbaert, I. Vikatou, and J. Pakkanen ed. 2022. *Shaping Cultural Landscapes. Connecting Agriculture, Crafts, Construction, Transport, and Resilience Strategies*. Leiden: Sidestone Press, pp.241–254.