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RESEARCH

Crafting resilience: persistence and adaptation of the ceramic manufacture at Roca Vecchia from the Middle to the Final Bronze Age phases

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Abstract
Through the second millennium BC, Bronze Age communities of Southern Italy have shown a remarkable degree of resilience in coping with changes in both macro-trends of cultural interaction and the landscape. In this paper, we will examine long-term processes of adaptation to shifting historical and environmental conditions from the vantage point of the *impasto* ware production at the site of Roca Vecchia (Melendugno-Lecce, IT), one of the main hubs of interaction for the Bronze Age of the Central Mediterranean. Sixty-eight ceramic individuals coming from the Middle to the Final Bronze Age levels and seven soil deposits from the site surroundings were analysed by petrography and fifteen were selected for SEM–EDX examination. We explore how changes in the complex history of the settlement and the surrounding landscape are matched in technological choices operated by the community of practice responsible for producing *impasto* pottery at Roca, in a moment when the long-range connection with the Aegean world was at its historical peak.

Keywords Ceramics · Landscape · Petrography · SEM–EDX

Introduction

Mediterranean coastal communities have often shown remarkable resilience over the long term, demonstrating a considerable degree of adaptability in choosing strategies that allowed them to cope with varying social, cultural and environmental conditions. The site of Roca Vecchia (also known in the literature as Rocavecchia or simply as Roca) located on the coast of modern-day south-eastern Italy (Fig. 1, DMS coordinates: 40°17′15.2"N, 18°25′35.9"E) is certainly one of the most important Bronze Age site in the Central Mediterranean, with a very rich and complex history, intertwined with major developments occurring at a Mediterranean-wide scale. Because of this, through time, one of the main *foci* of research at the site has been the analysis of the archaeological material coming from other parts of the Middle Sea and /or deeply inspired by oversees contacts (e.g. Guglielmino 2006; Iacono 2019; Jung et al. 2021). Beyond long-range external connections, Roca was also part of a broad landscape which has only now become accessible to being analysed thanks to the early results of the Roca Archaeological Survey (RAS), the first systematic archaeological survey focusing on the hinterland of the settlement. While it is known that landscape archaeology can provide information on trends of territorial exploitation/occupation, what is less frequently taken into account is that it can also provide crucial information on craft production. It can complement data coming from in-site sequences, on aspects such as location of workshops and/or raw material procurement, thus enriching the general picture of craft production at the site with our understanding of the surrounding landscape.

Within this effort of integrating the data from the site with those from the survey, this paper starts with the

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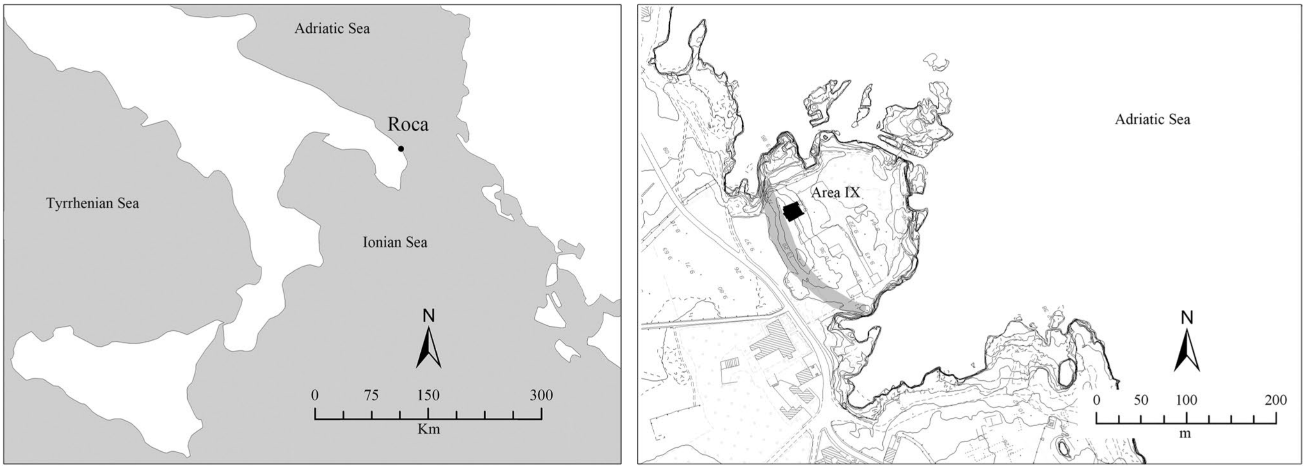

Fig. 1 Maps showing the position of Roca in southern Italy (left) and the archaeological site (right) with the fortifications in grey and Area IX in black discussed in the text. DMS coordinates: 40°17′15.2"N, 18°25′35.9"E. Picture by F. Iacono

examination of the so-called *Impasto* (local handmade pottery), from a well-stratified sequence at the site of Roca. From a ceramic production standpoint, one of the main questions is whether it is possible to identify substantial transformations in the technological choices over the protohistoric phases, through the long-lasting occupation at the site and the material culture changes observed macroscopically, and whether these could be potentially linked to different occupation/exploitation patterns of the surrounding landscape through raw materials selections. In order to reach this last objective, we surveyed the surroundings of the site looking for raw materials and sampled some deposits that could have been used for ceramic production and against which it is possible to compare the archaeological ceramics. Lastly, one of the purposes of this paper is to create a reference for manufacturing choices of ceramic production at the site, to be subsequently compared with the results of the surveyed material. From a long-term perspective, our study aims to reconstruct the *manufacturing landscape* around the site of Roca and whether it could be potentially linked to broader resilience strategies in the area.

The site of Roca and its surroundings in the Middle-Final Bronze Age phases

The life sequence of Roca, reconstructed after the intensive archaeological campaigns over the last 35 years, now offers the privilege of observing phenomena of persistence and adaptation of communities living at the site and/or in the surroundings, at times of change. Through the centuries, the site of Roca has experienced a complex history including violent destructions and rebuilding phases, which strengthen the impression of its crucial role in the early history of the Mediterranean. Such an impression is grounded in the rich monumental architecture, i.e. the fortification wall that has been uncovered in the well-preserved context of its destruction (which included also numerous human remains) and in the substantial traces of long-range connections. The latter have been identified since the earliest phases of the settlement. A considerable increase in such connections is recorded after 1200 BCE when at the site is possible to recognise both many long-range imports from a variety of areas in the Aegean world, and a rich production of local imitations (Guglielmino et al. 2010; Jung et al. 2021). Around 1100 BCE, when the rest of the central Mediterranean show a detachment from the former Mycenaean world, Roca and Salento preserved a degree of relationship with Greece, and particularly with the western Peloponnese (Iacono 2019; Iacono & Guglielmino 2021).

The earliest occupation of Roca dates to an advanced phase of the Protoapennine period (Table 1). Late Middle Bronze Age (=MBA) layers are identified in Area X as well as elsewhere in the settlement, thanks to the impressive destruction level which also obliterated the fortifications of the site. The fire destruction was probably due to a large war-like event, which also killed several individuals whose bones had been recovered in the debris of various areas of the fortification (Scarano 2012). Much of the Recent Bronze Age (=RBA) has been identified in areas X and IX where two stratigraphic sequences have been published (Pagliara et al. 2007, 2008). Area X contained the remains of a workshop for ivory carving (Pagliara et al. 2007), while Area IX yielded the remains of a very large feasting event entailing the participation of hundreds of people (Iacono 2015; Pagliara et al. 2008). Both Area IX and X continued to be occupied in the Final Bronze Age (=FBA), when frequentation at the site was characterised by the presence of large timber structures measuring tens of meters (Iacono

Table 1 Chronological scheme of the Area IX at Roca and correspondence with the Italian and Greek phases and absolute years in BCE (Before Common Era). MBA = Middle Bronze Age, RBA = Recent Bronze Age, FBA = Final Bronze Age, LH = Late Helladic. Table by F. Iacono

Italy	Roca	Greece	Absolute years BCE
MBA 3	Fortifications	LH III A2	1400
RBA 1		LH III B1	
	Area IX (Phase I)	LH III B2	1200
RBA 2	Area IX (Phase II)	LH III C early	
	Area IX (Phase III)		
	Area IX (Phase IV)		
	Area IX (Phase V)	LH III C middle	1150
FBA 1	Area IX (Phase VI)		
		LH III C late	1085
FBA 2	Area IX (Phase VII)	Submycenaean	1070

2019; Pagliara et al. 2007, 2008). Much is known about this phase at the site because deposits dating to the FBA have been sealed by a large fire event, involving much of the site (Maggiulli and Malorgio 2017; Pagliara 2003).

Until very recently, our knowledge of Roca was essentially limited to the settlement alone, with little understanding of its interface with the broader landscape. Thanks to the recent RAS project it has been possible to start to identify the main aspects of the history of the landscape surrounding Roca. The earliest occupation has been located at a certain distance from the main site, in the area surrounding the marshy lagoon to the west of the small peninsula where Roca is located. Here the occupation has been dated to a late Palaeolithic horizon thanks to the recovery of several flint elements (Iacono et al. 2020). The lagoon likely represented a considerable attractor in early prehistory and in later periods, when we start to identify artefacts datable to protohistory all around its margin. Besides these lithics, all the prehistoric material recovered in the survey is pottery, often datable to the Bronze Age. As it happens in surveys, primarily this material is relatively poorly preserved but despite this, some diagnostic elements are available and, at present, suggest that the landscape was occupied approximately during the same period as the site. However, such a consideration is based on a preliminary assessment and the situation is potentially subject to change with the continuation of pottery processing of the RAS.

The coexistence of different manufacturing traditions is one of the main characteristics of pottery production in the archaeology of Bronze Age Southern Italy. This is a feature that has long been recognised by previous research since the 1950s. The interplay between different classes of materials (i.e. those of impasto and Aegean-type pottery) has long been studied (Buxeda i Garrigós et al. 2003; Jones et al. 2014). It has been suggested by mainly Levi (1999; see also Borgna and Levi 2015) that the context of production of the two pottery classes, which was originally somewhat separated, might have ended up having similarities toward the end of the period. This is when impasto pottery of southern Italy started to show a considerable degree of homogeneity, which has been used to argue for an increased level of specialisation. The discussion on the interplay between these different traditions has primarily focused on formal/typological aspects (features borrowed from one class toward the other), rarely discussing potential technological affinities and how these have unfolded through time. In order to further explore these developments of ceramic production based on the macroscopic observation, since the early 2000s some vessels were investigated with the aid of different analytical techniques. Much of the focus, however, has been on Aegean and Aegeanising ceramics (Guglielmino et al. 2010; Jones et al. 2014, 2021; Jung et al 2021) and only a few Impasto ceramics were part of these studies (Guglielmino et al. 2010; Maggiulli and Malorgio 2017). Is it possible to glimpse traces of the emergence and affirmation of dark-on-light pottery realised with the aid of the wheel during the Bronze Age also in the production of standard impasto pottery? The large sample of Aegean-type pottery from South-eastern Italy, together with the large availability of standard impasto wares, seem to suggest that this area is particularly promising for exploring this possibility. Also, specifically, the sample from the well-explored and documented site of Roca can allow us to ascertain whether changes in pottery production were contemporary with major occurrences and hence were potentially part of broader resilience strategies enacted by local Bronze Age communities.

Materials

Chronologically and culturally, the earliest materials sampled from Roca seem to belong to the late Middle Bronze Age. The earliest phase within Recent Bronze Age has been identified in Area (=SAS) IX which offers a detailed picture of the evolution of impasto pottery making in an advanced phase of the Italian Subapennine phase. Indicators frequently found include a more frequent attestation of roll handles (as opposed to strap handles) than in the early Subapennine as well as features that are normally associated with an advanced moment within the Recent Bronze Age, such as grooved decoration, particularly on the carination of carinated cups/bowls (Pagliara et al. 2008: 255, fig.12.12). However, this period is relatively under-studied in Salento and hence any further subdivision within the period needs to be checked out against the possible existence of local developments under-defined by current exploration and research. Moving towards the FBA phases (Site phases VI-VII in Area IX which represents only one of the areas explored for this period at the site) the assemblage incorporates carinated cups with separated necks, sometimes decorated with grooves at the maximum point of carination, together with twisted handles and other features typical of this horizon in southern Apulia. These phases are both present in areas X and IX of the site, which can be linked directly thanks to the widespread destruction layers highly identifiable in both areas.

From a macroscopic standpoint, through the phases of the MBA and RBA, it is possible to notice a considerable variety of fabric types, based on clay selection, surface treatment as well as firing temperature/conditions. A noteworthy variability seems to be recognisable in the earliest phases (MBA) which have been more thoroughly studied, while from the RBA onward, three main sub-groups of pottery fabrics seem to be recognisable and have been categorised into three classes of coarse, semi-fine and fine. While this distinction between these groups is mostly due to surface treatment, there is some positive correlation between this latter aspect and fabric composition, with apparently finer material (in terms of lack of large-sized inclusion) and having a generally better surface finish. Another main aspect emerging in the RBA is also the attestation of well-fired lightly coloured ceramics, arguably based on more calcareous clays. These ceramics appeared at the RBA 2 phase, a period characterised by an intense interaction with the Aegean world where fine dark-on-light ceramics were common. In previous analytical studies, two main fabrics were identified (Levi and Cannavó 2018, 35) probably linked to these two macroscopic groups: one characterised by quartz-feldspars and argillaceous rock fragment (ARF), considered of local production and the other one by micritic calcite and fossils (Guglielmino et al. 2010).

Considering these premises, 68 ceramic individuals were sampled from the main chronological phases (the full list of sampled individuals is available in Iacono and Mentesana 2023): the 8 individuals from the MBA 3 phase come from the Monumental gate and the Postern B, C, D, and already published elsewhere (Scarano 2012); while the 60 individuals from the RBA 1–2 (Site phases I, II, V) and FBA 1–2 (Site phases VI-VII) were sampled from the SAS IX (Table 2). These individuals all belong to the Impasto ware, which could be further divided into two groups. The first one (61/68 individuals) has a black or brown colour core developed throughout the section while the surface might be black, brown, or mottled with red and black areas, usually burnished or smoothed (Fig. 2: a-b); only a few have red section and surface. Some other individuals (7/68) have a buff smoothed surface and dark core (Fig. 2: c). This last one has been identified as different for its appearance and also for the possible addition of shell fragments, some of which were visible to the naked eye.

A campaign of sampling of possible clayey deposits in the area was performed aiming at their characterization and comparison with the ceramics found at Roca. The geology of the area surrounding the site of Roca Vecchia is predominantly characterised by the Salento calcarenites formation (Pliocene–Pleistocene, see Largaiolli et al. 1969) (Fig. 3).

Table 2 Table summarising the number of individuals by phase and area. The full list of samples can be found in Iacono and Mentesana 2023. MBA = Middle Bronze Age, RBA = Recent Bronze Age, FBA = Final Bronze Age. Table by R. Mentesana

Chronological and site phase	Monumental Gate	Postern B	Postern C	Postern D	SAS IX	Total
MBA 3	1	2	3	2		8
RBA 1–2 (I)					10	10
RBA 2 (II)					10	10
RBA 2 (V)					10	10
FBA 1 (VI)					15	15
FBA 2 (VII)					15	15
Total	**1**	**2**	**3**	**2**	**60**	**68**

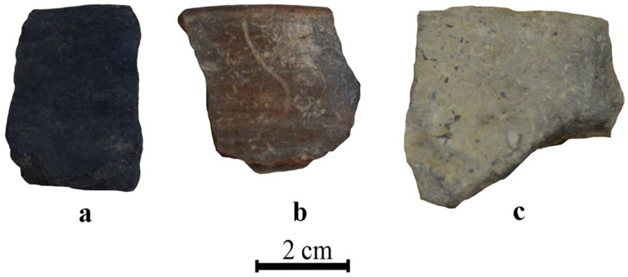

Fig. 2 Pictures of the representative impasto ware sampled: a) RO 19/42 impasto with a black burnished surface; b) RO 19/44 impasto with a brown often mottled surface; c) RO 19/54 impasto with a beige surface. Picture by R. Mentesana

Pliocene deposits go along the coast from Roca to the Alimini lake and are formed by yellow clayey calcarenites, rich of fossils. The deposits formed in the Pleistocene occupy the interior part of the area running along the coast and are composed of very fine marly calcarenites, also rich in fossils, which might be yellow or grey. Along the coast, more recent continental deposits of calcareous grey fine sands can be found, sometimes clayey. The Uggiano la Chiesa formation (Pliocene), which from the area of Meledugno goes south parallel to the coast, is characterised by yellow compact sands alternated with marly fossiliferous calcarenites. A few clayey outcrops can be found within these calcarenites formations, near the modern town of Melendugno to the west, and Borgagne to the south: grey-light blue plastic clays rich in quartz and macro and microfossils which in the upper layer leave the space for yellow clayey sands, with less abundance of macrofossils (Gallipoli formation, Pleistocene). The area of the actual town of Melendugno is characterised by the presence of Miocene formations (Andrano calcarenites) of white/grey calcarenites where clayey deposits might occur (Largaiolli et al. 1969, 25). Therefore, according to the geological maps, the clayey deposits which might be suitable for ceramics-making are very limited around the site, and mainly composed of calcareous sandy deposits rich in

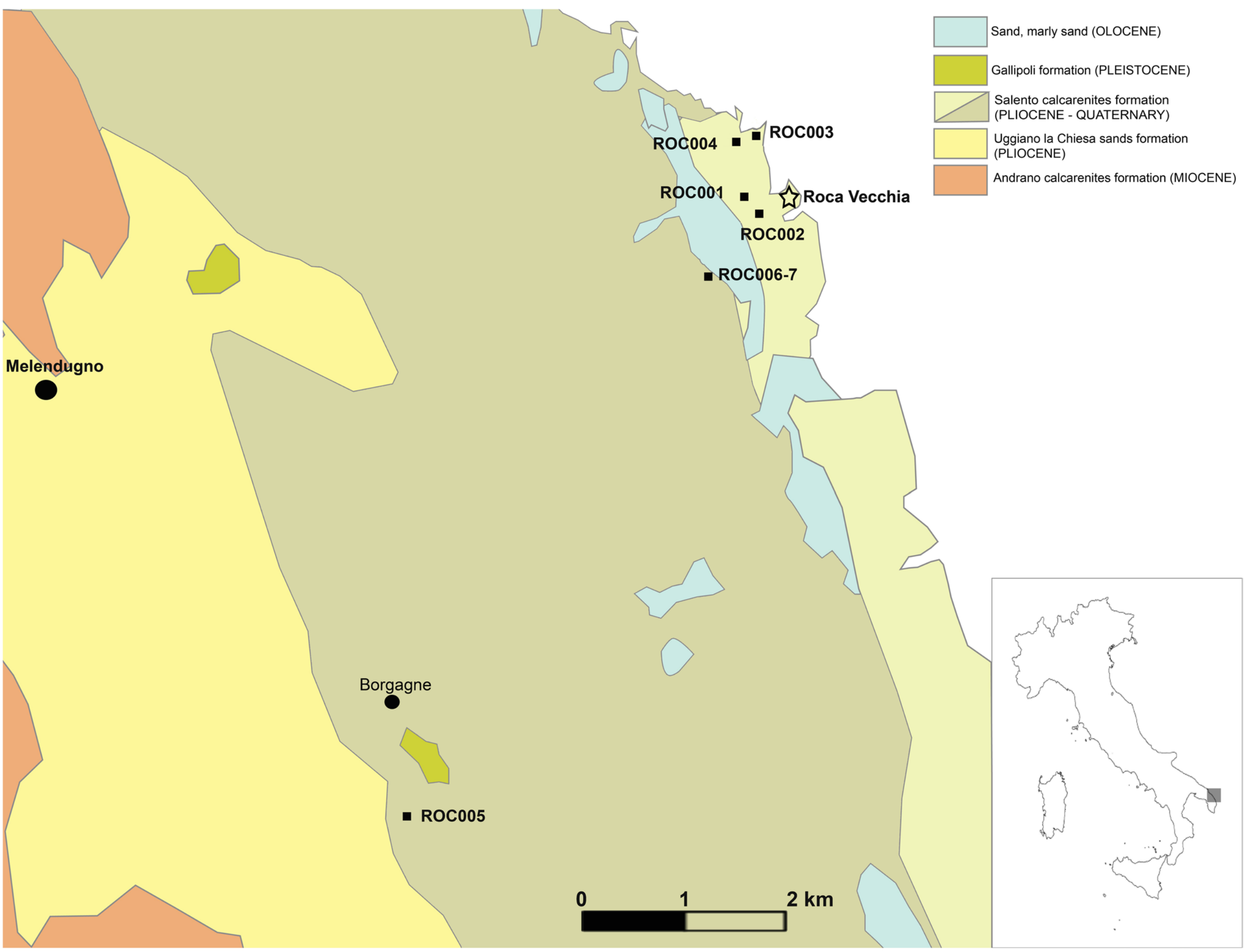

Fig. 3 Simplified geological map with the location of the site and of the soil deposits sampled (modified after Largaioli et al. 1969). Picture by R. Mentesana

macro and microfossils. Our survey near the site allowed us to distinguish seven deposits (ROC001-007, Fig. 3) with enough clay fraction to be manipulated. This matches only in part the geology described (Table 3). Most of the samples come from the area defined as Salento calcarenites formation, while ROC005 was located between this one and the Uggiano la Chiesa formation. The area corresponding to the Gallipoli formation was not identified by our survey. In contrast to what was pointed out in the geological map, colluvial clayey red deposits set into karstic cracks in the limestone plateaux (ROC003-004), typical of the so-called *terra rossa* deposits (Durn 2003; Merino et al. 2006; Vingiani et al. 2018), were identified near the sea. The terra rossa deposits of Salento, locally named *bolo*, have been studied in detail in the past (De Giorgi 1876a, b; Cotecchia and Dell'Anna 1959) often in correlation with the presence of iron-rich nodules, bauxite, potentially used for iron production in antiquity (Giardino 2017).

Methods

Theoretical framework

This paper develops its methodology around two main theoretical concepts, which have practical outcomes: 1) the importance of looking at ceramic technology as a social dimension of past communities; 2) and the role of landscape reconstruction in developing a better understanding of ceramic making and eventually in past perception-appropriation of space. As of the first point, anthropologists and then archaeologists have long recognised that the way objects are made, their technology, is an inherent part of the culture of a community: technology is made of choices and these choices are informed and meaningful of the entire cultural system of a group, rather than expressing only the everyday needs and ecology of a society (Pfaffenberger 1992; Lemonnier 1993; Dobres and Hoffman 1994). As we do not share the same system of values of societies in study, analytical techniques have proven highly beneficial in enabling us to look beyond the superficial aspects of the objects and to more thoroughly investigate those technological choices that are not apparent to the naked eye (Day 1989; Sillar and Tite 2000; Santacreu 2014). Therefore, in this paper ceramics are examined with a well-established analytical protocol (petrographic examination coupled with SEM–EDX observations) proposing the reconstruction of at least two aspects of the manufacturing operational sequence: raw material choices and manipulation and firing procedures. The observation of the continuity and changes of these aspects across phases will inform us about any sharing of manufacturing practices amongst potters (what has been defined as *community of practice*, Lave and Wenger 1991; Wenger 1998); their ways of facing challenging times as in the case of Roca; and the perception, movement, and use of their surrounding landscape. About this last point, some ceramic

Table 3 Soil deposits sampled with the DMS (degrees, minutes, seconds) geographical coordinates, geological information and the recorded colour at dry and fired state. Geographical coordinates have been collected by RM using the GOOGLE My Maps app and correspond to the deposit collection site. Table by R. Mentesana

ID	DMS GEOGRAPHICAL COORDINATES	NOTES	COLOUR (DRY)	COLOUR (FIRED)	LINEAR SHRINKAGE (%)
ROC001	40°17′16.728"N 18°25′17.076"E	Salento calcarenites formation; very sandy and rich in macrofossils	grey	Grey-beige	0
ROC002	40°17′11.076"N 18°25′20.46"E	Terra rossa?; very sandy, found in between a deposit similar to ROC001 and the bedrock	brown	red	5
ROC003	40°17′38.22"N 18°25′20.1"E	Terra rossa from karstic cones on the calcareous plateaux; less sandy than ROC001-2; plastic	orange	grey	2.5
ROC004	40°17′37.104"N 18°25′14.304"E	Terra rossa from karstic cones on the calcareous plateaux; less sandy than ROC001-2; plastic	red	red	10
ROC005	40°13′45.3"N 18°22′46.56"E	Salento calcarenites or Uggiano la Chiesa formation?; less sandy more plastic than ROC001-2	grey	orange	7.5
ROC006	40°16′50.016"N 18°24′59.112"E	Salento calcarenites?; found below ROC007; rich in black rounded inclusions	brown	red	7.5
ROC007	40°16′50.016"N 18°24′59.148"E	Salento calcarenites; found above ROC006; rich in macrofossils	dark grey	orange	0

technology studies often show a conflictual relationship with environmental and landscape approaches, probably due to the slightly deterministic view of the landscape in some past studies, where manufacturing choices were considered somehow constrained by natural resources (e.g. Arnold 1985; Kolb 1988; Matson 1995). While the concept and study of landscape as a social construction have been developing since the 1990s (Criado-Boado 1993; 1999; Ingold 1993; Knapp and Ashmore 1999) only a few research started to entangle landscape within ceramic studies with a social perspective (Tomkins et al. 2004; Michelaki et al. 2015; Mentesana et al. 2018). Following these approaches, in this paper, we advocate the importance of joining the investigation of craftsmanship and landscape. Firstly, the activities of craftspeople contribute to the formation of past cultural landscapes (cf. Perry 2016; Mentesana and Fragnoli 2020). Secondly, landscape reconstruction helps us understanding the choices made by craftspeople, especially in areas such as the Mediterranean, where the landscape radically changed over time (cf. Mentesana et al. 2016). The landscape around the site of Roca was explored and soil samples were taken considering the distance from the site and the changes in the surroundings, such as the presence of the lagoon.

Analytical approach: sample preparation and instrumental conditions

Samples from geological deposits were dried and mechanically dispersed in a wooden mortar to avoid crushing any particles. Samples were subsequently mixed with water and formed into rectangular moulds, dried at room temperature for a week, and then fired at 850 °C (ROC002-007) in oxidizing conditions; ROC001 was fired at 650 °C, due to the high amount of calcium carbonate that this sample could have. The firing regime included a heating rate of 200 °C/h; 1 h at 200 °C to ensure the removal of absorbed water; a soaking time of 1 h at maximum temperature; and finally a cooling phase at 200 °C/h, until room temperature was reached. Linear shrinkage was calculated by comparing the length of the briquette at the wet and fired stage. All the ceramic individuals and the fired geological deposits were analysed by PE. According to the grouping and the optical activity observed by Petrographic examination (PE), 15 ceramic individuals were chosen for further observation under Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM–EDX). The combination of these different techniques allows the study of possible provenance areas, raw material manipulation, possible forming methods, reconstructing firing regimes and surface treatments to some extent.

PE is used to characterise the composition and texture of the paste (Whitbread 1989, 1995; Quinn 2022). The petrographic examination was performed on 30μ-thick thin sections prepared as standard for ceramic analysis and observed on the petrographic microscope Olympus BX43P and the picture taken with the camera Olympus SC50. Petrofabrics are described according to Whitbread's system (Whitbread 1989, 1995).

SEM–EDX was used for the study of the microstructure, considered in terms of vitrification stages (no vitrification = NV, initial vitrification = IV, extensive vitrification = V, total vitrification = TV, Day and Kilikoglou 2001), and a semi-quantitative estimation of the calcium oxide (CaO) content, expressed in terms of low calcareous (< 6% CaO), calcareous (> 6% CaO) or high calcareous (> 20–25% CaO) pastes. These two features were used for estimating firing temperature in terms of equivalent firing temperature (EFT, Roberts 1963; Tite and Maniatis 1975; Tite et al. 1982). SEM observation was performed on fresh cross-section fractures passing through the oro-aboral axis of the body wall coated with a thin carbon film (~ 10 nm) by vacuum evaporation. The observations were made using an FEI QUANTA 200 coupled with a microanalyser EDX: Thermo Ultradry – Pathfinder and photomicrographs were taken at × 1000, × 2000 and × 4000. The observations were performed using an acceleration voltage of 20 kV and a working distance of 10 mm. EDX analyses were performed in at least three different spots of the section (at the core and at the two margins) at a magnification of × 1000 as PE examination showed the presence of a number of inclusions, shells and grog in the pastes, which could alter the analyses. The determined elements were: Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, K_2O, CaO, TiO_2 and Fe_2O_3 (as total Fe), expressed as oxides (%). For each individual, the SEM–EDX observations of the body and the edges close to the surface were compared to identify any significative chemical and microstructural differences that might indicate whether a slip was applied to the body or the burnishing was carried out directly on the body (Tite et al. 1982; Kilikoglou, in Wilson and Day 1994).

Colour differentiation across sections and on the surface was recorded to estimate the atmosphere in the firing structure in the last phase of firing or during the cooling phase (Rice 1987, 333; Rye 1981, 116; Mentesana et al. 2019; Mentesana, in Todaro et al. 2020; Amicone et al. 2020).

Results

Petrographic observations

The petrographic examination of the ceramic individuals led to the distinction of three main fabric groups and four singletons (see Table 4 and the fabric descriptions in the Supplementary material 1 summarised in Table 5). Fabric PROC01 includes 55 individuals from all the phases (MBA 3: 6/8, Phase I: 7/10, Phase II: 8/10, Phase V: 6/10, Phase

VI: 15/15, Phase VII: 13/15). The fabric is characterised by a colluvial deposit rich in quartz and feldspars, with a minor occurrence of other rock fragments such as chert and quartzite (Fig. 4, Mentesana 2024a). A distinctive feature is the presence in most of the samples of ferruginous concentration features, well-rounded or angular, and rich in the same rock fragments of the fabric. In some cases, clay pellets and argillaceous rock fragments can be distinguished from grog, while in others the distinction is very difficult: most of the textural features encountered have the same composition, texture and microstructure of the surrounding fabric creating doubts about their anthropogenic nature. In any case, the presence of grog fragments in some individuals (subgrouped in PROC01b) is clear across phases and its practices cannot be ascribed to a specific period or ceramic type. In most of the cases, the ceramic fragments used as temper are of the same fabric of PROC01, while a few individuals show the addition of grog coming from PROC02 fabric. In terms of provenance, the fabric shares the typical characteristics of the colluvial deposits, such as those known as *terra rossa* formations, or *bolo* as known locally. The fabric is heterogeneous in terms of texture, including well to poorly-packed individuals, and is variable in composition, which led to the hypothesis that different deposits with similar characteristics might have been used. Some of these deposits can be found near the site. The fabric of the soil deposits ROC002, 004–006 match fabric PROC01; among those, ROC005 and especially ROC006 include those ferruginous concentration features seen also in the ceramics (Fig. 5). Based on the published descriptions, this fabric matches that identified for the impasto ceramics in previous studies (Guglielmino et al. 2010; Levi and Cannavó 2018, fabric G6).

Fabric PROC02 is clearly distinguished from the previous one for the dominance of bioclastic limestone and shell fragments; most of the individuals present the addition of grog, similar in composition to fabric PROC01 (grouped in PROC02b, Fig. 6, Mentesana 2024a). This fabric is represented by 5 individuals scattered along the chronological phases considered (MBA 3: 0/8, Phase I: 0/10, Phase II: 0/10, Phase V: 4/10, Phase VI: 0/15, Phase VII: 1/15) and that were already macroscopically distinguished by their light brown surfaces. This fabric matches one of the deposits found near the site, ROC001 (Fig. 5), and therefore can be considered of local production as PROC01. The deposit ROC003 exhibits similar features, even though bioclasts are present in a smaller proportion. This fabric might be similar to that identified in a previous study based on the published description (Levi and Cannavó 2018, fabric S16).

In contrast, the characteristics of the 5 remaining fabrics do not match any of the soil deposits sampled or the local geology. Fabric PROC03 is represented by 3 individuals distributed variably across different phases (MBA 3: 0/8, Phase I: 1/10, Phase II: 1/10, Phase V: 0/10, Phase VI: 0/15, Phase VII: 1/15) and it is characterised by a fine micaceous fabric with the addition of grog (Fig. 7: a, Mentesana 2024a). Although the characteristic of this fabric do not enable us to determine a specific provenance, a similar fabric has been found in North-East Italy (fabric M9, Levi and Cannavó 2018). Fabric PROC04 includes only one sample (RO19/07, MBA 3) and it is characterised by well-rounded fragments of quartz and feldspars and the addition of grog. Fabric PROC04 is similar to fabric PROC01 from which is distinguished for the presence of a pyroclastic rock fragment (Fig. 7: b, Mentesana 2024a), which suggests that this individual may have an exogenous provenance. On the north of Apulia pumices have been encountered in ceramics (Cioni et al. 2000; Levi et al. 2005; Levi and Cannavó 2018, fabric E3), but the pyroclastic fragment in our individual resembles more a scoria than a pumice fragment, leaving the provenance still uncertain. Additionally, the provenance of the individual 19/08 (MBA 3, fabric PROC05) is uncertain: this fabric is characterised by the presence of serpentinite along with other metamorphic rocks, altered basalt and grog (Fig. 7: c, Mentesana 2024a). No suitable matches have been found in published materials and the presence of serpentinite suggests a possible provenance from either the Tyrrhenian coast (areas of modernday Liguria, Tuscany or Calabria) or the Adriatic coast (Croatian-Albanian region), where

Table 4 Contingency table of fabric by phase and possible provenance based on PE. Table by R. Mentesana

Fabric / Chronological phase (site phase)	PROC 01		PROC02		PROC03	PROC04	PROC05	PROC06	PROC07	PROC08	Total
subfabric	a	b	a	b							
MBA 3	5	1				1	1				8
RBA 1-2 (I)	5	2			1			1	1		10
RBA 2 (II)	6	2			1					1	10
RBA 2 (V)	4	2	2	2							10
FBA 1 (VI)	10	5									15
FBA 2 (VII)	9	4		1	1						15
Total	**39**	**16**	**2**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**68**
Suggested provenance	local		local		North Adriatic?	?	?	North/South Adriatic?	North/South Adriatic?	?	

Table 5 Summary of the main features of the fabrics identified. Refer to Supplementary material 1 for abbreviations and detailed descriptions. Table by R. Mentesana

Fabric ID				PROC01	PROC02	PROC03	PROC04	PROC05	PROC06	PROC07	PROC08
Fabric name				Medium-fine fabric with well-rounded quartz and feldspars, ferruginous nodules and grog	Medium-fine paste with quartz, bioclasts and grog	Micaceous fine fabric with grog	Medium-fine fabric with well-rounded quartz and feldspars, grog and a pyroclastic frg	Coarse paste with serpentinite, metaquartzite, and grog	Fine paste with spathic calcite and grog	Fine-medium paste with quartz, feldspars, and chert	Medium paste with basalt and grog
N Individuals				55	5	3	1	1	1	1	1
MICROSTRUCTURE	VOIDS		dominant inclusion_shape	planar/channel voids	planar/channel voids	planar/channel voids	planar/channel voids	planar/channel voids	vesicles	planar/channel voids	planar/channel voids
			dominant inclusion_frequency	50-70% dominant	50-70% dominant	50-70% dominant	50-70% dominant	50-70% dominant	30-50% frequent	50-70% dominant	50-70% dominant
			dominant inclusion_size	micro	micro	meso	meso	micro	micro	meso	meso
			preferred orientation	parallel	parallel	parallel	parallel	none	none	parallel	none
	Inclusions preferred orientation			none	concentric	concentric	concentric	none	none	parallel	none
	Inclusions spacing			double to open	single to double	double to open	single to double	double	single	single	single to double
GROUNDMASS	INCLUSIONS		c:f:v ratio	40:40:20 to 60:20:20	50:30:20	20:60:20	40:40:20	35:60:5	20:70:10	75:5:20	30:40:30
			Grain size distribution	unimodal	unimodal	unimodal	unimodal	bimodal	skewed unimodal	skewed unimodal	unimodal
			Sorting	well sorted	moderately sorted	poorly sorted	moderately sorted	moderately sorted	moderately sorted	poorly sorted	moderately sorted
			Overall Roundness	subrounded	subrounded	subangular	well rounded	subrounded	angular	angular	angular
			Overall Distribution	homogeneous	homogeneous	heterogeneous	homogeneous	homogeneous	homogeneous	homogeneous	homogeneous
			Overall Texture	medium	medium	fine	medium	coarse	fine	medium	medium
			Overall size_max	>2 mm pebbles	0.25-0.5 mm medium sand	0.25-0.5 mm medium sand	1-2 mm very coarse sand	>2 mm pebbles	1-2 mm very coarse sand	1-2 mm very coarse sand	0.5-1 mm coarse sand
			Overall size_min	0.0625-0.125 mm very fine sand	0.0625-0.125 mm very fine sand	0.0625-0.125 mm very fine sand	0.0625-0.125 mm very fine sand	0.5-1 mm coarse sand	0.125-0.25 mm fine sand	0.0625-0.125 mm very fine sand	0.125-0.25 mm fine sand
		Coarse fraction	Predominant to dominant	Monocrystalline quartz	Monocrystalline quartz	Grog	Monocrystalline quartz	Grog	Spathic calcite	Monocrystalline quartz	Grog
			Frequent to common	K-feldspars	PROC01: Bioclasts; PROC02b: Grog, K-feldspars, Plagioclase feldspars	Monocrystalline quartz K-feldspars	K-feldspars Grog	Metaquartzite Serpentinite	Grog K-feldspar Monocrystalline quartz	Chert Metaquartzite	Quartz K-feldspars Basalt Plagioclase feldspars Clinopyroxene Metaquartzite
			Few to very few	Polycrystalline quartz Chert Plagioclase feldspars Opaques nodules PROC01b: Grog	Polycrystalline quartz Clinopyroxene Opaques Amphiboles	Opaques Chert	Plagioclase feldspars Polycrystalline quartz	Chert Basalt Chlorite schist	Polycrystalline quartz	Plagioclase feldspars Grog?	Chert Volcanic glass? Opaques Gneiss frg.? Olivine
			Rare	Clinopyroxene Siltstones Muscovite mica Iron oxides Mica schist rock frag Spathic calcite Bioclastic limestone			Clinopyroxene Iron oxides Pyroclastic rock frg.				
		Fine fraction	Predominant to dominant	Monocrystalline quartz	Monocrystalline quartz Micritic limestone	Muscovite mica	Monocrystalline quartz	Monocrystallyne quartz Plagioclase feldspars	Quartz	Monocrystalline quartz	Monocrystalline quartz Feldspars
			Frequent to common	Feldspars	Feldspars	Monocrystalline quartz	Feldspars	Metaquartzite Chert	Spathic calcite Opaques	Feldspars White mica	White mica
			Few to very few	Chert White mica Epidotes Microfossils (foraminifera)	Muscovite mica Microfossils	Polycrystalline quartz Pyroxene	White mica	Serpentinite Mica	Mica	Clinopyroxene Amphibole	
			Rare								
	MICROMASS		Optical State	active	active to slightly active	active to inactive	active	active	slightly active	slightly active	active
			Homogeneity	homogeneous	homogeneous	heterogeneous	homogeneous	homogeneous	homogeneous	homogeneous	homogeneous
			Section colour	homogeneous to heterogeneous	homogeneous	heterogeneous	homogeneous	homogeneous	homogeneous	heterogeneous	homogeneous
TFC				present	none	none	present	none	none	none	none

ophiolite belts could be found. Fabric PROC06 includes only one sample (19/32, RBA 1-2 Phase I) characterised by the presence of spathic calcite as the dominant aplastic inclusion and grog (Fig. 7: d, Mentesana 2024a). Also in this case, fabric with these characteristics has been found in North-East Italy (S12, Levi and Cannavó 2018), but also in the northern part of nowadays Apulia (Coppa Nevigata, S8, Levi and Cannavó 2018; Recchia and Levi 1999). Fabric PROC07 (19/35, RBA 1-2 Phase I) exhibits large inclusions of chert and grog set in a fine matrix which reminds some fabrics from the North-East of Italy (Fig. 7: e, Mentesana 2024a) (fabric MS3, Levi and Cannavó 2018), even though PROCO7 does not include polycrystalline quartz in the coarse fraction as in the published examples. Chert-rich fabrics are also known to be used in later times on the modern Albanian and Greek coast, such as at Butrint (Fantuzzi 2019), Nikopolis (Moore et al. 2001) and Ithaca (Pentedeka et al. 2014). Lastly, the individual 19/43 (RBA 2 Phase II, PROC08) is characterised by a coarse fabric with basalt and grog (Fig. 7: f, Mentesana 2024a), whose provenance is for now dubious: basalt could be found in Sardinia, Sicily, the Aeolian islands, the North-East of the Italian peninsula and modern days Albania. None of the published examples provides a suitable match for the individual from Roca.

SEM–EDX observations

Individuals from the three main fabrics have been selected for observation with SEM–EDX (Table 6). From fabric PROC01, two individuals for each of the site phases were sampled in order to observe any change through phases (19/3, 6, 34, 41, 42, 55, 59, 71, 75, 78 79), even though the

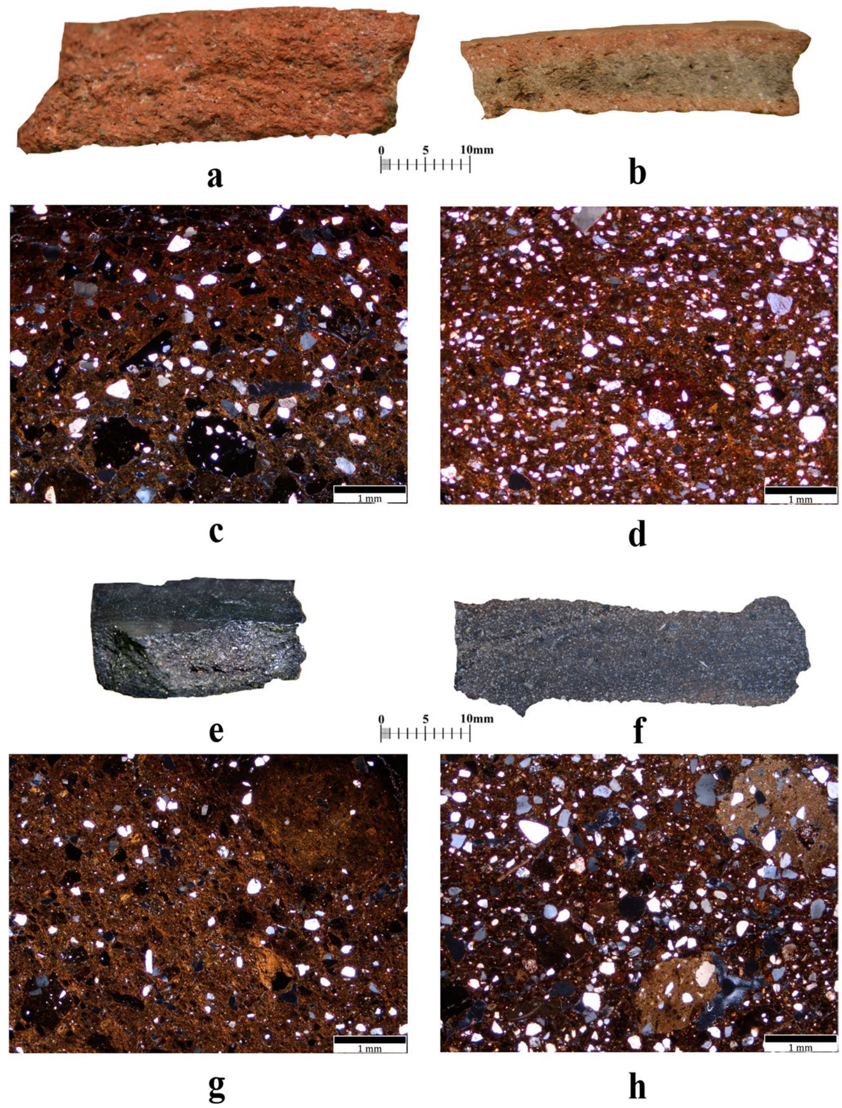

Fig. 4 Photos of the fresh cut section of ceramics and photomicrographs (XP) representing the local fabric PROC01. PROC01a: (a/c) individual RO 19/31; (b/d), individual RO 19/44. PROC01b: (e/g) individual RO 19/79; individual RO 19/58 (f*/h). *saw-cut section. Scale bar on photomicrographs = 1 mm. Further photomicrographs are available in Mentesana 2024a. Picture by R. Mentesana

high optical activity of the micromass observed in most of the individuals through PE already suggested a low firing temperature. All the individuals present a no-vitrified microstructure (NV) all over the section (Fig. 8: a-d, Mentesana 2024b). EDX analyses show that the calcium oxide (CaO) content in these individuals is below the threshold of 6% or around this value; therefore, all the individuals analysed could be considered made with a low calcareous fabric (for EDX results cf. Mentesana 2024b). The paste is also characterised by being iron-rich and tin-rich and common are small inclusions rich in iron and titanium or manganese in some cases (19/42). Individuals 19/39, 42, 55 and 19/79 show some defined area with cellular microstructure and microbloating: these refer to pieces of grog (firing waster?) due to the sharp difference in microstructure between this fragment and the remaining body (Fig. 8: c, Mentesana 2024b). In some cases, the composition of these fragments is also higher in CaO compared to the surrounding matrix, confirming that they belong to a different paste. The surface of all the individuals examined appears very well flattened and with a compact microstructure (Fig. 8: b, d), but no clear difference in chemical composition or microstructure was observed compared to the body (cf. Mentesana 2024b). At the stage of this research, this suggests that in the vessel examined burnishing was performed directly on the vessel body. Most of the individuals examined by SEM, as most of the individuals in this study, have a black surface, which extends to the core of the section or show core-margins colour variations in a few cases; in contrast, individuals 19/6 and 55 have red cores and surfaces (Table 6). These observations allow us to suggest that potters were seeking, and reaching in most cases, a dark surface most probably by creating a reducing atmosphere for at least the last part of the firing or during the soaking time (Rice 1987, 335; Rye 1981, 117; Jones 1986, 763–4). The presence of organic materials in the paste, whose traces are visible by PE, contributed to

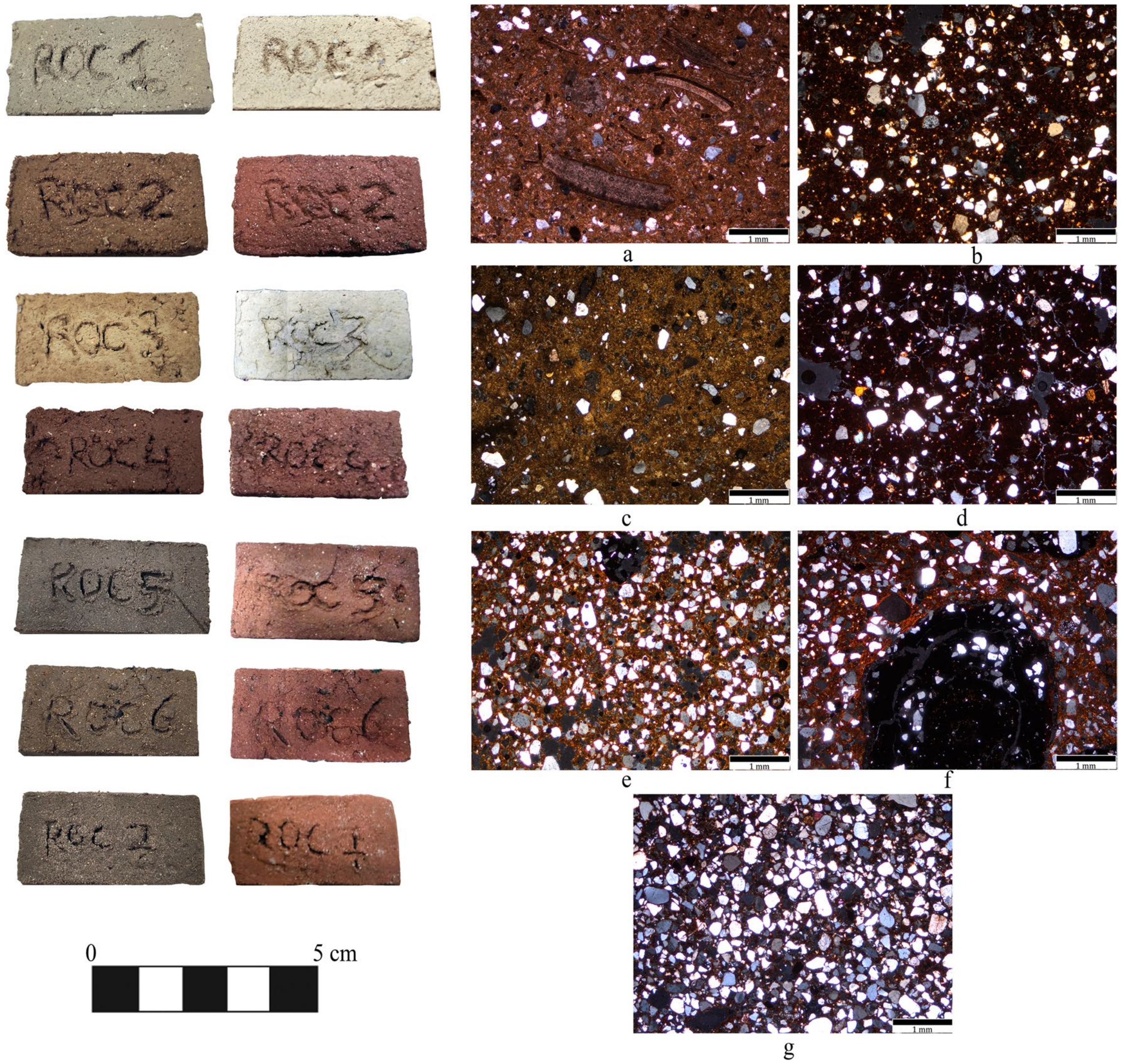

Fig. 5 Left: briquettes from soil deposits sampled (ROC001-007, from top to down) at the dry stage at the left and fired at 650 ºC (ROC001) and 850 ºC (ROC002-007) on the right. Right: photomicrographs of the briquettes, XP, ×25 (a: ROC001, b: ROC002, c: ROC003, d: ROC004, e: ROC005, f: ROC006, g: ROC007). A brief description could be found in the Supplementary material 1. Scale bar in the photomicrographs = 1 mm. Further photomicrographs are available in Mentesana 2024a. Picture by R. Mentesana

the formation of the black colour along the section of the vessels.

In contrast, individuals from PROC02 have a light-coloured surface, usually beige, with a dark or beige core. The presence of numerous shell fragments and the high content of CaO revealed by EDX analyses disturb a proper appreciation of the microstructure. However, SEM examination of the individuals 19/52 and 19/54 show difference in microstructure at the core and margins: 19/52 shows a IV microstructure at the core while at the upper margin the sintering is more developed with the typical microbloating of fast heating procedures; 19/54 show a general NV microstructure with some areas on the margins showing a start of sintering of clay filaments and forming typical microstructure of calcareous pastes at the initial vitrification stage (IV) (Fig. 8: e–f). The surface of both individuals looks flattened, but not finished as individuals from PROC01; no difference in composition or microstructure could be observed between the body and the surface (Mentesana 2024b). A low temperature firing (EFT: ~ 800–850 °C) in an oxidised atmosphere in the last stage of the firing can be suggested as part of the firing procedure. The difference in microstructure between the core and the surface might be due to fast heating firing (Buxeda et al. 2003; Mentesana et al. 2019; Amicone et al. 2021).

Also, the individual 19/33 of fabric PROC03 shows an NV microstructure (Fig. 8: g-h, Mentesana 2024b). The paste resulted in low CaO content and was rich in iron and titanium as individuals from PROC01; compared to other individuals, the paste resulted higher in potassium content,

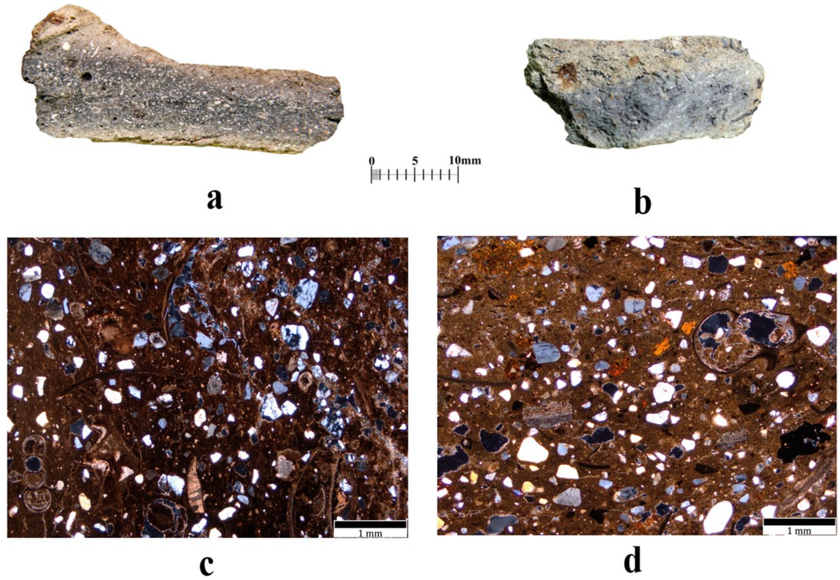

Fig. 6 Photos of the fresh cut section of ceramics and photomicrographs (XP) representing the local fabric PROC02. PROC02a (**a/c**) individual RO 19/51, (**b/d**) individual RO 19/54. Scale bar in the photomicrograph = 1 mm. Further photomicrographs are available in Mentesana 2024a. Picture by R. Mentesana

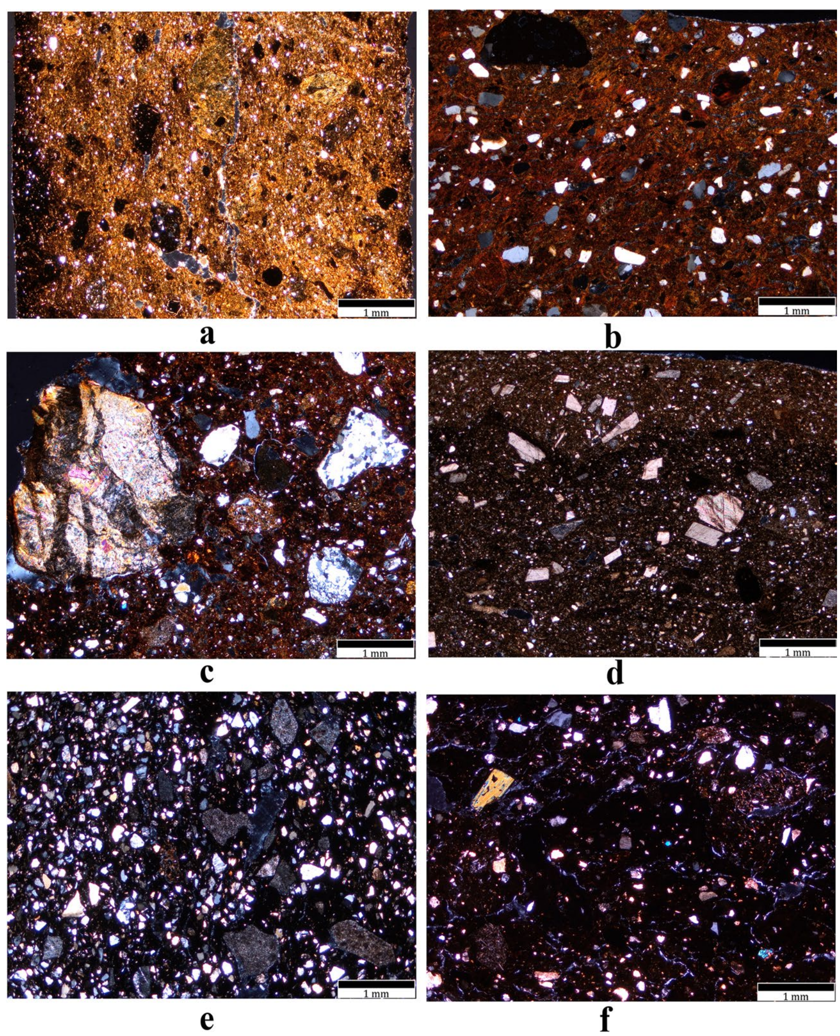

Fig. 7 Photomicrographs (XP) of non-local fabrics. (a) PROC03, individual RO 19/33; (b) PROC04, individual RO 19/07 with the pyroclastic fragment on the top left corner; (c) PROC05, individual RO 19/08; (d) PROC06, individual RO 19/32; (e) PROC07, individual RO 19/35; (f) PROC08, individual RO 19/43 with basalt rock fragments on the bottom left and on the top right corners. Scale bar in the photomicrographs = 1 mm. Further photomicrographs are available in Mentesana 2024a. Picture by R. Mentesana

Table 6 Table of the estimated equivalent firing temperature (EFT in °C) according to the optical activity by PE, the vitrification stages and CaO content by SEM–EDX and the atmosphere estimation by colour recording across the section. NV: no vitrification; IV: initial vitrification; low calc: low calcareous; high calc: high calcareous; ATM: final firing-cooling atmosphere estimation. EDX results are available in Mentesana 2024b. Table by R. Mentesana

Individual		Phase	Fabric	Optical activity	Vitrification Stage	CaO content	Core/margins colour	Surface colour	ATM	EFT
RO19/	3	MBA 3	PROC01	high	NV	low calc	black/brown	black + brown	R	< 750
RO19/	6	MBA 3	PROC01	high	NV	low calc	red/red	red	O	< 800
RO19/	33	RBA 1–2	PROC03	high	NV	low calc	black/black	black	R	< 750
RO19/	34	RBA 1–2	PROC01	high	NV	low calc	black/red	red + black	O-R	< 800
RO19/	39	RBA 1–2	PROC01	moderate	NV	low calc	black/black	black	R	< 750
RO19/	41	RBA 2	PROC01	moderate	NV	low calc	black/black	black	R	< 750
RO19/	42	RBA 2	PROC01	moderate	NV	low calc	black/black	black	R	< 750
RO19/	52	RBA 2	PROC02	moderate	IV/V	high calc	beige/beige	beige	O	~ 850
RO19/	54	RBA 2	PROC02	moderate	NV/IV	high calc	dark grey/beige	beige	O	~ 800
RO19/	55	RBA 2	PROC01	high	NV	low calc	red/red	red	O	< 800
RO19/	59	RBA 2	PROC01	high	NV	low calc	black/black	black + brown	R	< 750
RO19/	71	FBA 1	PROC01	high	NV	low calc	black/black	black	R	< 750
RO19/	75	FBA 1	PROC01	high	NV	low calc	black/black	black	R	< 750
RO19/	78	FBA 2	PROC01	high	NV	low calc	black/black	black	R	< 750
RO19/	79	FBA 2	PROC01	moderate	NV	low calc	black/black	black	R	< 750

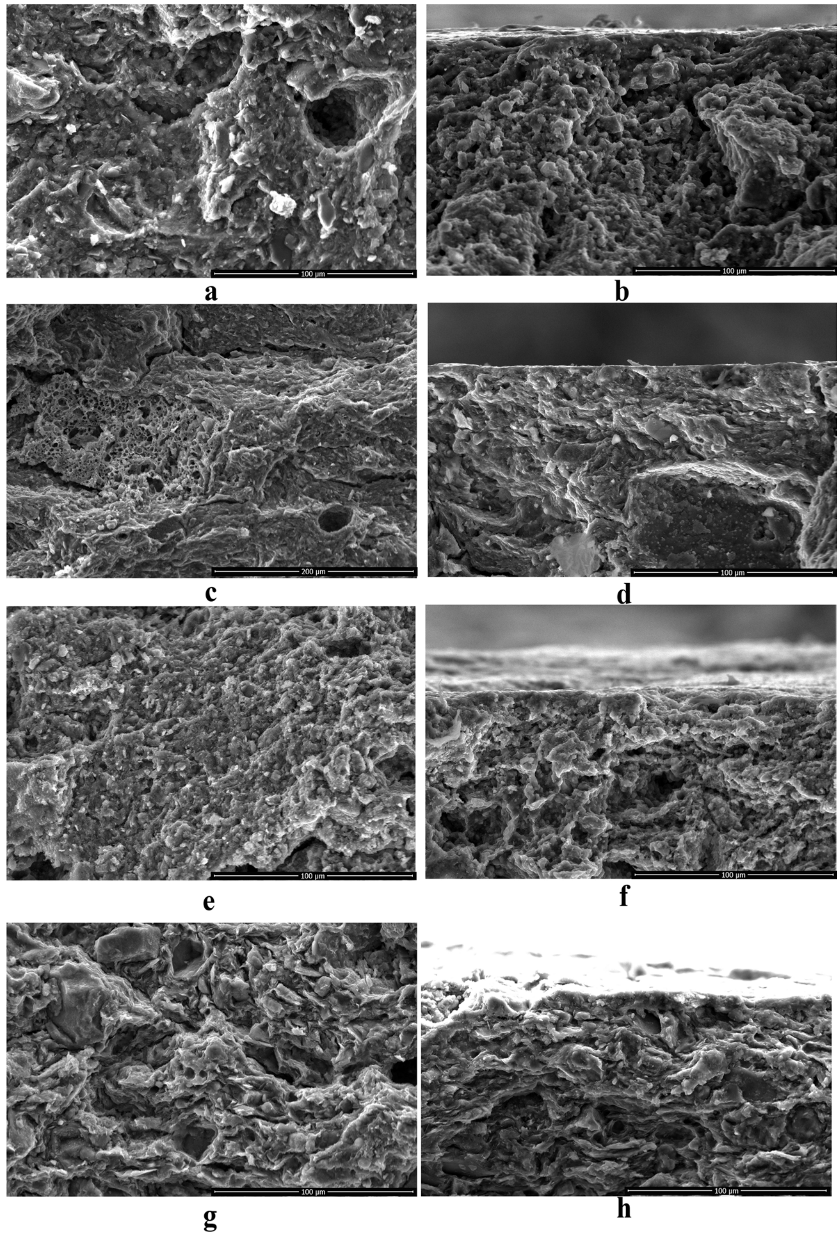

Fig. 8 SEM photomicrographs (SE) of some of the archaeological individuals discussed. Petrographic group PROC01: (a) RO 19/42 core and (b) margin and surface, NV microstructure; (c) RO 19/79 core NV microstructure and grog, (d) margin and surface. Petrographic group PROC02: (e) RO 19/54 core and (f) surface, NV microstructure. Petrographic group PROC03: (g) RO 19/33 core and (h) margin and surface, NV microstructure. Photomicrograph taken at × 2000, except for (c) at × 1000 to observe the difference in microstructure between the grog fragment and the remaining vessel. Further photomicrographs are available in Mentesana 2024b. Picture by R. Mentesana

probably due to the presence of mica in the paste as revealed by PE (Mentesana 2024b). The surface seems well flattened as that observed for individuals of PROC01 and it is chemically similar to the body (Mentesana 2024b). Also for this individual is suggested a low firing temperature in a reducing atmosphere at the last stage of the firing (EFT: < 750 °C).

Discussion

Resilience and the related concepts of sustainability have been at the centre of many archaeological debates over the last few years, in relation to: a) climate and/or other kinds of dramatic dynamics of change (sometimes also labelled as *collapse*) occurring through time and, b) the potential contribution to the emerging sustainability science, aimed at assessing how the relationship between humans and environment unfolded through time (Arthur 2016; D'Alfonso 2023; Lefebvre et al. 2022, Løvschal 2022, Riris and De Souza 2021, Russo & Brainerd 2021). Interestingly, although archaeology's unique relationship with material culture should allow this discipline the ability to address questions about how resilience intertwined with crafts and material production from a deep-time perspective, this field of enquire is notably absent in the archaeological literature. This study is among the firsts (with Caloi and Langhor 2019) to explicitly address this relationship in the archaeological past.

Although previous literature offers limited comparative potential on this theme, the results obtained can be usefully discussed in relation to the existing knowledge about the site. The petrographic examination of the individuals sampled allowed us to distinguish two main fabrics (PROC01-02) which can be considered made with raw material locally available, based on their composition and on the comparison with the collected soil deposits. However, for fabric PROC01 we must consider a wider area of procurement than for PROC02. Soil deposits similar to PROC01 could be found within 1 km (ROC002, 004, 005) as well as 8 km far from the site (ROC006). Given the variability encountered in this fabric and the presence of possible raw materials at at varying distances from the site, the term *local* should be understood in its broader sense. For now, a 10 km radius from the site is considered as the threshold. In contrast, the ceramics made with fabric PROC02 could be made in the immediate vicinity of the site as the best matching soil deposit has been found within a few meters radius (ROC001). The matching with the soil deposit allows us to exclude that shells were intentionally added by the potter. The examination of further material, especially coming from the survey, will aid us in better defining the geography of this manufacturing way of doing.

In terms of chronology, fabric PROC01 is present in all the phases considered, while fabric PROC02 is present from the RBA 2 (Site phase V) phases onwards, although elsewhere this fabric has been also macroscopically identified earlier during the RBA (Area IX Phase I-III). Furthermore, no changes in firing procedures could be observed during these phases. Even though the site of Roca was experiencing some radical changes, there seems a striking continuity in material choices and manufacturing methods for the dark burnished impasto making across phases, something observed in other parts of Italy as well (Bettelli et al. 2018; Levi and Cannavò 2018). Cannavó and Levi reported an increasing use of grog as a temper for *impasto* ware during the Bronze Age (2018, 48–57) especially common in the Terramare and central Adriatic areas. The ceramics from Roca examined here show a similar trend with an increased use from the RBA phases onwards, even considering the issues explained above in distinguishing grog from inclusions with similar optical properties. From the panorama observed in other Italian regions, the materials from Roca differ for the introduction of a light-coloured paste (PROC02 fabric) during the RBA. The types of vessel produced in this fabric do not differ from those made in fabric PROC01 even though the final visual impact was dissimilar. We might suggest that this might have been a way to reproduce light surfaced vessels, as that one on the Aegean style ceramics imported or locally made present at the site. In the final stages of the RBA, the percentage of Aegean-style ceramics is increasing (Guglielmino et al. 2017; Iacono 2019) and it might not be by chance that at this time potters were trying a way to reach a similar visual effect by exploring different raw materials available in the landscape.

The raw materials matching the two fabrics PROC01-02 are macroscopically well distinguishable in the landscape for colour, texture and composition and are being used for the production of pottery with respectively a dark and a light surface. SEM–EDX analyses confirm their difference in terms of chemical composition (PROC01: low calcareous; PROC02: high calcareous), which affects their final properties and visual features. Therefore, to produce these wares potters making ceramics at or near the site of Roca were looking for materials in the landscape with different properties, and in most cases, these were available in the surroundings. The intention to produce differently looking materials is also evident in the firing regimes used: even though all samples resulted low fired, the atmosphere was regulated at the end of the firing to obtain a dark or light surface. In most individuals the core is dark suggesting the presence of organic material in the paste and probably the short duration of the firing (Mentesana et al. 2019; Thér et al. 2019; Amicone et al. 2021). In spite of these differences, these productions were also intrinsically connected: the sharing of the ceramic repertoire, the presence of the pieces of grog fragments of the other fabric, and the low temperature firing regime (even though with different atmospheres) reveal that some of these potters were sharing the same knowledge, way of doing and probably the space of production. Although we cannot specify a precise production location for ceramics of fabric PROC01, we can determine that similar choices were shared across a broad area. If we can assess that the raw material is different, the know-how in terms of their manipulation and the other steps of the manufacturing sequence are similar for the dark burnished and the light-coloured impasto ceramics reinforcing the idea that these potters belonged to the same *community of practice*.

Furthermore, petrographic examination allowed us to identify some ceramics which, although being macroscopically similar to the rest of the ceramics sampled, are composed of certain types of rocks and minerals incompatible with the local geology and therefore are to be considered to be imported (PROC03-08). These individuals are concentrated above all in the early phases of the site and their origin can for now be generically identified in the north of Apulia, in the north Adriatic and possibly on the eastern Adriatic coast (Table 4). This is after all to be expected, given the role of Roca as an entryway to the Adriatic coast through time.

Conclusions

In a recent book, Caloi and Langohr (2019) put together case studies trying to investigate whether a period of profound changes, a *crisis*, affects crafts processes, especially of ceramics, one of the most ubiquitous and abundant archaeological material. The events occurring at Roca between the Middle and the Final Bronze Age phases were surely disruptive to the community (or communities) at the site, and definitely affected the south Adriatic dynamics. Trying to provide an answer to the important question set by Caloi and Langohr was one of the aims of this study with the long-term perspective of reconstructing manufacturing practices not only at Roca but *and* mainly in the surrounding territory. Our study examined a sample of the Impasto ceramics recovered using a well-established analytical protocol (petrographic examination and SEM observations) in order to observe technological change in detail. The result of our study appears to be extremely promising in different ways.

On the one hand, even though our sampling was not extensive, the Impasto ware from the site of Roca was examined systematically for the first time, allowing us to identify two main local productions: one present at the site since the first phase and directed to produce dark burnished vessels, while the other one appearing during the RBA was aimed at producing light-coloured/buff vessels. The identification of a chronological difference between these two productions at the site will be valuable in order to obtain a more fine-grained, fabric-based assessment of poorly preserved survey material of the Roca Archaeological Survey. At a broader historical level, in terms of the relationship between the site and the surrounding landscape, the identification of the potential source of this same fabric in an area that has produced surface material dating to the Bronze Age can provide further confirmation of a trend that has been so far only recognised through the archaeological survey evidence alone: a gradual expansion of the area of activity of the site during the Recent Bronze Age.

On the other hand, this study revealed a strong continuity in the ceramic making at Roca, which was somehow unexpected considering the violent destructions and rebuilding phases together with the different cultural components involved at the site. Although we could not ascribe the production of the dark impasto to one site/location but rather to a broader area, the persistent choice of similar raw materials in the landscape, others being available, and their manipulation (e.g. through the addition of grog), the choice of the low firing reducing atmosphere regimes and surface treatments, speaks out of a continued presence in the territory of these practices and on the high level of sharing of manufacturing procedures amongst communities. Further analytical work, including chemical analyses and the study of the ceramic materials recovered during the survey, will help in increasing the resolution of grouping and comparing this reconstruction with what might have been happening around the site of Roca. Furthermore, it would be beneficial to compare our results with the Aegean style ceramics to observe any possible technological interaction between these productions which for now seems very much distinct. For now, our reconstruction sees that the local communities chose to cling to their way of making ceramics, to *craft their resilience* towards changes and external inputs. By the RBA, we could observe a glimpse of divergence from the manufacturing tradition aiming at the production of light surface vessels. Was the raw material of such vessels the same as Aegean-type pottery but without any process of clay levigation? Only future research with an explicit sampling aimed at comparing these two productions at the site can shed light on this question, allowing us to learn more about the intermingling of pottery traditions at Roca.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12520-024-01991-w.

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Author contributions Conceptualization: R.M and F.I; methodology: R.M.; formal analysis: R.M.; investigation: R.M. and F.I.; resources, R.M. and F.I.; data curation: R.M. and F.I.; writing—original draft preparation: R.M. and F.I.; writing—review and editing: R.M., F.I. and. R.G.; visualization: R.M. and F.I.; supervision: R.M., F. I. and. R.G.; funding acquisition: R.M. and F.I. All authors have read and agreed to the published version of the manuscript.

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Data availability The raw data presented in this study are openly available in the CORA, Research Data Repository of the University of Barcelona: https://doi.org/https://doi.org/10.34810/data981, https://doi.org/https://doi.org/10.34810/data1170, https://doi.org/https://doi.org/10.34810/data11701.

The soil deposit geographic coordinates are openly accessible at this link: https://www.google.com/maps/d/edit?mid=1pJYOW754IAvAfQdcE8RF7aRTJ58ioGY-&usp=sharing

Following the advice by Quinn (2018), thin sections of the archaeological materials and soil deposits are stored at the ARQUB-GRACPE storage unit of the Department of History and Archaeology of the University of Barcelona and upon request can be made available to any researchers as comparative materials.

Declarations

Conflicts of interest The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Competing interests The authors declare no competing interests.

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