Received: 31 March 2021 | Revised: 5 October 2021 | Accepted: 1 December 2021

DOI: 10.1002/gea.21900

RESEARCH ARTICLE

Geoarchaeology An International Journal

WILEY

Sources of geomaterials in the Sicani Mountains during the Early Middle Ages: A case study of Contrada Castro, central western Sicily

Giuseppe Montana[1] | Maurizio Gasparo Morticelli[1] | Giuseppe Bazan[2] | Filippo Pisciotta[3] | Carla Aleo Nero[4] | Pasquale Marino[5] | Angelo Castrorao Barba[6]

[1]Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università degli Studi di Palermo, Palermo, Italy

[2]Dipartimento di Scienze e Tecnologie Biologiche Chimiche e Farmaceutiche (STEBICEF), Università degli Studi di Palermo, Palermo, Italy

[3]Aix-Marseille Université, Marseille, France

[4]Soprintendenza BB.CC.AA. of Palermo, Palermo, Italy

[5]Bona Furtuna LLC, Los Gatos, CA, USA

[6]Escuela de Estudios Árabes (EEA), Consejo Superior de Investigaciones Científicas (CSIC), Granada, Spain

Correspondence

Giuseppe Bazan, Dipartimento di Scienze e Tecnologie Biologiche Chimiche e Farmaceutiche (STEBICEF), Università degli Studi di Palermo, via Archirafi 38, 90123 Palermo, Italy.
Email: giuseppe.bazan@unipa.it

Funding information

Bona Furtuna LLC; Università degli Studi di Palermo

Abstract

From 2017, an unknown rural settlement in Contrada Castro at Corleone (Palermo Province, western Sicily) was investigated as part of the 'Harvesting Memories Project'. The stratigraphic sequence, supported by radiocarbon dating, has demonstrated a reoccupation of a pre-Roman site during the transition between the Byzantine and Islamic periods. In particular, the main occupation occurred in the late 8th–9th century when pottery kilns and a probable warehouse were constructed. During the 10th–11th century, a new structure with different orientations replaced the previous buildings that had already collapsed. Specifically focusing on a perspective of the household production and its relationship to the surrounding landscapes of this site, this paper presents the results of a geological survey and petrographic analysis of ceramic finds and lithic samples to identify the source area of the geomaterials used in the studied settlement. The ceramic finds were divided into different Paste Groups based on the characteristics of a polarizing microscope study. The use of some locally available raw materials was recorded both for ceramic and lithic samples. Such an approach enables us to better understand ceramic craft technology, clay and lithic procurement strategies and, more broadly, the consumption of household pottery in the Early Medieval site in Contrada Castro. Furthermore, this study verifies the close relationship that this rural settlement had with the surrounding resources in the area and reveals a connection with the city of Palermo during the Early Middle Ages.

KEYWORDS

archaeometry, geomaterials sourcing, landscape, Medieval archaeology, polarized light microscopy, pottery | Sicily

Scientific editing by Kevin Walsh.

1 | INTRODUCTION

In recent decades, interest in the archaeology of early medieval Sicily, which includes the Byzantine and Islamic periods (6th–11th century, AD), has grown considerably (Ardizzone & Nef, 2014; Molinari, 2016; Nef & Prigent, 2010). Specifically, owing to an increase in the knowledge of the chronological indicators in early medieval pottery in Sicily (Arcifa, 2010; Sacco, 2020), a better comprehension of the evidence for this period is possible. Archaeological surveys and new excavations have lent a new impetus to the debate. However, the period between the end of the 7th and 9th centuries remains the least known from an archaeological perspective for rural and urban areas. Specifically, in the rural world, little evidence of Byzantine and/or Islamic settlements exists. Examples of these include the Byzantine castrum of Monte Kassar (Carver et al., 2019; Vassallo et al., 2015), the Byzantine village of Rocchicella di Mineo (Arcifa, 2016), a rural site with Byzantine and Islamic phases of Colmitella in the province of Agrigento (Rizzo, 2014) and the Islamic fortified granary of Pizzo Monaco (Rotolo & Martín Civantos, 2013). Byzantine and Islamic structures, which showed long-term occupation (Castrorao Barba, 2016), have been found more frequently within Roman sites, such as the village of the Islamic and Norman period built on the site of the late antique Villa del Casale at Piazza Armerina in the territory of Enna (Pensabene & Bonanno, 2008), in the large villages along the roadside including Casale San Pietro in Castronovo di Sicilia (Carver et al., 2019; Castrorao Barba, 2015) and in Sofiana/Philosophiana (Vaccaro, 2017).

The discovery of new late Byzantine and rural Islamic sites in Contrada Castro (Corleone, Palermo) (Figure 1) is an important opportunity to gain knowledge about this 'dark age' in the history of the Sicilian countryside (Castrorao Barba et al., 2018, 2020). As a part of the 'Harvesting Memories: Ecology and Archaeology of Monti Sicani landscapes (central-western Sicily)' project, the investigations into the Contrada Castro site have identified an occupation sequence during the period between the 7th and 11th centuries, which were well supported by radiocarbon dating (Castrorao Barba et al., 2017).

The essential elements for reconstructing the 'material culture' of ancient rural communities include assessing technological expertise, trading circuits and cultural influences (Tite, 2008). This can be achieved by laboratory-based compositional characterization of the artefacts in the form of geomaterials in their natural state or after a transformation by pyrotechnology (i.e., ceramics), as well as by identifying raw material-supplying areas. By identifying pottery kilns related to the period of the late 8th–9th century, the relationship between Contrada Castro and the surrounding geomaterials, as well as the connectivity with other far areas, can be established. In this case study, provenance determination of archaeological samples was supported by a database concerning all the clayey materials traditionally destined for ceramic production in western and central Sicily (Montana, Cau, et al., 2011).

The archaeometric work involved a geological survey with sampling of the potential clayey raw materials in the area surrounding the site of Contrada Castro and laboratory-based petrographic analyses of the collected samples. The petrographic analyses using thin-section observations by polarized light microscopy focused on two macro-groups of materials: ceramics and stones. Ceramics are associated with pottery wares, tiles and kiln wasters, while stones are related to stone trays/plates (so-called 'testi in pietra') and building

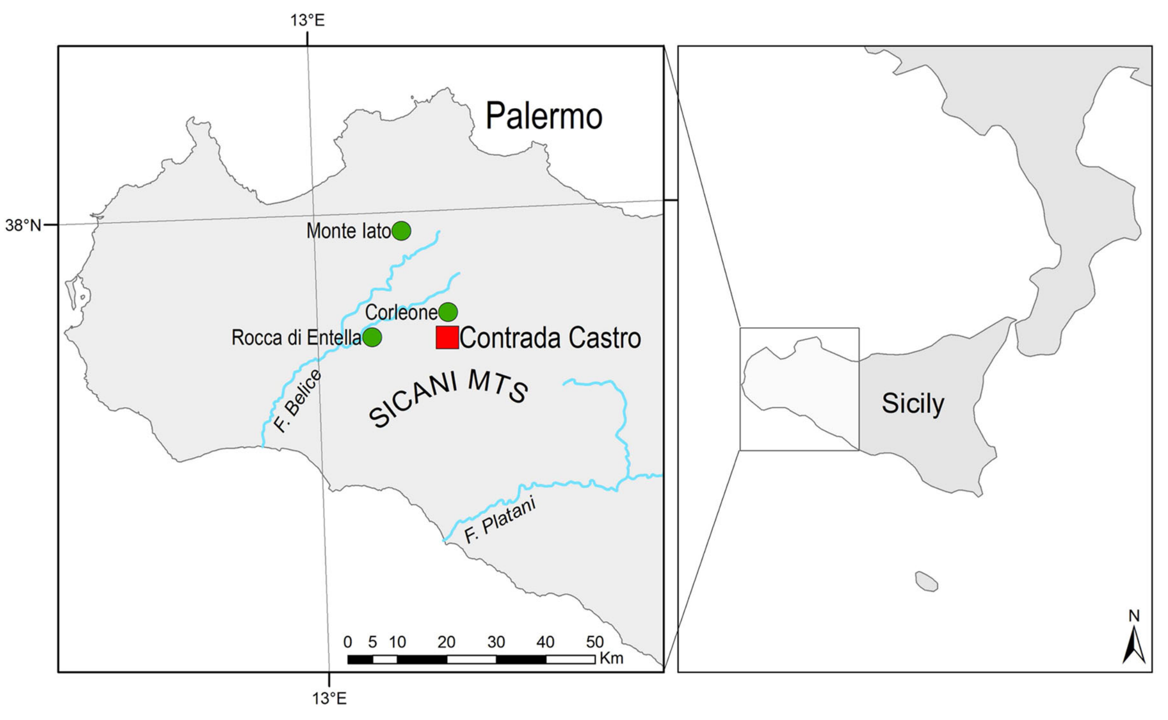

FIGURE 1 Case study area, central western Sicily (Corleone, Palermo) [Color figure can be viewed at wileyonlinelibrary.com]

materials. The identification of the supply areas of raw materials and the reconstruction of a micro-regional network of exchange, mainly from the city of Palermo to the inland and back, are expected to improve our knowledge of the rural society in post-Roman Sicily during the complex occupation period transition from the Byzantines to the Muslims.

2 | ARCHAEOLOGICAL BACKGROUND

The site of Contrada Castro covers an area of approximately 0.54 ha over a flat, raised, east–west-oriented plateau (Figure 2). In the north, it is adjacent to a sinkhole that separates it from the steep slopes of Pizzo Castro/Rocche of Mezzogiorno. Meanwhile, in the south, a nearly vertical slope exists towards the valley of the Giardinello torrent. The site is more accessible from the west via a path and from the east via a recently constructed dirt road. The site occupies a defendable and strategic position while being directly connected with the underlying valleys that are potentially exploitable for agriculture and crossed by possible road axes in this sector of the Sicani Mountains. This plateau is occupied by the remains of interconnected enclosures with 1-m-high dry walls, which were used for transhumant herding activities and were constructed under dry conditions using square blocks of various sizes.

The first excavation area was opened in the southeastern part of the plateau (Castrorao Barba et al., 2018, 2020) during 2017, 2018 and partially in 2019. According to the current research (summer 2019), the more ancient evidence of the site's occupation dates back to the late archaic/classical period (6th–5th c. B.C.). This is supported by a residual material and a collapsed squared/rectangular building, which have not yet been fully investigated. According to the current survey and excavation data, the site was reoccupied in the Byzantine period after a long hiatus. The only evidence above the classical period layers comprises two perinatal burials. The death of these individuals occurred at a gestational age of 40 ± 2 weeks, estimated according to the regression formulas of Scheuer et al. (1980). Based on a radiocarbon analysis (Castrorao Barba et al., 2018) of bone samples, the deaths of these individuals date back to the late 7th to early 8th c. AD (at confidence levels of 1-sigma [65%] AD 662 to AD 778, or 2-sigma [95%] AD 620 to AD 906). This chronology is confirmed by the discovery of a roof tile decorated with stamped striations that are typical of the Byzantine period in Sicily (e.g., Arcifa, 2010, pp. 108–111) on the surface of the layer where the burial area is cut.

FIGURE 2 Hill-top plateau of the early medieval settlement of Contrada Castro (Corleone, western Sicily) [Color figure can be viewed at wileyonlinelibrary.com]

The main occupation of this site can be articulated into two different periods: period A (late 8th–9th c. AD); period B (10th–11th c. AD).

2.1 | Period A (late 8th–9th c. AD)

A squared 5 × 5 m building was constructed in this area not much later than the indicated period (probably in the second half of the 8th c. AD), thereby representing Phase A1. This building is partially sunken, cutting into the bedrock in the south and in an earlier layer to the west (i.e., the earlier layer was cut by the construction of this building during a later phase), while the entrance to the building is located on the east side through a sloping ramp. The building was likely not entirely covered in the first phase, containing only a partial roof made of tiles. However, inside of the house, craft activities related to pottery and tile production took place. In fact, on the south side of the building, the remains of two circular kilns are connected to burnished layers and a large number of productive wasters (Figure 3). In particular, both kiln and ceramic wasters have been found (Figure 3 (1)) such as amorphous fragments featuring a purplish/greyish colouration, a bulgy surface and a bloated texture belong most likely belonging to the clay's structural features of the oven (either the floors/walls of the chamber or the kiln's dome); a whole stack of deformed pottery (most probably combed tiles), also, in this case, the purplish surface, burnt core and bloated clay body, point towards a failure in the firing process that caused the artefacts to collapse and fuse.

The first kiln was abandoned early on, while the second one was well preserved and was built nearby and had a circular stone structure. Directly in front of the kiln mouth, the soil was strongly reddened by thick ash layers filled with charcoal derived from combustion processes. One of the charcoals, a fragment from a small shrub of *Pistacia*, was dated using a radiocarbon analysis (Castrorao Barba et al., 2020), which confirmed that the building was used between the second half of the 8th and 9th centuries (reported 1-sigma [65%] accuracy age of AD 774 to AD 878; 2-sigma [95%] AD 762 to AD 900). The inner parts of the firing chamber and dome were probably made from yellow clay that was also used to create a curb-like structure around a stone-made pilaster that supports a possible cooking floor. These structures look much simpler than the other examples found in Sofiana/*Philosophiana* in Central-Eastern Sicily (Vaccaro & La Torre, 2015), and they were dated to the late 8th and 9th c. AD. Evidence for a possible cooking floor has not been found because the building was transformed during the second phase (Phase A2): the western entrance was closed, restorations were

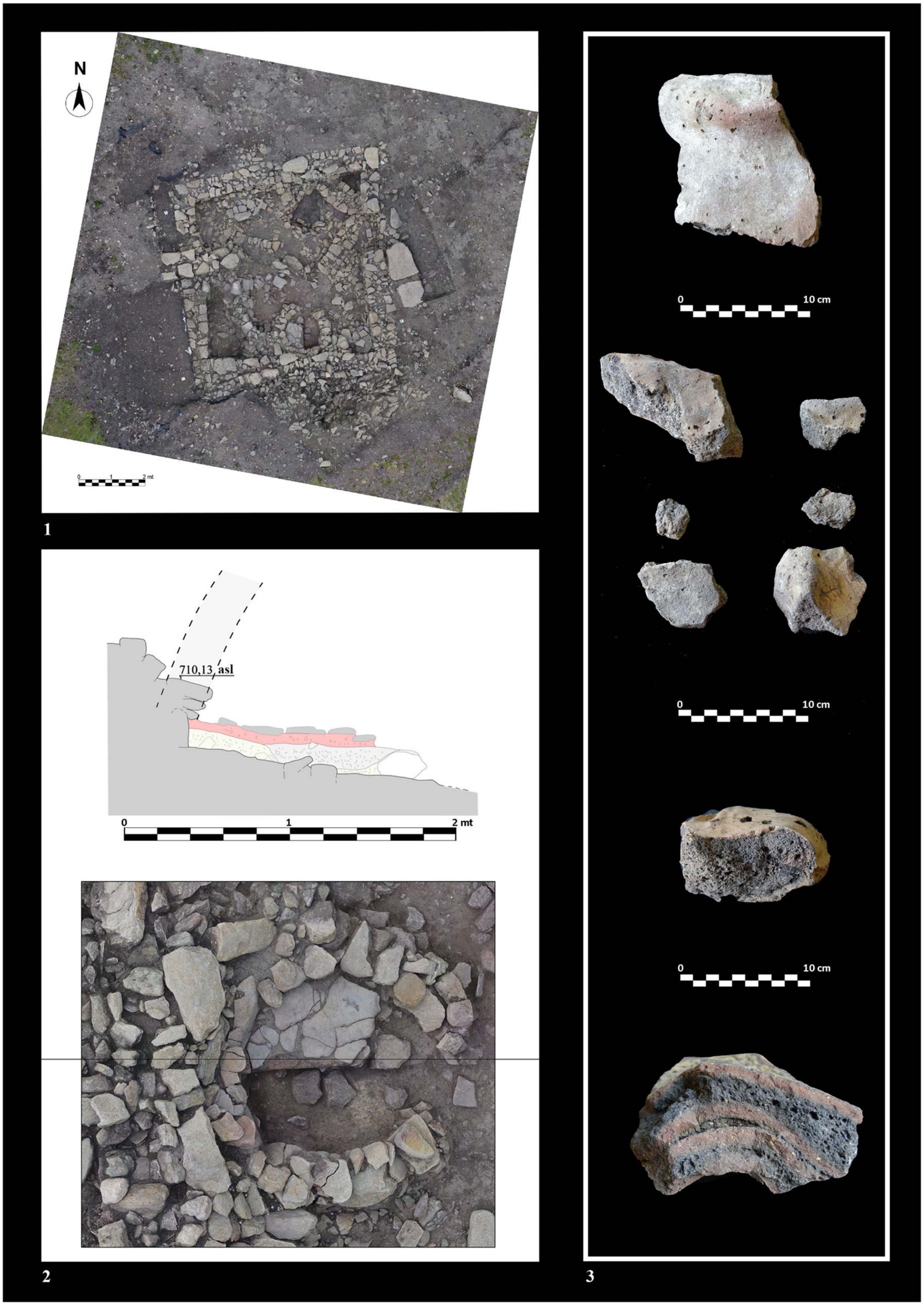

FIGURE 3 (1) Orthophotograph of the early medieval building with the two kilns. (2) Profile and characteristics of the fire chamber of the pottery kiln. (3) Kiln and ceramic wasters [Color figure can be viewed at wileyonlinelibrary.com]

identified along the eastern walls, a new earth floor covered the disused south-east kiln, the other kiln was converted into a cooking oven (possibly for bread) and a hearth base was added in the northern part. This building completely collapsed, as confirmed by a thick stone layer (Phase A3). A radiocarbon analysis (Castrorao Barba et al., 2020) performed on an animal bone found in this layer indicates a 9th-century date for the collapse (age at 1-sigma, 65% accuracy, of AD 800 to AD 878; age at 2-sigma, 95% accuracy, of AD 766 to AD 897).

2.2 | Period B (10th–11th c. AD)

Layers containing abundant sherds of pottery and animal bones probably indicate the collapse of this building and a transition to a new occupation period, which is related to another building with a completely different orientation compared to the previous one. This building was found preserved in a single foundation row, which was presumably made during two different periods.

The structures of this building and the activity layers of this period are poorly preserved and heavily damaged by postabandonment spoliations and agricultural activities. In fact, a stone layer found below the dark layer (containing most of the ceramic finds) immediately under the topsoil surface resulted from the spoliation and levelling of medieval structures after the abandonment of the site. Among the many animal bones from this stone layer, the ones of particular interest were the skeletal elements of a donkey that were radiocarbon dated to 10th–11th c. AD (1-sigma [65%] accuracy AD 965 to AD 1042; 2-sigma [95%] accuracy AD 890 to AD 1159; Castrorao Barba et al., 2018).

3 | LANDSCAPE AND GEOLOGICAL FRAMEWORK

The site of Contrada Castro, as already detailed in Section 1, lies in the territory of the Sicani Mountains in central western Sicily, which extends from the Belice River to the west and the Platani River to the east (Figure 1). Among the most important reliefs are Monte Cammarata (1546 m above sea level—a.s.l.), Monte Delle Rose (1436 m a.s.l.), Monte Barraù (1420 m a.s.l.) and Rocca Busambra (1613 m a.s.l.). The latter represents the highest ridge and the northern boundary of the Sicanian territory.

The study area represents the central western sector of the Sicilian chain where the orogeny comprises a stack of Meso-Cenozoic carbonate tectonic units, superimposed since the Middle Miocene along the southernward overthrust (Gasparo Morticelli et al., 2015). The formed tectonic wedge was covered during its development by silico-carbonate terrigenous deposits representing the rock outcrop 5 km away from the study area of Contrada Castro (Figure 4). In this sector, the tectonic units are locally exhumed in the Rocca Busambra ridge in the north and in the Monte Barraù in the southeast. The exhumation of the tectonic units was caused by reverse high-angle faults that deformed the terrigenous successions, producing the juxtaposition of the different outcropping rocks. In detail, the Oligo-Miocene sedimentary covers were divided into lithostratigraphic units superimposed on top of each other and differentiated lithologically (Di Stefano et al., 2013) to form a bottom-up sequence in the study area (Figure 5).

The Marne di Cardellia Formation (RDE segment in Figures 4 and 5) is composed of marl, sandy marl and brown and green clays with glauconite (RDEa segment) and turbiditic layers (with the thickness of up to 2 m), which consist of calcarenites with benthic foraminifera (Lepidocyclinides; RDEc segment). The overall thickness varies between 60 and 100 m (Late Oligocene–Early Miocene). This stratigraphic unit crops out between Monte Barracù and Monte Cardellia and is widespread in the Corleone region to the south of Rocche di Rao-Pizzo Nicolosi, where they are found at the core of the anticlines. The lithosomes that crop out at the Contrada Castro belong to this lithological formation.

The Calcareniti di Corleone Formation (CCR segment in Figures 4 and 5) is composed of glauconitic and bioclastic calcarenites, calcareous sandstones and green silty marls, with a thickness between 30 and 80 m (Early Miocene). The thickness of the formation increases near Corleone, which is accommodated by the relief. In this region, the tabular outcrops of this stratigraphic unit (Montagna Vecchia and Cozzo San Giovanni) are locally displaced by high-angle faults or involved in plicative deformation.

The Marne di San Cipirello Formation (CIP segment in Figure 4) is composed of grey–blue clayey and sandy marl with planktonic foraminifera having rare intercalations of sandstone (Middle–Late Miocene). This stratigraphic unit crops out in the northwestern part of the study area. A preserved stratigraphic unit comprising 180-m-thick grey clayey marl is found at 1 km on the road 'SP 47' in the direction from the town of Corleone to the town of Roccamena.

The Castellana Sicula Formation (SIC segment in Figure 4) is composed of grey–blue clays and yellowish, sometimes well-cemented, sandy pelites containing benthic and rare planktonic foraminifers that are intercalated with sandstone and quartz–micaceous sands. The thickness of the layer reaches 250 m (Middle–Late Miocene). The main outcropping area of this stratigraphic unit is located in the westernmost sector of the study area (Figure 4), particularly along the NNE–SSW-oriented sector between the San Giovanni district to the east and Cozzo Saraceno to the west. The arenitic lithofacies is represented by centimetre-to-metre-sized beds of quartz sandstones derived from the erosion of the older Numidian Flysch quartz arenites.

The Terravecchia Formation (TRV segment in Figure 4) includes coarse yellow sandstones and continental reddish conglomerates that are followed upward by turbiditic sandstone, sandy pelites and silty clays, reaching a thickness of up to 600 m (Late Miocene). This stratigraphic unit crops out in the westernmost sector of the study area between the Cozzo Ridocco and Madonna delle Vigne.

From this lithological framework, it follows that, as far as raw materials for ceramic use are concerned, up to four different formations are available as potential clay sources with reasonable proximity to the Contrada Castro site (i.e., Marne di Cardellia, Marne di San Cipirello, Castellana Sicula and Terravecchia Formations). With regard to building stone, lithosomes suitable for such use (i.e., calcarenites) are available

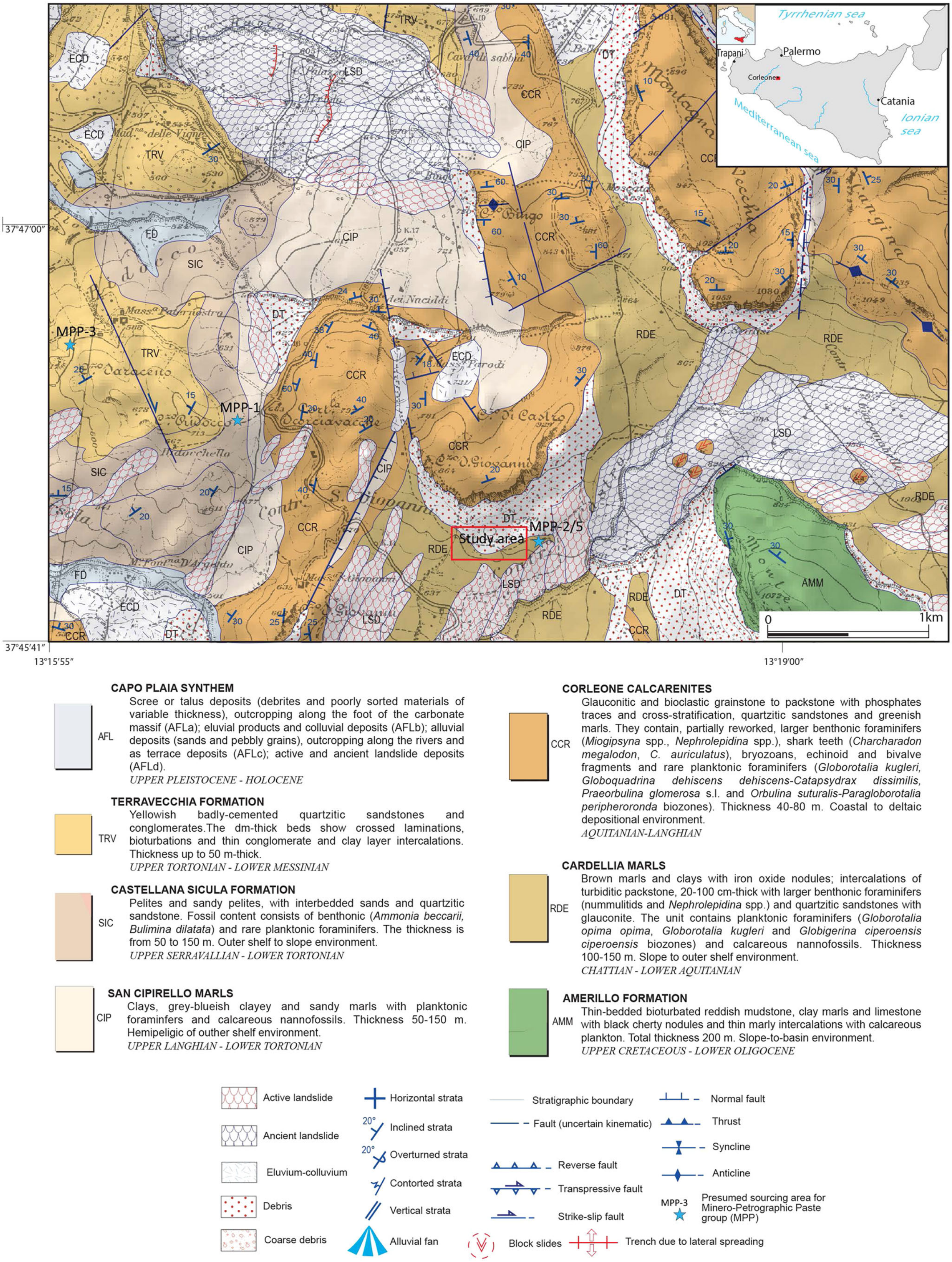

FIGURE 4 Regional geological map showing the main formation outcropping around the Contrada Castro (modified from Basilone et al., 2010; Di Stefano et al., 2013) [Color figure can be viewed at wileyonlinelibrary.com]

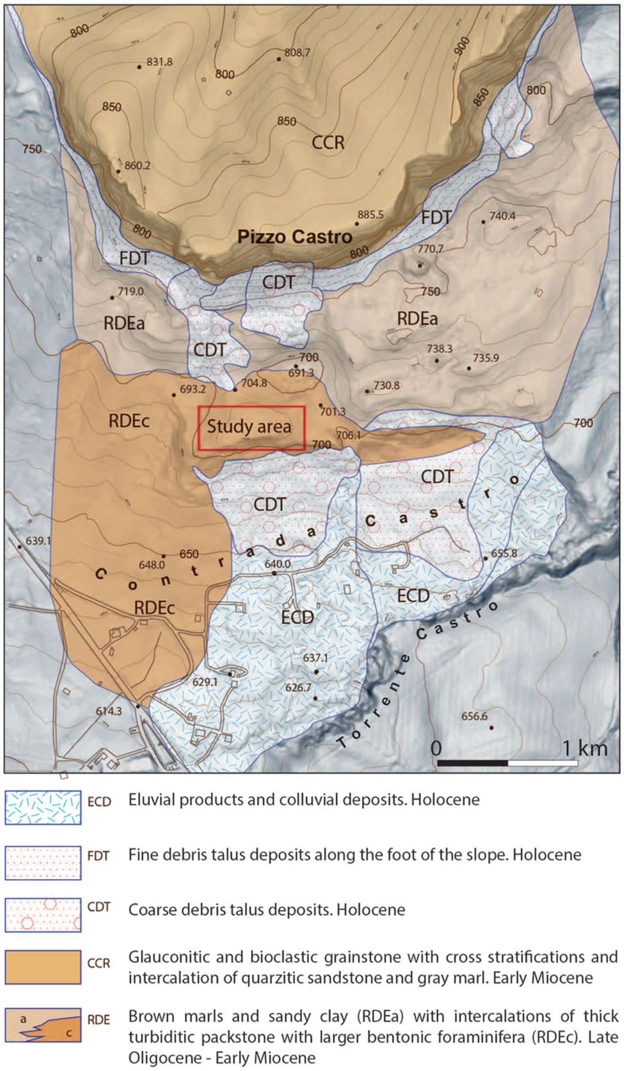

FIGURE 5 Geological map of the Contrada Castro area with details on the lithologies outcropping in the study area and in the immediate surroundings [Color figure can be viewed at wileyonlinelibrary.com]

within the Marne di Cardellia and Calcareniti di Corleone Formations widely outcropping around the study area.

The landscape fully reflects the above-described lithostratigraphic characteristics, characterized by two highly contrasting types of relief. Carbonate rock ridges emerge sporadically from a series of low-elevated clayey hills. Carbonate relief shapes are of different scales unlike the clayey hills. However, they often have asymmetrical profiles with moderately inclined stony and compact slopes and are bordered by debris layers. In some cases, they have summit plains surrounded by cliffs from which the local name 'Rocche' (fortress in Italian) was derived. These different geomorphological features (e.g., valleys or high-relief structures) are associated with different climatic characteristics. The mean annual temperatures range between 13.4°C (Piano del Leone weather station, 831 m a.s.l.) and 16.8°C (Bivona weather station, 503 m a.s.l.), and the mean annual precipitation varies from 826.7 mm (Piano del Leone weather station) to 612.2 mm (Lercara Friddi weather station, 658 m a.s.l.), with the maximum rainfall in December and January. Winter rainfall and the different permeability of limestone with respect to clays have contributed to the formation of several freshwater springs, which have played a crucial role in both human activities and biodiversity, hosting a very peculiar and rare flora, especially in the close Ficuzza Nature Reserve (Troia et al., 2012). In fact, despite long-term exploitation, the area still maintains a high level of plant diversity and a well-preserved rural landscape (Bazan et al., 2019; Bazan, Castrorao Barba, et al., 2020; Bazan, Speciale, et al., 2020; Gianguzzi & Bazan, 2019, 2020).

4 | MATERIALS AND METHODS

The sample objects of this study (29 samples) are mostly representative of period 3 and, to a lesser extent, period 4 of the Contrada Castro settlement (Table 1). They were selected for the purpose of representing the different categories of local natural and transformed geomaterials: ceramic kiln waste (4 samples), tiles (10 samples), daily use pottery (8 samples), raw clay (2 samples), bread baking stone plate (2 samples) and stone ashlars (3 samples). All the collected samples were subjected to petrographic analysis by optical microscopy using transmitted polarized light (section thickness of 0.03 mm) to define their textural and compositional characteristics and identify the corresponding raw material.

The assessment of textural and mineralogical similarities or differences between specific geomaterials (i.e., raw clays) and artefacts may allow compositional groups and productive contexts to be established and allow archaeologists to make historical and socioeconomic inferences (Montana, 2020 and references therein). Specifically, in the case of ceramic artefacts, thin-section microscopy can significantly contribute to establishing a production chain, distribution and use, as well as to infer the technical skills and even the social levels of the involved cultures (Quinn, 2013). For these purposes, the quantification of monomineralic grains and lithic fragments constituting the aplastic components of the ceramic paste highlights several diagnostic parameters that allow the correct provenance identification.

Thin-section petrography was performed using a Leica DC 200 polarizing microscope equipped with a digital camera. The relative abundances (modal mineralogy expressed in area percentage, %) of aplastic inclusions were determined using comparative tables (Matthew, 1991; Van der Plas & Tobi, 1965).

5 | RESULTS

All the ceramic samples, regardless of their intended use, were characterized by petrographic observations based on compositional and textural characteristics. Based on the obtained petrographic data, they were divided into four different paste groups according to the nature, abundance and size of minerals and lithic fragments composing the aplastic inclusions. With the aim of recognizing local productions and distinguishing them from

TABLE 1 List of the analysed materials

ID sample	Stratigraphic units	Type	Period/ phase	Chronology (AD)	Minero-petrographic paste group	Provenance
CST-1	US 37	Tile (production waste)	A3	9th	MPP-1	Local production
CST-2	US 51	Pottery (production waste)	A1	Late 8th–9th	MPP-1	Local production
CST-3	US 37	Tile (production waste)	A3	9th	MPP-1	Local production)
CST-4	US 40	Tile (production waste)	A2	9th	MPP-1	Local production
CST-5	US 52	Tile	A1	Late 8th–9th	MPP-2	Local production
CST-6	US 37	Tile	A3	9th	MPP-2	Local production
CST-7	US 52	Tile	A1	9th	MPP-3	Local production
CST-8	US 49	Tile	A1	Late 8th–9th	MPP-2	Local production
CST-9	US 49	Tile	A1	Late 8th–9th	MPP-2	Local production
CST-10	US 49	Tile	A1	Late 8th–9th	MPP-3	Local production
CST-11	US 37	Tile	A3	9th c. AD	MPP-3	Local production
CST-12	US 47	Tile	A1	Late 8th–9th	MPP-3	Local production
CST-13	US 52	Tile	A1	Late 8th–9th	MPP-2	Local production
CST-14	US 47	Tile	A1	Late 8th–9th	MPP-2	Local production
CST-15	US 40	Amphora (painted)	A2	9th	MPP-4	Import
CST-16	US 36	Amphora	B	10th	Single/ungrouped	
CST-17	US 9	Amphora	A3	9th	MPP-4	Import
CST-18	US 37	Painted flask	A3	9th	MPP-4	Import
CST-19	US 47	Cooking pot (olla)	A1	Late 8th–9th	Single/ungrouped	Import
CST-20	US 40	Cooking pot (olla)	A2	9th	MPP-5	Local production
CST-21	US 47	Cooking pot (olla)	A1	Late 8th–9th	MPP-5	Local production
CST-22	US 1003	Stone trays/plates	4	10th		Local production
CST-23	US 36	Stone trays/plates	4	10th		Local production
CST-24	US 40	Bread baking plate (ceramic)	A2	9th	MPP-5	Local production
CST-25	US 72	Inner structural clay of the kiln	A1	Late 8th–9th		Local production
CST-26		Local clay deposit				-
CST-27	US 32	Stone block of the building	A1	Late 8th–9th		Local production
CST-28	US 32	Stone block of the building	A1	Late 8th–9th		Local production
CST-29		Lithic element from the site area				Local production

imports, a cross-comparison was made with the lithological characteristics of the local clayey raw materials, which are considered suitable for ceramic use. This provenance study conducted using thin-section petrography was basically supported by an available database on the microfabric acquired after experimental firings of all the clayey materials traditionally destined for ceramic production in western and central Sicily (Montana, Cau, et al., 2011).

With regard to the lithoid samples constituting bread baking plates (samples CST-22 and CST-23) or structural elements (samples CST-27, CST-28, CST-29), which were discovered after the excavation, a similar procedure was adopted: petrographic characterization and comparison with the lithologies emerging in the surroundings of the Contrada Castro.

5.1 | Local clayey materials

Two of the samples analysed can be considered as representative of the ceramic raw materials that are available in the close vicinity of the site, namely, CST-25 (fragment of the kiln grid) and CST-26 (sandy clay material sampled from an outcrop of the Marne di Cardellia Formation, located a few hundred metres from the kiln).

The CST-25 sample was first dried in a ventilated oven, and then consolidated under vacuum using epoxy resin and thin-sectioned to be observed under the polarizing microscope. This material is derived from a marly clay with abundant calcareous microfossils that are almost unrecognizable under the microscope owing to a prolonged and repeated direct contact with the flames during the ceramic firing process. Quartz inclusions are abundant (up to 30%–35% area), mostly from fine (0.125–0.25 mm) to very fine (0.06–0.125 mm) sand grain size; however, they were poorly distributed. The groundmass contained blackish portions (without any optical activity) that included segregation of iron oxides and birefringent portions composed of microcrystalline calcite (micrite). Both plaques were irregularly distributed. Several glauconite pellets (subrounded or irregularly shaped particles) were also observed (Figure 6a).

The CST-26 sample was first dried in a ventilated oven, delicately disaggregated and subjected to conventional grain-size analysis methods that included wet sieving to separate the sand fraction and centrifuge cycles at 2000 and 4000 rpm for silt and clay-sized particles, respectively. Based on the grain-size analysis, the material was classified as sandy–silty clay (Figure 6b). The clay fraction represents 44% by weight of the sediment, while sand and silt comprise 37% and 19% by weight, respectively. More specifically, in the sandy fraction, the granules composed of very fine and fine sand (0.06–0.25 mm) represent 94% of the fraction weight, while the remaining part consists of medium and coarse sand (0.25–1 mm). A portion of the

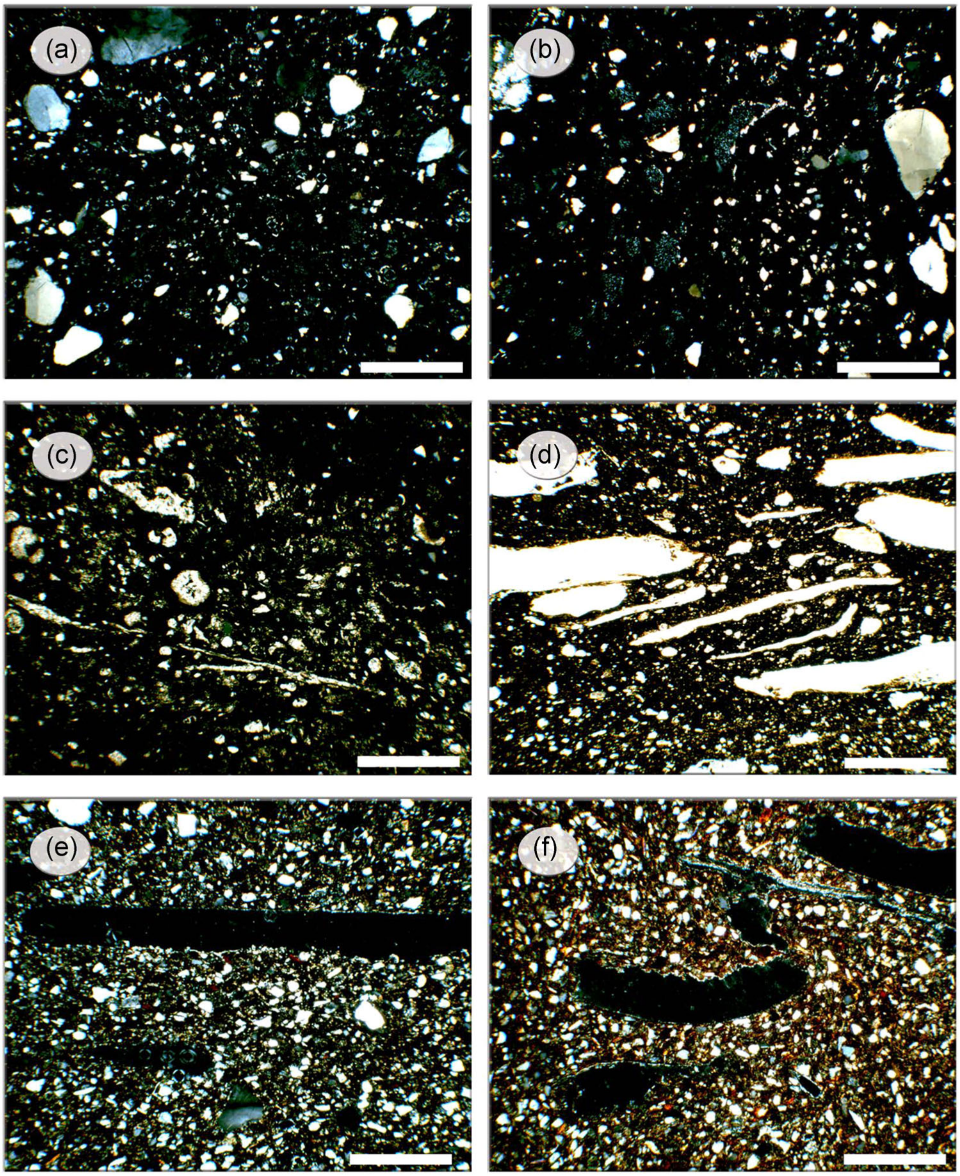

FIGURE 6 Thin-section microphotographs representative of the ceramic minero-petrographic paste groups MPP-1, MPP-2, and MPP-3 (scale bar is 0.5 mm; cross-polarized light, excluding photo D taken under plane-polarized light): samples CST-3 (a), CST-4 (b), CST-14 (c), CST-8 (d), CST-7 (e), and CST-12 (f) [Color figure can be viewed at wileyonlinelibrary.com]

bulk sample was also consolidated by epoxy resin and thin-sectioned to a thickness of 0.03 mm to be observed under the polarizing microscope. The abundance of sandy inclusions and coarse silt (0.04–0.06 mm) accounted for more than 40% of the area. Granules with dimensions falling within the fine sand class (0.125–0.25 mm) dominate. Fine sand (0.06–0.125 mm) is common, and medium sand (0.25–0.5 mm) is sporadic to rare. The aplastic inclusions are mainly composed of monocrystalline quartz grains and angular to subangular and subordinate quantities of calcareous microfossils (prevalent benthic and planktonic foraminifera on fragments of mollusk shells). Glauconite particles are common and sometimes subrounded (up to 0.4 mm). Sporadic to rare small subhedral crystals of plagioclase and K-feldspar were observed (Figure 6c). The groundmass contained widespread opaque lumps made of iron oxides and organic matter.

Excluding the firing exposure of CST-25, the CRS-25 and CRS-26 samples share strong compositional and textural similarities also to the MPP-2 and MPP-5 ceramic paste groups (tiles and cooking pots, respectively), both of which are linked to the Marne di Cardellia Formation.

5.2 | Ceramic materials

The minero-petrographic paste group MPP-1 includes samples CST-1, CST-2, CST-3 and CST-4 (Table 1). These samples showed quite a homogeneous paste with regard to both textural and compositional characteristics. The aplastic inclusions are mainly composed of monocrystalline quartz predominating over polycrystalline quartz, feldspars (K-feldspar and rare plagioclase, both in the incipient state of argillification), quartzarenitic lithic fragments and rare glauconite. Limestone lithic fragments are common, although they are often extensively transformed after overfiring, due to close contact with the flame and/or long exposure times. Thermal decomposition of calcite, as is known, begins at around 700°C, then evolves rapidly and ends at around 900°C (Rodriguez-Navarro et al., 2009). Consequently, calcareous grains are represented by secondary micrite lumps with an irregular contour or by cast pores formed as a result of the complete thermal decomposition of the original calcareous inclusions, which are mostly represented by planktonic Globigerina foraminifera (Figure 7a,b). The degassing pores, particularly abundant in the external part of the analysed ceramic fragments, can also be markedly subcircular and affected by the characteristic lightening edges of greenish colour. These subcircular features are occasionally partially filled with secondary calcite deposits. The frequency (i.e., abundance by area percentage) of aplastic inclusions always varies between 10% and 20%, based on the areal estimate carried out with the help of comparison tables. The grain-size distribution mainly ranged between coarse silt and coarse sand (0.04 and 1.0 mm), with a heterogeneous distribution and a maximum grain size of up to 1.3 mm. The texture of the groundmass, which is identified as optically inactive and dark brownish-black under the cross-polarized light, appears to be markedly heterogeneous, with several large lumps particularly rich in iron oxides. The latter is an indication of quick and coarse processing of the ceramic paste. The compositional and textural characteristics found for MPP-1 are well correlated with those known for the clays of the Castellana Formation (outcrops 2–3 km away from the site of Contrada Castro) as described by Montana, Cau, et al. (2011) and Montana, Polito, et al. (2011).

The minero-petrographic paste group MPP-2 includes the following samples: CST-5, CTS-6, CST-8, CST-9, CST-13 and CTS-14 (Table 1). The six tile samples that make up this ceramic paste group comprise marly clay and low quantities of siliceous aplastic inclusions covering approximately 5% of the area. The paste is very fine-grained, containing particles that range mainly between 0.04 and 0.1 mm in size. The silico-clastic fraction is mostly represented by angular monocrystalline quartz granules, as well as sporadic feldspar crystals (K-feldspar and plagioclase), subspherical cryptocrystalline glauconite particles and tiny mica flakes (Figure 7c,d). Some ceramic bodies are affected by an evident black core (CST-8, CST-9 and CST-13). The calcareous component is relatively abundant and consists of planktonic and benthic foraminifera (with the internal microstructure often visibly recrystallized), irregularly shaped micrite lumps and cast pores (derived from the thermal decomposition of microfossils). Therefore, it is possible to determine the aplastic abundance in the original ceramic paste (before the firing process) for approximately 25%–30% of the total area. The groundmass shows a moderate aggregate birefringence and no optical activity under cross-polarized light. The presence of elongated macropores or channels, which proves the addition of thin vegetable fragments (e.g., straw) to the paste, is a peculiar characteristic of all the samples in this group. The addition of straw for the production of tiles aims to lighten the ceramic paste and improve its workability, depending on the specific intended use of the finished product, and to optimize the performance in terms of insulation and waterproofing characteristics (Cuomo di Caprio, 2017). Some cast pores were filled with subhedral crystals of secondary spathic calcite formed during the burial phase. Based on the microscopic observations, we conclude that the raw clay material was likely sourced from the Marne di Cardellia Formation (outcrops ~1 km from the site of Contrada Castro).

The minero-petrographic paste group MPP-3 includes samples CST-7, CTS-10, CTS-11 and CST-12 (Table 1). This paste, similar to the MPP-2 group, is characterized by the presence of abundant aplastic inclusions (20%–30% area), which are mainly composed of mineral granules that are bimodal in the grain-size distribution between the coarse silt (0.04–0.06 mm) and very fine sand (0.06–0.125 mm). Fine sand (0.125–0.25 mm) is sporadic, and medium sand (0.25–0.5 mm) is rare. The aplastic inclusions are homogeneously distributed and mainly composed of monocrystalline quartz, followed by common to sporadic white mica tiny crystals, sporadic polycrystalline quartz, sporadic K-feldspar, rare plagioclase and very fine-grained quartzarenite fragments (Figure 7e,f). A modest primary calcareous component has also been detected, widely modified using the firing process and, therefore, represented by micrite lumps with subrounded or irregular shapes. The groundmass showed modest optical activity (aggregate birefringence) or inactivity, and it was slightly impregnated with secondary microcrystalline

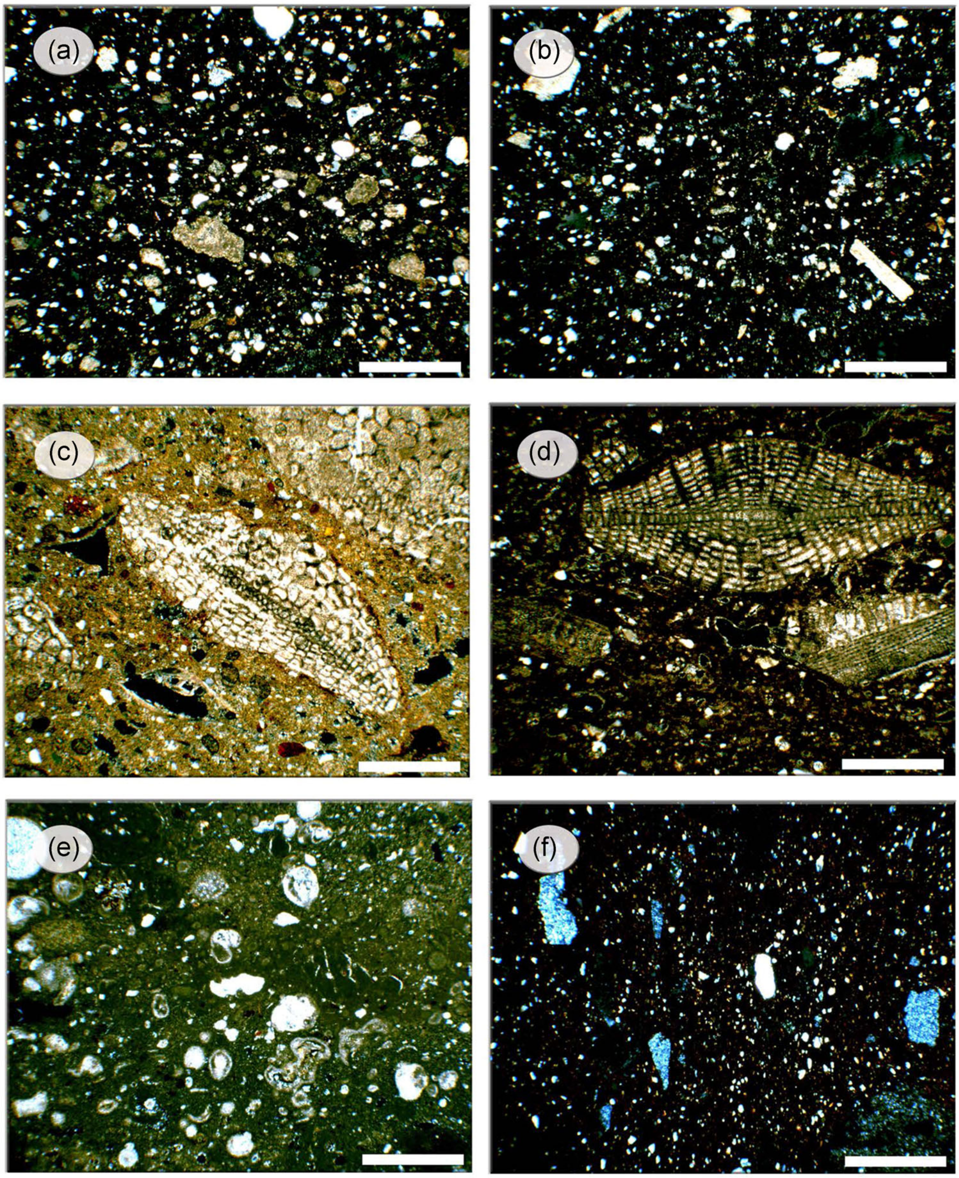

FIGURE 7 Thin-section microphotographs representative of the ceramic minero-petrographic paste groups MPP-4, MPP-5, and ungrouped (scale bar is 0.5 mm; cross-polarized light): samples CST-15 (a); CST-18 (b); CST-20 (c); CST-24 (d); CST-16 (e); and CST-19 (f) [Color figure can be viewed at wileyonlinelibrary.com]

calcite. In analogy to what was observed in MPP-2, elongated macropores (or channels) were common, suggesting the technological choice of adding straw fragments to the clay paste in the local manufacture of tiles. Some of the channels are characterized by the presence of aggregates of secondary spathic calcite with a 'dog-tooth' structure. Following these observations, we narrowed down the source area of the raw clay material used in MPP-3 to the Terravecchia Formation (Montana, Cau, et al., 2011; Montana, Polito, et al., 2011), which outcrops ~3 km away from the site of Contrada Castro and is coeval with the Castellana Sicula Formation; however, it has a relatively lower content of calcareous microfossils.

The minero-petrographic paste group MPP-4 comprises the two amphorae, including the painted samples CST-15 and CST-17, and the flask sample CST-18 (Table 1). MPP-4 is characterized by aplastic inclusions comprising of a calcareous component and an almost equivalent proportion of silico-clastic components. The overall abundance of the inclusions was quite variable, ranging from 15% (in CST-18) to 25% (in CST-17) of the total area. The grain-size distributions are markedly heterogeneous, from the size class of the coarse silt (0.04–0.06 mm) to those of the coarse sand (0.5–1 mm), with a slight prevalence of the medium sand size class (0.25–0.5 mm).

The silico-clastic components show that monocrystalline quartz prevails over polycrystalline quartz, chert (both in small and coarse granules), K-feldspar and fine-grained quartzarenite lithoclasts (Figure 8a,b). All the limestone granules (microfossils, bioclasts, lithic fragments) clearly show signs of the firing process and appear to be

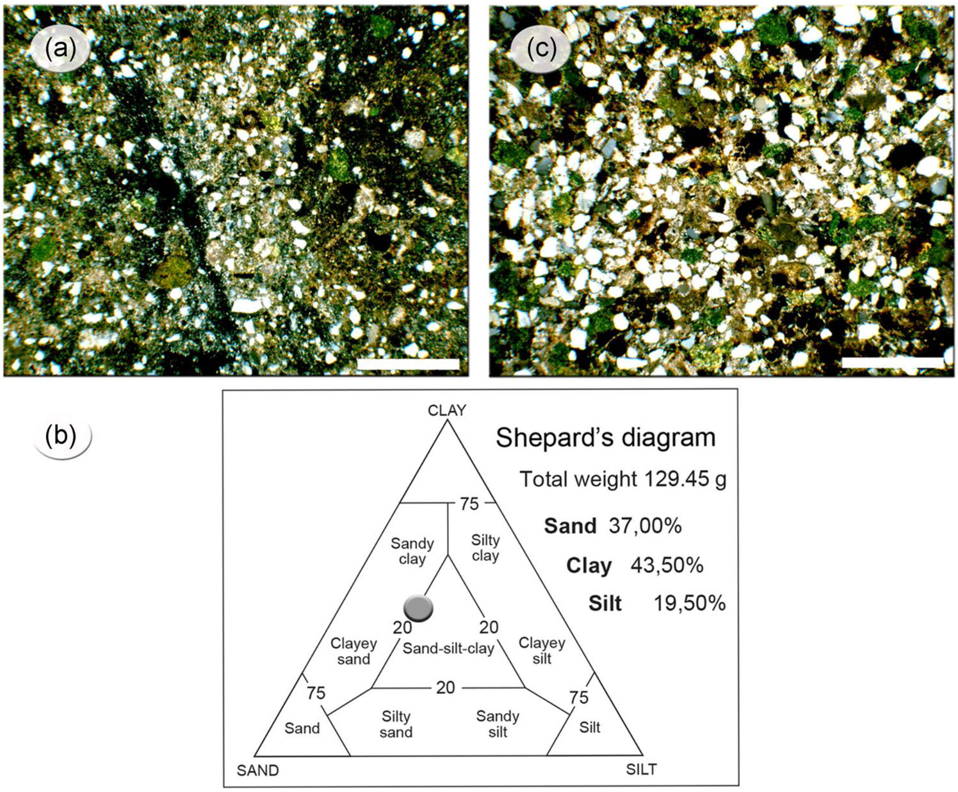

FIGURE 8 (a) thin-section microphotograph of sample CST-25, structural clay sampled from the kiln (scale bar is 0.5 mm; cross-polarized light). (b) Grain-size distribution of the clayey raw material that crops out few hundred meters away from the kiln site (sample CST-26) and its projection in the triangular Shepard's diagram. (c) Thin-section microphotograph of the sample CST-26 (scale bar is 0.5 mm; cross-polarized light) [Color figure can be viewed at wileyonlinelibrary.com]

re-carbonated and transformed into microcrystalline calcite (micrite) without any trace of the original internal structure. The groundmass is isotropic (i.e., optically inactive) and is characterized by numerous cast pores. Following these observations, we conclude that the likely source of the raw clay material used in MPP-4 was the Argille di Ficarazzi Formation. These clays are present about 70 km from Contrada Castro, along the coastal area of Palermo, where they have been used as a ceramic raw material since the Punic colonization in the 7th century B.C. (Montana, Cau, et al., 2011; Montana, Polito, et al., 2011). Therefore, it is believed that the ceramic products described above were produced in Palermo and imported to the study site.

The minero-petrographic paste group MPP-5 includes samples CST-20, CST-21 and CST-24 (Table 1). This ceramic paste is represented by two casseroles (ollae) intended for cooking food (CST-20 and CST-21) and a bread baking plate (CST-24). It was obtained from a very calcareous clay (marly clay) with very coarse natural inclusions, particularly macro-foraminifera Lepidocycline with dimensions exceeding 2 mm, and much smaller planktonic foraminifera (Figure 8c,d). The relatively good preservation of the internal structure of Lepidocycline suggests a relatively low firing temperature (~700–750°C). The silico-clastic component is less significant, covering an area between 25% and 30%, and mainly composed of angular monocrystalline quartz grains, with grain sizes ranging between coarse silt (0.04–0.06 mm) and very fine sand (0.06–0.125 mm). The groundmass, showing modest to evident optical activity, contains coarse cast pores with no preferential orientation. Based on these observations, we suggest that the raw clay material used in the MPP-5 group was likely sourced from the Marne di Cardellia Formation (outcrops found ~0.5–1 km away from the site of Contrada Castro).

Due to their peculiar textural and compositional characteristics, two ceramic samples, CST-16 (amphora) and CST-19 (cooking pot/olla), could not be assigned to any of the ceramic paste groups previously described and were, therefore, classified as ungrouped objects, which were likely not locally produced.

Object CST-16 is characterized by a paste that was derived from the firing of a marly clay, with sporadic and very fine-grained quartz inclusions (0.04–0.1 mm). The predominant inclusions are almost entirely calcareous in nature (covering 15%–20% of the area), represented by abundant planktonic foraminifera (Globigerinae) and coarse calcareous bioclasts or lithoclasts (up to 1.3 mm in size), decomposed and re-carbonated, showing segregation of amorphous iron oxides. Most bioclasts (or products of their transformation following firing at temperatures close to 900°C) were found to be of fine sand grain size (0.125–0.25 mm). The groundmass was optically inactive and characterized by numerous cast pores (Figure 8e). Based on this evidence, we concluded that the raw clay material used for the CST-16 object was likely sourced from the Marne di San Cipirello Formation, which crops out approximately 1–2 km away from the site of Contrada Castro. However, another plausible hypothesis is the importation from the site of Iatas (or Iato), also located in the area of the Monti Sicani where these marly clays have been used continuously since the 6th century BC.

The ungrouped object CST-19 contained a paste consisting of a low calcareous clay with relatively fine natural quartz–feldspathic inclusions. The inclusions were deliberately added by tempering with subangular to subrounded grains of chert or radiolarite that were up to 0.4–2 mm in size. The natural silico-clastic fraction is mainly composed of monocrystalline quartz and only subordinate polycrystalline quartz, feldspar and rare tiny flakes of white mica. These components fall mostly in the coarse silt (0.04–0.06 mm) and very fine sand (0.06–0.125 mm) grain-size classes (Figure 8f). Therefore, the grain-size distribution of this paste is clearly bimodal, with inclusion abundance between 15% and 20%. The groundmass is optically inactive and characterized by irregular, elongated pores, which show an evident preferential orientation, likely due to working by the pottery wheel. Based on these observations, we conclude that the potential raw clay material used for the object CST-19 was sourced from the Flysch Numidico Formation that outcrops ~70 km away (Palermo/Monreale area) from the site of Contrada Castro (Montana, Cau, et al., 2011; Montana, Polito, et al., 2011).

5.3 | Stone materials

The bread baking plates (samples CST-22 and CST-23) are made of stone materials that can be exploited owing to the technical characteristics relevant for their intended use: grain-sustained texture, fine grain size, good sorting, fine carbonate matrix, little or no secondary calcite cement and homogeneously distributed porosity. All the aforementioned characteristics are typical of a carving stone and guarantee good resistance to repeated thermal shocks up to 200°C (bread baking temperature in a wood oven). However, from a petrographic point of view, they were found to be produced of different rocks, both of which are locally available.

Sample CST-22 can be petrographically described as homogeneously grained, well-sorted biocalcarenite with sub-rounded bioclasts (transport index). The size of the calcareous granules falls mainly in the medium sand class (0.25–0.5 mm). Among the bioclasts, Oligo-Miocene benthic foraminifera (including Miogypsina), as well as fragments of echinoderms, algae and mollusks were recognized. Quartz (angular granules mostly 0.06–0.125 mm in size) is a relatively subordinate constituent in terms of abundance. In addition, irregular or subrounded granules of glauconite and irregular masses composed of iron oxides were detected (Figure 9a). The matrix was composed of microcrystalline calcite (micrite), which is sometimes partially recrystallized in sparry calcite (vadose meniscus cement). Based on these petrographic characteristics, we link the source of the raw material to the Marne di Cardellia Formation, which crops out ~0.5 km away from the studied site.

The CST-23 sample can be described as planktonic foraminiferal (Globigerina) limestone, with particle size ranging from 0.06 to 0.2 mm. Benthic foraminifera were much more subordinate. The texture was grain-supported, with an intergranular micritic matrix that is particularly rich in iron oxides. No sparry carbonate cement was observed; therefore, the lithotype was petrographically classified as packstone (Dunham, 1962). Very fine-grained quartz (0.04–0.125 mm) is very rare. Sporadic gypsum crystals were also identified, as well as glauconite particles and irregular masses composed of iron oxides (Figure 9b). The compositional and textural characteristics, as well as the biostratigraphic one, allow this sample to be precisely correlated to the lithostratigraphic unit of the Trubi that emerges approximately 7 km west of the studied site (Basilone, 2011; Di Stefano et al., 2013).

Samples CST-27 and CST-28 are both representative of the structural stone blocks of Phase 3A, dated back to the late 8th–9th c. AD. The CST-29 sample is an isolated stone block that was found in the excavated area. The two samples CST-27 and CST-28 are petrographically identical and can be described as medium-coarse-grained calcarenite packstones. They are characterized by benthic macro-foraminifera, containing Lepidocyclinae and, subordinately, Miogypsina (Upper Oligocene–Lower Miocene), as well as abundant glauconite (irregular or subrounded particles, up to 1–2 mm in size). Among the bioclasts, we observed fragments of echinoderms, red algae, lamellibranchs and gastropods. The prevailing size of bioclasts was in the medium sand class (0.25–0.5 mm) for CST-27 and the fine sand class (0.125–0.25 mm) for CST-28. Quartz grains with dimensions within the coarse silt class (0.04–0.06) and the very fine sand class (0.06–0.125 mm) are sporadic to rare. The matrix was composed of microcrystalline calcite (micrite), which is sometimes characterized by irregular blackish-brown patches composed of iron oxides (Figure 9c).

The CST-29 sample was slightly different from the above description due to a relatively greater abundance of monocrystalline quartz grains (angular to subangular). Glauconite particles were also common (Figure 9d). This lithotype matches the raw material used to make the stone bread baking plate CST-22. The textural and biostratigraphic features allow this sample to be associated to the Marne di Cardellia Formation that crops out ~0.5 km away from the studied site (Basilone, 2011; Di Stefano et al., 2013).

6 | DISCUSSION

The analysis carried out on the studied geomaterials allows us to make a series of interpretations regarding the relationship between the sources of materials and the different objects. In fact, the main aim of this study is to attempt to understand the supply dynamics linked to the production context found for period A (late 8th–9th c. AD).

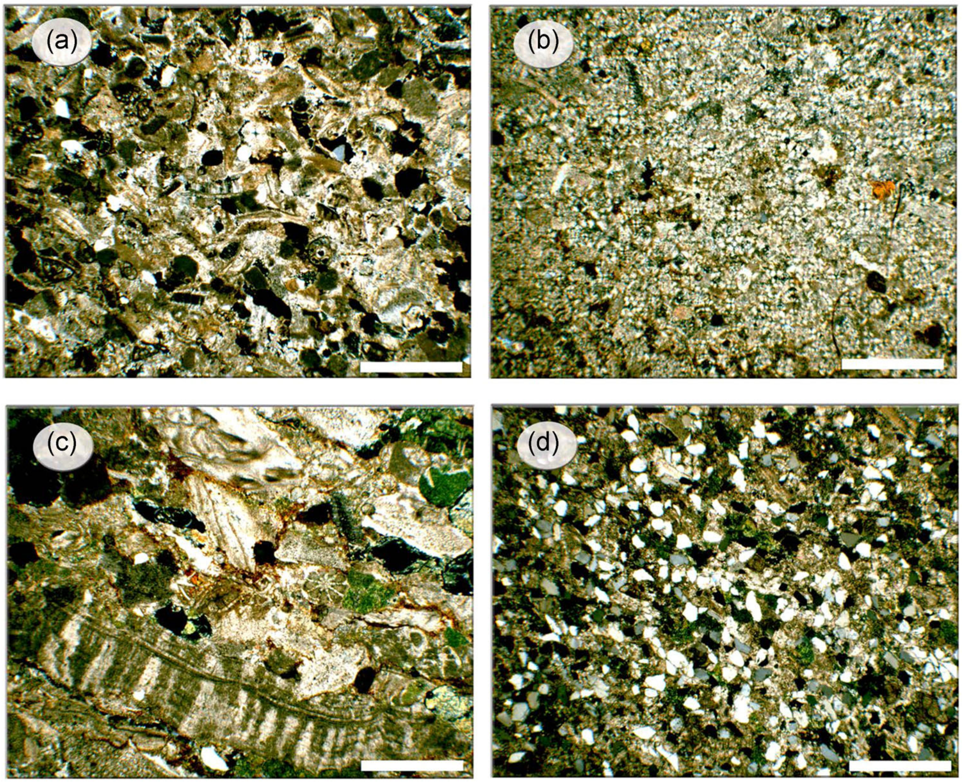

FIGURE 9 Thin-section microphotographs representative of the natural stone materials used in the site (scale bar is 0.5 mm; cross-polarized light): samples CST-22 (a), CST-23 (b), CST-27 (c) and CST-29 (d) [Color figure can be viewed at wileyonlinelibrary.com]

The lithic materials (CST-27 and CST-28) used in building were possibly collected near the site from the outcrop of the Marne di Cardellia Formation. The layer of clay (CST-25) that lined the internal firing chamber of the furnace possibly has the same provenance. This production structure is strongly connected with the geological resources present in the immediate vicinity and confirms the rational exploitation of the closest geomaterials, which were of sufficient quality for the intended use and to achieve the expected performance.

The tiles found at the site are part of a type of large, combed tiles with straw inclusions, already known from the Early Medieval and Medieval contexts in Sicily (Arcifa, 2010). The first group (CST-1, CST-2, CST-3 and CST-4) refers to production waste, among which there are probably also fragments of common or cooking pots, all referable to the minero-petrographic paste group MPP-1, which was related to the Castellana Sicula Formation 2–3 km away from the site. This type of paste had not been found until now in the ceramic finds from the excavation; therefore, it is possible to interpret these wastes as the result of an unsuccessful production attempt. Meanwhile, the tiles used on the site were made up of two different pastes. The first group (CST-5, CTS-6, CST-8, CST-9, CST-13 and CTS-14) was most likely produced in the found kiln and, on the basis of the compositional, textural and biostratigraphic characteristics, it can be associated with the Marne di Cardellia Formation (MPP-2) outcropping near the site. The second group (CST-7, CTS-10, CTS-11 and CST-12) was produced with clay from the Terravecchia Formation (MPP-3), which is largely distributed in the region and used in several other production sites (Montana, Cau, et al., 2011; Montana, Polito, et al., 2011) and crop out very close from the site of Contrada Castro (approximately 3 km). The presence of this group of tiles could be interpreted either as the short-distance import of products made in a kiln located outside the site or, more likely, as a result of an internal production, but for which it was decided to use a different raw material more distant than the closest Marne di Cardellia Formation. Of the samples analysed for period A, the cooking pots confirmed a local production linked to the Marne di Cardellia Formation (MPP-5). In fact, the two types of ollae (CST-20 and CST-21) refer to this group of pastes: CST-20 (Figure 10 (1a,b)), a fragment of the olla with an extroverted and enlarged rim with a small external recess between the attachment of the rim and the shoulder, and CST-21, a fragment of the olla with an everted rim and blackened on the external surface.

The ceramic handmade bread-baking plate (CST-24) (Figure 11 (1a,b)), also known as 'testo/testello' (Giannichedda & Zanini, 2011), whose paste has been grouped in MPP-5, is recorded (in terms of typology) in many rural contexts of peninsular Italy from the 6th/7th century throughout the Middle Ages (Augenti, 2016). Furthermore, it has been argued that similar forms of flatbread baking plates were not only recorded in Roman and Byzantine contexts in Egypt and Chios (Reynolds, 2016) but also in southern Spain such as in Visigothic and Byzantine sites and, more often, related to the so-called *ṭābaq* (Gutiérrez Lloret, 1991) in Islamic contexts of al-Andalus (Amorós Ruiz & Gutiérrez Lloret, 2020). This type of ceramic artefact,

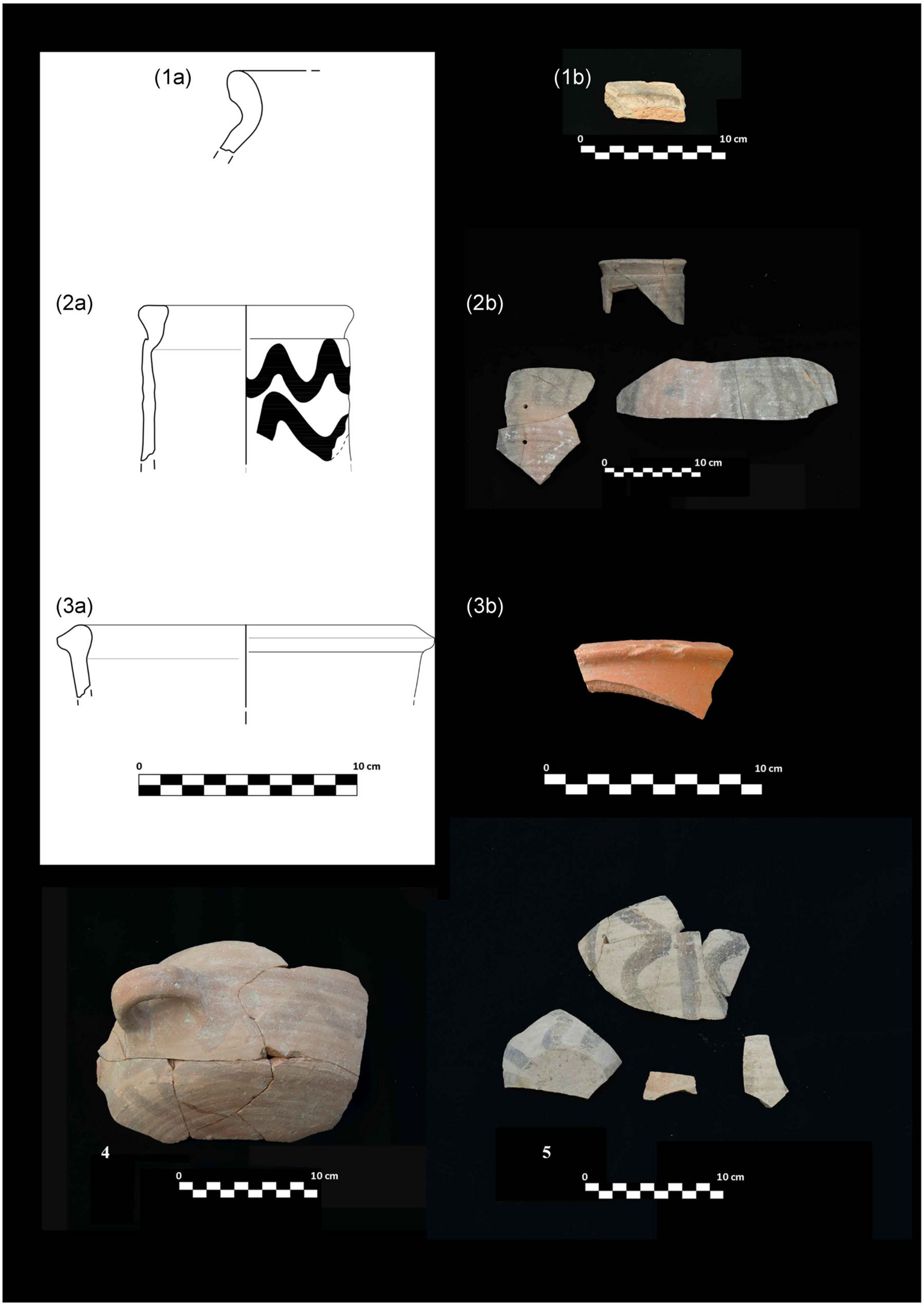

FIGURE 10 (1a,b) CST-20, olla/cooking pot; (2a,b) CST-15, painted amphora; (3a,b) CST-17, amphora; (4) CST-18, painted flask and (5) CST-16, painted small amphora with a sinusoidal motif [Color figure can be viewed at wileyonlinelibrary.com]

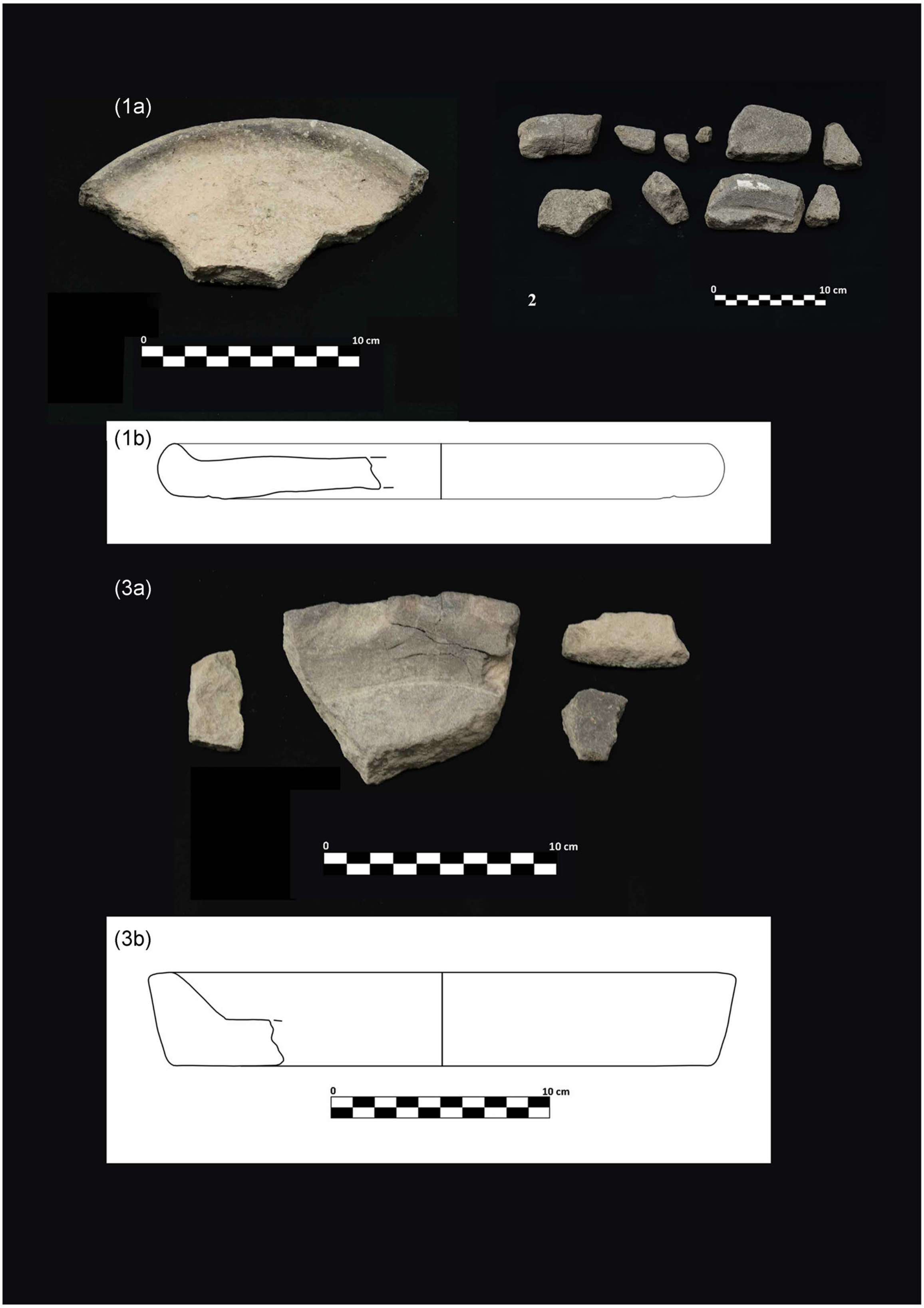

FIGURE 11 (1a,b) CST-24, ceramic bread baking plate; (2) CST-22, stone trays/plates ('testo in pietra') and (3a,b) CST-23, stone trays/plates ('testo in pietra') [Color figure can be viewed at wileyonlinelibrary.com]

probably used for cooking flatbreads, is hardly been recorded in the Early Medieval Sicily (similar examples from late 7th–8th c. AD layers of Cignana in Agrigento province, Rizzo et al., 2014). In contrast, the most commonly used objects were the so-called 'testi in pietra' (Arcifa & Bagnera, 2014) stone trays/plates. These are well known and closely connected to the Islamization of the island, especially of the western part, from the end of the 9th into the early 10th c. AD (Ardizzone et al., 2018), and were used at least until the 13th century. The two samples CST-22 and CST-23 can be related to the Islamic period (10th c. AD). In particular, sample CST-22 was made with raw material exploited from local outcrops of the Marne di Cardellia Formation (Figure 11 (2)), while sample CST-23 was made with the planktonic foraminiferal limestone belonging to the Trubi Formation, which outcrop approximately 7 km from the site (Figure 11 (3a,b)). For this reason, both can be likely considered as local productions. It should be noted that typologically similar finds were discovered in the territories of Contessa Entellina and Palermo, approximately 30 km west and 60 km north, respectively, from Contrada Castro, although manufactured with a different lithotype (Calcareniti di Corleone Formation) and attributed to a contemporary production from the site of Monte Iato (Corretti et al., 2016). These analytical results, altogether, highlight the picture of these specific productions to belong to the Islamic presence in the hinterland of Palermo. They not only suggest a network of exchanges from the territory with the city but also correspond to a series of local productions and internal exchanges between the various rural settlements that populated this inland from the Aghlabid period (late 9th to early 10th c. AD) to the definitive expulsion of the Muslims from these areas during the 13th century.

The connectivity of the Contrada Castro site with an exchange network linked to the city of Palermo and the countryside is indicated by the presence of three samples (i.e., CST-15, CST-17 and CST-18) produced with Argille di Ficarazzi clays located in the Palermo area.

The CST-15 sample (Figure 10 (2a,b)) relates to a vertical, slightly enlarged amphora with a rib in relief on the outside immediately below the rim, and a series of creases on the neck. On the neck, it has a brown decoration with a motif formed by two parallel and horizontal sinusoids. In addition, there were two compensation holes in the body of the amphora. On the body, it has a painted decoration with vertical bands alternating with sinusoidal bands (typical decoration of late 9th c. AD, but probably also earlier; see Sacco, 2018). The question remains open about the chronological origin of these amphorae and whether they were already in circulation before the Aghlabid period. The CST-17 sample (Figure 10 (3a,b)) is an amphora with a thickened rim that contains traces of red paint and a slightly pendulous triangular section. This typology currently finds comparisons with examples found in the late 9th-century contexts during the excavations of Palermo, such as Castello San Pietro, Palazzo Bonagia and the church of the Gancia (Sacco, 2018). The CST-18 (Figure 10 (4)) is a small flask with a probable hint of spout, a handle with an oval section and a horizontal ear and with a slightly rounded bottom. The decoration covers the entire surface with a continuous horizontal sinusoidal red band, and a sinusoidal pattern alternating with bands was also observed on the bottom. Currently, there is no comparison of this form that has a painted decoration equal to the amphorae with a sinusoidal motif.

It is interesting to note that, to date, the exploitation of Argille di Ficarazzi clays has been related to specific types of amphorae from the Aghlabid period, between the late 9th and beginning of the 10th c. AD (Alaimo & Giarrusso, 2004; Giarrusso & Mulone, 2014). However, the Argille di Ficarazzi clays (Montana, Cau, et al., 2011) were already widely known and exploited for the production of ceramics, at least from the 7th and/or 6th century B.C., well before the arrival of the Muslims in Palermo, and with a continuity up to the present day (Montana, Polito, et al., 2011). Regarding the Contrada Castro site, the stratigraphic sequence is confirmed by robust absolute radiocarbon dating and allows us to date these materials to the 9th century. The site collapsed afterwards and was no longer used at the end of the 9th century. Therefore, we can still hypothesize an early connection between Aghlabid Palermo and the territory of Corleone in the decades following the Islamic conquest of this town in AD 840. It is not possible to exclude a long-term city–countryside relationship, starting in the Byzantine period and running through to the first half of the 9th century. In fact, in the stratigraphic context of the late 8th to early 9th century, sherds of an olla with an extroverted rim (CST-19) made of clays of the Flysch Numidico Formation, likely coming from an area near the city of Palermo, are an element that can be better explored with further studies and analyses, to verify this city–countryside connectivity in the complex decades that preceded the Islamic conquest of western Sicily. Interestingly, the network of short-distance exchanges is illustrated by the import in the early 10th century of the small amphora (CST-16) (Figure 10 (5)), which was most likely sourced from the territory of Monte Iato, intensely occupied in the Islamic period, especially between the 10th and 11th centuries (Alfano & Sacco, 2014).

7 | CONCLUDING REMARKS

The discovery of an early medieval production context with kilns for tiles and ceramics in the Contrada Castro site is an element that sheds new light on a poorly documented period in the archaeology of the Sicilian countryside. In the complex historical framework of the last phase of the Byzantine rule on the island, preceding the Islamic invasion in 827 AD and of the long war of conquest of Sicily by the Aghlabids, it is still difficult to identify with certainty the rural settlements occupied at the end of the 8th century and the beginning of the 9th century. The Contrada Castro excavation is therefore a privileged observatory for understanding the phenomena of continuity, resilience and innovation that characterized the Sicilian countryside during the Early Middle Ages. In fact, the evidence that emerged from the Contrada Castro sequence shows two different aspects of the economic dynamics and human–environment interaction between the end of the Sicilian Byzantine period and Islamic ages.

First, the analysis of the exploitation of raw materials from the Contrada Castro site showed an excellent potential of the territory and a rational exploitation of the resources available locally for the production of tiles, cooking ware, daily-use ware, lithic trays, bread-baking plates and building stone materials.

This close link with the sustainability of the resources of the surrounding area was also confirmed by the intersection of information between the phytosociological characteristics of the area, the palaeoenvironmental data on wood species and crops associated with the charcoals and seeds found in the sites and the composition of the zooarchaeological record connected to the strategies of animal husbandry (Bazan, Speciale, et al., 2020; Castrorao Barba et al., 2021).

Despite this, the picture that emerges is not that of an entirely self-sufficient and isolated settlement. In fact, some data with regard to amphorae and, to a lesser extent, cooking pots indicate the existence of a short-scale network of exchanges, at least limited to the area of the Sicani Mountains, and a connection with the city of Palermo. In general, with regard to the local ceramic production at the settlement of Contrada Castro, it should be emphasized that several good raw clays can be sourced within a radius of 2–3 km, which are suitable for both brick (relatively richer of aplastic inclusions, up to 25%) and daily use pottery production. In particular, the use of clay materials sourced from the Terravecchia Formation has been frequently and diachronically recorded in western Sicily, likely due to its excellent quality that is particularly suitable for the production of the finest pottery (Montana, Cau, et al., 2011).

This connectivity of the rural site of Contrada Castro with the city of Palermo reveals new interesting questions about the relationship between the city and its territory in the different and complex phases between the decades immediately preceding the arrival of the Aghlabid army and the consolidation of Palermo as the capital of Islamic Sicily. Future research and integration with a comparison of contemporary contexts and well-dated stratigraphic contexts from Palermo (that have emerged in recent rescue excavations, Vassallo, 2020) will clarify the nature of this city–countryside relationship and its relationship with the historical macro-changes from the Byzantine to the Islamic periods, while always taking into account the *longue durée* factors in rural communities and its different and variable rhythms of resilience and response to political regime changes.

In summary, these new data show us how an integrated, interdisciplinary approach including archaeometric analysis, stratigraphic excavation and geological survey of the territory is fundamental for an enhanced appreciation of the economic and settlement dynamics associated with the poorly understood Sicilian countryside during a historical period such as the Early Middle Ages.

ACKNOWLEDGEMENTS

The authors would like to thank the anonymous reviewers for their helpful suggestions that improved the overall quality of the text. This study was supported by funds provided by Bona Furtuna LLC. The archaeological excavation has been carried out under the scientific direction of the 'Soprintendenza BB.CC.AA' of Palermo thanks to the support of Stefano Vassallo and Lucina Gandolfo. Angelo Castrorao Barba thanks the Spanish MINECO for the Juan de la Cierva-Incorporación research fellowship (IJCI-2017-31494) at the School of Arabic Studies (Escuela de Estudios Árabes, EEA-CSIC) of Granada (Spain).

AUTHOR CONTRIBUTIONS

Giuseppe Montana, Angelo Castrorao Barba and Giuseppe Bazan were involved in the conceptualization of the study; Giuseppe Montana and Maurizio Gasparo Morticelli formulated the methodology used in this study; Giuseppe Montana and Maurizio Gasparo contributed to the geological, petrographic and mineralogical interpretation; Angelo Castrorao Barba, Carla Aleo Nero and Filippo Pisciotta performed archaeological investigations; Giuseppe Bazan and Pasquale Marino performed landscape studies; Giuseppe Montana, Maurizio Gasparo Morticelli, Angelo Castrorao Barba and Giuseppe Bazan contributed to writing: review and editing; Giuseppe Bazan was involved in project administration; and Pasquale Marino was responsible for funding acquisition. All authors have read and agreed to the published version of the manuscript.

ORCID

Giuseppe Montana http://orcid.org/0000-0002-6459-1925
Maurizio Gasparo Morticelli https://orcid.org/0000-0002-9966-6800
Giuseppe Bazan http://orcid.org/0000-0002-4827-9579
Pasquale Marino https://orcid.org/0000-0002-7624-4955
Angelo Castrorao Barba https://orcid.org/0000-0002-4360-4328

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How to cite this article: Montana, G., Gasparo Morticelli, M., Bazan, G., Pisciotta, F., Aleo Nero, C., Marino, P., & Castrorao Barba, A. (2021). Sources of geomaterials in the Sicani Mountains during the Early Middle Ages: A case study of Contrada Castro, central western Sicily. *Geoarchaeology*, 1–20. https://doi.org/10.1002/gea.21900