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Landscape construction in southern Sardinia in the 4th Millennium BC: an approach using clay procurement

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ABSTRACT

Landscape is constructed through the diverse activities of individuals in the environment that surrounds them. In this article, we address the role that coastal and lagoonal areas played in the way in which the human communities that inhabited southern Sardinia during the Final Neolithic/Early Copper Age constructed their landscape. To this end, we approach how individuals managed the mineral raw materials available in these locations and constructed taskspaces embedded in the landscape. We studied the provenance of the clays used to make diverse types of artifacts (i.e., pottery, coatings on architectural structures and loom weights) using optical microscopy based on thin-section analysis. In addition, microfossils present in the samples have been identified. The link of these archaeological materials with certain sedimentary deposits from the surrounding area enables us to suggest a close interrelationship and knowledge exchange between different technologies with respect to the possibilities of the diverse resources available in the environment and the elements that formed the landscape of these communities. Thus, the preference to exploit raw materials from lagoonal and coastal areas demonstrates that these environments became a reference point in the construction of landscape and identity in these communities.

Keywords*:* ceramics; petrology; microfossils; taskspaces; intra-technological relations.

INTRODUCTION

Landscape must be regarded as highly mutable and related to categorizations and meanings that are socially and culturally constructed (see, for instance, Tilley, 1994; Roberts, 1996; Bender et al., 2007). From this perspective, the procurement of clay raw materials to produce a wide diversity of ceramic objects can play an important role (Albero, 2014a) because as C. Tilley (1994) correctly noted, "Landscapes are experienced in practice, in life activities". Thus, we must consider that clays and other raw materials used in pottery production are an active element of the environment. Clay deposits must be viewed as places, that is, as materials that in addition to the spatial physical dimension of the resources incorporate the intangible values that the individuals or groups who use and appropriate the raw materials award these materials. These places act as mnemonic devices, with which individuals recall historical events through particular narratives, thus generating mythical and collective experiences through their daily life in these landscapes. Raw materials are a set of essential elements that individuals perceive in a certain way depending on their historical contingency and rationality patterns, thus creating specific worldviews and communities of practice (Albero, 2016).

Additionally, the exploitation of clay for pottery production is embedded in taskspaces (Ingold, 2000; Michelaki et al., 2014). Many potters were also occupied in other activities, such as agriculture, animal husbandry, fishing and gathering. Thus, they developed specific taskscapes, which consist of different types of interrelated activities that occur in certain areas of a territory. This interrelationship encouraged individuals to acquire an extensive knowledge of the various biotic and abiotic resources of the environment. Thus, clay procurement was interconnected with many other practices that occurred in the landscape and in everyday life while being fully involved in certain intra-technological relations (Sofaer, 2006). In this sense, the exploitation of diverse resources in the same areas favored social interactions between the members of the community and the establishment of comprehensive knowledge regarding the resources available in the environment. These social connections facilitated a cultural construction of the landscape and the use and conceptualization of the space as a whole. Such interactions may be substantially more intense when certain activities are developed in the same spaces.

Thus, close ties are established between individuals and territory through shared and lived experiences as well as through social relationships and memories that involve the raw materials and their environments. Simultaneously, there is a reciprocal relationship in which these places are eventually involved in the way in which individuals conceive themselves (Sillar, 1997). In this process, resources and landscape become "an integral part of Bourdieu's habitus" (Knapp and Ashmore, 1999) and the history of individuals and groups, thus playing a significant role in human identity. Therefore, clay procurement is actively embedded in the construction of the landscape and the individual's identity because "to know a landscape is to know who you are, how to go and where you belong" (Tilley, 2004). Thus, it must be assumed that these *clayscapes* (Albero, 2016) participated in the social identity of the artisans who produced ceramic artifacts (Costin, 1998).

Based on this theoretical framework, this paper addresses the way in which Early Copper Age communities in the area of Selargius (Cagliari, Sardinia) constructed their landscape and taskspaces, thus promoting a number of intra-technological relationships. To this end, we analyzed the raw materials used in the production of ceramic artifacts at the archaeological site of Su Coddu/Canelles. This article continues the research on the ceramic assemblage from this archaeological site initiated in previous studies (Melis and Piras 2010; 2012; 2014). However, in this paper, we only focus on the analysis of raw material procurement and the consequences that this phase of the *chaîne opératoire* could have had for the individuals from Su Coddu/Canelles regarding the previously discussed phenomena. Although other ceramic materials from this archaeological site have been already studied in former works, in this paper we complete the previous research by interpreting the record using a theoretical framework related to landscape archaeology and the social theory of technology. These interpretative perspectives have not been applied yet, neither to this region nor this period of the prehistory of Sardinia. Additionally, we focus on the use of a particular type of material: sedimentary clay deposits of marine origin related to coastal environments. The aim of this approach is, on the one hand, to address the existence of certain intra-technological relationships related to the exploitation of these specific resources and, on the other hand, to understand the role that coastal and lagoonal landscapes might have played in the communities of this region of Sardinia during the Early Copper Age. Eventually, the analysis of the raw material procurement strategies will provide us with some clues about the mobility of the groups who inhabited the studied area.

ARCHAEOLOGICAL AND GEOLOGICAL CONTEXT

The prehistoric site of Su Coddu/Canelles

The settlement of Su Coddu/Canelles is located in southern Sardinia, close to a large number of marine and inland water bodies (Figure 1). Because of the proximity of the island's main city, Cagliari, which is a densely populated area, the modern landscape has been transformed by encroaching urbanization. Over time, this transformation has resulted in changes in the shorelines and obliterated an area of wetland immediately adjacent to the ancient village. However, many Neolithic and Chalcolithic archaeological sites have been identified within a radius of 10 km, all of them located in the Santa Gilla pond and the urban area that surrounds Cagliari. The most ancient site identified in this territory dates in Early Neolithic. The oldest part of the settlement (Su Coddu) was founded during the first half of the 4^{th} millennium cal. BC (Final Neolithic). The features of the context have been compared with San Benedetto di Iglesias, which come four ^{14}C datings from (AA78328, BP 5044±58, Cal. AL. BC 3942-3655, 95.4%; AA78329, BP 4969±52, Cal. BC 3940-3648, 95.4%; Beta-72233, BP 4920±70, Cal. BC 3920-3540, 95.4%).

The settlement gradually extended to the south during the course of the Early Copper Age and occupied a new large area (Canelles). The site was still inhabited during the first centuries of the 3^{rd} millennium cal. BC, as demonstrates a wide number of ^{14}C datings obtained from many of the structures excavated (Melis, 2013) (Table 1). As it can be seen, radiocarbon dating of bone fragments recovered from diverse buildings in the village indicates that the village was occupied over a long period. The bone fragments also demonstrate that the transition from the Neolithic to the Chalcolithic was a slow, gradual process that occurred approximately during the middle centuries of the 4^{th} millennium. This transitional phase is documented, for instance, in the structure 134 of Su Coddu/Canelles (LTL2930A, BP 4708±45, Cal. BC 3640-3551, 95.4%).

The settlement was typical of a type characteristic of Final Neolithic Sardinia: a nearly flat landscape, terrain suitable for agriculture, proximity to moving water, proximity to inland water bodies and the sea, the absence of natural or artificial defense barriers or vantage points for surveying the surrounding territory.

Although the site has been subjected to extensive excavation, its position on the immediate periphery of the modern town of Selargius has made it impossible to identify the site's precise extension. In fact, urban expansion has

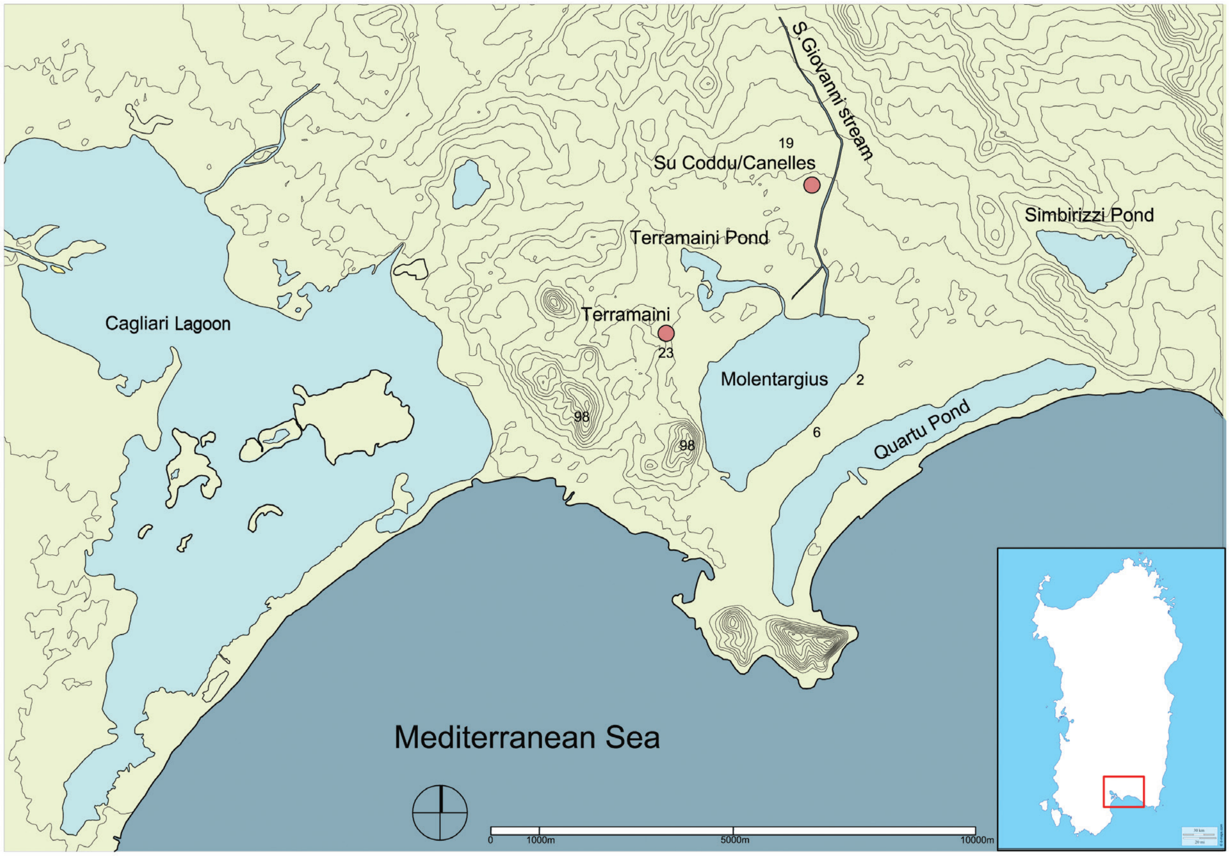

Figure 1. Map of the study area showing the location of the archaeological site and the morphology of the area around Cagliari (Source: Melis, Zedda, & Manca, 2012; drawing by Maria Grazia Melis and Silvia Manca).

often destroyed the remains of ancient buildings. However, the large expanse of the examined area, which amounts to approximately 4 hectares, is striking. The southern area, Canelles, where the samples analyzed for this article originated, occupies approximately 1.5 hectares. The extensive excavation of and accompanying interdisciplinary research (the latter still in progress) on the Su Coddu/ Canelles village have made it possible to reconstruct subsistence methods, in which agriculture played a more significant role than livestock. This distinction seems to become more pronounced during the Early Copper Age. Indirect evidence that suggests a predominant role of agriculture is associated with the existence of suitable lands for farming in the surrounding area. Moreover, zooarchaeological results show that terrestrial fauna and adult bovines are scarcely represented in the site, being the latter probably exploited for the production of milk, transportation and agricultural purposes. Another aspect that has to be taken into account is the presence of several silos, usually associated to the storage and preservation of cereals and other foodstuffs. In addition, the presence of a significant number of hand mills in the site must be also related to the processing of cereals, an action that has been also confirmed by the archaeobotanical analysis conducted (Melis et al., 2015).

In the field of artisanal production and in particular the transformation of clay, stone and hard animal materials, there is a gradual development in work processes that leads to a more opportunistic approach. Simultaneously, the use of metal increases, and its transformation in situ has been confirmed by the discovery of a crucible. This increasing use of metal was accompanied by developments in spinning, weaving and basketry, as indicated by the presence of spindle whorls, loom weights and imprints of wicker on the bases of a number of pottery artifacts, respectively.

The samples analyzed in this paper were recovered from a sector of the site (lotto Badas) in which 12 structures were identified. The materials selected are associated with six of these structures (structures 39, 43, 45, 46, 47 and 48).

These structures were partially dug in the ground and have diverse shape and function: circular-shaped rooms (structure 45), elliptical-shaped rooms (structure 43) or irregular rooms; wells and cylindrical silos (structures 39, 47 and 48); small circular pits interpreted as holes for poles; bonfires; structures of diverse shape that were used as dumps

Table 1. Radiocarbon datings associated with the second phase of Su Coddu/Canelles.

Archaeological context	LAB. Number	BP	Cal. BC	PROB.
Canelles, str. 39, US 1038	LTL295A	4554±45	3380-3090	54.6 %
			3375-3262	37.0 %
Canelles, str. 39, US 1085	LTL1104A	4512±50	3365-3051	91.6 %
Canelles, str. 46b, US 1202	LTL2931A	4481±50	3360-3010	95.4 %
Canelles, str. 46b, US 1186	LTL2932A	4350±50	3100-2880	95.4 %
Canelles, str. 47, US 1081	LTL1105A	4345±40	3090-3051	7.8 %
			3031-2890	87.6 %

for wastes. Some structures are more complex and have a circular (structure 46) or elliptical (structure 42) main room with other structures related to diverse functions, silos and ovens, attached. Organic matter imprints can be observed in many mud fragments, adobe bricks and coatings related to these structures, thus evidencing the use of both, mud and plants to construct walls and roofs.

Geological context

According to Carmignani et al. (1996) and Barca et al. (2005), Su Coddu/Canelles is located in an environment with Quaternary alluvial terraced deposits with abundant microfossils and granulometric heterogeneity (Figure 2). These deposits consist of coarse gravel, sand, aeolian sandstones, conglomerates, biocalcarenites and muds. The detrital materials originate in the granitic and metamorphic formation of the Sarrabus. This formation yields to a flat region on the west side of the study area, whereas the mountain formations are located in the east. Alluvial and colluvial deposits with coastal gravel, sand, silt, sandy and silty dark clays and mud rich in organic matter with fragments of marine and lagoonal shells have been documented in the south of Selargius.

The presence of substantial Lower and Middle Miocene deposits of marine origin with a contribution of continental materials was observed approximately 2.5 km to the east, north and west of the archaeological site. However, these gray marl clays with sand related to the Argille di Fangario deposit are also found beneath the Quaternary alluvial deposits in the vicinity of Su Coddu/Canelles. A deposit (Marne di Gesturi) formed by yellow marls with sand and silt, sandstones, conglomerates, limestone and calcarenites is also observed in this area.

At a greater distance from the study area, different types of non-calcareous deposits have been documented. On the one hand, there are Paleozoic metamorphic deposits approximately 7 km to the northwest. The Upper Ordovician - Lower Carboniferous formation of Pala Manna, which is formed of meta-sandstones, meta-siltites, quartzite, phyllite, meta-conglomerates, meta-volcanic rocks, metapelites and clays, should also be noted. Within this formation, Carboniferous-Permian materials with acidic rhyolites and to a lesser extent dacites also appear. On the other hand, there are Hercynian plutonic intrusive rocks associated with the unit of San Gregorio approximately 15 km to the west. Several porphyritic microgranites and, primarily, biotitic leucogranites and granodiorite outcrops form this geological unit. In addition, the previously noted Carboniferous-Permian acidic rhyolites and dacites also occasionally appear in this formation.

SAMPLING STRATEGY AND METHODS

The sampling strategy consisted of an exhaustive examination of the entire ceramic assemblage recovered from diverse structures excavated in Su Coddu/Canelles to obtain a set of samples representative of the diversity of fabrics present in the archaeological site. Subsequently, we characterized the petrological composition and performed a paleontological identification of the samples using optical microscopy and thin-section analysis. The aim was to identify the provenance of the raw materials used in the production of diverse types of ceramic artifact. Thus, we followed a holistic strategy in sample selection, which consisted of 41 pottery vessels, seven coatings from several architectural structures (structures 39, 46, 47 and 48) and a loom weight.

The compositional characterization of these different artifacts enabled us to establish whether the ancient craftspeople acquired different raw materials depending on the function of the final products. Additionally, the study of different types of ceramic material enabled us to establish new perspectives on the management of resources and its connection with the construction of landscape and taskspaces. Finally, this sampling strategy enabled us to assess in depth the relationships between different technologies (Tite, 1999; 2008).

The 48 selected samples were sectioned and polished for petrographic and textural characterization by optical microscopy. The optical examination of thin sections was performed using a petrographic microscope Leica DM2500P, which incorporates a micrometer. The lenses ranged from x16 to x400 magnifications. Photomicrographs of the samples were taken with a Leica DFC295 digital camera. The quantity of each compound was established using comparative charts (Matthew et al., 1991). Descriptions of the thin sections were made following the procedure

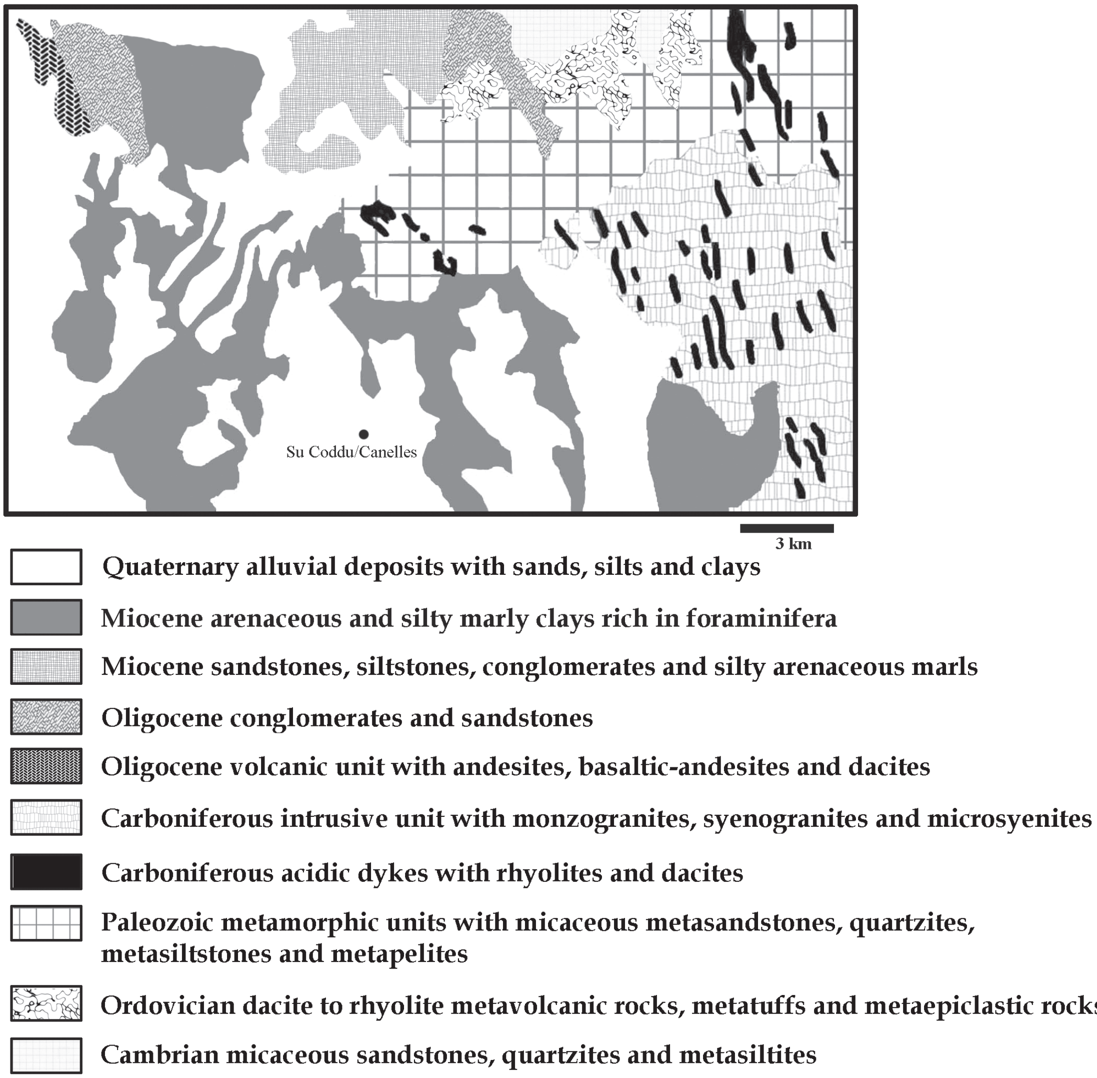

Figure 2. Simplified geological map of the study area (Source: Carmignani et al., 1996).

developed and detailed by I. Whitbread (1995). In addition, textural concentration features (TCF) were characterized considering the observations made by I. Whitbread (1986) and N. Cuomo Di Caprio and S. Vaughan (1993). In addition to the conventional petrological analysis, we also conducted micropaleontological analysis of constituent calcareous microfossils by means of thin section. As a number of researchers observe (Quinn and Day, 2007; Quinn, 2008), the study of microfossils represents a potential tool for determining the provenance of ceramics and raw materials involved in ceramic production.

RESULTS

The petrographic analysis enabled us to confirm that 50% of the studied samples are related to the use of marly clays. These clays have abundant sands and microfossils, whereby the presence of planktonic foraminifera is particularly remarkable. This type of material was already identified in previous studies on the pottery (Melis et al., 2006; Gradoli et al., 2013), the coatings of architectural structures (Mameli and Melis, 2008) and the loom weight (Albero, 2014b) from this archaeological site although not interpreted based on the theoretical background proposed in this paper. The remaining samples are associated with materials from other sources. These sources, which are quantitatively less significant, are related to diverse igneous, metamorphic and volcanic deposits located in inland areas. The detailed description and interpretation of these deposits with respect to their presence in the archaeological site is beyond the scope of this paper and consequently will be addressed in future publications.

Among the samples associated with the use of calcareous marls, we could distinguish diverse fabrics (see supplementary file Table S1 on the site) depending on grain size, the number of microfossils, the technical solutions observed and the type of archaeological material studied (i.e., pottery, clay coatings or loom weight). In certain cases, these fabrics are connected with the exploitation of diverse clay outcrops within the same geological unit, whereas in other cases, they are related to other technological choices, such as the addition of temper.

Pottery samples

Coarse-textured calcareous fabric

The micro structure of these samples has very few voids (2-3%) and ranges from dominant meso/macro-vughs and meso-channels to rare macro/meso-vesicles and very rare mega-vughs. The pores are open-spaced and well oriented along axes parallel to the vessel margins, occasionally partially filled with completely alloctonous secondary calcite. The non-plastic inclusions are single-spaced and poorly oriented in parallel with the vessel margins. The groundmass is dominant and heterogeneous through the section. The color is light brown (PPL, x400) to orange-brown (XPL, x400). This is a crystallitic b-fabric with a highly calcareous and optically active micromass. Planktonic (e.g., *Globigerina, Orbulina bilobata*) and benthonic foraminifera (e.g., *Cibicides,* miliolids*, Lenticulina, Lobatula*) occasionally filled with micro-spathic calcite, echinoid fragments, sponge spicules and red algae remains (Corallinacean) are highly abundant in the clay matrix.

The quantity of inclusions ranges from 25 to 30% (Figure 3a and 3b). The inclusions have a bimodal grain-size distribution with poorly sorted sub-angular to rounded coarse inclusions and rock fragments set in a finer-grained groundmass with foraminifera and sub-rounded to rounded inclusions ($c:f_{10\mu}:v$=66:24:10 to 57:37:6). The coarse fraction (i.e., very fine granules and fine sand) is dominant in the sample with a modal grain size of 1 mm in the long dimension. Monocrystalline quartz and K feldspar occasionally exhibiting perthitic structures (Figure 3c) are dominant within the coarse fraction although plagioclase and biotite laths are also commonly observed in the sections. Few sandstone, siltstone and muscovite laths are present in this fabric. Slate, phyllite, igneous rock fragments and volcanic tuff are observed in a very low amount in certain samples. Many grains have a moderately optically active thin coating on the perimeter that contains iron oxide, which appears as a faint orange color at the edges.

Fine-textured calcareous fabric

The microstructure and groundmass of this fabric have approximately the same features as the former. However, the microstructure differs with respect to the type of voids that are present. In this case, the voids range from dominant meso/macro-vughs and meso-vesicles to a small number of macro-vesicles and rare mega-channels and macro-planar voids. The pores are open to double-spaced and poorly oriented diagonally to or parallel with the vessel margins. The non-plastic inclusions are poorly to non-oriented in parallel with the vessel margins. The groundmass is typically homogeneous through the section. Planktonic (e.g., *Globigerinoides trilobus, Globorotalia peripheroacuta, Orbulina bilobata*) and benthic foraminifera (e.g., *Lobatula lobatula, Bolivinidae*) (occasionally filled with micro-spathic calcite), echinoderms, bryozoa, bivalves and coralline red algae (*Rodoficies*) are abundant in the clay matrix.

The differences primarily relate to the texture because this fabric has a decreased (15 to 20%) number of inclusions (Figure 3d). The inclusions consist of a small number of moderately sorted sub-angular to rounded coarse inclusions (i.e., coarse to fine sand) and rock fragments set in a substantially more finely grained calcareous groundmass that is rich in foraminifera with sub-rounded or rounded inclusions (Figure 3e). The fine fraction is dominant in all of the samples with a modal grain size of 0.12 mm in the long dimension ($c:f_{10\mu}:v$=17:80:3 to 32:53:15). The minerals and rocks observed and their frequency are highly similar to those documented in the previous fabric: monocrystalline quartz, K feldspar (microcline, orthoclase) and plagioclase occasionally partially altered to sericite, biotite and muscovite laths, siltstone, shale, phyllite and sphereulitic volcanic rock fragments (Figure 3f). However, in this fabric, we identified a higher diversity in the types of sandstone present (i.e., quartz-arenite, micaceous sandstone, calcareous sandstone, arkose) and the common presence of calcimudstone and few bioclasts, intraclasts, micro-spathic calcite, polycrystalline quartz and chert. There are also rare to absent biomicrite rock fragments, quartzite, pure amorphous nodules, and epidote. The presence of these minerals and rocks suggests the use of the same geological unit as in Fabric 1 although probably exploited from a more distal outcrop with a greater degree of erosion of the inclusions and a larger quantity of carbonate rocks.

Several types of argillaceous rock fragment related to clay pellets could be identified in the samples. They include clear, rounded TCF with equant shape and high optical density. The features are typically discordant with the matrix and finer-textured. There are also sharp TCF with rounded to prolate shape and neutral optical density. In all cases, the groundmass is calcareous, optically active or moderately active and brown/light brown (PPL, x400) to dark brown or orange-brown (XPL, x400). The concentrations are very fine-textured and related to mudstones. Finally, in one case, there is a sharp equant and well-rounded impregnative amorphous concentrations up to 0.5 mm with very high density and features discordant with the matrix and finer-textured. The groundmass is moderately active, dark brown (PPL, x400) to black (XPL, x400) and related to a crystallitic b-fabric. These inclusions must be associated

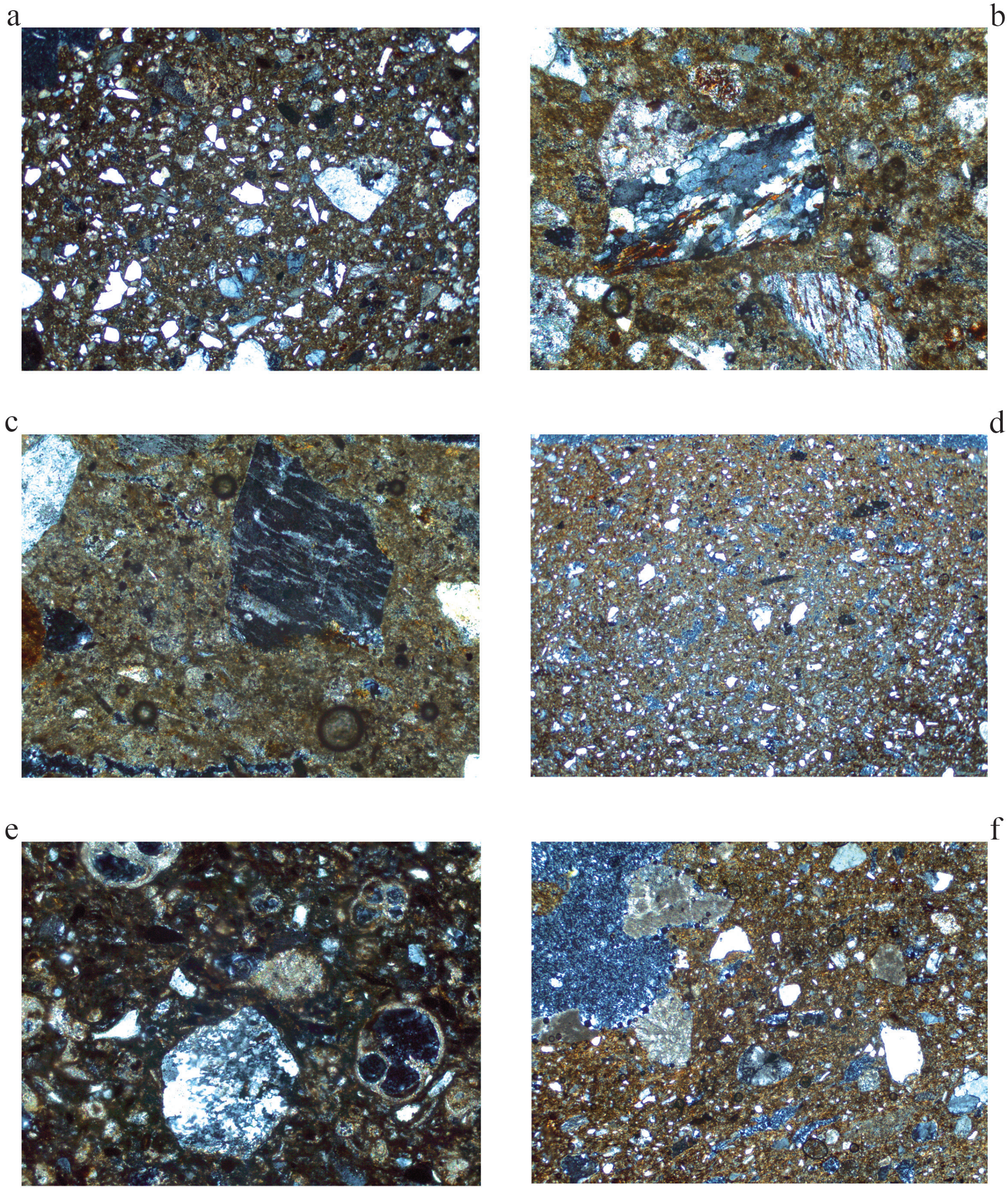

Figure 3. Calcareous fabrics: Thin-section micrograph of: a) a coarse-textured calcareous fabric that consists of a mix of metamorphic, sedimentary and igneous rock fragments (image width=8.3 mm; XPL); b) low-grade metamorphic rock fragments in a coarse-textured calcareous fabric (image width=1.3 mm; XPL); c) Typical perthitic structure in K feldspar in a coarse-textured calcareous fabric (image width=1.3 mm; XPL); d) a fine-textured calcareous fabric that consists of secondary fossiliferous marine clay containing a mix of metamorphic, sedimentary and igneous rock fragments (image width=8.3 mm; XPL); e) foraminifera, siltstone and calcimudstone in a fine-textured calcareous fabric (image width=1.3 mm; XPL); f) volcanic tuff and calcimudstone in a fine-textured calcareous fabric (image width=3.3 mm; XPL).

with amorphous material mixed with base clay to form clay pellets of pedogenic origin.

Very fine-grained calcareous fabric

This fabric has rare voids in the microstructure (1%), which range from dominant meso-vughs and meso-vesicles to very rare mega-vughs and planar voids. The pores and non-plastic inclusions are open-spaced and non-oriented along the vessel margins. The groundmass is light brown/brown (PPL/XPL, x400), highly calcareous, homogeneous and dominant through the section. Similar to the other fabrics identified in this paper, this sample is a crystallitic b-fabric with an optically active micromass. Planktonic foraminifera (e.g., *Globigerina praebulloides*) occasionally with micro-spathic calcite infilling cement and sponge spicules are very abundant in the sample (Figure 4 a,b).

In this case, the number of inclusions is low (10%), and the inclusions are sorted following an unimodal grain-size distribution with very few sub-rounded coarse inclusions (medium to fine sand) set in a substantially more finely grained calcareous groundmass very rich in foraminifera with well-rounded inclusions. The fine fraction is dominant in the sample with a modal grain size less than 0.12 mm in the long dimension ($c:f_{10\mu}:v=15:77:8$). The few inclusions observed within the coarse fraction consist of sub-rounded to rounded monocrystalline quartz, K feldspar and several chlorite laths. Quartz is also the predominant mineral in the fine fraction although muscovite laths are also commonly observed. Plagioclase and k feldspar were also documented although in lesser quantities. Finally, a number of pure amorphous nodules could be observed in the section.

This vessel is unique within the analyzed record and must be related to a figulina (i.e., very plastic and light-colored clay). This sample represents a highly calcareous fabric associated with a very fine clay with silt and very fine sand that stands out because of its high number of foraminifera and spicules. Additionally, this fabric lacks the metamorphic and igneous rock fragments observed in the other fabrics. Thus, the use of more distal sediments related to hemipelagic and turbiditic mudstones, which were formed at greater depth than the other identified clays, can be assumed.

Calcareous clay tempered with acid igneous rocks

The porous microstructure and groundmass of these samples are highly similar to the microstructure and groundmass observed in Fabric 2. However, the pores are open to single-spaced and the inclusions close to single-spaced and oriented in parallel with the vessel margins in certain samples. Additionally, there are slight differences in the groundmass of two samples, which can be related to clay mixing. The remaining variations between the samples are only in terms of matrix color and grain size. The color is light/dark brown to gray (PPL, x400) and orange-brown to dark gray or brown (XPL, x400). This is a crystallitic b-fabric with an optically active to moderately active micromass. A large number of planktonic (e.g., *Globigerina praebulloides, Globorotalia peripheroronda, Orbulina suturalis*) and benthonic foraminifera (e.g., *Bolivinidae, Lenticulina*), most of which are filled with micro-spathic calcite, and sponge spicules were identified within the calcareous matrix. In certain cases, the foraminifera are poorly preserved.

The number of non-plastic inclusions is highly homogeneous (15-20%). The inclusions have a clear bimodal grain-size distribution (Figure 4c) with poorly to moderately sorted angular to rounded coarse inclusions and rock fragments (very fine granules to fine sand) set in a substantially more finely grained calcareous groundmass rich in thermally altered foraminifera and sub-rounded to rounded inclusions. The texture is variable ($c:f_{10\mu}:v=65:25:10$ to $24:66:10$) although the coarse fraction is dominant in nearly all of the samples with a modal grain size of 0.5 mm in the long dimension. Plagioclase (anorthite/albite) and K feldspar (microcline, sanidine, anorthoclase) crystals with a limited number of perthitic textures and occasionally surrounded by amorphous hypocoating impregnations are dominant within the coarse fraction. Additionally, monocrystalline quartz and bioclasts are commonly observed in the sections. There are few to absent sandstones, wackestones, calcimudstone, siltstone, polycrystalline quartz, muscovite and biotite laths. A number of pure amorphous nodules and amorphous, strongly to moderately impregnated hypocoatings and depletions are rarely present. Finally, volcanic and felsic igneous rock fragments were rarely observed (Figure 4d).

In a number of samples, several TCF could be identified. The TCF are related to argillaceous rock fragments and clay pellets. These TCF are sharp, clear to merging and well-rounded with equant to prolate shape and low to high optical density. Their features are discordant with the matrix and finer-textured. The groundmass is active to moderately optically active and brown or brown-orange (PPL, x400) to dark brown or reddish brown (XPL, x400).

This material is a moderately calcareous fabric rich in feldspar, quartz and micro-spathic calcite related to a calcareous depositional environment in which fine sand and silt formed by the decomposition of granitic igneous rocks predominate. Several aspects indicate that these fine-grained calcareous clays were tempered with igneous rock fragments (up to 10%): 1) the coarse fraction includes angular crystals that have not been altered by the erosive processes that are expected in this type of alluvial sediment. Additionally, this angularity has not been observed in any other calcareous fabric of the site. 2) The inclusions have a clear bimodal distribution, a feature that is related in most cases to the addition of temper to the paste (Quinn, 2013). 3) In contrast to the other fabrics, these samples do not have

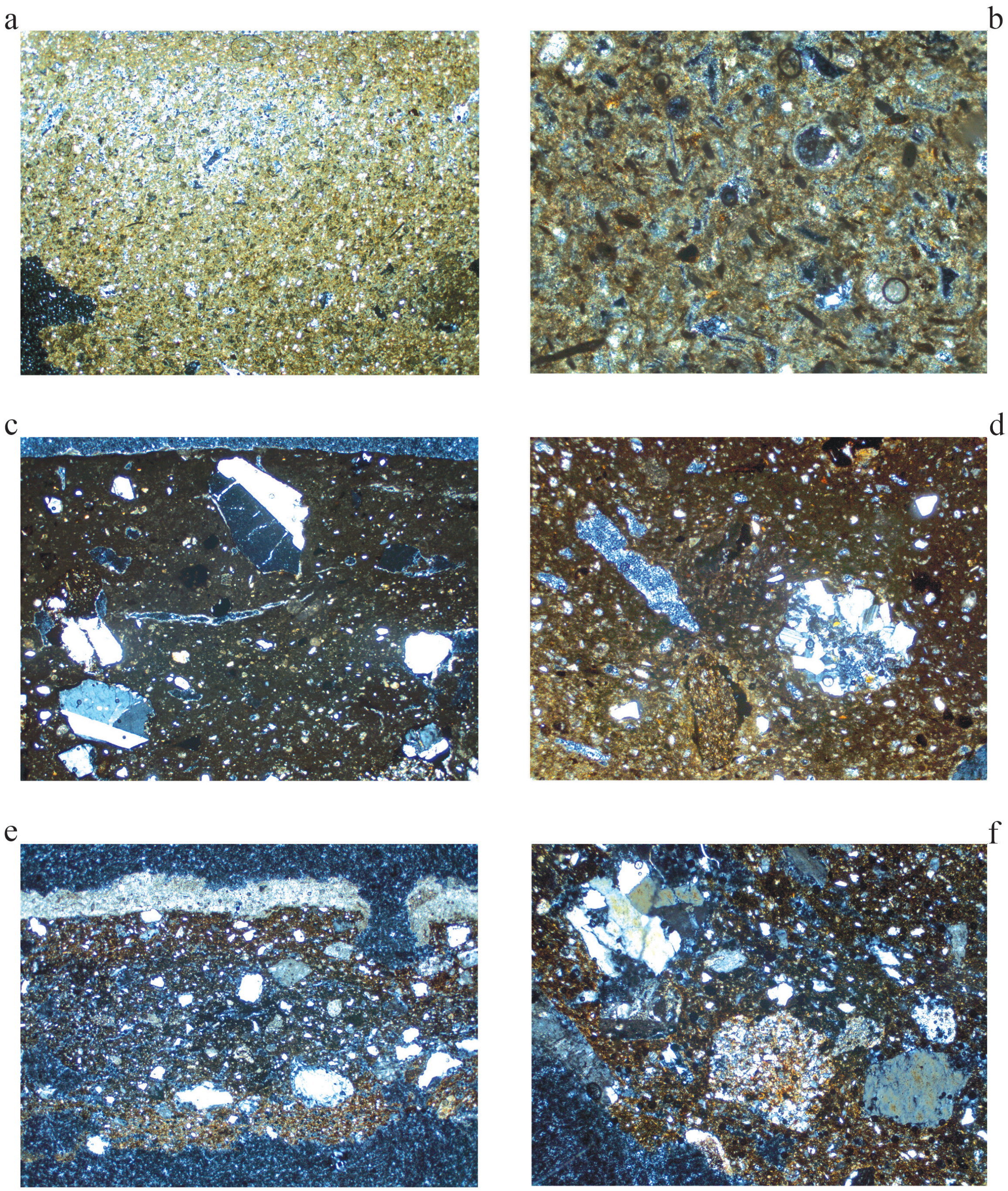

Figure 4. Thin-section micrograph of: a) Fabric 3 (image width=8.3 mm; XPL); b) planktonic foraminifera and sponge spicules in Fabric 3 (image width=1.3 mm; XPL); c) a fabric that consists of secondary calcareous clay rich in microfossils and possibly tempered with felsic igneous rock fragments (image width=8.3 mm; XPL); d) an acidic igneous rock fragment in the previous fabric (image width=3.3 mm; XPL); e) the Low Calcareous Fabric; Note the presence of completely alloctonous secondary calcite in the surface (image width=8.3 mm; XPL); f) a sandstone and a siltstone rock fragment in the Low Calcareous Fabric (image width=3.3 mm; XPL).

feldspar crystals altered to sericite, which indicates that the grains were not exposed to intense hydrothermal alteration processes. Finally, two samples have a heterogeneous clay matrix with streaks. These streaks consist of black fringes with quartz and feldspar crystals, which are sorted following a grain size that differs from that observed in the primary clay matrix. This heterogeneity can be related to possible clay mixing, i.e., highly calcareous clay rich in foraminifera mixed with darker non-calcareous clay without foraminifera less affected by alteration processes.

Low calcareous fabric

The porous microstructure and groundmass of these samples are analogous to those observed in Fabric 2. However, few foraminifera, such as planktonic taxa (e.g., *Orbulina bilobata, Globigerina praebulloides*) and sponge spicules, which were poorly preserved, could be identified within the calcareous matrix. The number of non-plastic inclusions is homogeneous (15%) in this fabric and has a bimodal grain-size distribution with poorly sorted sub-angular to rounded coarse inclusions and rock fragments (very coarse to fine sand) set in a finer-grained calcareous groundmass with a limited number of foraminifera and sub-rounded to rounded inclusions (Figure 4e). The coarse fraction is dominant with a modal grain size of 0.3 mm in the long dimension ($c:f_{10\mu}:v$=45:40:15 to 55:28:17). Monocrystalline quartz and K feldspar are dominant within the coarse fraction and fine fraction although plagioclase is also commonly present. Additionally, there are few siltstones, metasandstones and muscovite laths and flakes (Figure 4f). Clay pellets that consist of sharp TCF with high optical density are rarely observed in several samples. These samples stand out because of their thinner walls and the lower presence of microfossils and carbonate sedimentary rocks. The vessels of this fabric were shaped with more proximal deposits related to low calcareous clays that include sedimentary and metamorphic rock fragments as well as minerals derived from igneous rocks.

Loom weight

The few voids in the microstructure of this sample (5%) are predominantly meso/macro-vughs and macro/meso-vesicles. The pores are open-spaced and non-oriented along the vessel margins. The non-plastic inclusions are close to single-spaced and non-oriented in parallel with the vessel margins. The groundmass is dominant and homogeneous. The micromass is optically active and light brown (PPL, x400) to brown (XPL, x400). This is a crystallitic b-fabric with a highly calcareous matrix. Planktonic foraminifera (e.g., *Globigerina praebulloides, Globorotalia mayeri, Globorotalia peripheroronda, Orbulina bilobata*) sponge spicules and a small number of ostracods were documented.

The inclusions have an unimodal grain-size distribution with a very small number of very poorly sorted sub-rounded to rounded coarse inclusions (very coarse sand to fine sand) set in a finer-grained groundmass with sub-rounded or rounded inclusions (Figure 5a). The fine fraction is dominant in the sample with a modal grain size of 0.12 mm in the long dimension ($c:f_{10\mu}:v$=15:71:14). Monocrystalline quartz is dominant in the coarse fraction although K feldspar, siltstone and bioclasts are also commonly observed. Calcimudstone, plagioclase, pure amorphous nodules, polycrystalline quartz and biotite laths and flakes are also present in the section. Quartzite and phyllite rock fragments (Figure 5b) as well as sandstone, sphereulitic volcanic rock fragments, basic igneous rocks and epidote are observed rarely to very rarely. Monocrystalline quartz is dominant in the fine fraction although K feldspar is also frequent. In addition, plagioclase, micro-spathic calcite and pure amorphous nodules commonly occur in the section. There are a small number of biotite and muscovite laths within this fraction, whereas epidote and staurolite are rarely observed. There are a small number of TCF related to argillaceous rock fragments and clay pellets. These TCF are clear equant to prolate of very large size (<4.8 mm; mode=1.8 mm) with rounded and well-rounded shapes as well as slightly high optical density. The features are relatively concordant with the surrounding matrix but finer. The matrix is highly calcareous grayish brown (PPL/XPL, x400) and moderately optically active. The inclusions and the pores are not oriented along the feature margins. This sample represents an unfired loom weight made from a marly clay rich in foraminifera and silt. The dominant inclusions and rock fragments observed originated in felsic igneous rocks, such as granites, and to a lesser extent in metamorphic rocks with a low degree of metamorphism.

Wall coatings

The study of the clay coatings for architectural structures was organized using three layers according to the procedure applied by Piovesan et al. (2009), who distinguish between the following: 1) Scratch coat: a rough layer of clay which is applied on the smooth surface of a wall; 2) *Arriccio*: a series of layers made with sand and mortar; 3) *Intonaco*: the last layer, which consists of lime mortar and very fine sand. Although the samples analyzed here do not completely fit this description, these terms are useful to describe the diverse layers identified in the wall coatings. In this paper, we only focus on the first two layers (Figure 5c to 5f). All these samples have been classified in the same petrogroup, thus no differences in the clay materials used to build the different structures studied could be observed.

Scratch coat

The few voids observed in the microstructure of these samples (5-15%) are predominantly macro and meso-vughs and common macro-vesicles. The pores are normally open-spaced and oriented along the surface margin of the wall, whereas the non-plastic inclusions (15-30%) are open to single-spaced and non-oriented. The groundmass is dominant, light/dark brown to yellow/yellowish black (PPL, x400) and light/dark brown or black (XPL, x400). This is a crystallitic b-fabric with a calcareous matrix and an optically active micromass. Regarding the micropaleontological identification, we highlight the presence of bivalve fragments, poorly preserved planktonic (e.g., *Globigerina praebulloides, Praeorbulina sicana, Praeorbulina glomerosa, Globigerina* sp., *Globorotalia* sp.) and benthonic (e.g., *Lenticulina*) foraminifera and

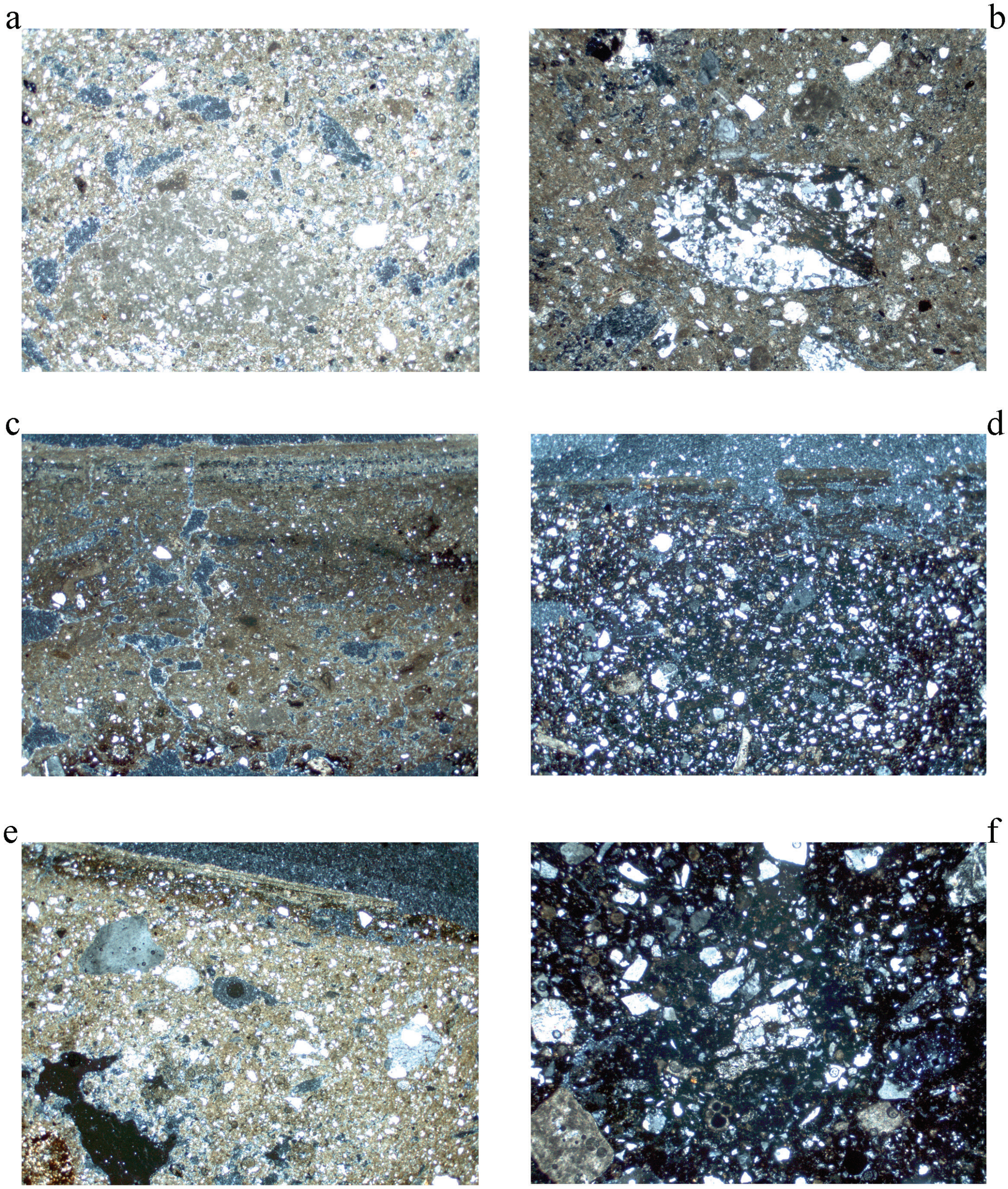

Figure 5. Thin-section micrograph of: a) the fine-textured paste used to produce the loom weight (image width=8.3 mm; XPL); b) a phyllite rock fragment in the loom weight (image width=3.3 mm; XPL); c) the three layers identified in a clay coating; Note the fine-textured paste of the *arriccio* and *intonaco* layers (image width=8.3 mm; XPL); d) Thin-section micrograph showing the coarser texture and black color of the scratch coat layer (image width=8.3 mm; XPL); e) the three layers identified in a clay coat; Note the different color of the *arriccio* layer (image width=8.3 mm; XPL); e) the scratch coat layer and the presence of calcimudstone and planktonic foraminifera (image width=3.3 mm; XPL).

sponge spicules.

The inclusions have a bimodal to polymodal grain-size distribution with poorly sorted subrounded to rounded coarse inclusions and rock fragments (very coarse to fine sand) set in a finer-grained groundmass with sub-rounded or rounded inclusions. The fine fraction is dominant with a modal grain size of 0.12 mm in the long dimension ($c:f_{10\mu}:v$=22:68:10 to 33:60:7). As observed in the previous fabrics, monocrystalline quartz is dominant in the coarse fraction although K feldspar is also commonly observed. Plagioclases, calcimudstone, chert, sandstone/metasandstone, biotite flakes, pure amorphous nodules and polycrystalline quartz are also present in the sections. In addition, shale, siltstones, augite, felsic and basic igneous rock fragments and volcanic rock fragments with crystal aggregates that form radiate to sphereulitic shapes are rarely present in certain samples. A number of elongated pseudomorphic amorphous depletion features related to organic fibers could also be identified. Finally, TCF related to argillaceous rock fragments could be rarely documented in few samples. These TCF are sharp or clear rounded with equant to prolate shape, high optical density and features discordant with the matrix and finer-textured. The groundmass is optically active to moderately optically active and brown (PPL, x400) to dark brown or black (XPL, x400).

Arriccio

The micromass and porous microstructure of this layer are highly similar to those of the previous layer although in this case the voids are open to single-spaced and poorly oriented along the surface margins of the wall. Several pores have completely alloctonous secondary calcite. The variations between the samples occur in terms of microstructure and the number of non-plastic inclusions. The non-plastic inclusions have the same characteristics as those in the scratch coat with respect to their orientation, size and shape. There are fewer inclusions (10-15%) in this layer, and the inclusions have a bimodal grain-size distribution with sub-angular to rounded coarse inclusions and rock fragments set in a finer-grained groundmass ($c:f_{10\mu}:v$=15:75:10 to 10:60:30). The mineralogical composition is analogous to that observed in the previously discussed layer. However, the previously observed rare to absent basic igneous rock fragments were not identified in this layer. In one case, there is a sharp to merging well-rounded TCF (i.e., a clay pellet) of up to 3.2 mm length with a prolate shape and neutral to high optical density with features concordant with the matrix.

In the studied samples, the covering of the walls was made by the application of successive layers. First, a thick, coarse-textured layer (the scratch coat) with microfossils that was also more or less rich in organic matter would have been applied. The presence of the organic matter gives the layer dark coloration, as observed in most of the samples. In certain samples, there are preserved remains of organic fibers. The next layer (*arriccio*) was applied on the former and varies in thickness (0.6-4.9 mm) and coloration. This layer is typically fine-textured and contains organic matter fibers. Finally, a milk lime coating (*intonaco*) was applied on top of the previous layer.

DISCUSSION

Raw material procurement and landscape construction

The petrological and paleontological analysis of the ceramics of Su Coddu/Canelles enables us to determine the origin of the raw materials used to produce the artifacts. The occurrence of the foraminiferal taxa reported (Figure 6) in all of the fabric types is consistent with the microfossil record of the Marne di Gesturi and Argille di Fangario formations, which are dominated by hemipelagic, Miocene deposits ascribed to N7-N8 Blow's biozones (upper Burdigalian to middle Langhian) and N8-N12 (middle Langhian to lower Serravallian), respectively. The occurrence of few benthonic foraminifers, typical of shallower environments (e.g., mioliolids, *Cibicides, Lobatula*) might indicate contamination from the Arenarie di Pirri Unit (Serravallian) that corresponds to a more littoral environment. The most widely accepted interpretation considers the Argille di Fangario Formation to be younger than the Marne di Gesturi and the latter to be older than the Arenarie di Pirri. However, in several locations, the Marne di Gesturi Formation is directly in contact with the Arenarie di Pirri (Serravallian). According to these observations, the Argille di Fangario could be coeval with the Marne di Gesturi but represent more distal conditions (Barca et al., 2005). In fact, the direct contact between the Marne di Gesturi and the Arenarie di Pirri might favor contamination by transferring sediments from the upper unit to the lower one during materials obtention.

All of the studied samples are characterized by a crystallitic b-fabric with an optically active groundmass. The samples have a calcareous matrix rich in foraminifera as well as abundant silt and fine sand that include sedimentary, granitic and to lesser extent metamorphic rock fragments. Thus, ancient craftspeople used a clay deposit of marine origin with alluvial sediments that primarily consisted of quartz-feldspar sandbars derived from the erosion of felsic igneous rocks and clasts of metamorphic rocks with a low degree of metamorphism. These alluvial materials were redeposited in the marine clays. The alteration of the feldspar to sericite indicates that these materials underwent significant hydrothermal processes, probably during their redeposition. In addition, it was well documented the presence of volcanic ash and tuff in the sections that are related to the presence of pyroclastic facies associated with volcanic eruption events. In short, the optical analysis suggests the use of marly clays of marine origin for the production of a wide range of artifacts. The high number of samples identified in the site that are related to this type of deposit makes clear the significance that raw materials located in lagoonal and coastal areas had in the daily life of the ancient communities under study.

In sum, the features of the marly clays used to produce the artifacts are in agreement with the composition of the Miocene deposits associated with the Marne di Gesturi,

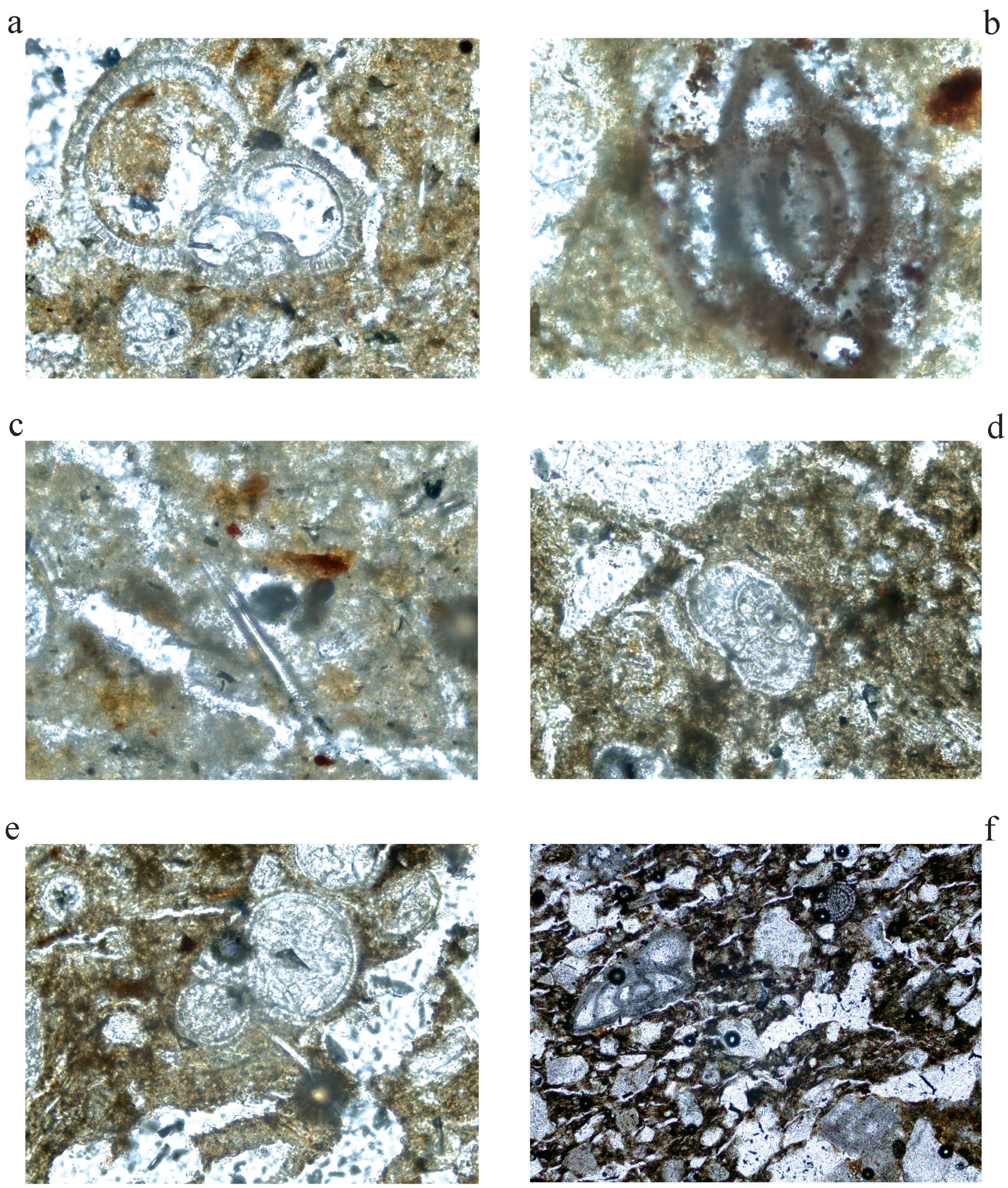

Figure 6. Thin-section micrographs of microfossils identified in the ceramic artefacts analyzed. a) *Globorotalia mayeri* (image width=0.32 mm; PPL); b) Miliolid (image width=0.32 mm; PPL); c) Sponge spicules (image width=0.32 mm; PPL); d) *Globorotalia continuosa* (image width=0.32 mm; PPL); e) *Globigerinoides altiapertus* (image width=0.32 mm; PPL); f) *Lobatula lobatula* (image width=1.3 mm; PPL).

which appears in a significant area of the surrounding territory of the site (<1 km), or the Formazione di Fangario (Barca et al., 2005). The latter deposit is well documented in the vicinity of the archaeological site, both in the west and under the Quaternary alluvial sediments (Mameli and Melis, 2008). The exploitation of these clay deposits by the individuals who inhabited the area would have been far easy thanks to the presence of a stream located in the east side of the site as well as a small swamp (disappeared in Modern times) placed in the west side. These deposits have abundant planktonic foraminifera, pelagic fauna, mollusks, echinoids, benthonic fauna and corals. Additionally, they possess pyroclastic and epiclastic facies that consist of interbedded conglomerates and sands in a clay matrix with clasts of volcanic rocks formed by pumice, sanidine crystals, plagioclase, biotite, quartz and volcanic glass.

The results suggest that as it is typical in many contemporary pre-industrial communities (Arnold, 1985, 2006) the raw materials were primarily procured from the environment nearest to the archaeological site from locations in which the clays were easily accessible and readily available. Thus, the settlement was established close to the raw materials, which reduced the cost of acquisition from an economic viewpoint. The organization of a settlement in a territory and its relationship with available resources can determine a clear preference for exploiting certain raw materials (Arnold, 2000). As previously stated, resources are scattered across the territory. Thus, individuals could use preferential exploitation strategies depending on the spatial pattern adopted, the existence of taskspaces and the way in which the landscape was constructed. The petrological analysis of the ceramic assemblage indicates the preferential use of coastal lagoonal areas, which were substantially more exploited than the inland landscapes that would have had a marginal utility.

In this regard, it is well known that the current lagoon of Stagno di Molentargius, where the archaeological site is located, was formed by a series of lagoons connected to the sea during the 4th millennia BC (Massoli, 1976). During this period, there was a strong link between the local communities and these marine wetland areas. In addition to the exploitation of the clayish resources noted above, the interaction of the individuals with coastal resources had also been demonstrated by archaeobotanical research focused on the analysis of the biotic materials recovered from the site. An example of this important relationship is the significant presence of malacofauna and other marine resources in the archaeological site (Melis, 2005; Melis et al., 2012) and the use of this malacofauna and even flamingo bones to produce diverse tools (Manca, 2013). The use of plants typical of wetland environments to build architectural structures and to produce basketry (Melis et al., 2012) has also been documented. All of this information regarding the management of abiotic and biotic resources is consistent and enables us to confirm that coastal areas and their resources were essential in the development of taskspaces that played an important role in the construction of the landscape of these communities. Additionally, it is clear that an intensive interaction between different technologies occurred in these coastal taskspaces not only with respect to the procurement of clays to produce diverse ceramic artifacts but also with respect to technologies with an abiotic and biotic basis.

Although we have noted the connection between different types of artifact and the preference for exploiting resources from coastal environments, it should be stated that there are certain differences between the identified fabrics that indicate that the artisans had a degree of freedom of choice. For example, although Fabrics 1, 2 and 5 display certain similarities, they exhibit differences in grain size and the number of inclusions and microfossils. A different sourcing point-either more proximal or distal-within the same marly clay deposit of marine origin can be suggested for all of these fabrics. The same occurs with Fabric 3, which has a very low amount of coarse inclusions and is associated with the exploitation of a different resource. However, this material is also linked to coastal and lagoonal environments. Thus, this diversity in the raw materials exploited evidences a wide mobility of the individuals throughout the lagoonal and coastal landscape of Selargius and Cagliari.

Other differences among the samples are related to technological reasons, as is the case of Fabric 4, which has a matrix that is highly similar to that of the previous fabrics. However, this fabric has a larger degree of heterogeneity because of the addition of crushed igneous rocks as temper to fine calcareous clays and perhaps the admixture of clays in certain samples of this fabric. All of these differences make clear that despite the exploitation of resources from the same type of environment the use of different technological choices in the production was socially accepted. That is, the existence of specific links between the individuals and the communal construction of their landscape did not forbid them a certain degree of leeway.

Intra-technological relationships

The petrological and paleontological analyses indicate that marly clays of marine origin were used in the production of pottery, coatings for architectural structures and loom weights. Thus, there is a clear connection between the composition and texture of the inclusions and rocks, as well as the microfossils, observed in the Fabric 2 and the fabrics associated with clay coatings and loom weights. This connection suggests the use of the same raw material. The regular use of this material to produce a wide range of ceramic artifacts reveals a lack of functional specialization regarding the selection of a specific raw material for each type of artifact. However, this fact also indicates that the ancient potters had a thorough knowledge of the physical properties of the raw materials and their possibilities with respect to the production of ceramic objects intended for diverse functions. In any case, the common exploitation of this type of resource-although performed using different technologies- has significant social consequences because the raw material procurement is fully involved in the interactions that the individuals establish among themselves and the way in which they construct their landscape. Thus, two different interpretative models can be suggested:

a) The existence of diverse groups of individuals dedicated to the production of different types of ceramic artifact but exploiting the same raw material. In this case, a high degree of social interaction between the craftspeople dedicated to different activities related to the transfer of knowledge regarding the resource and its physical properties can be assumed. This interaction also implies the creation of links between the individuals who exploited the raw materials, located the resources and understood the landscape by means of a common rationale. These links resulted in the creation of specific taskspaces, which were embodied by the interrelated activities that were performed in certain areas of the territory. This spatial interaction would have caused the creation of communal identity bonds between at least some members of the community.

b) It should be considered that potters could also be involved in other activities, such as textile manufacture and the construction or maintenance of dwellings, thus exploiting the raw materials and producing the tools they required to undertake these activities. The practice of a wide range of activities by a single individual is well documented by several ethnoarchaeological case studies. For instance, it has been commonly observed how the production of pottery and the application of clay coatings on domestic structures are often associated with women in many societies (e.g., Hodder, 1982; Albero et al., 2013). Therefore, activities such as the application of clay to coat the walls of the dwellings and the production of vessels and loom weights could have been performed by the same individuals. In this case, the exploitation and use of clays from coastal environments would have been embedded in the emergence of certain identities, including gender identity.

CONCLUSIONS

This petrological and paleontological study enabled us to address how the craftspeople active at the archaeological site of Su Coddu/Canelles preferentially exploited certain clays to produce different types of ceramic artifact during the Early Copper Age. There was a clear preference to exploit Middle Miocene fossiliferous marly clays-usually with coarse sand and primarily fine sand and silt-which were readily accessible and found close to the site. Regardless whether the exploitation of these clays involved different craftspeople, from the viewpoint of landscape archaeology, the regular exploitation of these resources resulted in the development of a common manner of conceptualizing the landscape and its various elements among the members of this community. As discussed in the paper, in addition to other mineral resources, the clays themselves could have played a significant role in this shared rationale.

The procurement of these clays transcended ecological aspects or the maximization of the invested energy and was related to locations that were loaded with social meaning and embedded in the social spaces of the community and the identity bonds created by its members. Therefore, these resources functioned as an essential element in the environment in which human beings lived and developed a wide range of activities in their daily life. Using these resources, people could establish close ties with the territory through lived and shared experiences, social relationships and memories. Thus, the communal exploitation of a particular clay deposit located in a specific area could reinforce the links between the members of the community as well as between them and a particular territory. From this perspective, we should not omit to emphasize the significance that these deposits could have had in the construction of the landscape and the identity of the inhabitants of Su Coddu/Canelles.

REFERENCES

Albero D. (2014a) Materiality, Techniques and Society in Pottery Production: The Technological Study of Archaeological Ceramics through Paste Analysis. De Gruyter Open Ltd, Warsaw/Berlin.

Albero D. (2014b) Caracterización arqueométrica de una pesa de telar de Su Coddu/Canelles. In: Lo instrumentario tessile della preistoria. I pesi da tellaio della Sardegna. (ed.): M.G. Melis, Quaderni del LaPArS 1, Sassari, 225-232

Albero D. (2016) Interpreting long-term use of raw materials in pottery production: an holistic perspective. Journal of Archaeological Science: Reports. DOI: 10.1016/j.jasrep.2016.04.008

Albero D., Calvo M., Javaloyas D., García, J. (2013) Homología y redes de aprendizaje: una aproximación a la producción de cerámica konkomba (NE Ghana). In: II Congreso Internacional sobre Estudios Cerámicos: Etnoarqueología y experimentación, más allá de la analogía. (eds.): J. Padilla, E. Alarcón, L. Arboledas and L. Chapon, Universidad de Granada, Granada, 19-21.

Arnold D. (1985) Ceramics theory and cultural process. Cambridge University Press, Cambridge.

Arnold D. (2000) Does the standarization of ceramic pastes really mean standarization? Journal of Archaeological Method and Theory 7, 333-375.

Arnold D. (2006) The Threshold Model for ceramic resources: A Refinement. In: Ceramic Studies: Papers on the social and cultural significance of ceramics in Europe and Eurasia from prehistoric to historic times. (ed.): D. Gheorgiu, BAR International Series 1553, Archaeopress, Oxford, 3-9.

Barca S., Melis E., Annino E., Cincotti F. (2005) Note Illustrative della Carta Geologica d'Italia alla scala 1:50.000, foglio 557, Cagliari. Servizio Geologico d'Italia. Carta Geologica d'Italia 1:10.000.

Bender B., Hamilton S., Tilley, C. (2007) Stone Worlds. Narrative and Reflexivity in Landscape Archaeology. Left Coast Press, Walnut Creek, CA.

Carmignani L., Barca S., Oggiano G., Pertusati P., Salvador I., Conti P., Eltrudis A., Funedda A., Pasci S. (1996) Carta Geológica della Sardegna 1:200.000. Servizio Geologico Nazionale d'Italia.

Costin C. (1998) Introduction: Craft and Social Identity. In: Craft and Social Identity. (eds.): C. Costin and R. Wright, Archeological Papers of the American Anthropological Association 8, 3-8.

Cuomo Di Caprio N. and Vaughan S. (1993) An Experimental Study in Distinguishing Grog (Chamotte) from Argillaceous Inclusions in Ceramic Thin Sections. Archeomaterials 7, 21-40.

Gradoli M.G., Manunza M.R., Meloni, P. (2013) Artecraft at the prehistoric village of Canelles - Selargius (Cagliari, Sardegna) interpreted through its pottery technology. A petrological characterization study and a provenance analysis. Poster presented in the 12th European Meeting on Ancient Ceramics, Padova, 19th-21st September.

Hodder I. (1982) Symbols in action. Cambridge University Press: Cambridge.

Ingold T. (2000) The temporality of the landscape. In: The perception of the environment: Essays on livelihood, dwelling and skill. (ed.): T. Ingold, Routledge, London/New York, 189-208.

Knapp A.B. and Ashmore W. (1999) Archaeological landscapes: Constructed, conceptualized, ideational. In: Archaeologies of Landscape: Contemporary Perspective. (eds.): W. Ashmore and A. Knapp, Blackwell Publishers, Malden, MA, 1-30.

Mameli P. and Melis M.G. (2008) Intonaci in edifici in terra cruda negli abitati preistorici della Sardegna. Dati archeologici e archeometrici preliminari dall'insediamento di Su Coddu/Canelles (Selargius, CA). 84° Congresso della Società Geologica Italiana, Rendiconti online della Società Geologica Italiana 3, 515-516.

Manca L. (2013) Fonctionnement des sociétés de la fin du Néolithique au début de l'âge du Cuivre en Sardaigne. Une approche inédite à partir de l'étude des productions en matières dures animals. Unpublished doctoral dissertation, Université d'Aix - Marseille, France.

Massoli R. (1976) Lo stagno di Molentargius. Gia Press: Cagliari.

Matthew A.J., Woods A.J., Oliver C. (1991) Spots before the eyes: new comparison of charts for visual percentage estimation in archaeological material. In. Recent developments in ceramic petrology. (eds.): A. Middleton and I. Freestone, British Museum Occasional Paper 81, London, 211-264.

Melis M.G. (2005) Nuovi dati dall'insediamento preistorico di Su Coddu-Canelles (Selargius, Cagliari). In: Communities and Settlements from the Bronze Age to the Early Medieval Period. (eds.): P. Attema, A. Nijboer, A. Zifferero, BAR International Series 1452, Archaeopress, Oxford, 554-560.

Melis M.G. (2013) Problemi di cronologia insulare. La Sardegna tra il IV e il III millennio BC. In: Cronologia assoluta e relativa dell'età del Rame in Italia. (ed.): D. Cocchi Genick, QuiEdit, Verona, 197-211.

Melis M.G., Mameli P., Piras S. (2006) Aspetti tecnologici e morfologici della ceramica eneolitica. Nuovi dati dall'insediamento di Su Coddu-Canelles (Selargius, Cagliari). Atti della XXXIX Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria Materie prime e scambi nella Preistoria italiana Vol. II. Firenze: Istituto Italiano de Preistoria e Protostoria, 1232-1235.

Melis M.G. and Piras S. (2010) Les productions céramiques en Sardaigne au IV^{e} millénaire av. J.- C. Nouvelles données sur le village de Su Coddu-Canelles (Selargius, Cagliari). Préhistoires Méditerranéennes 1, 101-118.

Melis M.G. and Piras S. (2012) L'analisi morfo-tecnologica della ceramica come indicatore delle transformazioni tra l'Ozieri "classico" e "finale". Atti della XLIV riunione scientifica. La preistoria e la protostoria della Sardegna Vol. II. Firenze: Istituto Italiano di Preistoria e Protostoria, 563-569.

Melis M.G. and Piras S. (2014) Observazioni tecnologiche su alcuni pesi da telaio preistorici. In: Lo instrumentario tessile della preistoria. I pesi da telaio della Sardegna. (ed.) M.G. Melis, Quaderni del LaPArS 1, Sassari, 211-224.

Melis M.G., Zedda M., Manca L. (2012) The role of marine and inland water resources in economic organization of Eneolithic communities. New data from Sardinia (Italy). Journal of Life Sciences 6, 679-693.

Melis M.G., Celant A., Zedda M. (2015) L'impatto di un ambiente umido nella paleoeconomia e nella paleonutrizione tra il Neolitico e l'Eneolitico. Nuovi contributi dalla Sardegna. L Riunione Scientifica dell'istituto Italiano di Preistoria e Protostoria, Roma 2015. http://www.preistoriadelcibo.it/sessione2-download.html

Michelaki K., Braun G., Hancock R. (2014) Local Clay Sources as Histories of Human-Landscape Interactions: a Ceramic Taskscape Perspective. Journal of Archaeological Method and Theory. DOI 10.1007/s10816-014-9204-0

Piovesan R., Curti E., Grifa C., Maritan L., Mazzoli C. (2009) Petrographic and microstratigraphic analysis of mortar-based building materials from the Temple of Venus, Pompeii. In: Interpreting Silent Artefacts: Petrographic Approaches to Archaeological Ceramics. (ed.) P.S. Quinn, Archaeopress, Oxford, 65-79.

Quinn P.S. (2008) The occurrence and research potential of microfossils in inorganic archaeological materials. Geoarchaeology 23, 275-291.

Quinn P.S. (2013) Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section. Archaeopress, Oxford.

Quinn P.S. and Day P.M. (2007) Ceramic Micropalaeontology: The Analysis of Microfossils in Ancient Ceramics. Journal of Micropalaeontology 26, 159-168.

Roberts B. (1996) Landscapes of settlement: Prehistory to the present. Routledge, London.

Sillar B. (1997) Disputable pots and disreputable potters: Individual and community choice in present-day pottery production and exchange in the Andes. In: Not so much a pot, more a way of life. (eds.): C. Cumberpatch and P. Blinkhorn, Oxbow Monograph 83, Oxbow Books, Oxford, 1-20.

Sofaer J. (2006) Pots, houses and metals: Technological relations at the Broze Age Tell at Szazhalhalombatta, Hungary. Oxford Journal of Archaeology 25, 127-147.

Tilley C. (1994) Phenomenology of Landscape. Places, Paths and Monuments. Berg, Oxford/Providence.

Tilley C. (2004) The Materiality of Stone: explorations in landscape phenomenology. Berg, Oxford.

Tite M. (1999) Pottery production, distribution, and consumption: The contribution of the Physical Sciences. Journal of Archaeological Method and Theory 6, 181-233.

Tite M. (2008) Ceramic production, provenance and use: A review. Archaeometry 50, 216-231.

Whitbread I. (1986) The characterization of argillaceous inclusions in ceramic thin sections. Archeometry 28, 79-88.

Whitbread I. (1995) Greek Transport Amphorae: A Petrological and Archaeological Study. British School at Athens. Fitch Laboratory Occasional Paper 4. The British School at Athens, Athens.