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CERAMIC PRODUCTION IN THE PLAIN OF THE SELE RIVER. THE PRELIMINARY RESULTS OF THE ARCHAEOMETRIC ANALYSES

Introductory Note

This paper shows a first overview of the archaeometric study carried out in the frame of the project "Ceramic Production in the plain of Paestum" (2016-2018)[1], which allowed the analyses of a large number of ceramic samples from the area of the Sele River plain including the town of Poseidonia/Paestum and its territory and the Etrusco-Italic settlements of Pontecagnano and Fratte.

In this paper a preliminary interpretation of the results is presented, focusing on thin section petrographic analysis via Polarised Light Microscopy (PLM) and chemical analyses performed via X-Ray Fluorescence (XRF)[2] on pottery and clayey raw materials[3] from the area of Paestum. The samples have also been studied via an interdisciplinary approach, combining archaeological fabric analysis and mineralogical-petrographic techniques and complement and enlarge in a decisive way the already existing fabric classification of Paestum, published in 2011[4].

THE TERRITORY OF PAESTUM

Ceramic samples from Paestum and from the sacred areas and necropolis in its territory were analysed through an archaeometric approach in order to define their provenance. Samples are both represented by coarse wares, fine-grained ware, and terracottas, dated from the 5th to the 3rd century B.C[5].

Samples of fine ware belong to the class of black-glazed ware, to wares with figured decoration and to miniature vessels of the same period, with few black-glazed samples dated to the 6^{th}-5^{th} B.C. Samples of clayey raw materials have also been analysed in order to find possible sources of raw materials exploited in the past for these productions. They are represented by marine clayey sediments extensively cropping out at the foothills of the Soprano-Vesole Mountains in the proximity of the towns of Capaccio and Trentinara. Alluvial/lacustrine clays are also found in the sedimentary layers of the alluvial plain of the Sele River[6].

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[1] This research was funded by the Austrian Science Fund FWF in the framework of the Lise Meitner Programme (project number: M 1918-G25) and carried out by Alberto De Bonis (project leader) and Verena Gassner (co-applicant), see also De Bonis and Gassner 2018 in this edition of FACEM.

[2] PLM and XRF analyses were carried out at the Department of Lithospheric Research, Universität Wien, Vienna, Austria in cooperation with Prof. Theodoros Ntaflos. Chemical analysis was performed on powdered samples with a sequential Phillips PW 2400 X-ray spectrometer using fused pellets for major elements and powder pellets for trace elements. Thanks are due to Ilka Wünsche for thin section preparation and to Peter Nagl for XRF analysis.

[3] Regarding clays in this paper only XRF results are presented.

[4] See the contribution of Trapichler 2018a and 2018b in this edition of Facem and Gassner and Trapichler 2011.

[5] See for the contributions of Cipriani, Rizzo, and Serritella 2018 and Ferrara, Giacco, and Capece 2018 in this edition.

[6] See De Bonis and Gassner 2018 in this edition.

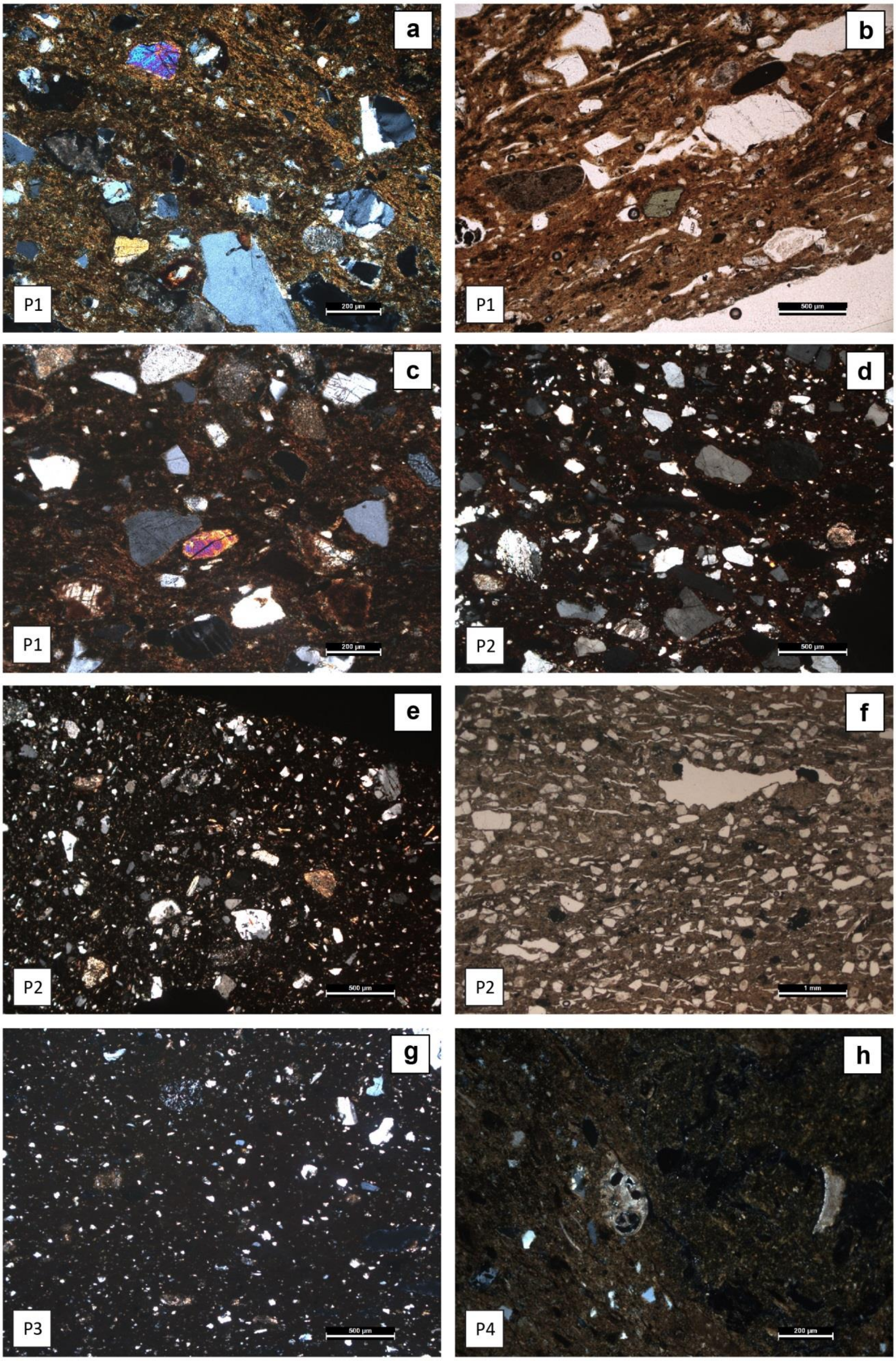

Fig. 1. Microphotographs showing the petrographic features of some representative samples of coarse ware. The petrographic groups P1, P2, P3, and P4 are also indicated. (a) M 26/23, common ware from the Heraion (crossed polars). (b) M 212/9, common ware from S. Nicola (parallel polars). (c) M 220/4, common ware from Capodifiume (crossed polars). (d) M 26/27, common ware from the Heraion (crossed polars). (e) M 213/7, figural terracotta from S. Nicola (crossed polars). (f) M 222/1, figural terracotta from Capodifiume (parallel polars). (g) M25/8, figural terracotta from the Heraion. (h) M26/26, common ware from the Heraion.

Coarse ware: common ware and figural terracotta

Coarse wares from the territory of Paestum are basically characterised by coarse, irregularly shaped, and abundant inclusions, mostly showing a siliciclastic composition. They are composed of frequent quartz and sandstone, along with occasional chert. Minor amounts of alkali feldspar, plagioclase, muscovite, and metamorphic rock fragments (schist, gneiss) also occur, along with occasional carbonate clasts often represented by microfossils or decomposed lumps. A large number of samples is also characterised by the presence of sporadic volcanic inclusions mainly represented by clinopyroxene and volcanic lithics (Fig. 1a–c). The petrographic composition of the inclusions in coarse wares is fully compatible with the geological features of the area, where predominantly siliciclastic-arenaceous and carbonate formations crop out along with less extended pyroclastic fall deposits related to the Somma-Vesuvius and Phlegraean Fields activity[7].

These features allowed for distinction of two large groups of samples with different petrographic features. A first group of samples, henceforth indicated as P1[8], is characterised by the presence of coarse siliciclastic and carbonate grains associated with volcanic inclusions. On the contrary, a second large group of samples (P2)[9] is characterised by the lack of volcanic inclusions (Fig. 1d–f); some of these samples show some variants as they do not contain carbonate inclusions.

The presence of samples belonging to groups P1 and P2 is independent from the ceramic class and the site of discovery. In the sanctuary of Capodifiume common ware belongs to P1 (Fig. 1c), except a lekane lid (M220/3) characterised by fine siliciclastic inclusions; terracotta figurines are characterised by a petrographic composition of P2, but differ for the very well sorted grain-size distribution of the inclusions (Fig. 1f). This distinctive feature of figural terracotta from this context is very interesting as it might indicate a very good selection of the temper and a more accurate production technology[10].

A few samples show different petrographic characteristics. Some of them are characterised by fine siliciclastic inclusions (Fig. 1g) and are ascribed to the petrographic group of samples P3[11]; other samples contain a larger amount of carbonate microfossils associated with siliciclastic and volcanic inclusions (Fig. 1h) and belong to the P4.

Some outliers also occur in the investigated archaeological contexts. In the site of Fonte, a sample (M219/3) is characterised by siliciclastic inclusions associated to biotite and coarse fragments of grog, while the sample M219/4 contains a larger amount of finer and serial distributed siliciclastic inclusions and slate.

The chemical composition of the coarse ware from the territory of Paestum is generally characterised by some variations. Figure 2a and b shows the chemical composition of samples collected in the sanctuaries of the Heraion and San Nicola, considering both common ware and figural terracottas. Most samples show a low concentration of CaO (1-4 wt. %) and a concentration of SiO_2 approximately ranging from 60 to 74 wt. % (Fig. 2a). Some samples of common ware from

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[7] See Amato et al. 2012 and De Bonis and Gassner 2018 in this edition.

[8] Most of these samples belong to fabrics PAE-C-1 and 2, and fewer to PAE-REG-C-1
equally present PAE-FT-1 and PAE-REG-F1, 3 and 4

[9] Samples mostly included in fabrics PAE-REG-C-1, 2, and 3. There are also terracottas with FT-1 (only 1), but more PAE-REG-FT-1, 2, 3

[10] Morra et al. 2013.

[11] Ascribed to fabrics PAE-G-3 and 5.

the Heraion are characterised by a moderately higher amount of CaO, approximately ranging from 3 to 8 wt. %; two fine-grained samples collected in the Heraion (M26/26, M26/37) can be grouped together and differ for a lower concentration of SiO_2 (Fig. 2a). Three samples of figural terracotta from the Heraion, two archaic (M25/8, M25/12) and one *tanagrina* (M25/7), along with a lid of common ware (M26/35) from the same context, and a figural terracotta from San Nicola (M213/2) are characterised by a high concentration of CaO ranging from 9 to 13 wt. % (Fig. 2a). This suggests that these samples were produced with different clayey raw materials characterised by a Ca-rich composition.

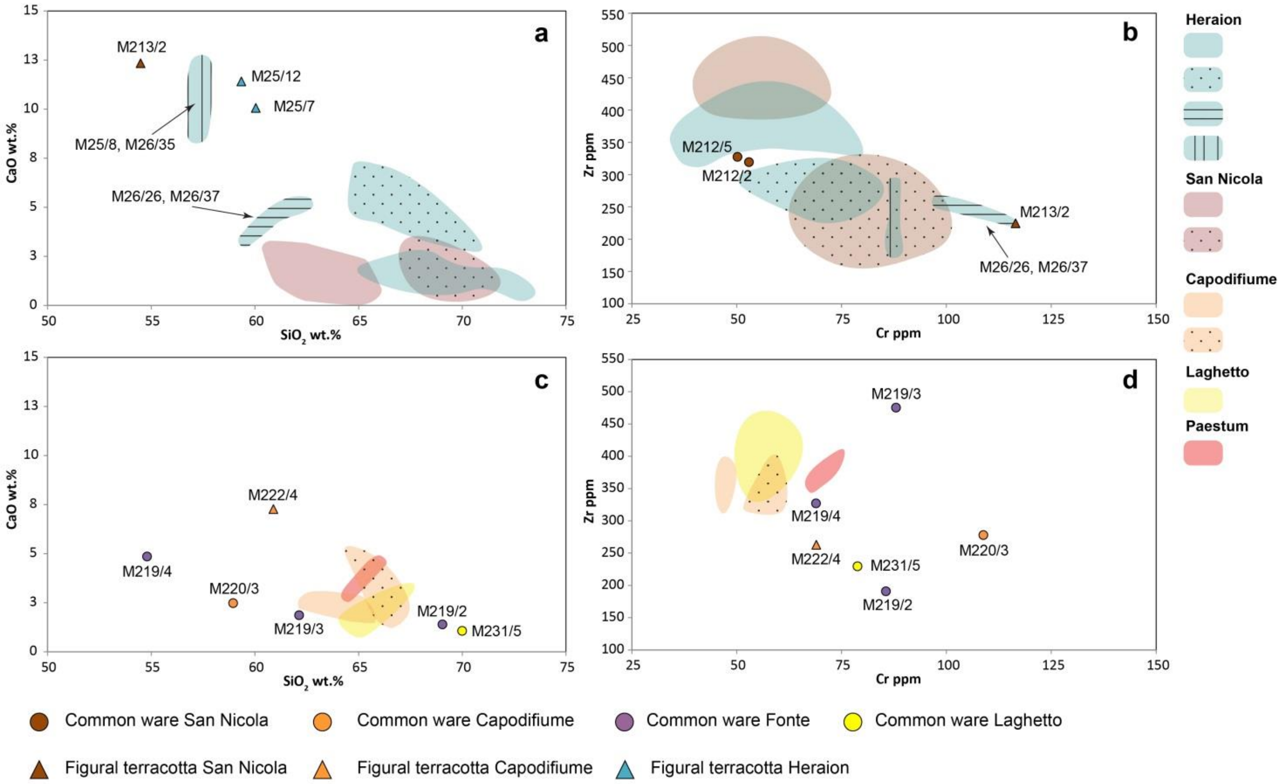

Fig. 2. Representative diagrams showing the compositional fields of the chemical groups of coarse ware, along with labelled outlier samples. (a, b) samples collected in the sanctuaries of Heraion and San Nicola. (c, d) samples collected in Capodifiume, Fonte, Laghetto and the town of Paestum.

As far as trace elements are concerned, we can distinguish two groups of samples, characterised by a concentration of Zr ranging from about 300 to 500 ppm (Fig. 2b), including most samples of the petrographic group P1. Two large groups show lower values of Zr (150-300 ppm) and values of Cr ranging from about 50 to 150 ppm (Fig. 2b). These groups include samples either belonging to the petrographic types P1 or P2, and also all samples included in the P3 and P4. One sample of figural terracotta from San Nicola (M213/2), along with samples of fine-grained common ware (M26/26, M26/37), show a higher concentration of Cr with respect to all other samples (Fig. 2b). Two samples of common ware discovered in San Nicola and represented by a mortar (M212/5) and a *tagenon* (M212/2) are isolated from the groups.

Figure 2c and d shows samples collected in the sites of Capodifiume, Fonte, Laghetto, and in the town of Paestum. Also in this case the CaO/SiO_2 pair shows concentrations comparable to most samples of the Heraion and San Nicola. Most samples from Capodifiume, Laghetto, and from the

town are homogeneous. In Capodifiume slight chemical differences are noticeable between common ware and figural terracotta, which are characterised by samples of the petrographic types P1 and P2 respectively; one sample of figural terracotta (M222/4) shows some differences, while a lekane lid (M220/3) differs for a lower concentration of silica and for higher Cr (Fig. 2c and d). Pottery from Fonte is characterised by a more variable composition and, as also evidenced by petrographic analysis, most samples must be considered as outliers. In particular, a sample of mortar (M219/4) shows a much lower concentration of SiO_2, while an olla (M219/2) and a lopas (M219/3) are characterised by very different values of Zr (Fig. 2c and d). All these differences can be due to the fact that this site is located along an important communication route toward the inland, where non-local pottery is very likely to find[12].
Samples from Laghetto are more homogeneous, apart from a sample of a loom weight (M231/5), which differs from the others (Fig. 2c and d).

Glazed ware and miniature pottery

Glazed wares (black-glazed and figured pottery), from the area of Paestum are characterised by fine pastes showing homogeneous petrographic features. Inclusions are generally very small showing a serial grain size distribution. They are represented by quartz, mica, and sporadic sandstone fragments occasionally of coarser size (Fig. 3a–c). Miniature pottery samples show a less homogeneous grain size distribution, but also contain frequent fine siliciclastic inclusions and sporadic sandstone fragments, in some cases associated to rare clinopyroxene (Fig. 3d).

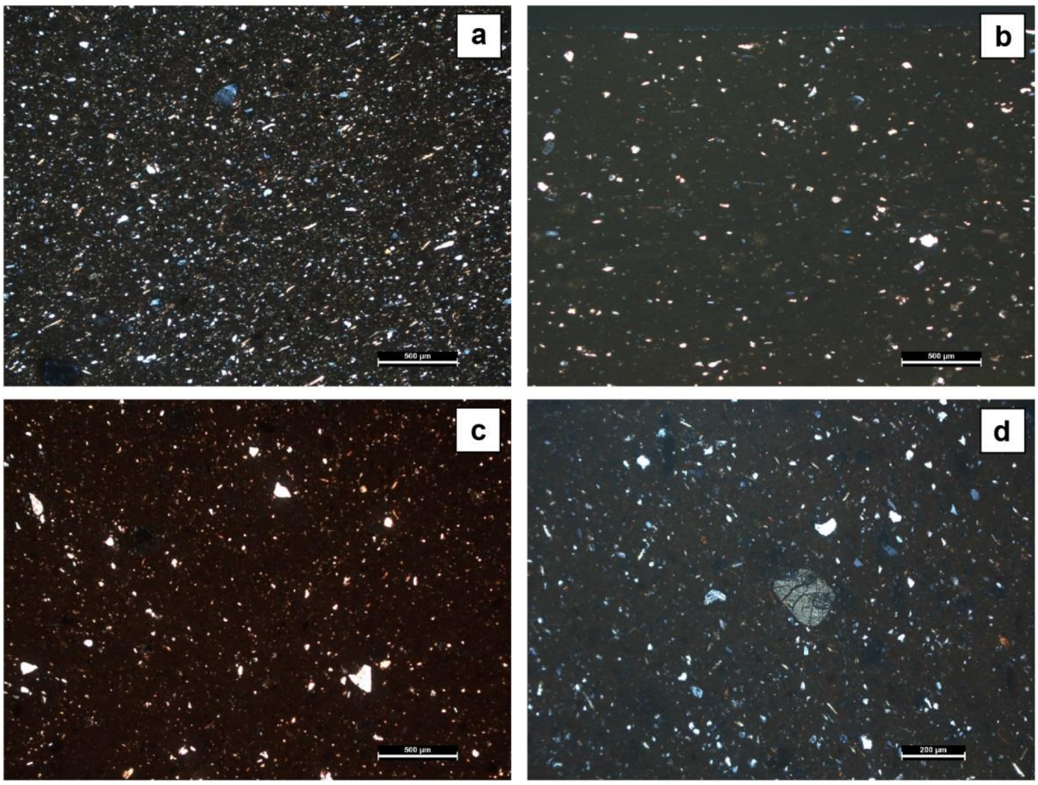

Fig. 3 Microphotographs showing the petrographic features of some representative samples of fine ware. (a) M 27/71, figured pottery from the Heraion (crossed polars). (b) M 232/1, figured pottery from Andriuolo (crossed polars). (c) M 228/3 Black-glazed pottery from Laghetto (crossed polars). (d) M 216/7, Miniature pottery from Getsemani (crossed polars).

[12] M. Cipriani, personal communication.

Chemical composition of black-glazed and figured pottery from all the investigated sites in the territory of Paestum is rather homogeneous, and only some elements show some variability. SiO_2 ranges from approximately 55 to 6 wt. %. CaO shows on average a moderate concentration attesting around 5-8 wt. %; some extreme values reaching a minimum of 2 wt. % to a maximum of 12 wt. % are also observed (Fig. 4a). Trace elements concentration is homogeneous in particular that of Zr (Fig. 4b). Only one sample of black-glazed pottery (M218/1) from the site of Fonte differs for higher Zr and lower Cr values (Fig. 4b).
Miniature pottery also shows a good homogeneity and, except for a slightly higher concentration of silica, all values are comparable to those observed for other fine wares; one sample (M216/4) differs for higher SiO_2 and lower CaO concentrations (Fig. 4a).

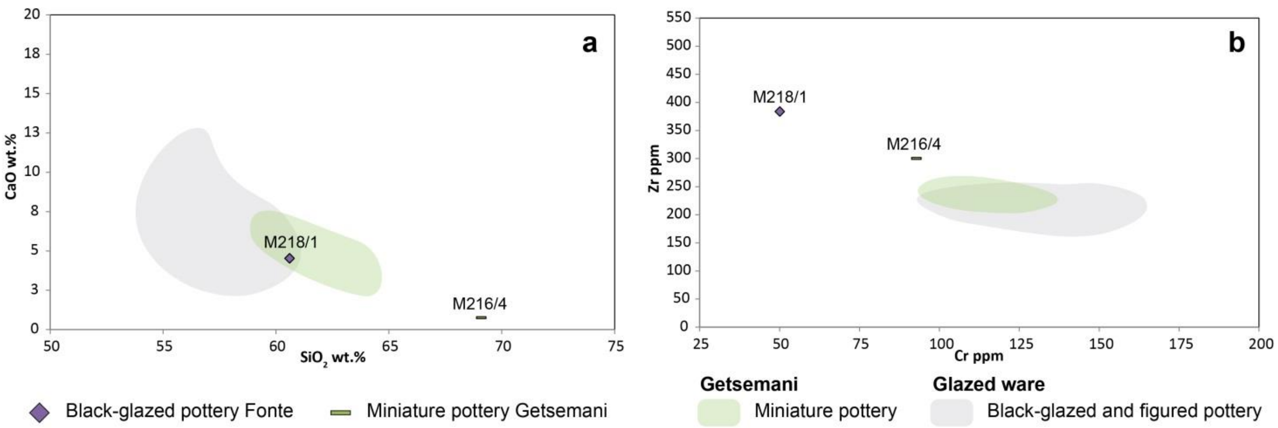

Fig. 4. Representative diagrams showing the compositional fields of the chemical groups of fine ware, along with labelled outlier samples.

Production indicators and clayey raw materials

Production indicators (PI) from the workshops in the town of Paestum and from the territory have been also investigated[13]. They are characterised either by fine- or by coarse-grained samples, showing the petrographic features of most glazed and common wares respectively. Similarly to coarse ware, also coarse-grained (PI) generally show a variable chemical composition (Fig. 5a and b). Raw materials show a rather heterogeneous chemical composition (Fig. 5) due to the fact that they represent several types of clay available in the territory of Paestum, an area characterised by a complex geological framework with different sedimentary formations[14]. For this reason, groups of coarse wares do not seem to precisely match any specific clay sample, but it is likely that this could also be due to the temper, which is supposed to have modified the original composition of clays[15]. However some comparisons are possible. In particular, coarse wares showing a Ca-rich

[13] In this paper the results of representative production indicators are reported: coarse-grained samples such as a kiln floor from the Curia in the town (M239/1), a spacer from Licinella (M226/1), and a bellow nozzle from Andriuolo (M233/1), along with a fine-grained spacer from the workshop in the town presented in Grifa et al. 2017. Other samples of production indicators, represented by deformed and incomplete pieces of figured and black-glaze pottery and kiln furniture, have also been studied. They are referred to the PhD Thesis of M.L. Rizzo and the results of the archaeometric analyses will be presented in forthcoming papers. See also Rizzo 2016.
[14] See article De Bonis and Gassner 2018 in this edition; Vitale and Ciarcia 2018; Cartographic sources from Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA).
[15] De Bonis et al. 2013 and 2014.

composition (9 to 13 wt. %), mostly characterised by petrographic features of P4, are compatible with clays from the area of Serre (Fig. 5). This is a very large outcrop located inland, not so far from the Paestum area (ca. 20 km), that could have been exploited for ceramics produced in that area (e.g. Eboli). Alternatively, the question of a possible transport of raw materials to workshops of Paestum remains open. Samples of the petrographic group P3 are more fine-grained and show some chemical differences compared to most coarse ware. Despite of this, they could be considered local as they show a good chemical affinity with local samples of local fine ware that is discussed below.

As far as fine ware (glazed and miniature pottery) is concerned, most samples are characterised by a quite homogeneous petrographic and chemical composition and also the representative sample of fine-grained PI, a spacer, fits well the composition of both glazed and miniature pottery (Fig. 5c and d).

In this case, a larger number of clay samples show a better chemical affinity with respect to that observed for coarse ware. Some small compositional differences are visible and are probably due to a levigation process acted for refining the clay through the removal of coarser grains before shaping the clay body, which possibly produced a slight shift of the original composition[16].

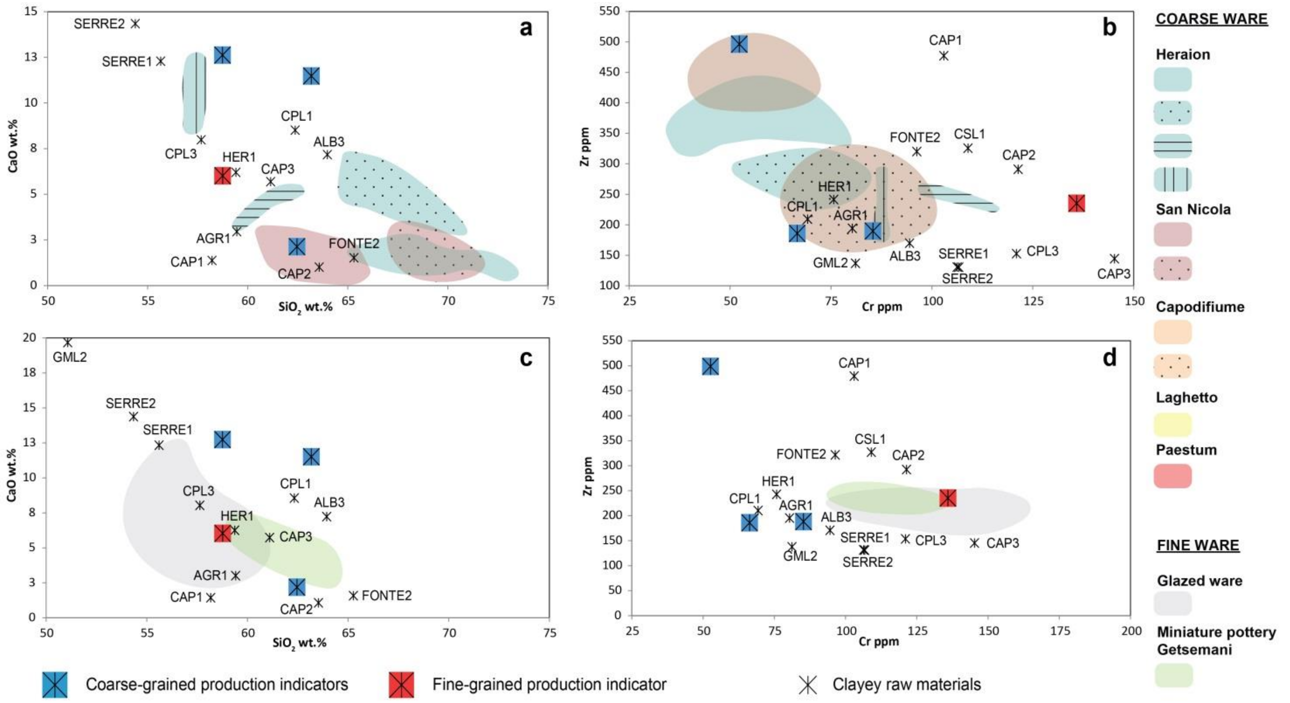

Fig. 5. Diagrams showing the compositional groups of probable locally-produced ceramic samples from the different investigated contexts in the territory of Paestum of (a, b) coarse ware and (c, d) fine ware, compared with some representative samples of coarse- ad fine-grained production indicators and clayey raw materials from the area of Paestum.

THE NORTHERN SECTOR OF THE SELE RIVER PLAIN: PONTECAGNANO AND FRATTE

A large number of ceramic samples belonging to different ceramic classes from the Etruscan-Italic towns of Pontecagnano and Fratte in the northern sector of the Sele River plain were analysed

[16] De Bonis et al. 2013.

through an archaeometric approach in order to define their provenance[17]. Samples are both represented by coarse- and fine-grained ware[18]. Coarse ware includes common ware (kitchen and cooking ware), ceramic building materials all dated from the 6th to the 3rd century BC, along with coarse pottery from the residential area Negri dated back to the last quarter of the 8th till the 6th century BC and defined as *impasto grezzo*. Fine ware is composed of black-glazed and figured wares dated from the 6th to the 3rd century BC, and linear/partially decorated pottery found in Pontecagnano dated to the 6th-5th BC.

Samples of clayey raw materials have also been analysed in order to find possible raw materials exploited in the past for these productions. They are essentially marine clays cropping out in the Picentine area, such as San Cipriano Picentino, Montecrovino Rovella and Pugliano, Giffoni Valle Piana, as well as in Rufoli (Salerno) along the Grancano valley, in close proximity to the archaeological site of Fratte[19].

Coarse ware

Coarse wares from the area of Pontecagnano and Fratte are characterised by a large amount of coarse grains mostly composed of volcanic inclusions. In several samples volcanic inclusion are associated to a minor amount of siliciclastic clasts, thus forming the petrographic group P6[20] (Fig. 6a and b), while in another group of samples (P7)[21] they are associated to both siliciclastic and carbonate inclusions (Fig. 6b and c). Siliciclastic inclusions are formed of quartz, sporadic sandstone and chert, while carbonate is represented by calcite (often decomposed) and limestone fragments. It is worth pointing out that all these samples contain a higher amount of volcanic inclusions compared to the coarse ware from the territory of Paestum. This is due to the greater proximity of Fratte and Pontecagnano to the eruptive centres of the Campania region. In particular, among the volcanic grains we can identify some leucite-bearing scoriae, which are typical of the Somma-Vesuvius activity[22]. Other volcanic inclusions are represented by clinopyroxene, volcanic lithics, alkali feldspar, plagioclase and occasional garnet and olivine (Fig. 6).

The chemical composition of coarse ware from Pontecagnano is quite homogeneous, showing a concentration of CaO generally lower than 5 wt. % and Zr approximately ranging from 300 to 450 ppm, and Cr on average slightly higher than 50 ppm; two samples of *impasto grezzo* M241/13 and M241/12 differ for a lower concentration of Zr, while the latter sample also differs for a higher concentration of silica (Fig. 7a).

Coarse pottery discovered in Fratte is included in three groups. A first group, including only samples from Fratte, which is characterised by a high concentrations of CaO and Cr. The remaining samples collected in Fratte, mostly represented by cooking ware, show a lower concentration of CaO and fall in two groups, a first one also including samples from Pontecagnano, and a second

[17] See article De Bonis and Gassner 2018 in this edition.
[18] See for reference the contribution Scafuro and Seritella 2018 in this edition of Facem.
[19] See article De Bonis and Gassner 2018 in this edition.
[20] Reference sample and also most of the pieces SAL-REG-C1, 2 and 4, SAL-REG-C-4. Fratte is better represented and also has a spacer as production indicator.
[21] SAL-REG-C-1-5 with a focus on SAL-REG-C-1, ref. sample is C-5. Interestingly, all samples SAL-REG-C-1 stem from Pontecagnano.
[22] See Morra et al. 2013; De Bonis et al. 2016.

one with higher Cr and lower silica, only including specimens from Fratte (Fig. 7b). A sample of archaic tile (M248/1) shows some differences from the other coarse ware from Fratte (Fig. 7).

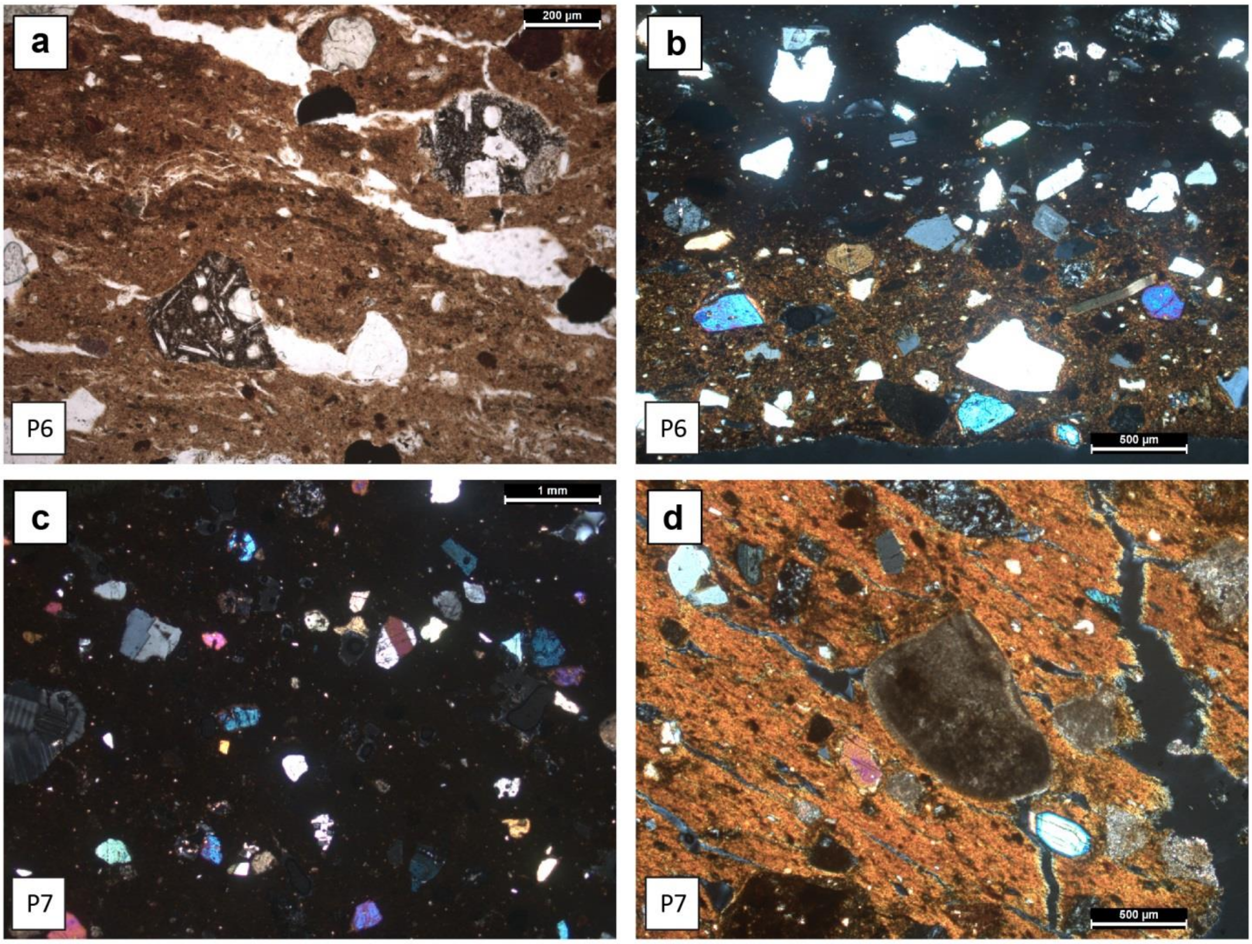

Fig. 6. Microphotographs showing the petrographic features of representative samples of coarse ware. Petrographic groups P6 and P7 are indicated. (a) M 247/1, cooking ware from Fratte (parallel polars). (b) M 241/4, common ware from Pontecagnano (crossed polars). (c) M 247/8, common ware from Fratte (crossed polars). (d) M 241/2, common ware from Pontecagnano (crossed polars).

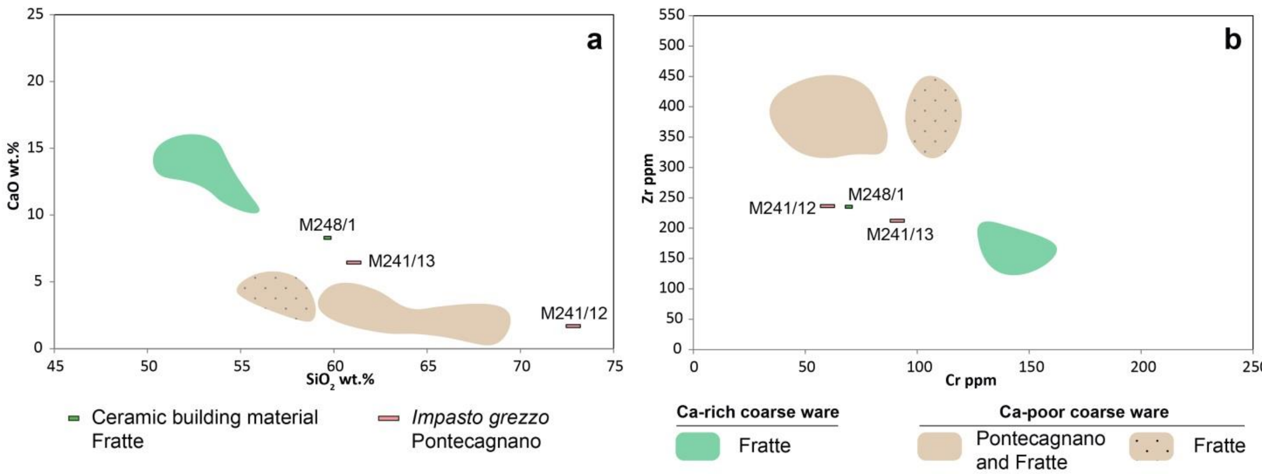

Fig. 7. Representative diagrams showing the compositional fields of the chemical groups of coarse ware collected in Pontecagnano and Fratte according to their Ca-rich or Ca-poor character. Labelled samples represent outliers.

Glazed ware

All glazed wares, regardless of their site of production and ceramic class, are included in a petrographic group (P8)[23] characterised by the presence of few and tiny inclusions of quartz, rare crystals of muscovite and clinopyroxene (Fig. 8a and b). A second group of samples (P9)[24] is formed by samples containing more and slightly larger inclusions, represented by quartz, muscovite, and occasional feldspar (Fig. 8c and d).

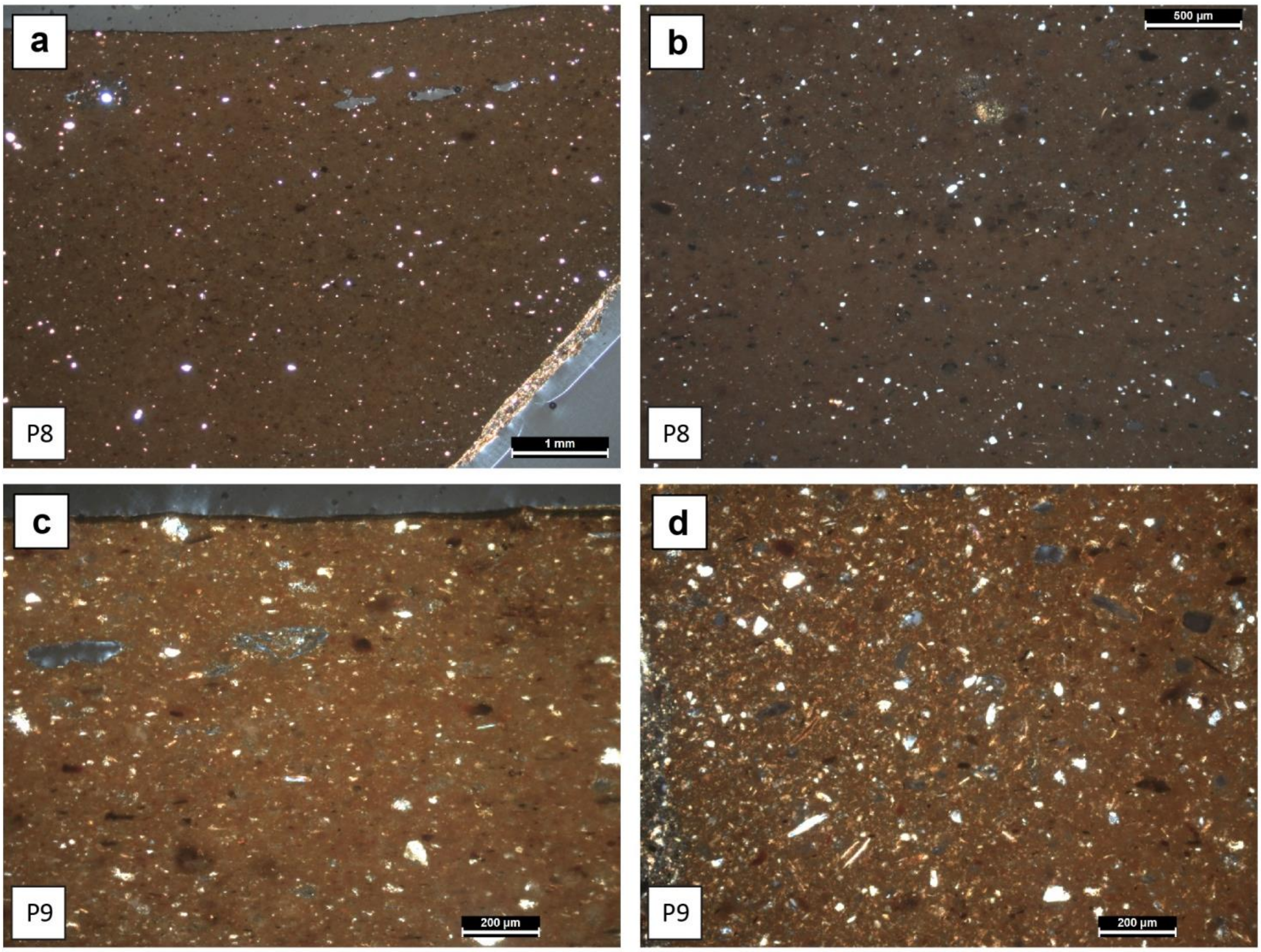

Fig. 8. Microphotographs showing the petrographic features of some representative samples of fine ware. Petrographic groups P8 and P9 are indicated. (a) M 240/1, black-glazed ware from Pontecagnano (crossed polars). (b) M 245/1, figured pottery from Fratte (crossed polars). (c) M 240/5, Black-glazed pottery from Pontecagnano (crossed polars). (d) M 242/6, Linear/partially decorated pottery from Pontecagnano (crossed polars).

From a chemical point of view, glazed ware collected in Fratte shows the highest concentration of CaO, approximately ranging from 12 to 15 wt. % (Fig. 9a). These samples are also characterised by a lower concentration of Zr (Fig. 9b). Samples from Pontecagnano form two groups, one showing a CaO concentration between 8 and 11 wt. % and another group showing lower values of CaO, from 4 to 7 wt.% (Fig. 9a). This latter group is also characterised by the highest concentration of Zr and includes the linear/partially decorated pottery (Fig. 9b).

[23] Very homogeneous fine ware fabrics SAL-REG-G-1, 1 sample SAL-REG-G-3.

[24] Most samples have been attributed to PAE-G-5, with few with samples probably attributable to PAE-REG-G-1.

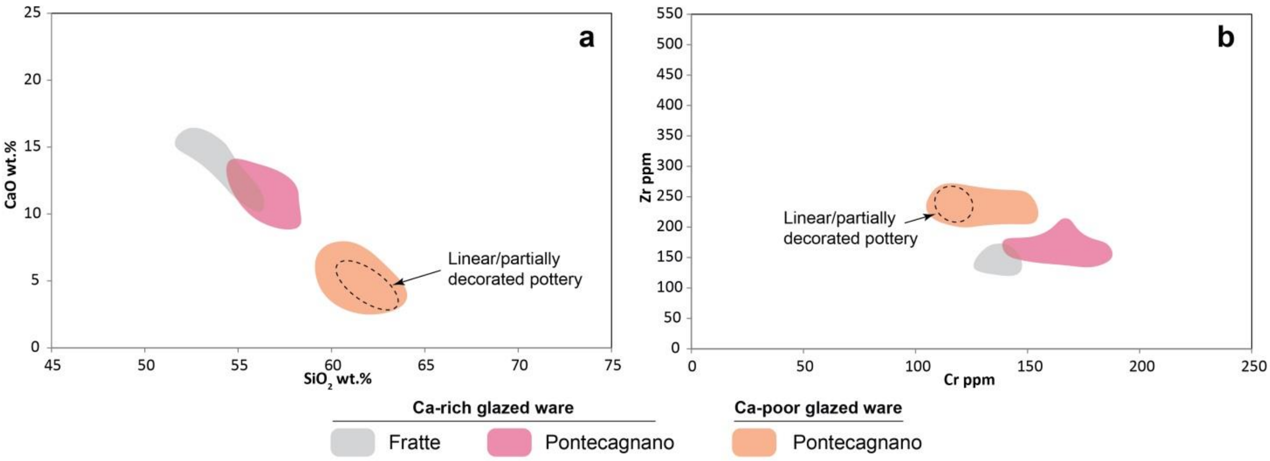

Fig. 9. Representative diagrams showing the compositional fields of the chemical groups of glazed ware collected in Pontecagnano and Fratte according to their Ca-rich or Ca-poor character.

Production indicators and clayey raw materials

The chemical composition of fine and coarse ware from the sites of Pontecagnano and Fratte was compared with that of local production indicators (PI) and selected samples of fine-grained PI from the area of Paestum. Clayey raw materials from the northern and southern part of the Sele River plain were also compared[25]. A strong compositional affinity is noticed between the high-CaO coarse and glazed wares collected in Fratte and production indicators from both Fratte and Pontecagnano workshops (Fig. 10). These samples also show a strong compatibility between the production indicators and local marine clays cropping out in the area of Rufoli (RUF1) and Montecorvino Rovella (MCR1).

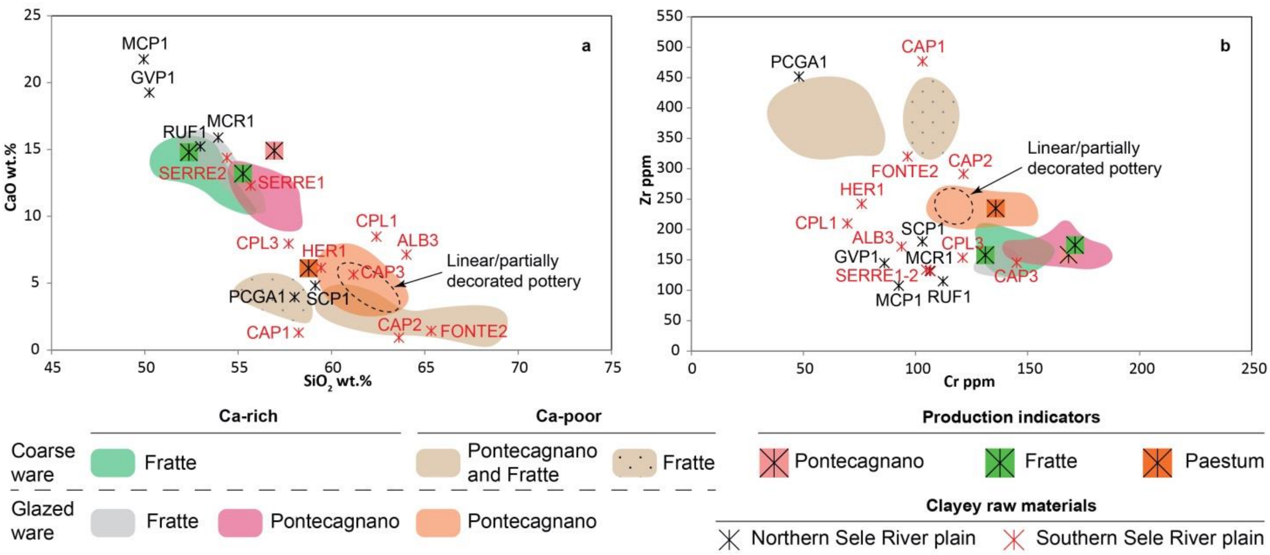

Fig. 10. Diagrams showing the compositional groups of probable locally-produced ceramic samples of both coarse and fine ware collected in Pontecagnano and Fratte according to their Ca-rich or Ca-poor character, compared with representative samples of production indicators from the area of Pontecagnano, Fratte, and Paestum, and clayey raw materials from the northern and southern part of the Sele River plain.

[25] All samples of production indicators are represented by spacers. Two local production indicators along with a fine-grained spacer from the workshop of Paestum were presented in Grifa et al. 2017. For the clays from the area of Paestum see the article Trapichler 2018a in this edition of Facem.

All coarse wares characterised by a low concentration of CaO are comparable only with a clayey material derived from the weathering of a pyroclastic deposit from the area of Pontecagnano (PCGA1).

The group of fine ware from Pontecagnano, including the linear/partially decorated pottery, which is distinguished by lower concentration of CaO and high Zr is compatible with a clay from San Cipriano Picentino (SCP1), cropping out not far from the archaeological area.

However, if we consider the composition of a fine production indicator from the workshop of Paestum we may notice a good affinity with this group. Also these samples show a fair compatibility with some clays from the plain of Paestum either of alluvial (HER1, CPL1 and 3, ALB3, FONTE2) or marine (CAP2 and 3) origin (Fig. 10)

CONCLUSIVE REMARKS

This first archaeometric interpretation has pointed out the characteristics of the ceramics found in the different investigated contexts. Above all, it provided clear distinctive features between the productions located in the two sectors north and south of the Sele River. However, also new interesting questions have arisen that need to be answered. The interpretation of all archaeometric data obtained during the project, including mineralogical, microchemical and microstructural analyses[26] for the investigation of technological processes (e.g., firing temperatures and coating), will then provide new indications to unravel issues raised from this initial overview on the ceramic production in the plain of Paestum.

Territory of Paestum

In the territory of Paestum coarse ware is generally characterised by a chemical variability independent from the context of discovery. On the other hand, petrographic features are more homogeneous and are marked by the presence of a large amount of siliciclastic inclusions often associated to minor carbonate; a large number of samples differ as it also contain sporadic volcanic inclusions. These petrographic characteristics are fully compatible with the geological features of the area of Paestum, where siliciclastic and carbonate lithologies are present along with minor volcanic deposits[27]. Moreover, the high number of recurring samples showing similar macroscopic and petrographic features, along with analytical evidences provided from previous works[28], strongly suggested a provenance of these productions limited within the area of Paestum. However, at the moment, it is difficult on the basis of fabric analysis to distinguish local productions belonging to specific contexts in the territory of Paestum or to the city itself.

More details have been identified in thin section for figural terracotta from Capodifiume that show a very peculiar microstructure characterised by the only presence of siliciclastic and very well

[26] Mineralogical analysis was performed at the Institut für Angewandte Geologie (IAG), University of Natural Resources and Life Sciences (BOKU), Vienna, in cooperation with Prof. Franz Ottner. Microchemical and microstructural analyses at Department of Lithospheric Research, Universität Wien, Vienna, in cooperation with Prof. Theodoros Ntaflos.

[27] Amato et al. 2012.

[28] See the contribution of M. Trapichler in this edition Facem; Abbas 1999; Sauer 2015; Gassner, Greco, and Sauer 2003; Gassner, Trapichler, and Sauer 2014.

sorted inclusions, possibly indicating a more accurate production technology, which probably mark a specific production of this context.
Clay materials collected in the territory of Paestum also show a certain variability and no clear correlation with coarse ware was possible. Probably this is due to the geological complexity of the territory or to chemical modification induced by the addition of temper. But some more questions remains open. In particular the possibility of exploitation of raw materials from a distant area, as from Serre, where large deposits of clays were probably used for Ca-rich ceramics in the workshop of Paestum. However, imports from workshop located in that area (e.g. Eboli), likely exploiting Serre clays, can be also taken into account. Another issue is the provenance of the outlier samples of coarse ware found in the archaeological contexts of the territory of Paestum. In particular samples found in the site of Fonte, that is located along an important communication route or samples lacking carbonate and volcanic inclusions, which could come from the territory of Velia[29].
Fine ware (glazed and miniature pottery) is characterised by chemical homogeneity and a better affinity with a local fine-grained production indicator and clays, strongly suggesting a local production. Minor macroscopic[30] and chemical differences have been noted, indicating a possible refining process of the clays (e.g., levigation) which possibly induced slight modifications.

Northern sector of the Sele River plain

The analysis of the ceramic samples from the Etruscan-Italic towns of Pontecagnano and Fratte showed the presence of a larger amount of volcanic inclusions compared with samples from Paestum. This feature has thus highlighted the spatial evolution of the petrographic composition of pottery from the area of Paestum to the northern sector of the Sele River plain[31]. This is due to the closer proximity of the northern area to the eruptive centres of the Campania region, and in particular to the Somma-Vesuvius, as indicated by the presence of leucite-bearing scoriae typical of that volcano. In particular, coarse ware can be easily distinguished from the one from the southern part of the Bay of Salerno also from a macroscopic point of view[32].
On a chemical point of view, several samples of glazed and coarse ware discovered in Pontecagnano and Fratte are characterised by a Ca-rich composition and other chemical features highly compatible with local marine clays and production indicators. This suggests that the two sites were supplied with raw materials from the local deposits of Ca-rich marine clays, which are still used today for the production of ceramics[33].
Other coarse ware showed a Ca-poor composition and it is not clear which clayey deposit was used for its production. Probably it could be pinpointed in the pyroclastic soils of the area of Pontecagnano/Fratte or on the hills located inland of Pontecagnano (sample SCP1), where Ca-poor marine clays ascribed to Sicilide unit occasionally crop out[34].

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[29] Gassner, Greco, and Sauer 2003; Gassner, Trapichler, and Sauer 2014; Sauer 2015.
[30] See Trapichler 2018a in this edition.
[31] See also Abbas 1999; Grifa et al. 2017.
[32] See Trapichler 2018b in this edition.
[33] Ogliara and Montecorvino Rovella. See also De Bonis et al. 2018.
[34] See article De Bonis and Gassner 2018 in this edition of Facem.

Very interesting is the Ca-poor fine pottery discovered in Pontecagnano, which also includes the linear/partially decorated pottery[35]. This group shows some affinity with the clay deposit SCP1 located inland. However the extension of this outcrop is not large enough to justify the high number of this type of pottery found in the necropolis. On the other hand, this group seems to share similar compositional features with both fine ware and the reference sample of fine-grained production indicator from Paestum and also a certain affinity with some clays from the plain of Paestum. Hence, these evidences would lead us not to exclude the possibility that this group of pottery was produced in Paestum.

As for the distinction between the productions of Fratte and Pontecagnano, it is not possible from this first archaeometric interpretation, as well as from fabric analysis[36], to distinguish them from each other. The only indications are the higher concentration of CaO observed for fine pottery from Fratte and for coarse ware from a macroscopic point of view. In fact, from the macroscopic observation of the coarse samples available, fabrics from Pontecagnano can be distinguished from those from Fratte[37], giving a hint for different raw material and/or manufacturing techniques.

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[35] This group corresponds to fabric PAE-REG-G-1. See http://facem.at/pae-reg-g-1

[36] See Trapichler 2018b in this edition.

[37] See Trapichler 2018b in this edition.

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