THE LATE ROMAN IN CAMPANIA REGION. SOCIO-ECONOMIC RECONSTRUCTIONS THROUGH THE MINERALOGICAL AND PETROGRAPHIC STUDY OF ANCIENT POTTERY

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INTRODUCTION

The Late Roman pottery assumes a particular relevance since the ceramic artefacts suffers a significant decline in quality during the Late Antiquity (3rd - 6th century A.D.) with respect to the fine Republican and Early Roman Imperial productions (*e.g.*, Black Glazed and Red Slip Ware), due to the severe political and economic crisis affecting the Western Roman Empire.

The economic crisis also involved the commercial trades in the Mediterranean, considerably reducing the goods' importation starting from the 5th century A.D. The decrease of importations entailed the development of independent workshops, mainly concentrated in *villae rusticae*, marking the disappearance of the large-scale production and the formation of productive systems with a micro-regional character, among which a network of micro-regional commercial trades developed (Toniolo, 2012).

Even though the morphological and typological repertoire appeared well-standardized, less professional workmanship, low accurate pastes and decorations, and not well-controlled technological processes characterise the Late Roman ceramic production, which began imitating the ancient Italian fine wares and African vessels and then evolved in an independent production (Arthur, 2007).

Following this general trend, the Campania region and in particular the Bay of Naples, an important commercial area for the Roman Empire, also experienced two natural disaster: the well-known 79 A.D. eruption, whose effects on social and economic setting lasted for several decades, and the following 472 A.D. Pollena eruption. Even if less destructive than 79 A.D. Pompeii eruption, Pollena eruption represents a sharp *terminus ante quem* that potentially can provide a clear snapshot of the culture and the economy for the cities and sites buried by the volcanic debris.

The transition from large-scale to micro-regional ceramic production required the characterisation of single micro-regions, for a better reconstruction of economy, trades and technology in Campania.

In this thesis it was approached the study of ceramic products of three different districts (Vesuvian, Phlegraean and Apennine areas), which fall within the most important Campanian regional contexts. The aim of this research was an accurate archaeometric characterisation of Late Roman ceramic artefacts by means of mineralogical, petrological, geochemical and spectroscopic techniques, in order to infer the ceramic technology adopted in Campanian workshops during the Late Antiquity.

Since ceramic technology is the mirror of social and economic trends, new perspectives of Late Roman culture were also drawn.

ANALITYCAL TECHNIQUES

A total of 55 ceramic fragments of common wares (table and cooking ware) were collected and characterised from the archaeometric point of view. The study of archaeological artefacts was carried out using a multi-analytic approach, aimed at the definition of raw materials exploited and the ancient technologies adopted for their production.

The whole set of analytical techniques was performed at the Laboratory of Mineralogy and Petrography of the Department of Sciences and Technologies of the University of Sannio, the University of Naples "Federico

II", the Department of Mineralogy and Petrology of the University of Granada and the "Istituto di Chimica Inorganica e delle Superfici" of the National Research Council (CNR) in Padova.

Polarized Light Microscopy (PLM), Image Analysis (IA), colorimetric measurements, X-Ray Fluorescence (XRF), X-ray Powder Diffraction (XRPD), Thermogravimetry and Differential Scanning Calorimetry (TG-DSC) coupled with Fourier Transform Infrared Spectroscopy for Evolved Gas Analysis (FT-IR for EGA), Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy (SEM/EDS), Room Temperature Mössbauer spectroscopy, μ-Raman Spectroscopy (μ-RS), Mercury Intrusion Porosimetry (MIP) and hydric tests allowed to define the mineralogical, petrographic, chemical and technological features of ceramic pastes.

RESULTS AND DISCUSSIONS

Pollena Trocchia (NA)

Twenty-three fragments of table and cooking ware were sampled in a *Villa Rustica* (Masseria De Carolis) in the town of Pollena Trocchia (NA), built in the 2nd century A.D. on pyroclastic rocks emplaced during the 79 A.D. Pompeii eruption and buried by pyroclastic flows deposits of Pollena eruption (472 A.D.; Martucci *et al.*, 2012). The site was excavated within the *Apolline Project,* a multidisciplinary project investigating the social settlements of the Northern side of Vesuvius-environs and their connection with inner Apennine and coastal areas during Late Roman period. The well-known chronological constrains (in-between the 79 and 472 A.D. eruptions) and the previous studies on other regional sites such as Naples, Pompeii and Herculaneum allowed a good comparison among the ceramic classes circulating in the reference period.

The samples of tableware encompassed three groups, divided, on the basis of the coating applied on the surfaces, in Slipped ware, Painted ware and Painted ware "*a straccio*".

Archaeometric analyses revealed a good compositional and mineralogical homogeneity. All ceramic bodies, red or light brown in colour, were manufactured with high-CaO clays (CaO on average 13.3 wt.%). They showed both seriate and bimodal texture, the latter when volcanic and/or siliciclastic temper was added to the base clay, although in low percentages (around 10%).

Since the addition of low percentage of temper does not change the chemical composition of a clayey deposits (up to 30%), the chemical features of ceramic samples were compared with the composition of high-CaO clays outcropping in Campanian region, whose exploitation for the production of ceramic material was attested (De Bonis *et al.*, 2013). The compositional affinities with the clays of the Ischia Island, largely adopted for the ceramic production in the Bay of Naples from the Greek to the Medieval periods, allowed to infer their use for this ceramic production.

As far as the provenance of temper is concerned, a pseudo-correlative spectroscopic approach by means of the combined use of μ-Raman spectroscopy and EDS was adopted. The occurrence of leucite, Lc-bearing scoriae and garnet suggested the provenance of the volcanic sand used as temper from the Vesuvian environment (Morra *et al.*, 2013).

Regarding the technology, mineralogical evidences highlighted different firing temperatures experienced by ceramic artefacts. In fact, samples with red pastes were fired at 850 and 900 °C, as confirmed by the detection of gehlenite and/or newly formed clinopyroxene along with calcite and illite/mica (Grifa *et al.*, 2009). Conversely, higher amounts of Ca-pyroxene detected in ceramic artefacts with brown pastes suggested higher firing temperatures (900-950 °C) experienced by the vessels (Grifa *et al.*, 2009). The occurrence of widespread hematite testified a firing process in oxidizing atmosphere.

The samples of cooking ware, instead, were characterised by coarser pastes with clear "sandwich structures", showing a sharp zonation, with two or three colours of the ceramic body. These potteries were manufactured mixing a low-CaO clays (on average 3.2 wt.%), compositionally similar to low-CaO marine deposits of the *Argille Varicolori* formation (De Bonis *et al.*, 2013), with a volcanic temper composed by sanidine, diopside, biotite, calcic amphibole, andraditic garnet, pumices, obsidians, scoriae and Lc-bearing

scoriae, in order to improve the technological performances of cooking ware and to mitigate the effects of fire during their day-to-day use.

Again, the mineralogical assemblage of the temper testified a local production since the exploitation of Vesuvian sand can be inferred (Morra *et al.*, 2013).

As far as the technological processes are concerned, the colour zoning of pastes testifies not-well standardized firing processes. In fact, Mössbauer and μ-Raman analyses performed on ceramic matrices revealed the occurrence of hematite at rims and magnetite in the black cores, inferring that the firing was carried out in reducing atmosphere, which allowed the development of reduced iron oxides, and the cooling was in oxidizing condition, when the magnetite transformed to iron (III) oxide (Nodari *et al.*, 2004). The mineralogical assemblages and the continuous vitrification structure developed during the firing suggest firing temperatures of *ca.* 900 °C.

"Ancient Appia Landscapes" surveys

The archaeometric investigation of ceramic materials coming from the archaeological surveys within the "Ancient Appia Landscapes" project in the Benevento surroundings represented an important opportunity to characterise the Late Roman ceramic production of the Apennine inlands, poorly studied until now, in an area strongly influenced by the Appian Way, one of the main communication routes in the Roman period.

The typological repertoire and stylistic features highlighted a clear predominance of presumed local pottery, accounting for rural life in the neighbourhoods of *Beneventum*, reflecting the general decrease in the penetration of imported goods into inner areas of Samnium from the 5th century (Germinario *et al.*, 2015).

The tableware unearthed during the surveys were characterised by fine-textured pastes and accounted for the exploitation of both low-CaO and high-CaO clays for their manufacturing.

The levigation process, supposed for the calcareous clays, could have determined a significant change in the composition of the base-clay, not allowing to hypothesize the provenance of calcareous raw materials. On the contrary, the chemical features of low-CaO samples suggested the exploitation of the carbonate-free *Argille Varicolori,* largely widespread in the Apennine geological sequences (Bonardi *et al*., 2009).

With regards to the technology, calcareous/fine-grained samples showed the occurrence of newly formed Ca-silicates (gehlenite and clinopyroxene), indicating firing temperature in the range 850-950 °C, whereas in no-calcareous tableware the presence of sporadic illite/mica and the extensive vitrification structures suggested firing temperatures ranging from 850 to 900 °C in oxidizing conditions (Germinario *et al.*, 2015).

The cooking ware showed, instead, coarser pastes manufactured with low-CaO clays, compositionally similar to the carbonate-free samples of tableware, adding volcanic (sanidine, plagioclase, diopside, Ca-amphibole, andraditic garnet, Fo-olivine, pumices, scoriae, Lc-bearing scoriae and obsidians) and/or siliciclastic (quartz and arenaceous fragments) temper, which suggested the use of sand, naturally composed by volcanic and sedimentary grains mixed together.

Since morphological and typological features accounted for local-produced artefacts, it can be supposed that the exploited sources of temper materials were located in the Benevento area, where Vesuvian pyroclastic deposits crop out along with sedimentary rocks (Germinario *et al.*, 2015).

As far as the technology is concerned, the mineralogical assemblage, the thermal behaviour and the vitrification structures were representative of different firing conditions experienced by the ceramic artefacts. The first evidence is the colour zoning of the ceramic body; both unzoned and zoned samples were, in fact, observed.

The occurrence of frequent or scarce illite/mica and the initial vitrification structures (Maniatis & Tite, 1981) allowed to infer rather low firing temperature (800-850 °C) in an oxidizing atmosphere experienced by the unzoned samples characterised by a red matrix. On the contrary, the zoned samples, showed textural and mineralogical features suggesting variable firing temperature, which could have exceeded 900 °C (Grifa *et al.*, 2009). Moreover, the sandwich structure testified a not controlled oxidation state of the furnace. The detection by μ-Raman spectroscopy of Fe-oxides in both oxidation states (hematite and magnetite) accounted for rapid

changes in fO_2 in the furnace. The zoning of the ceramic bodies, characterised by red oxidized rim and grey reduced cores, testified a reducing step during the firing, which allowed the development of magnetite, partially re-oxidized at rims, where hematite occurs (Germinario *et al.*, 2015).

Cuma (NA)

The ceramic findings coming from the archaeological site of Cuma, the most ancient Greek colony of the western Mediterranean Sea lying on the western coastline of Phlegraean Fields, were unearthed in a well, which was discovered in the western part of a funerary mausoleum of the Roman necropolis. The well, a water tank of a crafting space, was sealed by a Latin funerary inscription and conserved several ceramic artefacts in excellent conservation status, partially submerged by groundwater.

Along with samples of certain local provenance, ceramic artefacts with morphological similarities with the Eastern productions were found (Cavassa *et al.*, 2016).

The samples of local tradition were constituted by painted pitchers that showed compositional and mineralogical features compatible with Phlegraean raw materials. In fact, the samples were manufactured with calcareous clays (average CaO = 12 wt.%), compatible with the Ischia clayey deposits (De Bonis *et al.*, 2013), sometimes adding volcanic temper of Phlegraean provenance (Morra *et al.*, 2013). The occurrence of frequent illite/mica and calcite suggested low firing temperatures experienced by the samples, ranging from 800 to 850 °C.

Pyriform pitchers, cooking pots and one kettle, morphologically consistent with the eastern Mediterranean ceramic productions, were, instead, manufactured with low-CaO clays (< 4.4 wt.%). The pastes, generally with bimodal texture, showed, along with volcanic and siliciclastic phases, well-sorted calcite-bearing temper, decomposed in very fine birefringent crystals, never observed in Cuman ascertained productions until now.

Rounded- or elongated-shaped carbonate grains showed strongly CaO-depleted edges, whose diffusion toward the interface carbonate-matrix determined the formation of reaction rims with Al-rich clinopyroxene composition, although the pastes showed a non-calcareous composition.

Despite the low concentration of CaO, the formation of newly-formed pyroxene at the expenses of carbonates inferred that the base clay reached at least 850-950 °C (Grifa *et al.*, 2009), except for some samples in which frequent phyllosilicates were present; moreover, high weight losses were recorded in the dehydroxylation thermal range. For these samples lower firing temperatures (*ca.* 800 °C) were estimated.

The burial in a non-oxidising environment permitted post-earthen phenomena such as the development of pyrite framboids, mainly observed in pores and fissures of the ceramic pastes and also detected by EGA. The emission of SO_2 at around 475 °C, due to the pyrite breakdown during the thermal treatment, was a further evidence.

CONCLUSIONS

This research represented one of the first study aimed at a wider knowledge of Late Roman ceramic productions in Campania, which have always been matter of hard debating. In fact, until few years ago, during archaeological campaigns in Vesuvius-environs, the Late Roman layers were ignored in order to reach the more "interesting" context of Imperial and Republican ages.

Ceramic fragments from three important Campanian districts, namely Vesuvian, Phlegraean and Apennine areas, were collected, approaching the technology/provenance archaeological problems by means of "customary-" (*e.g.*, OM, XRF, and XRPD) and "innovative-" (*e.g.*, μ-RS, TG/DSC-FT-IR-EGA) analytical techniques. The following conclusion can be drawn:

- although a significant decrease in the quality of ceramic productions, the morphological *repertoire* appeared rather well-standardized during the Late Roman period. Despite the fragmentation of the workshops, similar shapes were observed in the analysed micro-regional contexts, suggesting that independent productions followed the same typological standards;

- archaeometric characterisation of ceramic artefact coming from Pollena Trocchia, Benevento surroundings and Cuma shed light on similar manufacturing processes adopted during the Late Roman period in Campania region. As far as tableware is concerned, in all analysed samples rather fine ceramic bodies were observed, but the application of thin and inferior slips highlighted the poor attention to the aesthetic characteristics of the artefacts. The aesthetic values succumbed to purely functional or practical ones, within the more general context of changing values. The cooking ware, instead, showed clear evidences of low accurate productive processes, in terms of mix designs and firing conditions. The samples coming from Pollena Trocchia and Benevento surroundings displayed textural and mineralogical features indicating rough firing procedures, due to rapid and not well-controlled firing conditions. The compositional and stylistic features accounted for a good similarity between the two micro-regional contexts, among which regional commercial trades could insist. Conversely, in the Phlegraean area the recovery of ceramic artefacts, morphologically similar to products of Aegean tradition widely imitated in the Southern Italy during the Late Roman period (Gliozzo *et al.*, 2005), confirmed the influence of imported goods in the ceramic production of the coastal areas, where extra-regional trades again occurred;

- the multi-analytical approach represented a useful tool for a complete reconstruction of ancient technology adopted for the ceramic production. Alongside to the common techniques, which allowed to approach the archaeometric studies in a customary way, "innovative" techniques, increasingly widespread in the field of Cultural Heritage, were adopted, achieving interesting results in the reconstruction of the productive processes. The application of spectroscopic techniques, the combined use of μ-Raman-Mössbauer or μ-Raman-EDS in a sort of "pseudo-correlative" spectroscopy turned out to be very advantageous in terms of reliability of data. In fact, this approach allowed to improve the mineralogical characterisation of ceramic artefacts, to reduce the acquisition times and the quantity of material required, often precious, and to obviate the sample preparation requirements. The achievement of successful results, consistent with those achieved by the widely-used methods, highlighted the potential of such techniques in the archaeometric researches, which represent a viable alternative when the "customary" approach is inhibited.

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