Cooking and common wares in the Late Antique rural site of Plaça Major de Castellar del Vallès (Catalonia, Spain): archaeometric characterization

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ABSTRACT

This paper presents an archaeometric analysis of utilitarian ceramics from a Late Antique rural site in the area of Vallès (Catalonia, Spain), with the aim of investigating their provenance and shedding light on some aspects of their production technology. A total of 55 samples of cooking and common wares were analyzed using a combination of instrumental analytical techniques, including thin-section optical microscopy, X-ray diffraction, and WD-X-ray fluorescence, in order to carry out a petrographic, mineralogical, and chemical characterization of the materials. A variety of petrographic fabrics were identified, generally composed of inclusions derived from granitic rocks, along with metamorphic inclusions in many cases. This variability is not related either to ceramic typologies or to chronological phases, but to slight variations in the raw materials and/or paste recipes. Compositional similarities point to a broadly common origin for a large part of the ceramic assemblage. All fabrics identified may be compatible with the hypothesis of a local provenance, although a wider regional provenance cannot be excluded on geological grounds. This study is a step forward into the understanding of cooking and common ware production in northeastern Iberia during Late Antiquity.

INTRODUCTION

Ceramic assemblages documented in Late Antique archaeological sites in northeastern Iberian Peninsula usually contain large quantities of coarse and cooking wares. An increasing number of archaeological studies focused on these ceramic classes can be found mainly in coastal urban centers in the current territory of Catalonia such as Tarragona (Macias Solé 1999, 2003), Barcelona (Beltrán de Heredia 2005; Buxeda and Cau 2005) and Mataró (Buxeda and Cau 2004; Cela and Revilla 2004, 2005), which in

Late Antiquity were the ancient cities of *Tarraco-Tarracona*, *Barcino-Barcinona* and *Iluro-Alarona*, respectively. Relevant assemblages of coarse and cooking wares have been documented also in other urban centers located either on the Catalan coast (e.g. Empúries/*Emporiae*: Llinàs 1997; Aquilué 1999) or inland (e.g. Guissona/*Iesso*: Uscatescu and García Jiménez 2005), as well as in numerous Late Antique rural settlements (e.g. Castanyer and Tremoleda 1999; Coll et al. 1997a, b; Coll and Roig 2000, 2011; Francès et al. 2007; López et al. 1997; Roig and Coll 2012). These studies, along with others focused on a wider regional scale (Cau et al. 1997; Coll and Roig 2003, 2011; Folch 2005; Macias and Cau 2012; Roig 2011), have progressively increased our knowledge of coarse and cooking wares found in Late Antique sites of the region.

In the last two decades, some of these ceramic assemblages have been the object of archaeometric analyses for the characterization of the materials and the examination of specific problems related to provenance and production technology (Buxeda and Cau 2004, 2005; Uscatescu and García Jiménez 2005). These archaeometric studies have been mainly focused on ceramic contexts from urban contexts in major cities (particularly Barcelona and Mataró), and they included the analysis of imported coarse and cooking wares in order to investigate long-distance trade networks. Some of these studies also enabled the identification and preliminary characterization of regional wares, usually related to petrographic fabrics with dominant granitic composition (Buxeda and Cau 2004, 2005).

In recent years, archaeometric studies focused on the characterization of coarse and cooking wares found in Late Antique rural sites and small settlements have started to provide significant new evidence on the complexity and diversity of these regional wares in northeastern Iberia (Riutort et al. 2017, 2018). Ceramic contexts in these sites usually comprise large quantities and a wide variety of possible local or regional pottery. The progressive characterization of these materials is crucial for a better understanding of the patterns of pottery production, distribution and consumption, and it will serve as a basis to explore intra- and inter-regional trade or exchanges in this area during Late Antiquity. In order to shed new light on these issues, this paper presents an archaeometric study of a Late Antique pottery assemblage found at the rural site of Plaça Major de Castellar del Vallès[1] (Catalonia, Spain) (**Fig.** 1), through a combined petrographic, mineralogical, and chemical analysis of the materials. The focus are the coarse and cooking wares documented at the site, which are dominant in the ceramic assemblages. The aim is to examine the hypothesis of a local or regional provenance for the ceramics, as well as to gain an insight into some features of their production technology. Potential changes in the pottery materials consumed —and possibly produced— at the site are also explored, by comparing ceramics found at different contexts dated from the 5th to the 7th centuries AD. The characterization of this pottery assemblage will certainly contribute new evidence to our understanding of regional wares in northeastern Iberia during Late Antiquity.

[1] The exact location of the site, based on the geographic coordinates provided by Vissir software from Institut Cartogràfic i geològic de Catalunya (ICGC) is: ETRS89 41º37’0.23066” N, 2º5’14.09885” E.

PLAÇA MAJOR DE CASTELLAR DEL VALLÈS: A LATE ANTIQUE RURAL SITE

Castellar del Vallès is a town located in the region of Vallès, about 25 km north of the city of Barcelona (Catalonia, Spain) (**Fig.** 1). Due to this proximity, the site —which was a rural settlement— belonged in the Late Roman period to the *ager* of *Barcino-Barcinona*. Archaeological excavations at the Plaça Major (main square) of Castellar del Vallès uncovered a long stratigraphic sequence with several phases of human occupation, from the Neolithic to the Late Antiquity (Roig and Coll, 2010a, b). The site could only be partially excavated, due to its situation under an inhabited town.

The present contribution is focused on findings from the Late Antique period, including two different phases, one dated to the 5th century AD (phase III) and another one dated between the 6th and the 8th centuries AD (phase IV).

The remains documented in phase III correspond to the industrial area of a fifth-century Late Roman *villa*. Semicircular pits and small kilns were uncovered, related to the manufacture of building materials (Roig and Coll 2005, 2007, 2010a). At a later moment of the 5th century AD, this area was abandoned and used as a domestic rubbish dump, where various ceramic materials including finewares —such as African red slip ware (ARS) and *dérivées-des-sigillées paléochrétienne* (DS.P.)—, African amphorae, and coarse and cooking wares of presumable regional provenance, as well as coins, metal tools, and slag were found.

The phase IV of the site is associated with a Visigothic *vicus* or small village. It comprised three distinct areas: a dwelling area, with huts made of perishable materials —as suggested by postholes— and a central hearth; a storage area; and a working area, which included a press and *lacus* —probably for wine production—, as well as *dolia*, canals, and rubbish dumps (Roig 2011; Roig and Coll 2007, 2010a). Ceramic findings consist predominantly of regional coarse and cooking wares, while clearly imported materials are scarce, with only a few African red slip wares represented. The Visigothic settlement of this phase was also associated with a large necropolis, dated to the 6th-7th centuries AD (Roig and Coll 2005, 2007, 2010a). The organization and general characteristics of the settlement in this latest phase, along with the abandonment of the previous Late Roman structures of the site, have some parallels in other nearby rural settlements such as Can Gambús 1 (Roig and Coll 2006, 2012), and seem to show an evolution from a Roman-style *villa* to a Visigothic *vicus*, with new architectonical structures which are similar to the ones found in some Central European settlements of the same period (Roig 2009).

In geological terms, Castellar del Vallès is located on an alluvial terrace of the Ripoll river valley, in the Catalan Coastal Depression. The site is dominated by Quaternary sediments with gravels, sands, silts and clays (**Fig.** 2). The area surrounding the site, however, is characterized by a complex geological background, since it is located at the foot of the Sant Llorenç del Munt mountain massif, which is part of the Catalan Pre-Coastal Range. For this reason, several outcrops of plutonic, metamorphic and sedimentary rocks are present near the site, including Paleozoic granites, granodiorites, phyllites, hornfels, schists and quartzites, as well as Triassic sandstones, clays and carbonate rocks, in addition to various Paleogene, Neogene and Quaternary sedimentary deposits (**Fig.** 2) (ICGC 2005; Cirés and Berastegui 2011).

MATERIALS AND METHODS

Large quantities of coarse and cooking wares related to the Late Antique phases of the site were uncovered. Fifty-five of these vessels were selected for archaeometric characterization (Table 1; **Fig.** 3), including materials from phases III and IV, in order to explore potential diachronic changes or continuities during the Late Antique period, between the 5th and the 7th centuries AD.

The majority of the ceramic assemblage corresponds to handmade or slow wheel-made cooking wares. A total of 44 samples of cooking wares were analyzed, including cooking pots for boiling (n = 28), casseroles (n = 13) and one-handle pots (n = 3). Sampling also comprised 10 common wares (five jars, four mortars and a basin), either wheel-made or slow wheel-made, in addition to a handmade *dolium* or storage vessel. The ceramic samples analyzed were usually undecorated, except for two jars with stamped decoration and a cooking pot showing lineal incised decoration.

Macroscopic characteristics of these ceramics indicate that they were mostly fired in a reducing-reducing firing atmosphere, therefore in reducing conditions during both firing (heating and maintenance) and post-firing (cooling). Only 11 of the ceramics analyzed were fired in a reducing-oxidizing atmosphere (Table 1). Almost all cooking wares in the assemblage were related to reducing-reducing firing conditions, whereas the majority of common wares correspond to pottery fired in a reducing-oxidizing environment, with a few exceptions (Table 1).

The ceramic samples were studied using a combination of instrumental analytical techniques for their archaeometric characterization. This included petrographic-mineralogical characterization through thin-section optical microscopy (OM), mineralogical analysis through X-ray diffraction (XRD), and chemical elemental analysis by means of wavelength dispersive X-ray fluorescence (WD-XRF).

OM petrographic-mineralogical analysis of thin sections was carried out using an Olympus BX41 polarizing microscope, equipped with a digital camera Olympus DP-70, and working between ×20 and ×200 of magnification. Ceramic fabrics were studied and described following the methodology proposed by Whitbread (1989, 1995) and Quinn (2013).

For XRD and WD-XRF analyses, a sample of each specimen was powdered and homogenized in a tungsten carbide mill and dried at 100 °C for 24 h. The mineralogical composition of the ceramics was examined through XRD analysis, using 1 g of the pulverized samples. Measurements were taken using a PANalytical X'Pert PRO MPD alpha 1 diffractometer, working with the Cu Kα radiation (l = 1.5406 Å). Spectra were taken from 5 to 80° 2θ, using a step-size of 0.026° 2θ and a step time of 47.5 s. The evaluation of crystalline phases was carried out using the software HighScore Plus by PANalytical, which includes the Joint Committee of Powder Diffraction Standards (JCPDS) data bank. Based on the mineral phases identified in each diffractogram, an estimation of equivalent firing temperatures (EFT) (Roberts 1963) was carried out (e.g. Cau 2003; Cultrone et al. 2001; Maggetti 1982; Maggetti et al. 2011).

WD-XRF chemical analysis was performed using a Panalytical-Axios PW 4400/40 spectrometer. Major and minor elements were determined by preparing fused beads, using 0.3 g of powdered specimens in an alkaline fusion with lithium tetraborate at a 1/20 dilution. Trace elements were determined using pressed pellets made from 5 g of a specimen mixed with an Elvacite agglutinating agent, placed over boric acid in an aluminum capsule, and pressed for 60 s at 200 kN. Sixty International Geological Standards were used for calibration (Hein et al. 2002). A total of 25 elements were quantified: Fe_2O_3 (as total Fe), Al_2O_3, MnO, P_2O_5, TiO_2, MgO, CaO, Na_2O, K_2O, SiO_2, Ba, Rb, Th, Nb, Pb, Zr, Y, Sr, Ce, Ga, V, Zn, Cu, Ni, and Cr. The loss on ignition (LOI) was determined by heating 0.3 g of dried specimen at 950 °C for 3 h. Elemental data were subjected to statistical treatment using the software R (Baxter 2015; Baxter and Cool 2016); for multivariate statistical procedures, chemical concentrations were transformed into additive logratios (Aitchinson 1986; Baxter 1994; Buxeda 1999).

RESULTS

Petrography and mineralogy

The thin-section petrographic analysis allowed the differentiation of three main fabric groups, in addition to four individual fabrics (Table 2). Further information on the mineral phases was obtained from XRD, which enabled estimation of EFT for each ceramic sample (Table 3).

- Fabric Group 1: coarse granitic fabrics

The majority of the samples (n = 24) were included in this group (Table 2). Fabrics in this group showed a dominant granitic composition, along with a contribution of sedimentary rocks (**Fig.** 4). Inclusions consisted predominantly of quartz, alkali feldspar, biotite and plagioclase, as well as granitic rock fragments composed of these minerals. The occurrence of micrographic and granophyric textures in these granitic rock fragments was commonly observed. Coarse inclusions of this fabric also comprise sedimentary rock fragments, mainly quartz sandstone, whereas rare fragments of mudstone can be found as well. The fabrics in this group also contain accessory inclusions of clynopyroxene, epidote and, more rarely, amphibole and zircon.

These fabrics generally show bimodal grain-size distribution of the inclusions, with a dominant and moderately sorted coarse fraction, ranging from medium sand to very coarse sand in most cases. The clay matrix is non-calcareous in all samples, with brown to gray-black color in PPL, usually showing variations related to core/margin color differentiation or to gradual changes in color between the inner and outer surfaces.

Up to five fabrics were differentiated within this fabric group, based on variations in the frequency of specific inclusions, in textural parameters, or in the characteristics of the matrix (Table 2; **Fig.** 4). Fabric 1.1 is the most represented one, with 12 samples, and is characterized by all the features previously mentioned for the group. The other five fabrics are less common in the assemblage and may represent variants possibly related to the main Fabric 1.1. Fabric 1.2 (n = 5) contains coarse rounded opaque inclusions, which are not present in the other samples of the group. In Fabric 1.3 (n = 2) the fragments of Fe-rich mudstone are more frequent than in other fabrics; this fabric also contains micritic lumps, while sandstone fragments are absent. Fabric 1.4 (n = 3) is characterized by a more abundant content in biotite than other fabrics of the group. Finally, Fabric 1.5 (n = 2) is differentiated by a less coarse texture, with lower percentage of coarse sandy fraction than the rest of the samples in this group.

Ceramics in Fabric Group 1 are usually characterized by relatively low firing temperatures, since they show only primary mineral phases in the XRD spectra, including quartz, alkali feldspar, plagioclase and illite-muscovite. This suggests EFT below 800/850ºC in samples with small peaks of calcite, or below 900/950ºC in non-calcareous pottery samples (Table 3). The peaks of plagioclase found in XRD spectra for all the samples of this group may be interpreted as a primary phase, in agreement with the common presence of plagioclase inclusions observed in thin section. There are only a few samples in Fabric Group 1 that were fired at higher temperatures according to XRD results (Table 3). These are non-calcareous samples which usually show total decomposition of illite-muscovite as well as presence of spinel as a firing phase, or very rarely small reflections of hematite (in PMCV07).

- Fabric Group 2: coarse granitic and metamorphic fabrics

The samples in this group (n = 25) are related to fabrics in which the inclusions are derived from both granitic and metamorphic sources (Table 2; **Fig.** 5). These include, on the one hand, dominant inclusions of quartz, alkali feldspar, plagioclase, biotite, and granitic rock fragments formed by these minerals. On the other hand, metamorphic rock fragments derived from phyllite and quartzite are present, in addition to fragments with granoblastic texture containing quartz, alkali feldspar and micas. Sedimentary rock fragments are also common in the fabrics of this group, particularly derived from mudstone and sandstone. Accessory inclusions of clynopyroxene, epidote and chert can also be found.

Texturally, the fabrics in Group 2 are similar to those in Group 1, with a bimodal grain-size distribution of inclusions and the presence of a predominant coarse fraction, which is moderately sorted, and composed mainly of medium to very coarse sand. The clay matrix is non-calcareous and ranges in color from brown to gray or black (PPL), often with heterogeneities in a same sample.

Seven petrographic fabrics were differentiated in this group, based on the relative frequencies of the granitic or metamorphic contribution, as well as on other particularities of their composition or textural parameters (Table 2; **Fig.** 5). The main fabric, 2.1, is observed in 13 samples and is characterized by the dominance of both granitic and metamorphic inclusions, in a coarse fraction with predominant medium to very coarse sand grains. Fabric 2.2 (n = 2) shows a higher frequency of metamorphic rock fragments than in other fabrics of the group. Fabric 2.3 (n = 1), with dominance of both granitic and metamorphic inclusions, presents a different texture, with a coarser mode of the coarse fraction, including a higher frequency of very coarse sand (1-2 mm). On the other hand, in Fabrics 2.4 to 2.7 metamorphic rock fragments are less frequent, whereas the granitic contribution is largely predominant. Fabric 2.4 (n = 1) is differentiated by a higher frequency of sandstone fragments and a finer texture, with very few inclusions over 1 mm in size. In Fabric 2.5 (n = 3) the coarse fraction contains common carbonate inclusions, particularly micritic lumps, whereas Fabric 2.6 (n = 3) is biotite-rich and, finally, Fabric 2.7 (n = 2) shows common fine inclusions of epidote.

XRD results indicate that the vast majority of the samples in Fabric Group 2 were fired at relatively low temperatures, as suggested by the absence of firing phases (Table 3). Like in Fabric Group 1, almost all samples in Group 2 revealed a non-calcareous composition, with presence of quartz, alkali feldspar, plagioclase and illite-muscovite as primary mineral phases, which suggest an estimated EFT below 900/950ºC. In two samples (PMCV02 and PMCV06) small peaks of calcite were identified through XRD, pointing to an EFT not higher than 800/850ºC. There are only two ceramic individuals in Fabric Group 2 which showed peaks of spinel as a firing phase (Table 3), in one of them (PMCV08) with total decomposition of illite-muscovite, suggesting an EFT over 950-1000ºC.

- Fabric Group 3: fine-textured, calcareous fabrics

Two ceramic samples were included in this group, which is clearly differentiated from Groups 1 and 2 in terms of both petrographic composition and textural parameters (Table 2; **Fig.** 6a-b). These are fine fabrics characterized by the presence of frequent carbonate inclusions (particularly micritic calcite), in addition to fine grains of quartz and biotite. Conversely, the coarse sandy fraction is scarce, containing a few inclusions of quartz, alkali feldspar, biotite, plagioclase, granitic rock fragments, sandstone and micritic lumps. The matrix shows a brown color in PPL, and seems to suggest the use of a calcareous clay paste.

The two samples in this group were fired at different temperatures, according to the results of XRD mineralogical analysis (Table 3). Sample PMCV19 shows primary mineral phases only, including quartz, alkali feldspar, plagioclase, illite-muscovite and calcite; the absence of clear firing phases (i.e. gehlenite or pyroxenes) as well as the observation of plagioclase inclusions in thin section suggest that the peaks of plagioclase in the XRD spectra may be interpreted as a primary phase. Conversely, in sample PMCV35 illite-muscovite is totally decomposed, while well-developed peaks of pyroxene are observed, indicating a higher EFT in this case (≥950/1000ºC).

- Other fabrics

In addition to the three main petrographic fabric groups identified, there are also four samples that cannot be fitted in any of these groups and were considered as loners or representations of smaller and non-defined fabrics (Cau et al., 2004) (Table 2; **Fig.** 6c-f).

Two of these samples, PMCV13 and PMCV26, show partial similarities in composition with Fabric Group 2, but are clearly differentiated from the latter by the absence of granitic rock fragments and a much finer texture. They are characterized by the presence of quartz, plagioclase and biotite inclusions, in addition to metamorphic rock fragments (derived from phyllite mainly), mudstone fragments and other accessory inclusions. In sample PMCV13 the matrix is more micaceous than in PMCV26, suggesting that they should be considered as different fabrics. XRD results indicate a higher firing temperature for PMCV26 than for PMCV13 (Table 3). This might help to explain, at least in part, the differences in fabric observed between both samples in thin section, but it cannot be assured that these differences are only due to varying firing conditions.

On the other hand, sample PMCV48 presents strong similarities with Fabric Group 1, in terms of composition and general textural features (i.e. coarse granitic fabrics), However it has been classified as a petrographic loner due to the additional presence of accessory volcanic inclusions. These consist of large fragments of volcanic rocks (with porphyritic texture, including phenocrysts of quartz and clinopyroxene in a fine-grained groundmass), in addition to clynopyroxene and amphibole inclusions. XRD results indicate an EFT below 900/950ºC for this sample.

Finally, sample PMCV27 is characterized by a dominant sedimentary composition, including frequent fragments of sandstone (with ferruginous cement) and micritic lumps. It also contains inclusions of quartz, a few granitic rock fragments and biotite. This ceramic individual was fired at temperatures over 950-1000ºC, as suggested by the mineralogical composition observed through XRD (Table 3).

Chemical analysis

The chemical results for the 55 ceramic individuals analyzed by WD-XRF indicate that large part of the samples are relatively homogeneous in terms of elemental composition, except for small variations in some elements (Table 4). Most of the samples —with the only exception of PMCV19 and PMCV35— are characterized by a low calcareous composition (CaO < 5%, in most cases below 2%) and high SiO_2% (usually 60-70%), whereas MgO percentages are generally below 2%, and K_2O percentages tend to be relatively high (3-4%). Concentrations of Na_2O show higher variation than other major or minor elements, ranging between 0.6-2.5%.

Further details on the chemical variability of the data set can be obtained by calculating the compositional variation matrix (CVM) (Aitchinson 1986; Buxeda 1999; Buxeda Garrigós and Kilikoglou 2003). The total variation (v_t) value obtained, 1.82, is relatively high and indicative of a polygenic sample. The CVM also reveals that most of this variability is introduced by variations in P_2O_5 ($\tau_{.i}$ = 11.88), Cu ($\tau_{.i}$ = 8.07), Ni ($\tau_{.i}$ = 6.43), Na_2O ($\tau_{.i}$ = 6.54), CaO ($\tau_{.i}$ = 5.61), Cr ($\tau_{.i}$ = 4.22) and Pb ($\tau_{.i}$ = 3.56). The high τ_i value for CaO must be affected to a certain degree by the presence of two calcareous samples, as mentioned before, but also of a few other samples with CaO percentages between 2-4%, in an assemblage largely dominated by ceramics with very low CaO%, generally <2% (Table 4).

A cluster analysis (CA) of the chemical data provided a first graphic insight into the compositional similarities between samples. For the statistical treatment, concentrations were previously transformed into additive log-ratios (alr) using Al_2O_3 as a divisor, since it was the element with the lowest variance ($\tau_{.i}$) according to the CVM. P_2O_5 and Pb, which are related to high $\tau_{.i}$ values in the CVM, were excluded from this analysis due to possible contamination problems related to these elements. The cluster tree obtained from CA showed the presence of three main clusters (**Fig.** 7), which are also confirmed by a principal component analysis (PCA) (**Fig.** 8), based on the same subcomposition as in the CA.

The majority of the pottery samples analyzed are included in a large cluster C, in which two chemical groups can be identified, C1 and C2 (**Fig.** 7). Both groups are actually similar in their compositions, except for very minor differences in Na_2O and in a few trace elements (Table 5; **Fig.** 8). In fact, calculation of CVM for these two groups reveals low v_t values in both cases (0.38 for group C1 and 0.49 for group C2), but even if both groups are considered together the v_t is still relatively low (0.64) and might be indicative of a broadly monogenic group of pottery (Buxeda et al., 2001; Buxeda Garrigós and Kilikoglou, 2003), especially in the case of handmade coarse pottery (Cau Ontiveros et al., 2019).

On the other hand, seven ceramic individuals (PMCV08, PMCV13, PMCV21, PMCV24, PMCV26, PMCV27 and PMCV47) form a separate cluster B in CA and PCA (**Fig.** 7-8). They are characterized by lower Na_2O% and slightly higher concentrations of Cu, Ni, Cr, V and Zn than those in samples of cluster C (Table 4). Finally, cluster A comprises the few samples in the data set with CaO% over 3% (**Fig.** 7-8). Here two small sub-clusters can be differentiated: one including two samples (PMCV19 and PMCV35) with calcareous composition (CaO>5%), and another one with three samples (PMCV06, PMCV15 and PMCV30) characterized by a border calcareous composition (CaO 3-5%).

DISCUSSION

The results of the archaeometric analysis showed no direct relation between the main petrographic groups identified (Fabric Groups 1 and 2) and the clusters resulting from the statistical treatment of the XRF chemical data (**Fig.** 7). Even if the majority of samples in chemical group C1 are coarse granitic fabrics (Fabric Group 1) and the majority in chemical group C2 are coarse granitic and metamorphic fabrics (Fabric Group 2), there are still exceptions in both cases, which suggest that a clear correspondence between these main fabric groups and chemical groups cannot be established. Conversely, the only two samples in Fabric Group 3 were clearly differentiated from the rest of the assemblage for their chemical composition (**Fig.** 7), since their calcareous fabrics were directly related to the higher CaO% observed in these samples (**Fig.** 8). Chemical results also indicate compositional similarities between samples PMCV13 and PMCV26, two petrographic loners with partial fabric similarities as well.

The coarse inclusions derived from granitic, metamorphic and sedimentary rocks that characterize the majority of the ceramics analyzed might be interpreted either as an added temper or as naturally occurring inclusions of the raw clay used for pottery manufacture. Outcrops of these various classes of rocks are common in the vicinity of Castellar del Vallès (**Fig.** 2) and may have been exploited as sources of sand for tempering. However, the Quaternary alluvial sediments, where the site is located, also receive contribution of materials from the adjacent geological deposits; for this reason, clays and other alluvial sediments in the vicinity of the site may also contain naturally occurring inclusions derived from different outcrops of granitic, metamorphic and sedimentary rocks. Further analyses on geological samples from this area will be needed in order to identify the exact sources of raw clays and to better understand the raw material processing techniques followed by the potters at Castellar del Vallès.

In any case, the obtained results indicate that the petrographic composition of the ceramics is consistent with the hypothesis of a local provenance, even if a broader regional provenance cannot be excluded. Also the composition of sample PMCV48, which contains accessory volcanic rock fragments (in addition to dominant granitic inclusions), may be compatible with a local provenance, since the occasional presence of localized Ordovician volcanic rocks among the Paleozoic outcrops near Castellar del Vallès has been reported (Cirés and Berastegui 2011). This hypothesis is supported also by the strong similarities in chemical composition observed between PMCV48 and various samples of Fabric Groups 1 and 2 (**Fig.** 7). In general, the presence of granitic and/or metamorphic rock fragments (in variable amounts) in all the fabrics of coarse and cooking wares analyzed in this study is compatible with the geological background of the area surrounding the site and, therefore, suggests that all these utilitarian wares could have been produced locally. Clay deposits potentially used for pottery production were available at a distance less than 5 km from the site, providing additional support to the hypothesis of a local provenance.

Further conclusions can be drawn from the comparison between the archaeometric results obtained and the archaeological information of each pottery sample analyzed (**Fig.** 7; Table 1). All samples with a calcareous or border calcareous composition (Cluster A in **Fig.** 7-8) correspond to common wares, either mortars or jars. However, two different trends can be observed in terms of raw materials and processing techniques among these samples: on the one hand, fine-textured calcareous fabrics, with CaO over 6%, which include mortars only; and, on the other hand, border calcareous wares (CaO 3-5%) including jars and a mortar, associated with variants of coarse granitic and granitic-metamorphic fabrics (Fabrics 1.5 and 2.5). Nevertheless, a few common wares (jars, a mortar, and a basin) were manufactured using low calcareous clay pastes, in a variety of granitic-metamorphic fabrics (Fabrics 2.1, 2.4 and 2.6) or metamorphic fabrics (loners PMCV13 and PMCV26).

The use of non-calcareous clays for pottery making was frequent in northeastern Iberia during Late Antiquity, as observed in *Barcino* (Buxeda Cau 2005), *Iluro* (Buxeda Cau

2004), and some rural sites nearby, such as Can Gambús (Riutort et al. 2017) or Horts de Can Torras (Riutort et al. 2018). These clays were used mainly for cookwares due to technological advantages in relation to heat conductivity and resistance to fracture (Cau et al. 1997; Hein et al. 2008; Müller et al. 2014). In some cases, calcareous clays were also used to manufacture common wares in the same sites, what could be associated with technological features such as the reduction of shrinkage time or the better resistance to thermal shock during firing (Albero 2014). Nevertheless, sporadically, we find what can be considered as common wares produced with non-calcareous clays, that in our sampling are one mortar and two jars.

In summary, the results indicate that a diversity of raw material sources and/or paste recipes were followed in the production of the common wares found at Plaça Major de Castellar del Vallès. This high variability is observed for both chronological phases at the site: all the common wares analyzed from phase III (5th century AD) showed different fabrics (Fabrics 1.5, 2.1, 2.5, 2.6, 3 and petrographic fabric loners), whereas the few common wares analyzed from phase IV (6th to 7th centuries AD) were again associated with different fabrics in each case (Fabrics 1.5, 2.4 and 3).

A variety of fabrics and compositions was also found for the cooking ware assemblage from the site, but in this case the ceramics were manufactured using always low calcareous clay pastes (CaO <3%). This must be associated with technological choices related to improving the resistance to thermal shock (Picon 1995). The cooking wares in the assemblage of Plaça Major de Castellar del Vallès were produced using raw materials rich in coarse granitic and, sometimes, metamorphic inclusions in variable amounts (Fabric Groups 1 and 2), with very rare exceptions like the sedimentary fabric observed in loner PMCV27. The results of archaeometric analyses indicate a variety of fabrics in the cooking wares, mainly Fabrics 1.1 and 2.1, but also other less common fabrics (Fabrics 1.2, 1.3, 1.4, 2.2, 2.3, 2.5, 2.6 and 2.7, in addition to petrographic loner PMCV48). In spite of this diversity, chemical results suggest strong compositional similarities between these fabrics and point to a broadly common provenance for the majority of cooking wares, as indicated by the low v_t values for chemical groups C1 and C2, even when considered together. Some of the cooking wares, however, are slightly different in chemical composition compared to groups C1 and C2, especially in the case of samples included in compositional Cluster B (**Fig.** 7-8). The few cooking wares in this last cluster are characterized by granitic-metamorphic fabrics (2.1 and 2.3), and the particularities of their chemical composition may suggest the use of slightly different raw materials from those used for samples in Cluster C, even if these differences cannot be correlated to any specific feature of the samples in thin section.

The overall results indicate, therefore, that the cooking wares found at the site were manufactured using approximately similar raw materials and paste recipes, with minor variations in fabric or chemical composition that might be the result of exploiting slightly different sources of raw materials in the surroundings of Castellar del Vallès. These variations have no relation to the typology of cooking wares, since different forms of cooking pots and casseroles are included in the same petrographic fabrics and chemical groups (**Fig.** 7). The only correlation observed between fabric and typology of cooking wares concerns Fabric 1.3, which includes two casseroles, but even in this case they show variations in chemical composition (**Fig.** 7; Table 4). Another exception concerns one-handled pots, since the three samples analyzed of this pottery form are related to biotite-rich fabrics (Fabrics 1.4 and 2.6: **Fig.** 7), although the latter were found also in a few cooking pots (PMCV17 and PMCV22) and a common ware (PMCV25).

Similarly, the compositional variability of the cooking wares cannot be explained based on chronological grounds, as the various fabrics and compositions identified are associated with both phases III and IV, again with the only exceptions of Fabric 1.3 (absent in phase IV) and fabrics related to individual samples. From this results, it seems evident that the cooking wares found at Plaça Major de Castellar del Vallès, presumably locally produced, showed a continuity in the raw materials and processing techniques from the Late Roman period (phase III) to the Visigothic period (phase IV), with the same diversity in terms of petrographic fabrics and chemical compositions over the centuries.

Finally, it is worth mentioning that the only sample of storage vessel or *dolium* analyzed in this study, PMCV53, showed the same petrographic fabric (1.1) as several cooking wares. This suggests the use of similar materials and techniques to produce utilitarian wares for different functions, in this case cooking and storing foodstuffs, although a larger sample of local storage vessels will be needed in order to further explore similarities and differences in the production of both classes of pottery at the site or region.
As concerns the firing conditions of the pottery, the results of the analysis suggest that, in general, both the cooking wares and the common wares from Plaça Major de Castellar del Vallès were usually fired at temperatures not higher than 900/950ºC, under reducing-reducing conditions in the case of cooking wares or reducing-oxidizing conditions in the majority of common wares. There are, however, some exceptions to this trend, in terms not only of firing atmospheres (Table 1) but also of firing temperatures, as indicated by results of XRD mineralogical analysis (Table 3). Rare examples of samples fired at relatively high temperatures (over 950/1000ºC) are observed in both cooking and common wares, and in relation to different forms, indicating that these occasional variations in the firing process are not correlated to typological or functional characteristics of the pottery produced. In the case of cooking wares, manufactured with low calcareous clay pastes, the relatively low firing temperatures observed in most cases were desirable in order to obtain high-quality products for the function intended, whereas the few high-fired examples could have had problems with thermal shock resistance an therefore were not the most suitable vessels for cooking purposes (Picon 1995; Travé et al. 2019).

CONCLUSIONS

The archaeometric analysis of utilitarian wares found in Late Antique contexts of Plaça Major de Castellar del Vallès revealed the predominant use of low calcareous clay pastes rich in granitic inclusions and variable amounts of metamorphic inclusions, except for some common wares for which calcareous or border calcareous clay pastes were used. The geological background of Castellar del Vallès is compatible with the hypothesis of a local provenance for both cooking and common wares, however it is not possible to exclude a possible provenance in the wider area of Vallès on strictly lithological grounds (ICGC 2005).

A similar range of granitic and granitic-metamorphic fabrics in the production of cooking and common wares has been reported also for other Late Antique rural sites in the area of Vallès, such as Can Gambús and Horts de Can Torras (Riutort et al. 2017, 2018). Utilitarian wares could have been produced locally in these sites, based on the existing archaeological evidence and the preliminary archaeometric analyses carried out so far. However, these sites are located very close to each other and surrounded by similar geological formations, resulting in strong similarities in terms of petrographic fabrics and chemical composition of the pottery. This poses a problem for the differentiation of ceramics produced at each site, as well as for the distinction between local or regional wares in each case. Further research is required to solve this complex issue, including the analysis of potential clay sources throughout the region and a combined micro- and macro-regional approach (Riutort et al. 2018).

In any case, the results of the archaeometric characterization of cooking and common wares from Plaça Major de Castellar del Vallès reflect, on a smaller scale, the general trends observed in the wider region of Vallès during the Late Antique period. Ceramics found at the site, especially the handmade or slow wheel-made cooking and common vessels, could have been locally produced, but a diversity of fabrics was identified, broadly related to each other. Most of these ceramics were included in a large chemical group with low total variation, pointing to a similar geochemical origin, while less represented chemical groups or compositions, slightly different from the main group, might be indicative of the use of other nearby sources of raw materials and/or minor variations in the paste recipes. These variations had no direct relation either to the class/type of pottery manufactured or to the chronology of the ceramic contexts. Conversely, the evidence seems to indicate that a number of small local or regional workshops could have coexisted, following in general the same technological traditions but using raw materials from slightly different sources (Buxeda et al. 2003; Cau 2003). Broadly similar raw materials, paste recipes and firing techniques were used to produce the majority of cooking wares and some common wares as well, while others —particularly in the case of common wares— were associated with somewhat different raw materials or technological choices.

The results of the study also suggested a continuity in general aspects of pottery production between phases III and IV of the settlement of Plaça Major de Castellar del Vallès, that is, from the fifth-century Late Roman *villa* to the Visigothic *vicus* (small village) dated to the 6th-8th centuries AD. The archaeological remains of an industrial or working area at the site may support the hypothesis of a local production during Late Antiquity, that could have continued using similar techniques and raw materials throughout the life of the settlement, with a marked decline in the 7th century AD (Roig and Coll 2010a). However, the absence of ceramic kilns in the settlement makes this hypothesis difficult to prove; except for some kilns producing building materials, so far no pottery kilns have been excavated at this site or nearby Late Antique settlements in the Vallès. The archaeological record ─including a dwelling area, a working area, and a storage area─ seem to indicate a self-sufficient system producing enough to cover the basic needs of the inhabitants and generating a relative surplus that was possibly exchanged through regional trade. This pattern has been repeatedly observed in other Late Antique rural settlements of northeastern Iberian Peninsula (Gurt and Navarro 2005; Chavarría 2007). Again, broader studies focused on a wider regional scale will be needed in order to better understand the patterns of pottery production, distribution and consumption at this region.

The present study provided an overview of the ceramics consumed and likely produced in Castellar del Vallès during Late Antiquity, from the 5th to the 7th centuries AD. The results should be interpreted in relation to the general context of transformations of the rural settlements and the countryside in the Catalan region, when Roman *villae* experienced the progressive abandonment of their dwelling areas and were replaced, during the Visigothic period, by the construction of small villages composed of huts (Chavarría 2007; Gurt and Navarro 2005; Roig 2009). This period of social and cultural transformations was also reflected in changes in the models of pottery production and distribution. Imports of utilitarian wares —especially of cooking vessels— experienced a gradual decrease, which started in 4th century and became more evident in the 6th century, until the 7th-8th centuries when these imports are very rare (Járrega 2013; Macias and Cau 2012). Concerning regional cooking wares, there is a tendency to simplification of shapes and typological repertoires, while the firing process usually takes place in reducing-reducing environments, resulting in pots with predominantly dark surfaces. This trend will continue later during the Medieval period (Travé et al. 2013, 2014, 2015), in the context of new changes and transformations of the societies that inhabited the northeastern part of the Iberian Peninsula.

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Table captions

Table 1. List of analyzed samples, with their main archaeological information

Table 2. Summary of the results of thin section petrographic analysis

Table 3. Mineralogical composition and equivalent firing temperature (EFT) of the analyzed samples based on XRD results

Table 4. Elemental composition of the 55 ceramic samples analyzed through WD-XRF. Concentrations of major and minor oxides (and LOIs) are in percent; other minor and trace elements are in parts per million

Table 5. Mean normalized chemical composition (WD-XRF) of the two main groups, C1 and C2, defined from multivariate statistical analysis of the data. Mean (m) and standard deviation (sd) values are given for each element. Concentrations of major and minor oxides are in percent, trace elements are in ppm

Fig. captions

Fig. 1. Location of Castellar del Vallès, in the context of northeastern Iberian Peninsula, and plan of the archaeological excavations at the Plaça Major (main square) of the town (based on Roig and Coll 2005)

Fig. 2. Geological map of the Vallès area, with the location of Plaça Major de Castellar del Vallès (based on ICGC 2005)

Fig. 3. Representative illustrations of coarse and cooking wares found at Plaça Major de Castellar del Vallès: cooking pots (a-b), one-handle pots (c), casseroles (d-e), mortars (f-g), and jars (h-i). Drawings by J. Roig (from Roig and Coll 2011; Inserra 2016)

Fig. 4. Photomicrographs of ceramic thin sections of Fabric Group 1, taken under crossed polars (XP). (a-b) Fabric 1.1. (c) Fabric 1.2. (d) Fabric 1.3. (e) Fabric 1.4. (f) Fabric 1.5

Fig. 5. Photomicrographs of ceramic thin sections of Fabric Group 2, taken under crossed polars (XP). (a-b) Fabric 2.1. (c) Fabric 2.2. (d) Fabric 2.3. (e) Fabric 2.4. (f) Fabric 2.5. (g) Fabric 2.6. (h) Fabric 2.7

Fig. 6. Photomicrographs of ceramic thin sections, taken under crossed polars (XP). a-b: Fabric Group 3. c-f: other fabrics or petrographic loners

Fig. 7. Dendrogram resulting from a cluster analysis (using the centroid agglomerative method and the squared Euclidean distance) on 55 ceramic samples, based on the alr-transformed concentrations of Fe_2O_3, MnO, TiO_2, MgO, CaO, Na_2O, K_2O, SiO_2, Ba,

Rb, Th, Nb, Zr, Y, Sr, Ce, Ga, V, Zn, Cu, Ni, and Cr, using Al_2O_3 as divisor in the log-ratio transformation of the data. Main clusters (A–C) and chemical groups (C1, C2) are indicated. Petrographic, typological and chronological data for each sample are given

Fig. 8. PCA based on the same alr-transformed subcomposition as the cluster analysis (CA). Plot of the first two principal components (PC1 vs PC2) with their scores and loadings. PC1 and PC2 account for 49% and 16% of the total variance, respectively. For each sample, an indication of the ceramic form is given with symbols (cooking wares in red, common wares in green, storage ware in black). Main clusters (A–C) and chemical groups (C1, C2) derived from CA are indicated