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**POMPEII AS A POTTERY PRODUCTION CENTRE**

An archaeometric approach

**Introduction**

Recently a new project of archaeometric investigation focused on pottery production and circulation at Pompeii was undertaken in cooperation between University of Venice Ca’ Foscari, the laboratory of ARCHEA1 in Warsaw and the Free University of Berlin. The project aimed to give a scientific description and interpretation to a number of wares of supposed local and regional production, retrieved during recent stratigraphic excavations undertaken in Regio VI, insulae 7 and 14 and by past excavations (1980–1981) carried out in the western part of the forum at Pompeii2. The issue of distinguishing wares locally manufactured at Pompeii from products manufactured in the surrounding region (so called Vesuvian region) was particularly crucial for the purposes of the above research work. The following contexts proved to be useful in order to define what could be securely identified as a local production:

1. The pottery from the filling of a pit (XB 11), part of a trench (XB) dug in the forum, next to the basilica area3. Among the retrieved ceramics, this layer yielded clear archaeological evidence for local pottery production, consisting of 78 complete kiln spacers, together with a large number of misfired pottery sherds in plain and black gloss ware and numerous sherds of red figured ware. The pottery can be dated by comparanda from the late 4th to early 3rd century B.C.

2. Further evidence for local (pottery wasters, moulds) and possibly local pottery production was detected in trench VII B and in probe VII, located alongside the eastern side of the sanctuary of Apollo4. A number of layers yielded, among other ceramics, abundant re-deposited votive material such as lamps, terracotta figurines, thymiatheria, miniature pottery and unguentaria5. The morphology and fabric of many of these objects suggested a possible local/micro-regional production of the votive material, likely to be connected with sanctuary needs.

3. A number of pottery wasters was retrieved during stratigraphic excavations carried out by the University of Perugia6 in the domus VII,15,9–10 at Pompeii. The excavators identified a kiln active during the mid-2nd century B.C. The kiln was located north-west of the sanctuary of Apollo and archaeologists suggest that pottery production may have been functional to this sanctuary.

The typo-/chronological aspects of the examined ceramics are discussed in a separate contribution by COTTICA ET AL. in this volume, while this present study aims to investigate local and regional productions from an analytical perspective.

**Methodology**

Three independent archaeometric methods of ceramic material classification were applied. Initially using MGR-analysis7 the analysed sherds were grouped according to the plastic raw material used in their production. Then thin-section studies were used in order to describe the non-plastic part of the ceramic body as in the case of the natural clastic inclusions of the clay, or fine or coarse temper added by the potter. Finally, chemical analysis of all ten major elements and of a series of fifteen trace elements by wavelength-dispersive X-ray fluorescence (WD-XRF), together with multivariate grouping of the resulting data, allowed to establish which sherds were
made from the same ceramic body, e.g. in the same workshop. The limiting factor of grouping sherds using the above mentioned analytical methods is that the variation within a given workshop has to be known. Therefore many samples have to be analysed and the variation of all data received from the three methods have to be combined. This latter point is especially crucial in the study of the pottery from Pompeii and from the Vesuvian region. As it will be shown, MGR-analysis results in many groups slightly differing in composition. Not all these groups can be seen in the chemical data and, as an additional problem, chemical analysis and multivariate classification put together samples which are significantly different according to the thin-section studies.

Therefore the main problem to be solved was to establish reference groups in order to distinguish between workshops certainly active in Pompeii on the basis of archaeological evidence, other workshops present in the surrounding region and pottery from other provenances (i.e. non Vesuvian ceramics).

Altogether 121 samples from Pompeii were analysed from the context described above. A large number of analytical data on black and red gloss pottery from Campania were already available for comparison in the authors’ database. In addition, the Berlin data bank of some twenty-five thousand analyses comprises reference groups of vernice nera and terra sigillata from numerous sites in Italy and beyond.

The procedure of pottery analyses followed our down-up sampling strategy. Initially all 121 samples were classified by refiring small fragments at 1100° and 1200° C (abridged MGR-analysis). As identical refiring behaviour corresponds to a similar chemical composition (if the influence of the coarse inclusions could be neglected), 23 samples had not necessarily been analysed by WD-XRF, so we could reduce costs. Based on the resulting compositional groups, 52 thin-sections have been studied, a number which certainly should be increased in the future. These latter studies turned out to be essential in distinguishing e.g. the local reference group 1a, showing that the same raw materials were used over a long period of time and for very different pottery types. The mean, standard deviation and coefficient of variation of the chemical analyses of group 1a samples are given in Table 1.

Vessels belonging to group 1a are made from calcareous clay with Calcium contents between 10 and 16 % CaO. The clay contains microfossils e.g. foraminifera (fig. 1a-c) and quartz and, depending on the firing temperatures, fine mica. Larger inclusions are of volcanic material of up to 1 mm grain size, consisting of rock fragments (fig. 1d), pyroxene and feldspar (fig. 1a,c). Fragments refired at 1200° are molten to a round ball with pale to dark olive green colours which also could be brown-olive green, or olive green, with brown irregular distributed parts indicating some mixing of clays. By refiring behaviour and thin-sections, a few subgroups could be distinguished: these however need more analytical research before an assured interpretation can be brought forward.

### Group 2

A further group of samples in refiring and in chemical analysis turned out to be similar to reference group 1a but with distinct higher contents of Sodium. These samples form the compositional group 2 which is much more inhomogeneous than group 1a, with clearly visible subgroups. One of these subgroups combines three wasters from a kiln excavated in domus VII, 15, 9–10 by the University of Perugia. The mean composition of these wasters is shown in Table 1 and compared to the overall mean of group 2. Group 2 comprises samples of moulds, bricks, lamps, common ware, miniature ware and, like in group 1, terra sigillata. In all six thin sections which have been made of group 2 samples, the presence of typical inclusions of volcanic material (fig.

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10 A detailed description of the methods is given in the paper by Daszkiewicz et al. in this volume.
11 Most of these data were the result of past studies already presented elsewhere (Soricelli et al. 1994; Faber 2003).
12 e.g. Hedinberg 1999a, b; Schneider 2000, 2009; Schneider/Daszkiewicz 2006.
13 This is based on experience of several thousand samples analysed both by MGR-analysis and WD-XRF.
14 Within this context it is interesting to note that the mean of three chemical analysis of sigillata from Pompeii made by ICP-MS (cfr. J. McKenzie in: Cottica/Zaccaria Ruggi: forthcoming) is similar to our reference group 1a. She called this mean CRSW2 (Campanian Red Slip ware). Her second group CRSW1 of three samples of sigillata found at Pompeii chemically corresponds to Production A sigillata (see footnote 21).
15 Because some samples were attributed to group 1a only by MGR-analysis, the average is made of the 27 samples which have been analysed also by WD-XRF.

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Local pottery production at Pompeii

### Group 1a

One result of the study is very clear. The analysed distance holders, four of the five green wasters, fourteen of the sixteen black gloss wasters found in the stratigraphic unit XB 11, form one homogeneous group coded as group 1a. This group includes also the nine analysed sherds of red figured ware from the same context. This compositional group therefore certainly represents a reference group of locally produced fine wares in Pompeii. From chemical analysis, MGR-analysis and thin-sections fifteen samples from other find places supposed to be of local origin could also be attributed to group 1a. These samples include six black gloss sherds, two of which display a grey core like Campana C. The analysed items belonging to this group contain one of the miniature vessels from the temple of Apollo, a mould and four lamps of type Esquilino and type Ricci C, one of them regarded as a waster. One sherd of terra sigillata with a coarse fabric and one lead-glazed sherd are also matching group 1a, showing that the same raw materials were used over a long period of time and for very different pottery types. The mean, standard deviation and coefficient of variation of the chemical analyses of group 1a samples are given in Table 1.
Fig. 1. Photomicrographs of typical micro-fabrics and inclusions (XPL, width of field 0.7 mm): a) lamp of type Esquiline (V729/group 1a) showing microfossil and plagioclase; b) mould (V732/group 1a) with two microfossils and a volcanic rock fragment; c) miniature vessel (V872/group 1a), inclusions as in fig. 1a; d) terrasigillata (V738/group 1a), coarser volcanic inclusions in a lower fired matrix than in figs. 1a–c; e) mould (V733/group 2a), inclusions and matrix as in fig. 1d; f) common ware (V748/group 2b), volcanic inclusions in a high fired isotropic matrix; g) brick (V755/group 3), showing microfossil, plagioclase and pyroxene; h) sigillata Puteolana (5369), high fired red matrix with fine mica; i) regional imitation of Eastern sigillata (V975) with inclusion of a microfossil and pyroxene in calcareous matrix with fine quartz and mica; j) Production A sigillata (V776), black spots are tiny glass fragments, k) sigillata from Arezzo (4898), high fired red matrix with fine mica; l) Gnathia style pottery (MD4210), inclusion of a micaceous rock fragment in red matrix with quartz and fine mica.
1e–f) and rare microfossils confirms the similarity to group 1a. The mean of Dressel 1 amphorae of Eumachia analysed by Thierrin-Michael and Mazza16 and believed to represent the local products at Pompeii corresponds well to the mean of group 2. In spite of its large variation, group 2 may be taken as a second reference group for local pottery manufactured at Pompeii.

Miscellaneous local or regional wares

Three bricks of supposed local fabric have also been analysed. They form a homogeneous group in MGR-analysis. Thin-sections display the same inclusions as in group 1a but in larger sizes e.g. volcanic rock fragments and microfossils (fig. 1g). The bricks chemically differ significantly from local groups 1a and 2 (table 1) and certainly were made from other raw material available within the Vesuvian area. The same can be said of Pompeian Red Slip ware, of which two groups could be distinguished.

On the basis of macroscopic observation, archaeologists identified two further groups of fabrics of possible local origin. All samples belonging to these latter two macroscopic fabric groups after analysis turned out to belong to various compositional groups, which all differ significantly from reference groups 1a and 2. Part of these samples17 is characterized by Calcium contents below 8 % CaO and very high values of Lanthanum, Cerium, Yttrium and Niobium. Refined fragments are slightly overmelted with a brown colour. This behaviour and composition differs from that of reference group 1a. Volcanic inclusions in thin-sections, however, show that this pottery was also made within the Vesuvian area.

All the other analysed black gloss pottery, lamps18, moulds, unguentaria, miniature vessels (all from trench VII by the sanctuary of Apollo) and common ware belong to various clearly distinguishable groups, most of which by thin-sections are characterized by volcanic inclusions and thus, as long as proofs for a local production at Pompeii are lacking, must also be regarded as regional products19.

Some remarks on terra sigillata and “Gnathia style” pottery

Most of the analysed samples of terra sigillata are imports to Pompeii which can be attributed to known production centres. Puteolan terra sigillata is chemically very similar to the local pottery of group 1a but, in spite of similar high Calcium contents it is very different in thin-sections (fig. 1h), which do not display any volcanic inclusions of rock fragments or pyroxene. As an example of typical Puteolan terra sigillata, the chemical composition of a sherd stamped SGRENII Q. POMPEI20 is given in table 1. A group of three analysed samples of sigillata imitating Eastern sigillata forms, but with volcanic inclusions and foraminifera in thin-sections (fig. 1i), could be distinguished. Chemically the group is very similar to group 1a and to Puteolan. It certainly represents local or regional products. Other sigillata sherds stamped ICVII (?) and PHILEROS (in Greek letters) belong to the well known group of Produzione A Sigillata21, characterized in thin sections by tiny glass fragments (fig. 1j); only in rare cases volcanic inclusions of larger size can be seen. Similar, but larger, glass fragments of a more brownish colour are typical for Campana A to which an analysed rhymatherion could be attributed. Chemically the two groups of red and black gloss pottery from workshops in Naples22 are characterized by high Sodium and Potassium contents and very low Chromium and Nickel traces (table 1).

Several sherds could be attributed to sigillata Aretina as for example a sherd stamped C.VIBIEN/FAVST. Although in thin section sigillata from Aerezzo (fig. 1k) is very similar to Puteolana (fig. 1h), chemically it can be distinguished by somewhat higher contents of Titanium, Chromium and Nickel.

A last group of likely imports is represented by a few analysed sherds of “Gnathia style” pottery. Their chemical composition does not match published data for Gnathia style pottery from Taranto23 and thus the group represents another workshop of this pottery (table 1). In the thin-sections volcanic inclusions are lacking (fig. 1l), as any other indication of the production area.

Conclusions

Laboratory research clearly demonstrates that local pottery of group 1a, Puteolana and Cales are chemically quite similar and a secure attribution of individual sherds needs additional analysis of thin-sections or MGR-analysis. In spite of a large number of chemical data available for pottery from Campania, MGR-analysis should be made on a larger scale to get independent arguments for a precise distinction between the various compositional groups24.

References

17 These are a little black gloss cup and a mould (group 6), thymiateria and a terracotta figurine (group 7).
18 There are at least two groups of lamps of type Ricci C. In group 1a are three such lamps together with a lamp of type Esquillino, the remaining seven lamps of type Ricci C, with inclusions of volcanic rock fragments and slate, form group 8 with subgroups 8a–c.
19 Analytical data of these items and a more detailed interpretation will be published in a separate paper.
20 A full discussion of the analysed stamped terra sigillata is presented by E. TOMASELLA III; COTTICA/ZACCARIA RUCCIO forthcoming.
21 This name used by PENA/McCALLUM 2009, 113, instead Soricelli’s “produzione A di Baia di Napoli” (also known as “Tropolitanian Sigillata”) is given preference to the name Campanian Red Slip Ware (CRSW) used by McKenzie (see footnote 14) which is not unequivocally connected with this group of sigillata and also could be mixed with Cypriot Red Slip Ware.
22 Finds from a workshop for Campana A had been analysed (SORBELLI ET AL. 1994), including one clay sample found within this workshop. This sample, however, did not derive from a geological layer and could also have been imported from the island of Ischia as was hypothesized (e.g. by PICON 1994). The clay used for Produzione A differs significantly from the clay used for Campana A.
24 Comparison of refined samples of various sigillata (MGR-analyses) was presented at a conference in Rome (M. DASZKIEWSZCZ/BORRY/G. SCHNITZER, Provenance of Terra Sigillata determined by MGR-Analysis. Poster at the RCRF Congress in Rome 2002).
Pompeii as a Pottery Production Centre: an Archaeometric Approach

As far as fine wares in group 1a are concerned, the question of the origin of the clay used by potters in Pompeii is still not solved, although archaeological evidence clearly attests that these were locally manufactured at Pompeii. The calcareous clay containing foraminifera, quartz and mica, in spite of some volcanic inclusions, is not of volcanic origin and very probably was not available in the immediate surrounding of Pompeii. Its composition is typical for calcareous marine clay and it was used in the production of the black (and red) gloss pottery. On the other hand, not all of the volcanic inclusions can be explained as local volcanic sand added by the potter and in the finer fabrics of group 1a the inclusions look more like original contents of the clay. Therefore, the provenance of the clay should be located in an area touched by the ashes of the Vesuvius but different from the volcanic glass containing ashes present in the clays used by potters in Naples.

The problems of the provenance of the clay used in Pompeii were discussed in much detail by Peña and McCullum. Analyses by neutron activation of ten fired clay samples are given in their paper including seven samples of miocene marine clay from Ogliara and Montecorvino in the Salerno region. However, only four of the nine important major elements are determined and the series of trace elements differs from the trace elements determined for the purposes of this present paper by WD-XRF. Therefore the comparison of the Peña/McCallum data with the data presented here has only a limited value. The contents of the twelve comparable elements, however, are very similar to those of groups 1a and 2. Certainly, further studies will be useful: these should include a larger series of clay samples fired at various temperatures up to 1200°C, to be compared with the results of MGR-analyses and thin-section studies of the fired clay samples. This methodology will be necessary to confirm the hypothesis that clay from the Salerno region was used for producing fine wares in Pompeii.

Finally, it is of interest to note that combined archaeological and archaeometric evidence suggests the presence of pottery kilns operating between the late 4th and the mid-2nd century B.C. in the forum area, probably connected with the sanctuary of Apollo. From the mid-2nd century B.C. onwards, following the significant rebuilding activities and changes that affected the urban layout of Pompeii, pottery workshops disappeared from the forum area. The model sanctuary/pottery workshops was dismissed and kilns moved to new locations, functionally fitting to the network of streets and city gates, and focused on an efficient connection between the city and its hinterland.

Tab. 1. Chemical analyses by WD-XRF of local pottery groups 1a and 2 from Pompeii compared to the mean of three kiln wasters from domus VII.15.9–10, and to the mean of two bricks with local fabrics, and to several black or red gloss wares given here as examples (inv. nos. given in brackets).

| Reference group 1a: n = 27 | SiO₂ | TiO₂ | Al₂O₃ | Fe₂O₃ | MnO | MgO | CaO | Na₂O | K₂O | P₂O₅ | V | Cr | Ni | Ni (Cu) | Zn | Rb | Sr | Y | Zr | Nb | Ba | La | Ce | Pb | Th | ppm |
|---------------------------|------|------|-------|-------|-----|-----|-----|------|-----|------|---|----|----|----------|---|----|----|---|---|----|----|----|----|---|----|----|------|
| Mean                      | 54.52| 0.779| 17.54 | 6.59  | 0.088| 3.15| 12.97| 0.85  | 3.12| 0.43 | 154| 150| 66 | 49    | 104| 147| 446| 27 | 153| 19 | 351| 31 | 75 | 24 | 14 |     |
| Std ±                     | 1.25 | 0.023| 0.61  | 0.20  | 0.007| 0.21| 1.21  | 0.21  | 0.35| 0.13 | 16 | 6   | 3  | 9    | 12 | 18 | 38 | 2  | 7  | 2  | 48 | 10 | 8  | 17 | 6  |     |
| CV %                      | 2.3  | 2.9  | 3.5   | 3.1   | 7.5  | 6.6 | 9.4   | 24.7  | 11.2 | 31.2 | 10.7| 4.2 | 4.6 | 19.1 | 13.2| 12.1| 8.5 | 7.2 | 4.7 | 11.9| 13.8| 32.0| 10.8| 69.3| 44.0|    |

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