Archeometric Research on Ceramics from ancient Pompei and Hierapolis (Turkey)

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I. INTRODUCTION

The University of Venice Ca’ Foscari, in collaboration with the National Laboratories of Legnaro at the National Institute for Nuclear Physics (INFN), launched last year a new research project focused on the analysis of archaeological ceramics from the sites of Pompei (southern Italy) and Hierapolis (western Turkey). The stratigraphic excavations in Pompei are led by A. Zaccaria Ruggiu (University of Venice Ca’ Foscari) since year 2000 and take place in Regio VI, insulae 14 (in the area of the House of Orpheus) and 7 (House of Apollo), officina lignaria, domus VI, 7, 7 and VI, 7, 26. The same team is carrying out excavations at Hierapolis (modern Pamukkale, Turkey) since 1989. Research at the site has been performed by the University of Venice as part of the activities undertaken by the Italian Archaeological Mission at Hierapolis, currently directed by F. D’Andria (University of Lecce). The team has been digging a large late antique residential complex in insula 104, comprising at present three well-appointed houses. Furthermore, in the upper levels of stratigraphy a series of Mid-Byzantine dwellings has been excavated. The archaeological ceramics from both sites have been studied adopting an interdisciplinary perspective that combines the traditional morphological approach with pottery characterization, quantification and contextual analysis of the retrieved data.

One of the main aims of research is to achieve scientific definitions of the fabrics and the wares in order to proceed with the study of pottery distribution and circulation and ultimately, in order to deal with issues such as trade and exchange of ceramics [1] and their content (the latter case applies especially to amphorae, which in antiquity transported oil, wine, fish sauce and alike) at micro (intra and extra regional exchange) and macro (long-distance, transmarine exchange) level.

II. SAMPLE PREPARATION AND ASSAY OF THE EXCAVATED SAMPLES

Initially all classes of ceramics have been studied macroscopically with magnifying lens and then polished sections have been observed under a reflected-light microscope, using basic principles in optical mineralogy [2]. Then, thin slices of selected samples have been analyzed in order to achieve a minero-petrographic characterization of the clay matrix and its inclusions. At the same time a provisional fabric series could be set.

Subsequently a quantitative element analysis using Proton Induced X-Ray Emission (PIXE) has been applied to the fine-grained fabrics, such as: black glazed wares; terra sigillata (or red glazed wares); thin walled wares and related fine-wares [3]. A subject of interest has been the elemental composition of both the surface and the in-depth material (the clay composition) of the fine ware.

The ceramic samples for surface analysis have been shaped to discs with diameters of 16mm to fit the multi-sample holder. Subsequently their surfaces have been cleaned using ethyl alcohol and distilled water. To analyze the elemental composition of the clay, the surface and the underlying layers with a thickness up to 3mm have been removed mechanically. A zirconium oxide crystal blade has been used for the layer subtraction, thus ensuring that no other elements than zirconium could be deposited on the sample surfaces. The surface layer then has been cleaned using ethyl alcohol and distilled water. Samples from certified reference material “IAEA/SOIL-7” have been prepared for the measurements as well in order to obtain the absolute elemental concentrations of the analyzed ceramics. All the samples have been coated with a thin carbon layer to ensure their electroconductivity.

Proton beams with energy of 1.8 MeV have been delivered by AN2000 accelerator of the National Laboratories of Legnaro, INFN, Italy. The emitted X-rays have been detected by high-purity germanium X-ray detector (ORTEC Iglet X-series) with a resolution of 145 eV at 5.89 keV.

III. DATA ANALYSIS AND DISCUSSION

To identify the groups of objects with similar composition (i.e. originating from the same region) a multidimensional cluster analysis in the space of the elemental concentrations and their mutual ratios has been performed.

In the case of Pompei preliminary results allow us to identify clearly and to define products from Etruria, the Campanian region, imports form Southern Gaul, the Anatolian coast, the Aegean and so forth.

An example of two-dimensional plot of the measured concentrations of Sr and Ca for the ceramic fine ware from Pompei is presented in Fig. 1. From the plot one can see
that the analyzed fine ware samples form three groups (clusters) with similar concentration of Sr and Ca: a group from the Vesuvian area and the Bay of Naples; a group from Arezzo (in the ancient Etruria) and a group corresponding to the so-called “Campana A” ware.

**FIG. 1:** A two-dimensional plot of measured concentrations of Sr and Ca for the ceramic fine ware from Pompei

The results about the possible groups, obtained using cluster analysis in the space of the measured elemental concentrations of the ceramic fine ware can be correlated with the results of the minero-petrographic analysis. On the other hand the measured values for the elemental concentrations can be compared with the already published ones for similar fine wares or to fulfill the missing values for the fine ware in the data bank. These data, along with published information, will form the basis for a study of the distribution of ceramics found in the Campanian region on a GIS (Geographical Information System) platform.

In the case of Hierapolis samples of red glazed wares (well known in scientific archaeological literature as *terra sigillata* and *Late Roman Red Slip Wares*) and fine-grained plain wares (*i.e.* without any treatment nor glazing applied to their surfaces) have been analyzed, in addition to a few ceramic kiln wasters (therefore products of local origin to be used as reference data). An example of two-dimensional plot of the measured concentrations of Sr and Ca for the red glazed wares and fine-grained wares from Hierapolis is presented in Fig. 2. From the figure one can distinguish a group of local-production wares that in turns is compounded by two subgroups of red-slipped wares and plain wares. Moreover, ceramic wasters (basins, lids, terracotta water pipes, etc.) cluster together while the clearly visible outliers represent vessels imported to Hierapolis.

The obtained results will help us to investigate the issues of ancient economy and especially the regional production of fine tableware in late antiquity (IV-VII centuries A.D.), as opposed to long-distance imported wares from North Africa, Cyprus, the western Aegean coast and so forth.

**FIG. 2:** A two-dimensional plot of measured concentrations of Sr and Ca for the fine wares, plain wares and ceramic wasters from Hierapolis

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