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Insights into Ceramic Technology of Roman-Late Roman Wares from Surface Survey in Sphakia Area, Crete through a petrographic and geochemical approach

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Background

Sphakia is a diverse and moutainous region in SW Crete, Greece. Today it is rather remote and marginal but in the Roman and late Roman times large ports grew in the area resulting in an unprecedented economic boom. This is reflected in the pottery that was uncovered during the Sphakia Survey Project with significant quantities of vessels, especially amphorae and fine decorated pots, some identified as Cretan, others as possible off-island imports.

Objectives

The aim of this project is to investigate the firing technology of various types of pottery through the evaluation of the sintering of the ceramic pastes and the identification of the new formed mineral phases. This study is complemented by petrographic description, mineralogical determination (XRPD) of the ceramic fabrics, and chemical analysis (SEM-EDS). The outcome of this integrated study combining archeological information and archaeometric data is hoped to shed new light on issues such as the identification of Cretan production against potential imports from off-Cretan centers and local imitations of foreign prototypes.

Methods

A total of 101 ceramic sherds were analyzed through mineralogical and petrographic techniques. Petrographic analysis was performed on thin sections prepared from sherds using a Zeiss AxioScope A.1 polarizing microscope. Fresh fractures of the ceramic sherds were examined in scanning electron microscope (SEM). The analysis was performed on gold coated specimens using a JSM JEOL 6300 SEM equipped with an Energy Dispersive X-ray spectrometer (EDS) in the Laboratory of Electron Microscopy and Microanalysis at the University of Patras, Greece. The mineralogy of all studied samples was determined by means of X-ray Powder diffraction (XRPD) using a Bruker D8 Advance diffractometer in the Department of Geology, University of Patras.

Results

The petrographic assessment helped us to establish five fabric groups and two loners. The ceramic shapes recognized include fine drinking and serving vessels such as bowls, cups, dishes, plates and transport vessels, mainly amphorae. In spite of their qualitative similarities in terms of their content in aplastic inclusions, the textural differences observed through Optical Microscopy helped us identify the following fabric groups (Fig. 1):

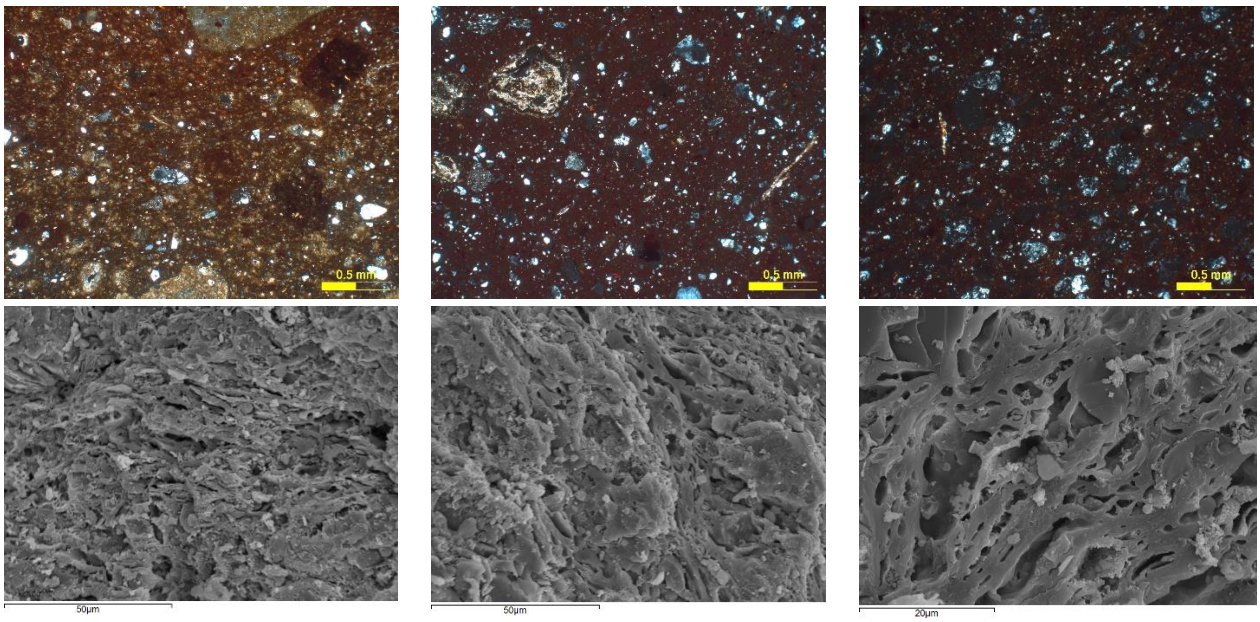

Figure 1. Characteristic photomicrographs (upper row) in crossed Nicols and secondary Electron SEM micrographs (lower row) of representative samples from groups A, B, C (samples 58, 83, 23).

- Group A: Micritic limestone + biotite ± chert
- Group B: Quartz + polycrystalline quartz + micritic calcite extensively decomposed
- Group C: Quartz + polycrystalline quartz
- Group D: Quartz + polycrystalline quartz + mica + micritic calcite extensively decomposed
- Group E: Quartz + white mica + brownish mica
- Loner 1: Quartz + white mica + brownish mica + subrounded volcanic fragments (diabase; hyalophyric) + sub-anglular plagioclase
- Loner 2: Quartz + brownish mica

XRPD and SEM/EDS allowed the establishment of the firing regime, and the overall pyrotechnology available to the ancient potters. The mineralogical groups identified through XRPD are presented in Table 1. The preliminary SEM/EDS results allowed the chemical characterization of the various petrographic groups and corroborative evidence for the firing temperatures obtained through XRPD. Thus, Group A and loners are non-calcareous (CaO<6%) and present low firing temperatures (Cultrone *et al.* 2001), while Groups C and E are calcareous (CaO>6%) and present higher firing temperatures. The remaining groups present a variability of firing temperatures and chemical compositions. As to clay microstructure (Maniatis *et al.* 1981) the preliminary results indicate that fabric group A exhibits initial vitrification (IV) with isolated smooth surfaces, fabric group B presents continuous vitrification (CV) with a continuous smooth vitrified layer visible across the sample, and group C presents extended vitrification (V) with deformed phyllosilicates.

Table 1. Classes created according to the same mineralogical assemblages and firing temperatures as estimated through the XRPD analysis. Abbreviations are according to Whitney & Evans, 2010.

Classes	Mineralogical assemblages	Equivalent Firing Temperatures
I	qz+ ilt± ab± cal± an± or	<850
II	qz+ an+ hem± mul	>850
IIIa	qz+ an+ ilt+ px+ hem± or± anl	~850-950
IIIb	qz+ an+ ilt+ gh+ px+ hem± or	~850-950
IV	qz+ an+ gh+ px+ hem	~950-1000
V	qz+ an+ px+ hem+ gh± or± cal	~950-1000
VI	qz+ an+ px+ hem	>1000

Conclusions

To sum up, this study deals with pottery that was produced in or reached this remote part of Crete in an era of intense circulation and sea trade in the Mediterranean. Archaeometric analysis including thin section petrography, XRPD, and SEM/EDS allowed an integrated technological study of the ceramic vessels. Several mineralogical and chemical groups were established indicative of different technologies of manufacture in terms of clay recipes and pyrotechnologies. This approach offered new insights on ancient potter's choices and practices as well as on the origin of the final product.

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