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Title: ELECTRON MICROPROBE ANALYSIS ON ANCIENT CERAMICS. CASE STUDIES FROM ROMANIA

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Corresponding Author: Univ.Prof.Dr. CORINA IONESCU, Ph.D.

Corresponding Author's Institution: Babes-Bolyai University

First Author: CORINA IONESCU, Ph.D.

Order of Authors: CORINA IONESCU, Ph.D.; Volker Hoeck, Univ.Prof.dr.; Lucretia Ghergari, Univ.Prof.dr.

Abstract: Abstract. Electron Microprobe Analysis (EMPA) is a widely applied technique in geological sciences, but rarely used for archaeometric purposes, i.e. for ceramics or glass remnants. The main benefit is the possibility to identify components, matrix and temper, with a wide range of size, independent of their nature as primary minerals or firing products. Additionally, the combination of Backscattered Electron Images (BSEI) with precisely positioned point analyses is a prerequisite in chemical mapping of minerals

The electron microprobe studies performed on Late Bronze Age ceramics from Ilişua, Transylvania (Romania) demonstrates nicely the merits in determination temper and matrix minerals. However, limitations are inherent in this method. These include problems in identification of matrix minerals because of their extremely small grain size, the sometimes poor crystallisation, incomplete dehydroxylation during the firing, or the rehydration and/or rehydroxylation during the burial and the lack of any structural information

Our analyses revealed a highly porous ceramics, with a very complicated illitic-kaolinitic matrix and various clasts, i.e. fragments of quartz, feldspars and micas. Heavy minerals, lithoclasts, bioclasts, soil aggregates and four different types of ceramoclasts are also present but not included in this study. Here we present EMPA data for selected mineral phases such as plagioclases ranging from oligoclase to bytownite, K-feldspar, phengitic muscovites and matrix compounds. Besides the temper minerals several new phases, formed during the firing process, most likely An-rich plagioclase, K-feldspar and a SiO_2-Al_2O_3 compound similar to pyrophyllite. Matrix minerals are frequently "contaminated" with elements such as e.g. additional Fe, Al or P trapped inside the new lattice or possibly on the surface. The detailed knowledge of the mineral composition based on EMP analyses enables a major step forward in estimating the provenance of the temper minerals, e.g. the derivation of the various plagioclases from basalts and gabbros vs. granites and gneisses. Combined with the BSEI the distinction of firing phases as opposed to temper material is strongly improved. The matrix mineral analyses revealed a complex pattern with phase composition not common among clay minerals such as illite or kaolinite. For better understanding the matrix relations the chemical data must be complemented by structural X-ray investigation. These findings influence also strongly the assessment of the technological conditions of firing.

Suggested Reviewers: Marino Maggetti Univ.Prof.dr.
Univ.Prof.dr., Department of Geosciences, Earth Sciences, University of Fribourg
marino.maggetti@unifr.ch

component. These are metastable phases, formed upon firing and have often a non-stoichiometric composition, thus being difficult to characterize in terms of mineralogy. Frequently they are “contaminated” with elements such as e.g. additional Fe, Al or P trapped inside the new lattice or alternatively at the surface. To distinguish among the primary and the secondary (firing) phases based only on EMP analyses can be relatively difficult, but it becomes more easy utilizing BSEI (Fig. 5b).

The detailed knowledge of the mineral phase composition based on EMP analyses allows the classification of shards, and improves greatly the possibility to identify the raw materials and their provenance, as well as to reconstruct the technological conditions of firing.

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