

## **MEDIEVAL BALKANS CERAMICS: PHYSICOCHEMICAL CHARACTERIZATION OF FINDS FROM SERBIA AND REPUBLIC OF MACEDONIA**

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Imported from various imperial centers for the manufacture of pottery, tableware of Byzantine origin were discovered in archaeological excavations of fortified towns, fortresses and monasteries on the territory of medieval Serbia and Republic of Macedonia. Early medieval Balkans ceramic is well described by the archaeologists and art historians on the basis of decoration, shape and other style characteristics. Archaeological hypothesis based on visual observations, suggests that majority of the investigated pottery shards are dated 11<sup>th</sup> to 12<sup>th</sup> century and were imported, while there is a group of pottery produced in domestic workshops dated 14<sup>th</sup> to 15<sup>th</sup> century. The aim of archaeometric study is to confirm or deny such hypothesis.

Thus, combination of several physicochemical methods has been used for characterization of pottery shards from archaeological sites in Serbia (Ras, Reljina gradina and Novo brdo) and in Republic of Macedonia (Skopje and Prilep). Comparison of the experimental results for archaeological ceramic finds was made.

The aim of this work is determination of chemical and mineralogical composition as well as the technology of production of the body of the ceramic shards. To reach this goal we have studied the ceramic body by X-ray powder diffraction (XRPD), FTIR spectroscopy, energy dispersive X-ray fluorescence (EDXRF) and inductively coupled plasma optical emission/mass spectrometry (ICP-OES/MS).

The mineralogical composition was determined on the basis of FTIR spectra and XRPD patterns of ceramics. Quartz is generally the most abundant mineral phase, especially in the case of shards from Novo brdo and Reljina gradina. Majority of the samples contain alkaline feldspars, orthoclase, anorthite, calcite and muscovite-illite but in various amounts. Hematite, albite, augite, dolomite, gehlenite and chlorite were present in small quantities.

Multivariate statistical analysis was performed in order to establish correlation between the variables and samples, by using results of FTIR spectrometry. FTIR spectra of 58 samples submitted for chemometric analysis were normalized and then smoothed using Savitzky-Golay method with a 25 points third order polynomial filter. After that, numerical differentiation was performed to obtain the first and the second derivative spectra. Chemometric tools we employed count principal component analysis (PCA), hierarchical cluster analysis (HCA) based on Ward's method and linear discriminant analysis (LDA). These techniques were applied on FTIR spectra of all the samples, as well as on their first and second derivatives. For all calculations SPSS 12 software was used. Prior to LDA, samples from Serbia were separated in three groups (NB, RAS, RG), while all the samples from Republic of Macedonia were treated as members of individual group (MK). This classification was based on their archeological origin and supported by the results of unsupervised methods (PCA and HCA).

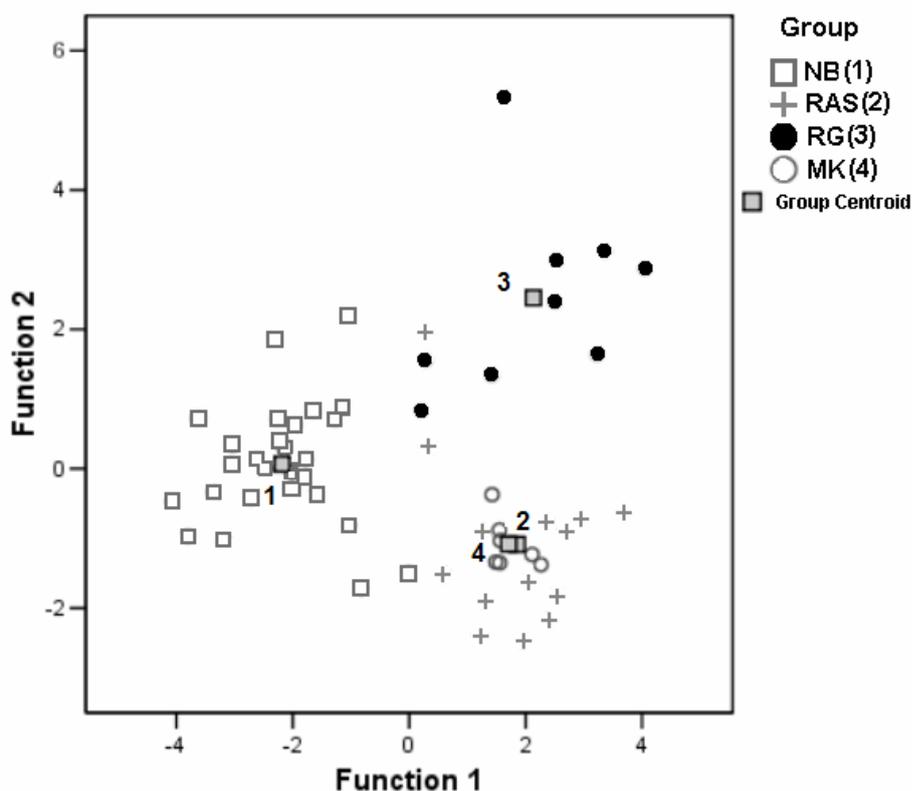


Fig. 1. Linear discriminant analysis of FTIR spectra of pottery shards from Ras, Novo brdo, Reljina gradina (Serbia) and from Prilep and Skopje (Republic of Macedonia)

Analysis of the obtained results has showed that good model can be built on these assumptions (over 90 % of the samples were correctly classified). When we used a model based only on the

samples originating from Serbia, samples from Republic of Macedonia were all classified with samples from Ras, which is good indication that these two groups of samples have the same origin. All the results indicate that pottery from Ras, Skopje and Prilep are of the same origin. In order to find out the routs of their import, the further investigations should be made. The chemical, mineralogical composition and optical microscopy data of the shards from Novo brdo and Reljina gradina confirm hypothesis of their local origin.