Application of Chemical and Chemometric Analytical Techniques to the Study of Ancient Ceramics from Dougga (Tunisia)

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Abstract

Chemical characterization has been carried out on sherds of archaeological pottery from Dougga (Northern Tunisia). ICP-OES and AES analyses were performed for the quantification of fourteen elements. Statistical techniques have been employed in order to define grouping of different pottery sherds. It was quite difficult to establish a good classification and distribution in well defined clusters of the samples from Northern Tunisian kilns; the Sidi Aich (Southern Tunisia) kiln samples were selected as a control group and resulted to be different.

Introduction

The archaeological ceramic sherds examined in this study belong to three different ceramic classes (*African Red Slip Ware*, the so called *Dougga Ware* and the *African cooking ware*). They come from the excavation and surveys carried out at Dougga (high Tunisian Tell) and in particular from the rural settlement of Ain Wassel (12 Km N-W from Dougga). They date to the Byzantine period (VI-VII century A. C.). The archaeometrical investigation is aimed to the characterization of the *Dougga Ware* class which was probably a local imitation of standardized shapes belonging to the *African Red Slip Ware*. This fine ware, well attested from the archaeological point of view, was produced in Tunisia and spread all over the Mediterranean. Aim of this work is to assess the provenance of the *African Red Slip Ware* excavated at Ain Wassel in order to clarify the ceramic circulation models in a rural context and to spread new light on the relationship between production and consumption sites. Chemical data have been submitted to multivariate treatments in order to identify groups of sherds having similar composition, i.e. the same provenance.

Materials & Methods

The chemical characterization has been carried out on 67 pottery sherds belonging to the three ceramic classes the *African Red Slip Ware* (S), the *Dougga Ware* (D) and the *African cooking ware* (C). Furthermore a control group formed by 12 samples from Sidi Aich (Southern Tunisia) kiln (F) has been considered. The samples have been analysed through ICP-OES (Jobin Yvon model 24) and AES (Perkin Elmer model 3100 flame) techniques [1]. Fourteen elements has been determined: Ca, Al, Fe, Mg, K, Ti, Na, Mn, Cr, Cu, Ni, Zn, Zr and Sr. Samples have been crushed to powder using an electric drill with a diamond tip and, to avoid contamination from the burial, the surfaces of the pottery were previously removed. Then a total digestion was performed in a platinum crucible on 20 mg of powder as follows: 1 mL of HF 40%, 2 mL of HNO_3 65% and 1 mL of $HClO_4$ 65% (to let HF excess evaporate off). After cooling, the solution has been diluted to 25 mL with high purity water (Milli-Q water, Millipore, USA) and transferred into a plastic flask. All the chemicals used were of analytical grade.

In this work multivariate statistical analyses [2, 3] have been carried out to identify groups of sherds on the basis of their chemical composition. Compositional data have been analysed using

SCAN software package (Minitab), STATISTICA 7.1 (StatSoft Italia srl) and XLSTAT 2006 (Addinsoft). Unsupervised and supervised pattern recognition was applied in this study.

Results

Taking into account all the analysed elements, only about 30% of the total mass is determined (as the sum of the concentrations of major elements, reported as oxides, and minor elements) while the remaining fraction is SiO_2 probably added as quartz temper [4]. For this reason these samples are highly homogeneous from the chemical point of view. As a consequence the classification of the sherds is difficult resulting in a not clear separation of the classes.

Unsupervised pattern recognition methods as cluster (hierarchical and k-means) and principal component analysis have been applied. In Fig 1 the results of cluster analysis are reported. Hierarchical clustering has been performed starting from the scores obtained by PCA analysis after data autoscaling. The application of supervised pattern recognition as RDA and SIMCA is still in progress.

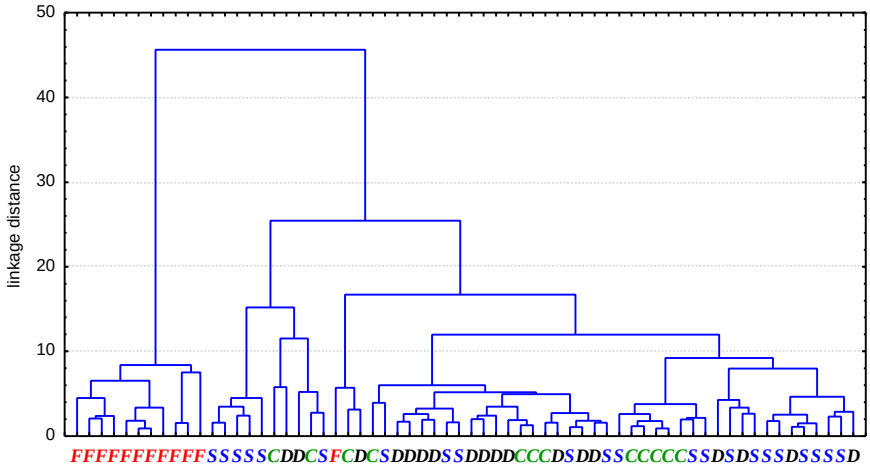

Fig 1; Cluster analysis of all samples with Euclidean distance and Ward method (F = Sidi Aich kiln, S = *African Red Slip Ware*, C = African cooking ware, D = *Dougga Ware*).

Conclusions

It was quite difficult to establish a good classification and distribution of the samples in well defined clusters apart from the Sidi Aich (South Tunisia) kiln samples selected as a control group, because of the high homogeneity of the samples and of the regions where they are from.

Dougga Ware consists in late derivative forms attested in the Byzantine contexts of Ain Wassel and it is very similar to *African red Slip Ware* both morphologically and compositionally.

References

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