A Chemometrics Approach to the Historical and Geographical Characterisation of Different Terracotta Finds

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Abstract

One of the most interesting application of chemometry is the possibility to classify archaeological finds. For this kind of samples, in fact, several time we have a very high number of chemical data (a set for each analytical technique); so we need a tool that can help us to obtain informations from the data matrix able to classify the samples.

In this work we show the results of a multivariate analysis to the historical and geographical classifications of different terracotta finds, by elaborating chemical data obtained from ICP analysis.

The 20 terracotta finds that we have analysed come from 4 different archaeological sites three Italian and one Libyan.

Introduction

The development of modern analytical techniques has allowed to solve a lot of problem concerning all kinds of disciplines.

Several time we can obtain for a sample a numerous series of data, obtained by means of different analytical techniques. So the attention of the analysts is more and more focused on the elaboration of a so high number of data.

This elaboration it is necessary in the classification and study of archaeological finds, so that a new discipline is born: the archaeometry, that is the application of scientific methods and analysis techniques on archaeological problems. One of the most important steps of these studies is the statistical elaboration of multivariate data obtained by physical and chemical analysis of ancients artifacts.

Most of archaeometric literature is devoted to the study of ancient potteries [1], characterised by means of chemical variables (oxides, trace elements, e.g.). The most important purpose of these studies is the determination of their historical and geographic origin [2], to obtain information about the used materials, the manufacturing techniques, and the cultural and commercial exchanges.

The potteries under test come from four different archaeological sites:

- Archaeological dig on the Libyan Sahara Tadrart Acacus massif known as the "Uan Telocat" shelter, (about 5000 B.C.): the finds are five potsherd, with impressed decoration obtained using double-pointed comb-like instrument;
- Civitella di Chieti dump: three finds are classified as terracotta fragments from fictile statues belonging to the pediment conventionally defined as "type A" and three from pediment defined as "type B"; two other finds belong to the two pediment statues, although no certain attribution could be made to either. These finds are dating to 1^{st}-2^{nd} centuries B.C.
- Ariccia: three finds originating from different portions of a slightly less than life-size votive statue representing a female figure seated on a throne and dated as 3^{rd}-2^{nd} century B.C.
- Rome: four renaissance potsherds from the excavation of the Rome chancery dating to the 15^{th}-16^{th} centuries.

Materials & Methods

All the samples, in the form of non homogeneous fragments, were first carefully round into homogeneous powder.

The analysis was performed by an ICP Jobin-Yvon JY 70 Type III (Inductively Coupled Plasma Emission Spectrophotometer). The solution to be analysed was obtained by mixing 200 mg of the ground specimen with 1.0 g of lithium tetraborate in a graphite crucible and by heating in an oven to 1000°C for 40 min after slow rising up to 700°C. The pearl was cooled and than dissolved in 250 ml of aqueous solution containing 4 ml of HNO_3 (65% w/w) and 4 ml of HCl (37% w/w %), stirring for 5 h.

All the data obtained by ICP analysis and elaborated by Lotus 123 v 9.8 to make data matrix, the var-var charts, the correlation matrix, and by MVSP to calculate Principal Components Analysis (PCA) and charts design.

Results

The data matrix is composed by 19 objects and 22 metals from main components (Ca, Si, Mg, e.g.) up to trace elements (Be, Zr, Os, e.g.). The first data treatment is cut away elements not present in all objects. After one of the elements with "same" information is removed (correl. Ca-Sr 0.9) and finally with the loadings of PCA is used to find same number of main and trace elements.

After this variable selection the chemometrics approach of this study has allowed us to highlight a clear difference on the chemical composition among the finds corresponding to Sahara, Civitella and Ariccia site. A less clear difference is noticeable for the renaissance finds (Fig 1). It can also noticeable that all the nine finds of Civitella can be grouped in an only one cluster well separated from the others.

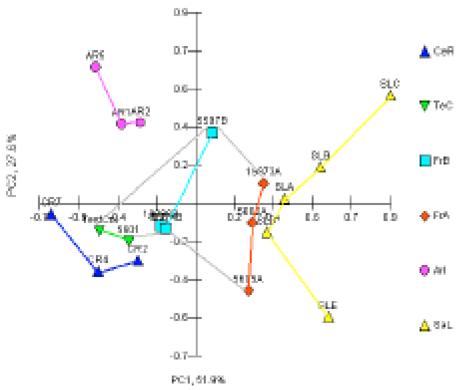

Fig. 1; PCA obtained with autoscaling of main cations (Ca, Fe, Si, Ti) and trace (Os, As, Cu)

Conclusions

The obtained results provide a typical example illustrating how we can highlight different clusters for several samples characterised by a large data matrix. On the basis of these results we can confirm the differences among the samples. On the other hand these results are expected because of the historical and geographic origin of the finds. For a best archaeological investigation we will consider other finds of the same age but different geographic origin or vice versa.

References

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