Procedures of Statistical and Spatial Analysis in Support to the Studies on the Phoenician-Punic Metallurgical Production in the Western Mediterranean Sea

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Abstract

Phoenician People expanded in the Mediterranean Sea, with different aims: lots of studies concerne the interactions of their Culture with the ones they came into contact with. A recent approach is to consider colonial expansion as a carrier of technological knowledge. A significant case is the problem of the cultural assignment to the manifacture of those objects under the definition of "orientalizing production" (showing mixed cultural features).

The problem has been here approached by archaeometallurgy, applying Principal Component Analysis on about 3,000 chemical composition of alloys, trying to verify if the method is valid to show useful information for this topic. Three different pretreatments have been applied on the data set and the application of the results to a cartographic software (GIS) suggested a precious way to discriminate groups and further clarify the meaning of principal components of georeferenced data.

Introduction

An important consequence of the commercial contacts Phoenician People had kept with other populations has been the interaction of these cultures; this net of relations played a very important role contributing to the creation of a Mediterranean koiné, that determined the consequent develop of the Mediterranean countries.

An interesting case study is given by the issue of the cultural attribution of the manufacture of a class of objects that, under the typological point of view, are clearly related to the influence of the Phoenician culture but they show coarseness and technical features not comparable with those typical of Phoenicial People and ascribable to a local manufacture. A new approach is given by archaeometallurgy and consists in considering Phoenician colonial expansion as a carrier of technological knowledges.

Principal Component Analysis was chosen as analytical method to be performed, with the aim to verify whether it is able to reveal groups and give useful information to solve the archaeological issue. Hypothesis is that Phoenician and local productions of objects are differentiable on the basis of the chemical composition of the alloys. This can give indication of different mining source or extractive and metallurgical processes.

Three pretreatment have been applied (autoscaling, centered log-ratio transformation and isometric log-ratio transformation), evaluating which of them is most capable of showing groups.

Then, scores of artifacts, related to the first three principal components (after a clr transformation) were coupled with the respective longitude and latitude of the object: in this way it is possible to realize three thematic maps, one for the scores along each component, performing analgorithm of interpolation (Inverse Distance Weighting, in a GIS software), and using a different colour to cartography the trend of the scores through the space. Overlapping the three maps you can obtain a cartographic visualization of the PCA results with the possibility of distinguish further groups on the basis of the latent geographic variable.

Materials & Methods

Compositional analyses were collected from literature, considering bronze artifacts with various functions, related to the different cultures that hanged in the Iberian Peninsula from Early Bronze Age up to Late Iron Age. About 3,000 analyses were digitalizated with their geographic information too (latitude, longitude) and instrumental information. About 87% of the analyses is on 9 elements (Fe,

Ni, Cu, Zn, As, Ag, Sn, Sb, Pb); the remaining is almost on 5 elements (Fe, Cu, As, Sn, Pb). Almost all the analyses are closed compositional vectors.

MatLab® (for PCA calculation) and gvSIG (GIS) are the software used for this work. Algorithms for the pretreatment are defined as in [1,2]. Algorithm for IDW is that fournished with the toolbox of gvSIG.

Results

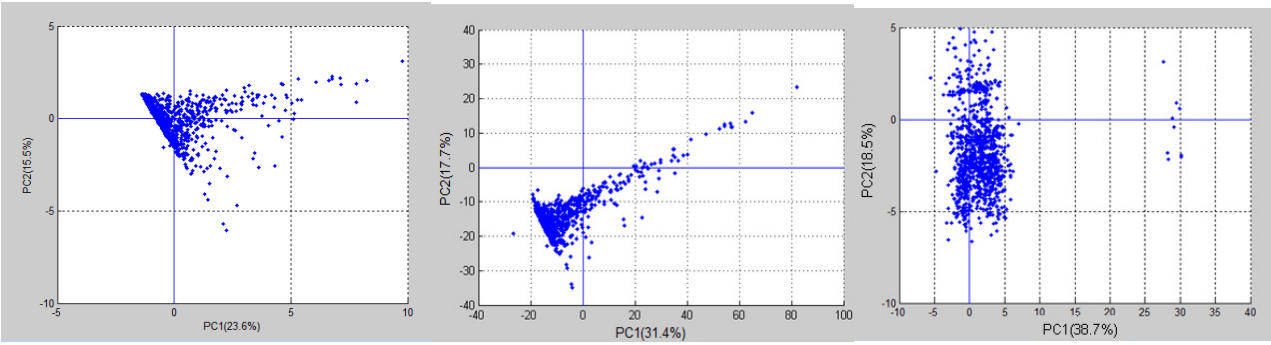

Fig.1; comparison amog different pretreatment, , starting from the left autoscaling, clr and ilr respectively

In fig.1 three different pretreatments are shown.

The best separation of the scores is with the ilr transformation, as the simplex geometry is no more recognizable; no group can be distinguished, even with marks for the different cultures, as in fig.2.

Fig.2 suggest there is no strong evidence of any difference in composition among cultural groups. It should be noted however that the graphic is confused by the presence of latent variables, not included in PCA calculations: obviously the presence of different kind of artifacts (requiring slightly different alloys to be made and used) and the difference in provenance. It has no particular sense calculate PCs on such a different set of variables, so other ways to highlight their influence are required.

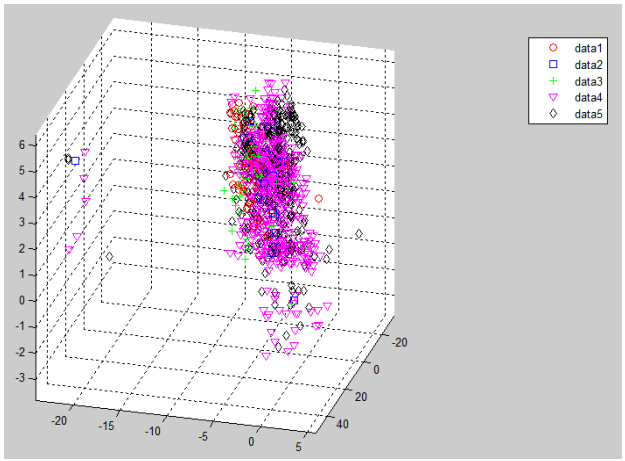

Fig.2; PCA with ilr pretreatment and
on the basis of the culture of the manufacture

After the elaboration of the three thematic maps and their overlapping, PCA can be visualized as in fig.3.

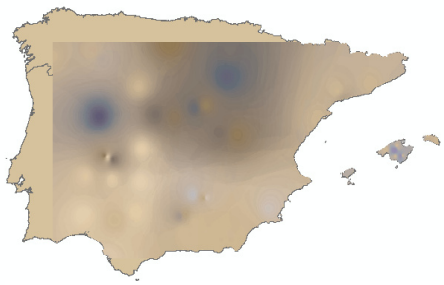

Fig.3: thematic map of the values of the scores of the first three PCs

Conclusions

In fig.3 some defined compositional groups or trends are recognizable in correspondence with areas influenced by different cultures and this should be considered a signal that this way to treat PCA results can reveal further structures among data, before not recognizable.

References

1) J. Aitchison, *A Concise Guide to Compositional Data Analysis*, 2nd Compositional Data Analysis Workshop, Girona, 2003

2) Buenestado P., Jarauta-Bragulat E., Hervada C.; 2003, "An algebraic method to compute transformation and back transformation of compositional data", in Journées geostatistiques Abstracts, *Journées geostatistiques*, 2003, 15-25