



## **Synergy Between Non Invasive Measurements and Multivariate Analysis in Cultural Heritage**

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### **Abstract**

The use of portable instruments in the archaeometric study of ancient artefacts mostly fulfilled in a non invasive manner has become a very common practise over the past few years.

Among all the new instruments that are on the run the Field Portable Energy Dispersive X Ray Fluorescence (FPEDXRF) spectrometers proved the greatest speed up.

In this paper we are going to show three cases in which multivariate statistics had the ability to provide an easier analysis of the big amount of data available to the researchers with the development of a new generation of Portable Systems applied to the study of Cultural Heritage.

### **Introduction**

The use of portable instruments in the archaeometric study of ancient artefacts mostly achieved in a non invasive manner has become a very common practise over the past few years. This new way of making scientific measurements opened a great number of methodological questions on the employment of such techniques. A sure benefit of the use of portable systems is the systematic analyses on a big number of artefacts accomplished in situ. As an example of a portable instrument and the kind of results it may be collected we show the work of a Field Portable Energy Dispersive X Ray Fluorescence (FPEDXRF) spectrometer. This kind of analysis gives multi-elemental information about the analysed spot, this means that at the end of the work data sets collected by researchers are intrinsically multivariate. Only in few cases it may be sensible to study a single variable, but in most instances all the variables need to be simultaneously examined. In the three examples of use of multivariate analysis on FPEDXRF data we show how statistical analyses can explore relationships in the data or test specific hypotheses about the observations. In the first example [1] we studied 62 coins from the numismatic collection of the Capitoline Coin Cabinet of the city of Rome to establish modern fakes; with this kind of data it was enough to isolate each variable and study it separately from each other. In the second example [2] the equestrian statue of Bartolomeo Colleoni in Venice (by Andrea del Verrocchio around 1480) was systematically analysed, for diagnostic purposes, with a portable EDXRF (Energy Dispersive X Ray Fluorescence) system in situ with 63 different measurements; to grasp the structure of these observation a full cluster analysis was performed. In the third example [3] Principal Component Analysis was necessary to confirm a specific archaeometric hypothesis to clarify possible pertinence and homogeneousness on the origin of the number of tin/lead-soldered fragments of a Chinese Taotie mask (X-VIII centuries B.C.).

### **Results**

First example: The Capitoline Coin Cabinet of the city of Rome was established in 1872 following the Stanziani's generous bequest of coins and precious germs. Other contributors followed this first donation. Work is in progress to establish modern fakes in the group of coins of the Castellani's donation. Up to now FPEDXRF measures have been performed on 62 coins from

the numismatic collection. The measure of fineness achieved by the analysis has to be crossed with data reported in literature and numismatic studies. Good results were obtained with a single variable study. As a matter of fact the silver content of the coins seems to be the most sensitive parameter.

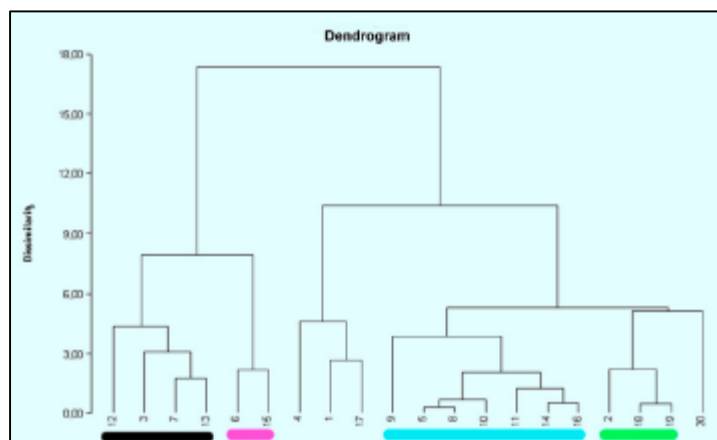


Fig 1; Cluster analysis on the EDXRF measures of the Colleoni bronze statue in Venice.

Second example: A diagnostic campaign on the equestrian statue of Bartolomeo Colleoni in Venice has been carried out availing of a portable EDXRF system, 63 different measurements were made. A multivariate cluster analysis (Euclidean distance and Ward's method of aggregation) was performed on the collected data with the purpose of separating the different groups. The results are shown in the dendrogram in Figure 1, the meaningful groups are highlighted with different colours.

Third example: A bronze finishing in the form of a Taotie mask was examined within the ambit of a

campaign for the diagnostic investigation and conservation of East Asian works of art housed by

Rome's MNAOr (National Museum of Oriental Art). Principal Component Analysis applied on the observations allowed to advance a pretty solid interpretative hypothesis concerning the composition of the object accepting ancient fragments and rejecting new cast ones. In figure 2 the graph shows the PCA results.

## Conclusions

Benefits of the use of portable systems in the systematic analyses on a big number of artefacts can be fully reached only if multivariate analysis is achieved. FPEDXRF perfectly highlights the necessary synergy between non invasive measurements with portable systems and multivariate analysis.

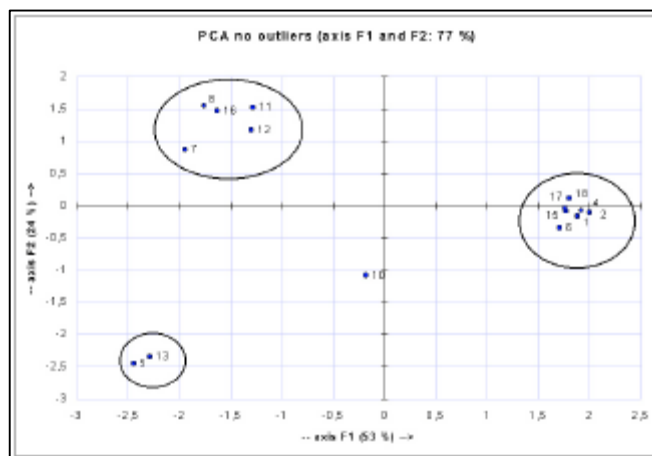


Fig 2; PCA on the EDXRF measures on the Taotie Chinese mask.

## References

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