The Corrosion of Archaeological Copper Alloys. The Case Study of a Coin Hoard From the Tenuta Radicicoli-del Bene, Rome.

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Abstract

Corrosion of archaeological objects, especially those made of copper or its alloys, is topic of many studies in different fields of science. Nevertheless, corrosion is dependent on many factors so that it is still difficult to correlate causes to effects and to understand the processes that have taken place. This study is centred on a recent archaeological finding consisting in an ordinary vase of pottery that contained 144 roman coins of the Empire Age. All coins are made of copper alloys (brass and bronze). Aim of research was to identify dominant factors affecting the corrosion processes and therefore the state of preservation of the coins. The correlation among different variables were analysed.

Introduction

Much research has been carried out on the corrosion of archaeological metals, ranging from the effects of soil conditions (Tylecote, 1979), to the identification of new corrosion products (Scott and Fabrizi, 1987) and to the formulation of a growth model for the two main corrosion structures observed on archaeological bronzes (Robbiola and Fiaud, 1992). However, as corrosion depends on many factors, it is difficult to correlate causes to effects and to reach clear conclusions regarding the processes that took place. Corrosion studies that aim at correlating causes and effects can seldom be based on archaeological objects, as these findings rarely satisfy the necessary conditions (e.g. large number of similar samples for statistic significance along with a homogeneous population). On the other hand, as corrosion on archaeological objects takes place over a long time, alternating periods of active attack to periods of stability, it is difficult, or even impossible, to reproduce these complex phenomena in the laboratory; the importance of studies based on authentic materials, that integrate and validate laboratory experiments, is therefore clear.

Materials & Methods

The subject to research is a little hoard consisting in 144 copper alloy coins (104 Sesterzii, 13 Dupondii, 24 Asses) of the Roman Imperial Age (69a.C.-192a.C.) contained in an ordinary vase of pottery, covered by a lid. The microexcavation and the successive conservation of the coins was carried out in the metal conservation laboratory of the National Roman Museum. The hoard was particularly interesting for corrosion research because:
- the microexcavation is well documented and the position of the single coins in the vase is known,
- the number of samples is large, allowing for good statistic significance,
- the system "hoard" is simple and spatially limited,
- the state of preservation of the coins was rather inhomogeneous,
- the corrosion layers of all the coins could be described through six recurring "corrosion patterns", determined by morphology and colour,
-an unusual yellow corrosion product was observed.

In order to identify the dominant factors in the corrosion processes and therefore for the state of preservation of the coins, we analysed the correlation among different variables. These were identified through the following investigations:
- qualitative compositional analysis of the coins by XRF;
- preliminary elemental analysis of the corrosion products by XRF (on powder samples) and successive SEM-EDXS-analysis (on selected samples and coins). Moreover XRD analysis (on selected powder samples) allowed to identify the crystalline components.

The choice of the analytical methods was heavily affected by the non-destructive approach that was considered mandatory in these investigations.

Numismatic studies provided data for the coins 'classification with regard to type and year of emission. Photographic documentation of the microexcavation allowed graphic elaboration aimed at evaluating the influence of the position on the preservation of the coins and on the corrosion patterns. A form was developed to collect information on the state of preservation of the coins, on the types and abundance of corrosion products and on the corrosion patterns of the single coins.

Results

Coins 'composition: the main copper alloying elements are Zn, Sn and Pb. We observed that their relative abundance in the alloy is related to the year of emission, which is consistent with previous studies.

Corrosion products: the identified corrosion products come from all the main components of the alloy (zinc was detected by XRF, but not by XRD, due to the poor detection limit of the latter) and are almost all common in burial contexts. The yellow corrosion product is unusual. Analytical data indicate a mixture of tin oxide and lead stannate.

Position in the vase: no relationship between the coins ' position and the state of preservation (or corrosion pattern) was found, see Fig. 1.

Conversely a close relationship was found among the coins ' composition, their corrosion patterns and their state of preservation.

Fig. 1 Image of the hoard during the microexcavation in laboratory.

Conclusions

A relationship between the state of preservation (degree of corrosion) and the composition of the coins 'alloys was highlighted. In general coins with high zinc and low lead are better preserved. But high zinc alone is not sufficient for good preservation. Best preserved coins show an additional amount of tin. This addition inhibits an important corrosion phenomenon of the pure brass coins, probably dezincification. This hypothesis is under verification also with multivariate analysis.

References

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