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P53 - Micro-PIXE Analysis of Ancient Roman Coins

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The presence of surface silver-enriched layer is quite common in objects made of a silver-copper alloy. In this work, some silver coins have been sectioned to study their microstructure and especially to assess the presence or absence of corrosion layers, enriched layers and non-homogeneities between surface and bulk. Some papers in literature have already discussed the topic [1-2]. Coins presented here are victoriati and quinarii minted by the Roman republic between the II and the I century B.C.

Micro-PIXE measurements were carried out on cross-sections at the AN2000 microbeam facility using 2 MeV protons. The beam was focused to a spot size of $\sim 5 \mu\text{m}$ and raster-scanned over the samples both on parts close to the surface and in several areas of the bulk. Quantitative analysis has been carried out by means of the Gupixwin software (version 2.1.3).

The presence of a very thick surface silver-enriched layer ($100\text{-}150 \mu\text{m}$) has been confirmed on the victoriati, while other analysed coins do not appear to be affected by this phenomenon. Profile measurements carried out on victoriati show that silver content is clearly higher in the surface layer, suggesting an intentional depletion occurred with acid chemicals during minting operations, as reported in [1]. The most interesting results, however, concern the distribution of minor elements along the section. Elements like chlorine and iron, commonly present in soil and water, are detected mainly in the silver enriched layer close to the surface and can be therefore linked to alteration phenomena due to the bury conditions. On the other hand, gold is clearly linked to silver as it appears mostly present in the silvery layer. Nickel and zinc seem, on the contrary, to be correlated to copper, since their presence is concentrated in the bulk.

In conclusion, the strong different elemental distribution between surface and bulk implies that compositional analyses carried out with surface techniques on untreated surfaces on silver-copper alloys are not reliable to provide fineness of ancient coins. These measurements confirm also that the victoriati series is strongly characterized by the presence of thick surface silver-enriched layers, as shown in recently published data [3].

[1] L. Beck et al., Nucl. Instr. and Meth. B 226 (2004) 153.

[2] L. Beck et al., Nucl. Instr. and Meth. B 266(10) (2008) 2320.

[3] F.J. Ager et al., Nucl. Instr. and Meth. B 306 (2013) 241.

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