X-RAY INVESTIGATIONS ON ANCIENT GOLD COINS: SYNCHROTRON RADIATION CONTRIBUTION TO HISTORY AND NUMISMATICS

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X-rays are an excellent investigation tool in the field of cultural heritage, this is mainly due to their capability of yielding fine details about chemical and structural information of a sample without damaging its integrity [1-4]. Synchrotron Radiation (SR) sources offer additional advantages to the X-ray techniques carried out with laboratory sources: the tuneable photon energy and the high photon flux provided by synchrotrons allow one to optimise the sensitivity to a given element while pushing the detection limits down to the ppm range. These characteristics enable to detect and quantify trace elements in artefacts. From such quantification, insightful details on the materials employed in the fabrication and on the fabrication process itself can be obtained.

In this work, four gold coins dated back to the Roman Empire (IV - V century) were studied with X-Ray Fluorescence (XRF) and X-ray Absorption Near Edge Spectroscopy (XANES), both carried out at XRF beamline, at Elettra Sincrotrone Trieste.

XRF was used to investigate the elemental distribution on the surface of each coin, discriminating between the composition of the metallic alloy and that of successive deposits due to the burial period. A fine analysis of the SR-XRF spectra was performed to assess the small variation in Au purity among the four coins. Such variation, analysed as a function of the time of coinage, provides insight on the inflation or devaluation dynamics in the ancient coinage. Additional details were then gained from the study of the contaminants. Indeed, indications about the Au purification processes and the geographical location of the Au mine are enclosed in the chemical composition and in the relative abundance of such elements. Thanks to the high sensitivity of SR-XRF, a precise quantification of trace elements like Pt, Pd, Ag, Hg, Cu, and Zn could be carried out, enabling historians and numismatics to reconstruct not only the methodologies employed in ancient metallurgy, but also to gain details about the geographical location of the mines, coinage processes, and gold purification methods.

XANES was employed to assess and quantify the phases of Fe, Zn, and Cu present on the coin surface. In the case of Fe, once identified the different oxides present in the sample, their relative abundance can be used to evaluate the geographical provenance of the burial soil. Indeed, the formation of the Fe phases is regulated by temperature and water activity, both indications of geographical areas [5].

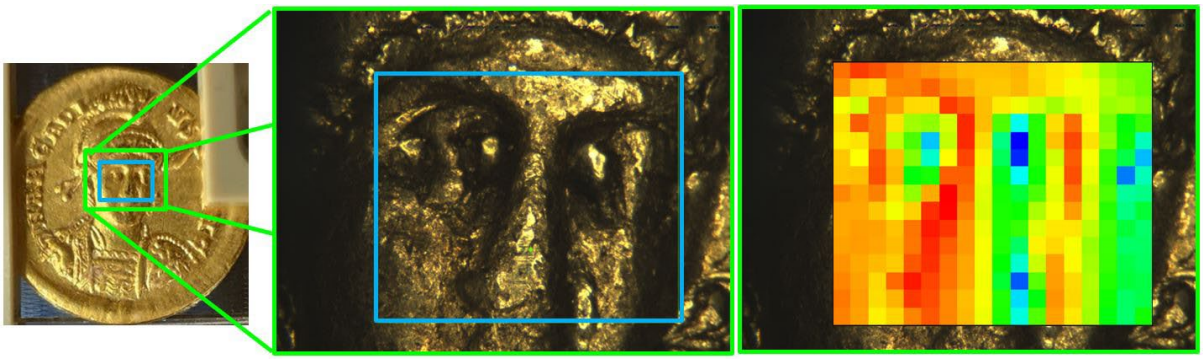

FIG. 1. (left) Recto of one of the four samples investigated, (center) magnified area of the coin surface: the blue square marks the region where XRF maps have been carried out, (right) SR-XRF map of the selected area is superimposed to the optical image.

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