

# Potentialities of X-ray fluorescence analysis in numismatics: the case study of pre-Roman coins from Cisalpine Gaul

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**Abstract** X-ray fluorescence (XRF) is a well-known technique for the analysis of ancient metals. Thanks to the availability of portable instruments (p-XRF), it is extensively used for the chemical characterization of coins directly in museums. In this work, the potentialities of the technique have been investigated, through its application to a case study concerning the Cisalpine Gaul coinage. More than 200 drachmas have been analysed to discriminate different productions on the base of minor elements. Major elements, on the other hand, have been used to trace alloy changes through the centuries. As concerns the quantification of the silver content (fineness), XRF and neutron diffraction results have been compared, in order to check the presence of surface-enriched layers.

**Keywords** XRF · Numismatics · Coins · Silver · Archaeometry

## Introduction

X-ray fluorescence (XRF) technique is a well-known analysis tool for the study of ancient metals. Nowadays, it is a valuable method to perform not only qualitative analyses as a first

screening on cultural heritage objects, but also quantitative analysis if ideal conditions are met. Moreover, thanks to the availability of portable and handheld instruments that can be easily brought to museums, galleries and collections, the investigation of large number of objects directly in situ has become possible, in an absolutely noninvasive way, thus providing the opportunity to work with big data sets.

On the other hand, limits of X-ray fluorescence technique, when applied on untreated surfaces of archaeological artefacts, are well known as well. Several works have described how the corrosion, the presence of alteration layers on surface and the limited signal depth of fluorescence photons make its application on many metal artefacts more difficult. In these cases, XRF analysis does not allow a quantitative computation of major elements, since these elements are non-homogeneously distributed and therefore the analysed volume would not be representative of the object under investigation. As concerns the ancient silver-alloy coins, the presence of thick surface silver-enriched layers (Tate 1986; Beck et al. 2004) is rather common and therefore a precise quantification of the fineness (precious metal) for debased coins cannot be achieved. Indeed, XRF analysis could overestimate the content of silver, being unable to analyse the inner core, making metrological studies extremely difficult or even impossible with this technique.

Nevertheless, XRF data could become extremely useful for numismatics studies for other research topics. Several works show, for instance, the possibility to discriminate different productions on the base of minor and trace elements usually linked both to silver and copper (e.g. Au, Pb, Bi, As), and sometimes interesting results from a historical point of view have been gained. The most important techniques which enable to gain such results are neutron activation (Gentner et al. 1978) and, recently, mass spectrometry coupled with laser ablation (Blet-Lemarquand et al. 2009; Sarah et al. 2007).

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