Metallurgic Analysis of Tetrarchic Folles – Research Proposal

**Overview**

Roman Tetrarchic Folles, minted from 294 – 305CE, following Aurelian’s monetary reform in 274CE and later, with their introduction in Diocletian’s reforms in 294CE, were significantly debased from the pre-274 Denarius and the contemporary Argenteus, maintaining a low-percentage silver (Ag) composition of ~1.7%. However, in order to distinguish these coins as part of the silver coinage system, these coins were ‘washed’ with a silver-coating, through an acid-soak enrichment process. Due to the process employed, the wash was characteristically only a thin layer of the relatively large coin and hence, over time eroded and degraded. Therefore, three primary inquiry questions should be asked of this process and will be explored in various modes of spectroscopy. They are as follows:

1. To what extent has the silver-wash eroded?
2. Following this erosion, to what extent has the now exposed bronze alloy oxidised?
3. Of the remaining silver, what alloying agents or contaminants were present in yhe wash?

**Spectroscopic Technique**

XRF will be the primary analysis technique for this research, due to the low information depth of ~1μm to 1mm, allowing for a focused analysis of the silver wash and a comparative compositional analysis to determine the extent of erosion. RAMAN spectroscopy will also be employed to determine the extent of oxidisation of the bronze alloy underneath the silver wash.

**Analysis Details**

(COPE, 1996) investigated the internal composition of the Tetrarchic folles, by means described in (CALEY, 1964). Regarding silver composition, I compiled his data to include mean and standard deviation by mint location, providing a baseline for my analysis. The data is attached at the end of the proposal, but on average, the folles contain approximately 1.7% silver (Ag) by mass, 90% Copper (Cu), 5% Tin (Sn), 5% Lead (Pb) and trace amounts of other alloying agents such as Iron (Fe), Nickle (Ni), Zinc (Zn). He also, suggests, as expected, a much higher percentage composition of Ag in the surface wash.

XRF analysis can as such be used to make a comparative analysis to (COPE, 1996)’s results. Although XRF cannot provide exact measurements regarding percentage composition by mass, rough proportional determinations can be made by comparisons of peak heights of different elements, such that higher percentage compositions will yield higher K and L peak heights. As the information depth of XRF is greater than the width of the surface wash, an ideal scan, assuming no erosion, will see high concentrations of Ag, followed by Cu then Sn, as well as contaminating or alloying agents to be investigated. With increased erosion, as such, peaks should approach the internal Ag percentage compositions of 1.7%, which should follow Cu, Sn and Pb.

Samples with high erosion of the inert Ag wash will hence see high levels of oxidisation, which may cause unexpected peaks of O in the XRF analysis. The level of this data corruption may be ascertained with a RAMAN analysis, which has been seen to be effective in detecting CuO and Cu2O bonds, allowing for a maintenance of validity in the experiment despite the oxidising erosion.

As such, in order to ascertain the rate of Ag erosion and to determine the level of erosion of the samples, both XRF analysis and RAMAN spectroscopy will be useful in determining levels of Ag and presence of CuO and Cu2O on the sample.

# References

CALEY, E. R., 1964. ANALYSIS OF ANCIENT METALS.

COPE, L. H., 1996. THE ARGENTIFEROUS BRONZE ALLOYS OF THE LARGE TETRARCHIC FOLLES OF A. D.. *The Numismatic Chronicle,* pp. 123-125.

