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Understanding Rome's ancient past: An analysis of gold and silver coinage from the Roman Empire

The fineness and quality of a state's coinage is often used as a proxy for its fiscal health, meaning the purity and chemical composition of coins are of real historical interest. Sampling of such objects is often at the surface or near-surface, but, in ancient coinages, these areas can be unrepresentative of the bulk alloy –sometimes radically so. In this paper, investigations on Roman gold and silver coinage using muonic X-ray emission spectroscopy (μXES) are reported.

Most Roman silver coins were produced from an alloy of copper and silver. Mints were able to disguise debasements from the general public by heating the silver-copper alloy blanks, oxidising the copper at the surface, and then soaking them in an organic acid. This stripped the copper from the surfaces of the blanks, causing a honeycomb structure of nearly pure silver to be consolidated as a rich layer when they were struck into coins. This technique could even be made to work on alloys that contained more than 80% copper. The result is that coins left the mint looking as if they were pure - at least on the surface: depth controlled μXES measurements reveal the true purities of such coins.

XRF analyses suggested some gold coins produced during the AD 68/9 Civil Wars held by the Ashmolean Museum were heavily debased, contra to existing analyses suggesting only minor reductions in purity at this time. With the techniques used on Roman silver in mind, μXES was used to eliminate the problem of 'surface enrichment'or compositional differences between 'surface'and 'core'. The results determined that very impure gold coinages really were produced, with some being debased with copper to alter the colour of the alloy. The use of copper in this way by the Romans is some 185 years earlier than first thought.

Primary authors: HILLIER, Adrian (STFC); Dr GREEN, George (Ashmolean Museum and the University of Oxford); Dr ISHIDA, Katsuhiko (Riken); Mr AGORO, Toluwalase (ISIS Neutron and Muon facility); Mr BUTCHER, Kevin (University of Warwick)

Presenter: HILLIER, Adrian (STFC)

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