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THE EARLIEST ROMAN COUNTERFEIT BY MEANS OF GOLD/MERCURY AMALGAM

A hoard of Roman coins recently came to light in an excavation conducted by archaeologists of the *Soprintendenza Archeologica di Roma* under the direction of Dott. S. Musco.[1] The coins, which had probably been kept in a leather pouch, had been hidden in a niche in the wall of a simple country house to the east of Rome. The date of the building is difficult to establish; it must lie between the second century BC and the first century AD.

The hoard consisted of 86 silver denarii, one gold aureus of Augustus and one gold quinarius of Tiberius, plus what appeared to be a third gold coin, of Tiberius, the topic of this study.[2] The physical data respective to the coins of Augustus and Tiberius are listed in Table I.

I (C.B.) was given the task of analyzing two coins from this hoard, i.e. the aureus of Augustus and the third gold coin, the 'aureus' of Tiberius. The analysis was performed by measuring density, XRF and SEM (scanning electron microscopy); the reference standard for the XRF was the same as previously described and discussed.[3]

Table I

Type of coin	*Weight (g)*	*Volume (mL)*	*Density (g/mL)*
Augustus, aureus	7.72105	0.425	18.167
Tiberius, 'aureus'	3.90970	0.369	10.595

The aureus of Augustus showed no unexpected features (*see Table II*)

1 C. AURISICCHIO, E. SENATORE, D. FERRO, International Seminar on Materials and Thermal Properties in Cultural Heritage, Rome, 30 May – 1 June 1996.

2 The coins were not properly recorded. The denarii went from the late Republic to Tiberius; the two gold coins were an aureus of Augustus of the type of RIC 206, and a gold quinarius of Tiberius. The publication mentioned above did not give references, and the coins themselves have since become inaccessible, according to the *Soprintendenza* on account of their enormous value...

3 C. BOTRÈ, E. FABRIZI, G. SCIBONA, P. SERAFIN PETRILLO, Applicazioni della spettroscopia con fluorescenza a raggi X nello studio di antiche monete romane: implicazioni di carattere storico ed economico, Boll. di Num. 13, 1989, pp. 129-143; C. BARTULI, C. BOTRÈ, E. FABRIZI, Analisi mediante fluorescenza con raggi X di monete argentee romane di periodo repubblicano. Un interpretazione storica, RIN 98, 1997, pp. 85-107.

Table II

Augustus, aureus	*Au %*	*Ag %*	*Cu %*
Obverse	99.10	0.88	0.02
Reverse	99.30	0.69	0.01

What was striking from the first moment about the Tiberius coin was the strange, uneven aspect of its surface (*see Fig. 1*).

Fig. 1

Table III

Tiberius, gilt denarius	*Ag %*	*Au %*	*Hg %*	*Cu %*
	98.5	1.0	0.4	0.1

It is evident from table III that despite its pale yellow color the 'aureus' is not a gold coin but a gilt silver denarius. Moreover, the coin's density corresponds perfectly to that of a normal silver denarius of the period, as does the weight (*see Table I*).

What makes this counterfeit coin so remarkable is the presence of mercury (Hg): it is the first known instance of the use of mercury/gold amalgam for counterfeiting at Rome. According to Pliny the Elder, the technique of using gold amalgams for gilding was known after the 2nd century AD only.[4] Gilding

[4] Hist. Nat. XXXIII, 65.100. It is not altogether clear which technique Pliny referred to; see O. VITTORI, Interpreting Pliny's Gilding: archaeological implications, Rivista di Archeologia 2, 1978, pp. 71-81; *id.*, Pliny the Elder on gilding, a new interpretation of his comments, Gold Bulletin 21/1, 1979, pp. 35-39. For a different interpretation see K. ANHEUER, Im Feuer vergoldet (Mainz, 1999), p. 18.

of objects, mostly of bronze, was known in China in the third century BC; however, it is more likely that leaf gilding was used, not fire gilding.[5]

At a time when electrochemical methods were unknown, falsifying a silver or bronze coin by gilding presented serious difficulties,[6] especially to obtain thin and homogenous layers on a surface which was in relief.[7] Leaf gilding would be too delicate and almost impossible to apply to small objects like coins, where the relief is of fundamental importance; worse, they would not last long enough.[8] Thus the development of a technique which allowed alloying the liquid mercury with gold and/or other metals was an important step ahead. There were still serious inconveniences to fight, such as the poor stability of the resulting alloy, not to mention the high toxicity of the mercury of which though the ancients may not have been aware.

It was among the Celtic tribes of Central Europe and Britain that the technique of using gold amalgams for gilding was developped. They used it to falsify coins; however, in the case of the British false coins they applied the amalgam to a base metal core *before* the striking.[9] This is clearly not the case of the Tiberius denarius where it was put on the struck coin. Another Celtic coin, a stater of the Vindelici (a so-called rainbow cup), copper gilt with traces of mercury was found in the excavations at Manching in Bavaria.[10] As the counterfeit British coins, it dates to the later part of the first century BC. Apparently, knowledge of the Celtic technique lingered on in Southern Germany where two fire-gilt coins of Nero, both with traces of mercury, turned up in excavations: an aureus with a copper core near Ingolstadt[11] and a gilt bronze quadrans found near the upper Danube;[12] most likely they were produced locally. At Rome, however, it seems that the technique did

5 For the technique see ANHEUER (see previous note) pp. 15-16; P.S. LINS, W.A. ODDY, The Origins of Mercury Gilding, Journal of Archaeological Science 2, 1975, pp. 365-373; W.A. ODDY, Gilding of Metals in the Old World, in: S. LE NIECE, P. CRADDOCK, eds., Metal Plating and Platination (Oxford, 1993), p. 171f..

6 For the various techniques see W.A. ODDY, M.R. COWELL, The Technology of Gilded Coin Forgeries, in: M.M. ARCHIBALD, M.R. COWELL, eds., Metallurgy in Numismatics, vol. 3 (London, 1993), pp. 199-221.

7 The authors of the first publication (see above, n. 1) came up with the extraordinary suggestion that the gilding might have been achieved by dipping the denarius in liquid gold – difficult, given that gold has a higher melting point (1063°C) than silver (960°C).

8 E.g. the aureus of the Civil Wars with a copper core found in 1985 on Lake Geneva, see A. GEISER, E. ABETEL, Un petit trésor mixte à Lausanne-Vidy, SM 36/142, May 1986, p. 38, 6.

9 ODDY, COWELL (above, n. 6), esp. pp. 205-210. These counterfeits are all decidedly underweight.

10 U. ZWICKER, Untersuchungen an goldplattierten keltischen und griechischen Münzen, JNG 23, 1973, p. 115-117. The second, more detailed publication of the fire-gilt stater which was announced on p. 116 has not appeared so far. See also H.-J. KELLNER, Die Münzfunde von Manching und die keltischen Fundmünzen aus Südbayern (1990), p. 51, 53.

11 H.-J. KELLNER, in: H. SCHÖNBERGER, Kastell Oberstimm, Limesforschung 18, 1978, p. 155, 79 and p. 164.

12 Unpublished, Prähistorische Staatssammlung, Munich. The authors are indebted to Dr B. Ziegaus, Munich, for this information.

not become widespread until the 4th century AD; the one well known exception is a fire-gilt head on a bronze statue of Nero.[13] The only other known Roman silver coins gilt with gold/mercury amalgam before the Constantinian period are antoniniani of Caracalla and of Elagabalus,[14] dating to ca 215-220 AD from a find in Palestine; they were surely gilt to pass as double aurei, a denomination Caracalla had introduced in 215. The gilding was probably done in the Near East, where the technique of firegilding silver became popular with the coming of the Sasanians who used it for their famous silver vessels with hunting scenes.

The archaeological team had strictly forbidden any mechanical tests on the gilt denarius; however, simple examination of the coin under an electron microscope shows how uneven the thickness of the mercury/gold alloy is (this may partly be due to evaporation, see below). That the density of the gilt denarius corresponds exactly to that of a normal silver denarius is due to the high silver content of about 99 %; atypical elements such as the gold and mercury present in very low concentrations could influence the density only minimally. If further proof of the coin's falsity were needed, a look at the XRF spectrum (*Fig. 2*) shows that the surface of the alloy is affected by different degrees of alteration.[15]

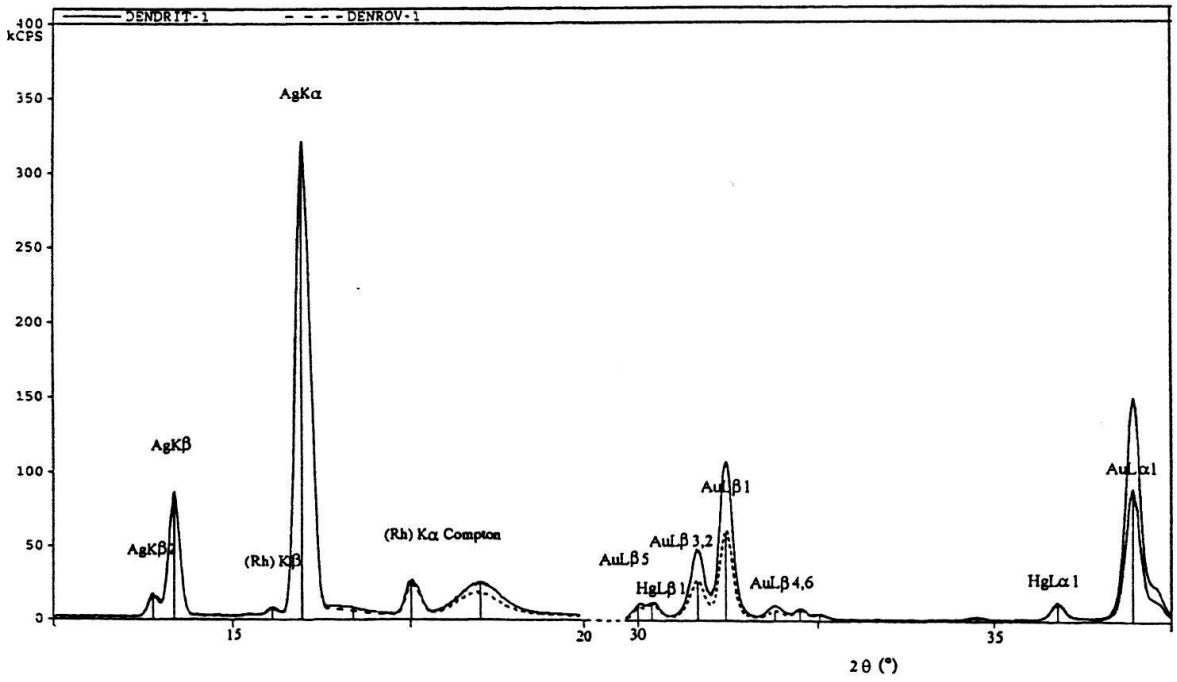

Fig. 2

[13] H. BORN, K. STEMMER, Damnatio memoriae – Das Berliner Neroportrait (Mainz, 1996).

[14] A.M. BURNETT, The Galilee Hoard of Gilded Antoniniani, Coin Hoards 7, 1985, pp. 176-177; ODDY, COWELL (above, n. 6), p. 207, no. 26 (Caracalla), and no. 27 (Elagabalus).

[15] The different positions of the 'spikes' indicate the presence of different metals in the alloy; their size reflect the respective percentages. It is evident that the structure and the chemical composition of the surface are far from uniform and different on obverse and reverse.

When the denarius was gilt in ancient times it was clearly with the scope to pass it off as an aureus; we can therefore assume that the original gilding was homogenous. Mild heating may have been used to get rid of excess mercury in order to give the counterfeit coin the correct yellow color which was expected of an aureus. In the end the only difference between the counterfeit and the 'real thing' would have been the low weight.

Mercury will evaporate quickly when subjected to heat. It also evaporates, albeit very slowly, at room temperature in the course of time. Heating is the simpler way to increase its vapor pressure (P_{mmHg}); for approximate calculations the following equation can be applied to a wide range of temperature (0°C - 150°C) which includes room temparature.[16]

$$\log P_{mmHg} = -3212/T + 8.0$$

Our gilt coin was exposed to atmospheric conditions for nearly two thousand years, long enough for a good part of the mercury of the original alloy to disappear by evaporatation, leaving the denarius with its present blotched appearance and, of course, clearly exposing it as a fake.

The physico-chemical techniques which in this case helped to unmask an ancient counterfeit are also useful in the study of plated denarii (*subaerati*) whose surface structures differ from their core. They can be helpful in reading the 'history' of the coin when other techniques, such as neutronic diffraction, would be of little use. It goes without saying that the XRF examination needs confirmation from other quarters (style, history, etc.). It is, however, difficult to understand why a technique applied to the study of the surface layers should by itself be called dangerous.[17]

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[16] Industrial Hygiene and Toxicology, F.A. PATTY, ed., Vol. II, 2nd ed. (New York 1963), p. 1093.
[17] P. SERAFIN PETRILLO, Boll. di Num., Suppl. al no. 4, 1987, p. 49.