

The
BULLETIN
of the
AUSTRALIAN
INSTITUTE
for
MARITIME
ARCHAEOLOGY



1984
VOLUME 8 NUMBER 2

A GENUINE SIXTEENTH CENTURY FORGED COIN

Dr. Ian D. MacLeod

Department of Materials Conservation and Restoration

Introduction

An interesting byproduct of the conservation treatment given to corroded silver coins recovered from the *Batavia*, and the *Rapid* is that some contemporary forgeries have been discovered. One forged Spanish silver dollar from the *Rapid* was found to have been made of a copper based core which was laminated with sterling silver and which bore the correct impressions of a coin made at the Mexico mint in 1796. After being stabilized by the alkaline dithionite method (MacLeod, 1979:165), the core of the coin was seen to have been corroded inwards from the milled edge which exposed the thin silver top and bottom layers. A fragment of a Rijksdaalder c1620 from the *Batavia* was examined after previous treatment had revealed the laminated structure. The lack of records of previous treatments and absence of a sample of corrosion products precluded a detailed analyses of the base-metal core. Despite these problems there was sufficient residual material to establish that a 0.5 mm layer of sterling silver had been formed around a copper alloy to effect the forgery (MacLeod, 1982:317). Recently, a second example of a forged coin from the *Batavia* was examined in its untreated state and the report below describes how the coin was stabilized and how, through an analysis of the corrosion products and residual metal, the composition and probable mode of fabrication of the original coin was ascertained.

Description of the coin

The coin (BAT916) was recovered during the 1974 excavation on the *Batavia* site and was first examined by the author in October 1982. The coin appeared as a fragmented hollow disc about 4 cm diameter and 2 mm thick. It was covered with marine organisms and corrosion products. The seaward surfaces had the same type of concretion and corrosion products that are commonly found on aerobically corroded coins that assay at $93.5 \pm 1.0\%$ silver and $6.5 \pm 1.0\%$ copper. The coin was fragmented (Fig. 1) with about 5% of one surface missing. Lustrous ruby red crystals of cuprite (Cu_2O) lay amongst patches of red brown iron stained concretion and large areas of the blue-green copper (II) hydroxy chloride atacamite, $\text{Cu}_7\text{Cl}_{14}(\text{OH})_{10}\cdot\text{H}_2\text{O}$. The inner surfaces of the coin (Fig. 2) were partly covered with a grey blue corrosion product film which was all that remained of the base metal core.

Before any chemical treatment was initiated, samples of the corrosion products on both faces of the coin were taken for subsequent nondestructive analysis using X-ray diffraction (XRD) and Scanning Electron Microscopic (SEM) techniques (Robinson, 1979:1322). After the SEM and XRD work was completed the corrosion products were dissolved in 5 wt% nitric acid, 2 wt% hydrochloric acid and 1 wt% tartaric acid and analysed for nine elements using an atomic absorption spectrophotometer (AAS). The SEM analysis of the inner corrosion products showed that they contained a large amount of tin, antimony, lead, silver and traces of gold as well as a large amount of silica (SiO_2). The chemical analysis combined with the XRD and SEM data showed that approximately 72% of the silver was present as silver chloride with the balance being metallic silver. The other elements are present in the form of the corrosion products which were identified by x-ray diffraction techniques (see Table I). The absence of any metal sulphides amongst the oxidized metal is consistent with the well oxygenated nature of the *Batavia* wreck site.

10 1 cm

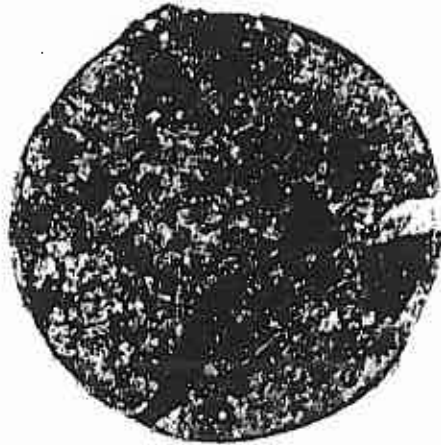


Fig. 1. Obverse of the forged coin (BAT 916) before any treatment

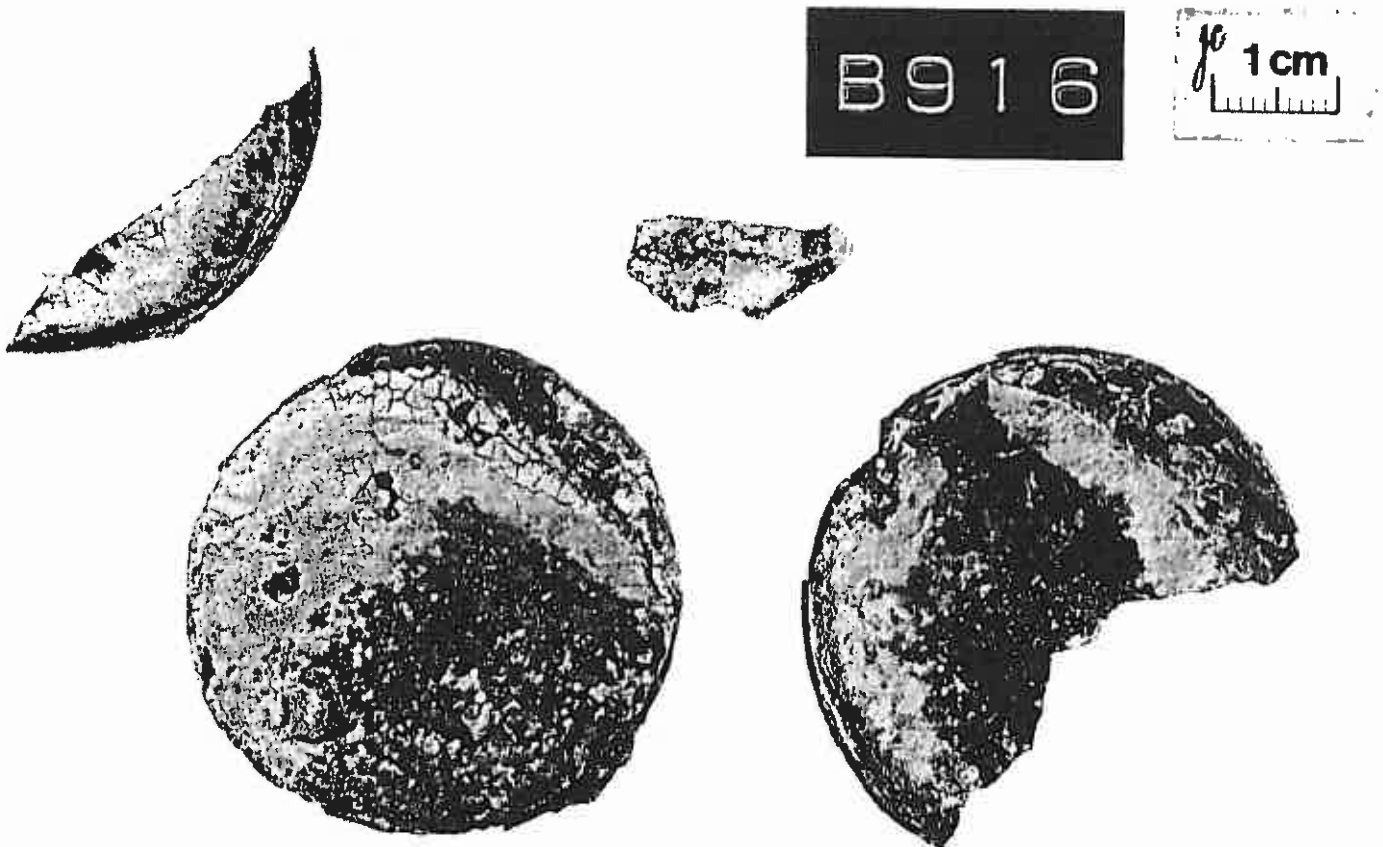


Fig. 2. The inner surfaces of the forged coin showing the corrosion products (light grey) from the core material on a background of silver chloride

TABLE I

Composition of corroded core material from the forged *Batavia*
coin

Element	wt% of element measured in corrosion prod- ucts (AAS)	Mineral phase (XRD)	Calculated composition (wt% of mineral phase in corrosion prod- ucts)
Silver (Ag)	30.96	Ag AgCl	8.66 29.62
Tin (Sn)	19.89	SnO ₂	22.19
Zinc (Zn)	2.18	ZnSn(OH) ₆	9.54
Copper (Cu)	6.87	Cu ₂ O	7.73
Lead (Pb)	5.32	3PbCO ₃ · 2Pb(OH) ₂ · H ₂ O	6.78
Iron (Fe)	1.58	FeO · OH	3.09
Antimony (Sb)	0.63	Sb ₂ O ₃ · Cl ₂	0.79
Bismuth (Bi)	0.45	Bi ₂ O ₃	0.50
Nickel (Ni)	0.11	NiO	0.14
Silicon (Si)	-	SiO ₂	10.86
TOTAL	67.99	-	99.9

Having established the composition of the corrosion products it is possible to use this data to calculate the composition of the original core if we assume that the ratios of metals is the same in both cases. Analyses of corrosion products and parent metals from a wide range of shipwreck sites has shown that for non ferrous metals on an aerobic site the normalisation method would tend to slightly overestimate the tin, lead and zinc values and underestimate the copper and antimony levels. (MacLeod, 1984:). Since the total metal values in the oxidized layer add up to 67.99%, each element can be multiplied by a factor of (100/67.99) to 'normalise' the total to 100%. The normalised values of 45.5% silver, 29.3% tin, 10.1% copper 7.8% lead and 3.2% zinc, plus smaller amounts of other metals, appear to be very unusual on first inspection (see Table II). Why would forgers use such a large amount of silver when it is the most expensive of all the components? The high silver content of the core on the *Batavia* forgery is in marked contrast to the 2.2% in the *Rapid* coin but it is similar to the amount found in some modern forgeries of 19th century Dutch coins where the silver analysis ranged from 54.2 to 74.8% (see Table II). One possible reason for the large amount of silver in the blank material is the melting point of such a mixture. If the components of the core behaved like a simple silver-tin alloy of similar composition the mixture would have melted at approximately 460 degrees C (Hawkins, 1973:256) which is more than 500 degrees C lower than that needed to melt the core of the forgery from the *Rapid*. The practical implications of this are obvious - the *Batavia* coin and the modern forgeries from Penang could be melted at temperatures reached by a hot wood fire without the need of a sophisticated furnace since the m.p. range of 460 degrees C to 840 degrees C is readily attained in such fires.

The cleaned inner surfaces of the silver casing were examined under the microscope to see if details of its structure could give any clues regarding the techniques used in its manufacture. Inspection of the SEM micrograph (Fig. 3) showed that the inner surface of the remaining metal appeared to be somewhat porous and that it may have been cast. Since the practical problems of casting a sterling silver skin (m.p. approx. 900 degrees C) around a low melting blank (m.p. approx. 460 degrees C) are great it seemed unreasonable to assume that such techniques had been used. A closer inspection of the seaward surface of the coin showed that it was microporous (see Figs. 3 and 4 for details) - such porosity is not found on corroded genuine sterling silver coins.

It was decided to analyse a sample of the remaining metal to see if the results would help in our attempts to establish the method of fabricating the coin. A 15mg sample was dissolved in nitric and tartaric acids and the AAS analysis showed up 87.1% silver, 4.1% copper, 2.4% antimony, 2.2% zinc, 1.6% lead, 1.6% bismuth, a trace iron and no tin (see Table II). The composition of the outer layer of the forged coin is significantly different to that calculated for the inner core and so the differences in corrosion characteristics of the inner and outer regions is not unexpected as the higher tin content would make the inner layers more reactive. The most probable explanation of all these observations is that a metal alloy of composition similar to that calculated for the core was used in casting the coin blanks. The blanks were subsequently placed in an etching solution, such as tartaric acid, that dissolved most of the tin and some of the lead and copper. The etched blanks were then stamped to give them the appearance of genuine coins.

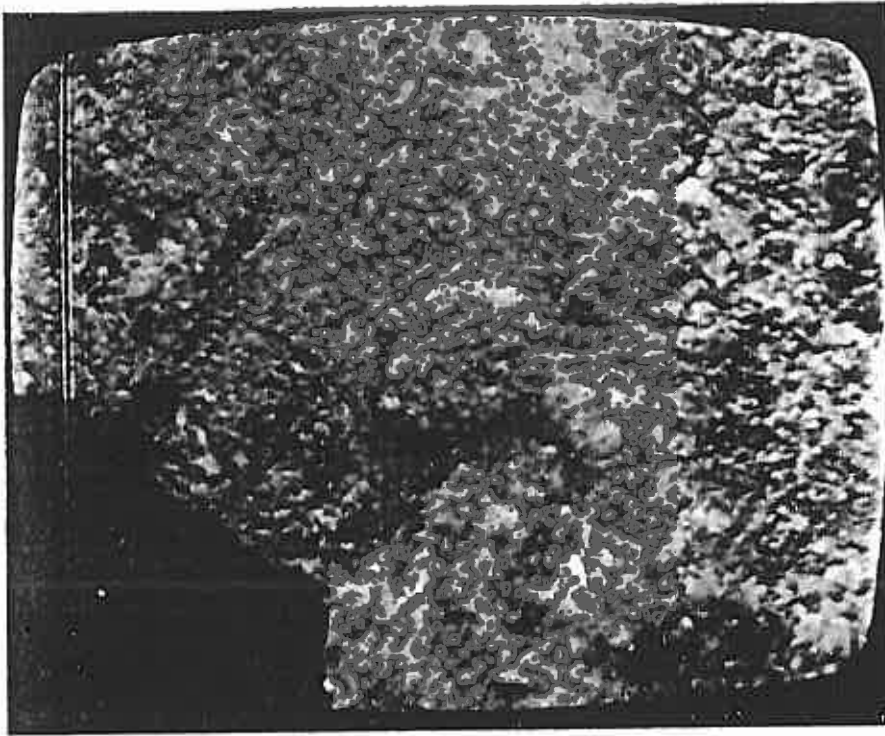


Fig. 3. Scanning electron micrograph of the inner surface of the forged coin showing the flow line pattern of the cast silver casing. Full width 2.64 mm

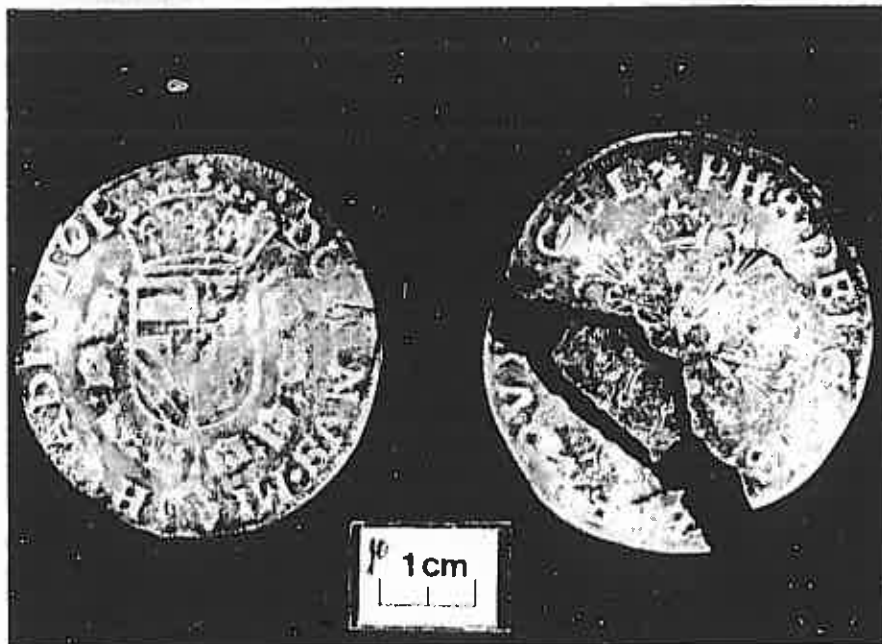


Fig. 4. The forged coin after topical treatment with an alkaline dithionite paste

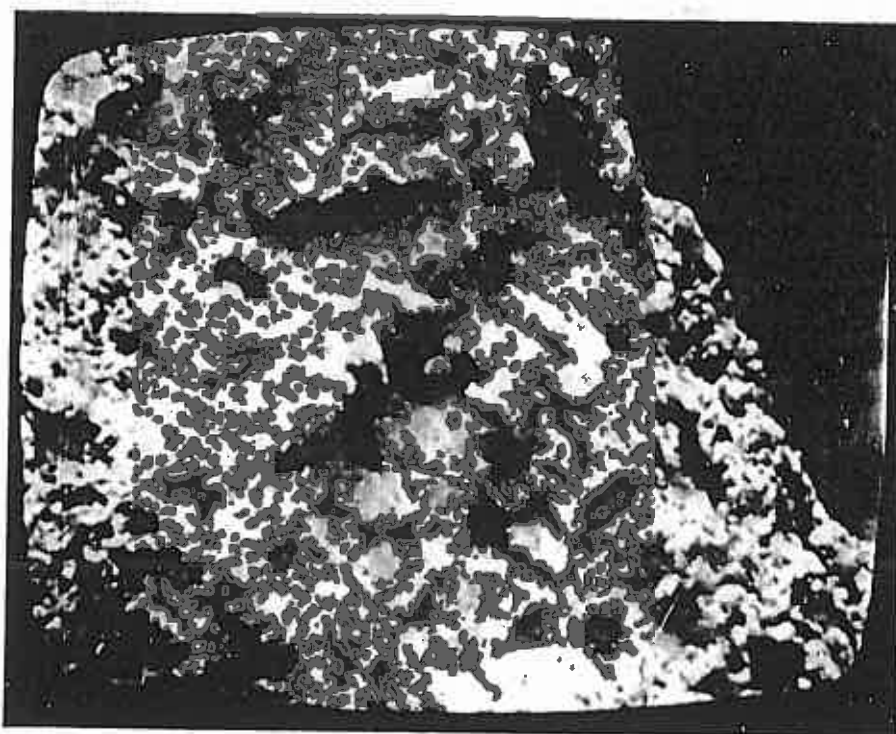


Fig. 5. Scanning electronmicrograph of the outer surface and edge of the forged coin after conservation treatment. The crystalline and porous nature of the surface are readily seen where the metal has been broken. Full width 0.26 mm

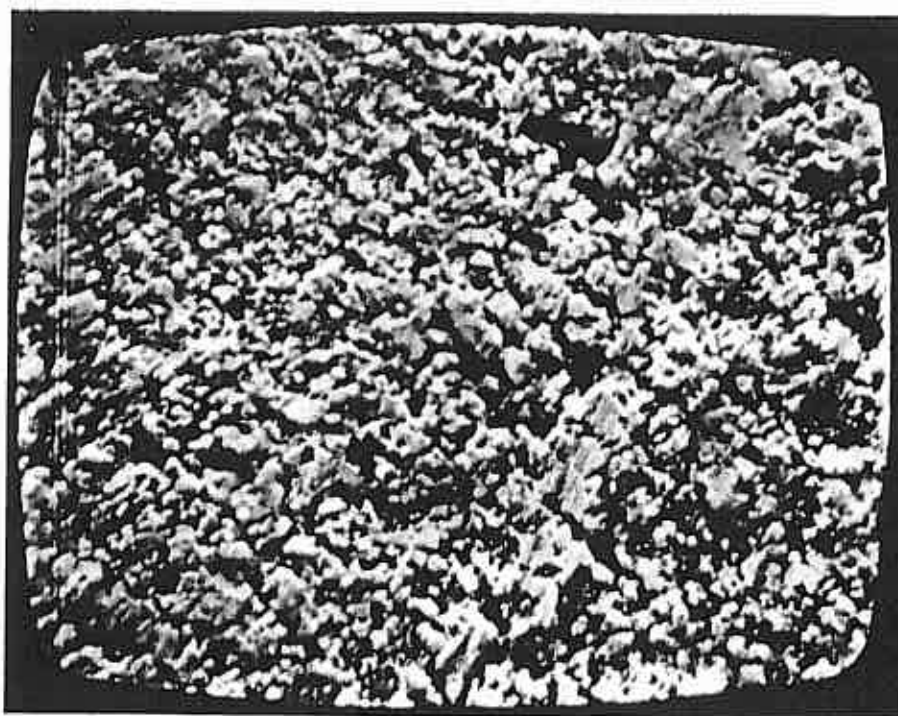


Fig. 6. Scanning electronmicrograph showing the general surface of conserved coin - note the porous nature of the outer layers. Full width 0.26 mm

TABLE II

Percentage (weight) composition of metal cores from forged silver coins

	BAT 916 ¹	"1842" 2½ Guilder ²	"1847 2½ Guilder ²	"1796" M8R ³	BAT 916 ⁴ Outer layer
Ag (silver)	45.54	54.2	74.8	2.18	87.1
Sn (tin)	29.26	n.d.	0.15	1.01	<0.01
Zn (zinc)	3.21	0.011	0.07	0.73	2.20
Cu (copper)	10.10	44.8	22.3	94.5	4.12
Pb (lead)	7.82	0.94	2.6	0.67	1.64
Fe (iron)	2.32	n.d.	n.d.	n.d.	0.006
Sb (antimony)	0.93	-	-	n.d.	2.42
Bi (bismuth)	0.66	-	-	n.d.	1.58
Ni (nickel)	0.16	-	-	0.35	n.d.
Total	100.00	99.95	100	99.44	99.066

¹ Calculated values

² The 1842 and 1847 coins were modern forgeries from Penang, Malaysia (MacLeod, 1981:65)

³ Sample from the core of a coin found on the *Rapid* site (MacLeod, 1982:317)

n.d. not detected

⁴ Data from analysis of remaining outer layer of the coin.

Conservation Treatment:

Once the corrosion products had been dusted off the inner surfaces of the silver casing the coin was placed in 10 vol% hydrochloric acid for half an hour to remove any copper, calcium and iron minerals from the seaward surface. The upper surfaces were "cleaned" by rolling a cotton bud, covered with a paste of 1M sodium hydroxide and solid sodium dithionite, over the corroded silver. This treatment converted the oxidized silver back to the metal. A few days after the initial dithionite treatment some blue copper sulphide spots had developed on the coin surface. These spots were simply removed by swabbing with 0.1M sodium cyanide in a 0.2M sodium carbonate solution.

The dithionite treatment revealed the inscriptions and the lettering PHS.DEI.G.HISP.Z.REX.DUX.GEL, (1)5 68 on the obverse and DOMINUS.MIHI.ADVITOR on the reverse side (see Fig. 4).

Discussion

The apparent date on the coin is 1568 - only part of the 5 was visible and the 1 was on an area that had been lost on the site. The lettering is the same size and script as genuine Burgundian Crowns of the Spanish Netherlands province of Gelderland dated 1568. The crown on the reverse side of the forgery is larger than that on a 1568 genuine Gelderland coin in the Museum's collection but it is identical to the crown on 1567 coins from both Gelderland and Brabant. The forged coin was 41.7 mm in diameter and 2.14 mm in thickness which is typical of genuine coins of that period.

It is reasonable to assume that the forged coin was part of the general bullion cargo and that the presence of a forgery was not suspected. The outer silver rich layers are thick enough to withstand a deep scratch which was often used in the normal course of commerce to check on the quality of the coin. Since the lettering and other impressions on the surfaces match those of genuine coins from the same province and similar date it appears that the forged coin was stamped in the government mint or with dies that were made to exactly match those used by the mint.

The etching of the cast blank sealed the ultimate fate of the forgery for once it was immersed in the sea the different composition of the layers meant that the coin functioned as galvanic couple, i.e. a short circuited battery. Porosity from the initial casting would have helped the sea water to penetrate into the tin rich layer. Preferential corrosion of the tin rich inner layer continued until no solid metal remained whereupon the previously protected silver rich layers began to corrode to produce a surface corrosion layer similar to that found on genuine coins. The calculated density of the outer layer of the coin is essentially the same as sterling silver (10.17 cf. 10.35g.cm^{-3}) whilst the inner layer would have had a lower value of 9.4 because of the large amount of tin. Any difference between the weights of the forged and genuine coin could have been easily corrected by a slight increase in the thickness of the forgery. Under the conditions normally encountered in commerce the forged coin would probably have remained undetected.

Acknowledgements:

I am grateful to Stan Wilson, Curator of Numismatics of the WA Museum for bringing the coin to my notice and to Jeremy Green for permission to work on the fragments. My thanks go to Jon Carpenter for the macro photographs and to Geoff Kimpton for finding the coin on the wreck site.

References

- Hawkins, D.T. and Hultgren, R., (1975),
Constitution of Binary Alloys.
Metals Handbook, Vol.8, 8th Edn:256
American Society for Metals, Metals Park, Ohio
- MacLeod, I.D. and North, N.A., (1979),
Conservation of corroded silver.
Studies in Conservation, 24:165-170
- MacLeod, I.D. and Ritchie, I.M., (1981),
Detection of debasement in (forged) silver coins
by means of corrosion potential measurements.
Archaeometry, 23(1):65-70.
- MacLeod, I.D. (1982),
A study of some forged silver coins recovered from
17th C and 19th C shipwrecks.
Chemistry Australia, 49:317-320.
- Robinson, B.W. and Nickel, E.H., (1979),
A useful new technique in mineralogy: the back
scattered electron/low vacuum mode of SEM operation.
American Mineralogist, 64:1322-8.

