4.2 **Analysis of pewter-clad studs sf 2363 and 2383** by Peter Northover

Two metal studs, sf 2363 and 2383, from Romano-British context F818 were submitted for metallurgical study. The studs were completely mineralized; the majority of the corrosion products were coloured green and can be assumed to derive from copper alloys, although there was also some corroded iron. Corrosion products with a greyish appearance were also visible. These could also have derived from copper alloys, but equally could have come from a lead or tin alloy. The shafts of the studs appeared to be iron with a hemispherical head of a lead-tin alloy, which presumably gave rise to the grey corrosion products. This head was in turn covered by a domed sheet copper-alloy cap, possibly formed directly over the lead-tin alloy lump. The purpose of this study was to characterize the grey corrosion products.

Sampling and analysis

Given the fragile state of the studs it was decided to sample only one. Accordingly a small section of corrosion product was detached from the head of one stud using a scalpel. The sample, labelled #R1842, was hot-mounted in a carbon-filled thermosetting resin, ground and polished to a 1µ diamond finish. Analysis was purely qualitative using an energy dispersive X-ray spectrometer in association with a scanning electron microscope. The polished sample was also examined in the optical microscope.

Composition

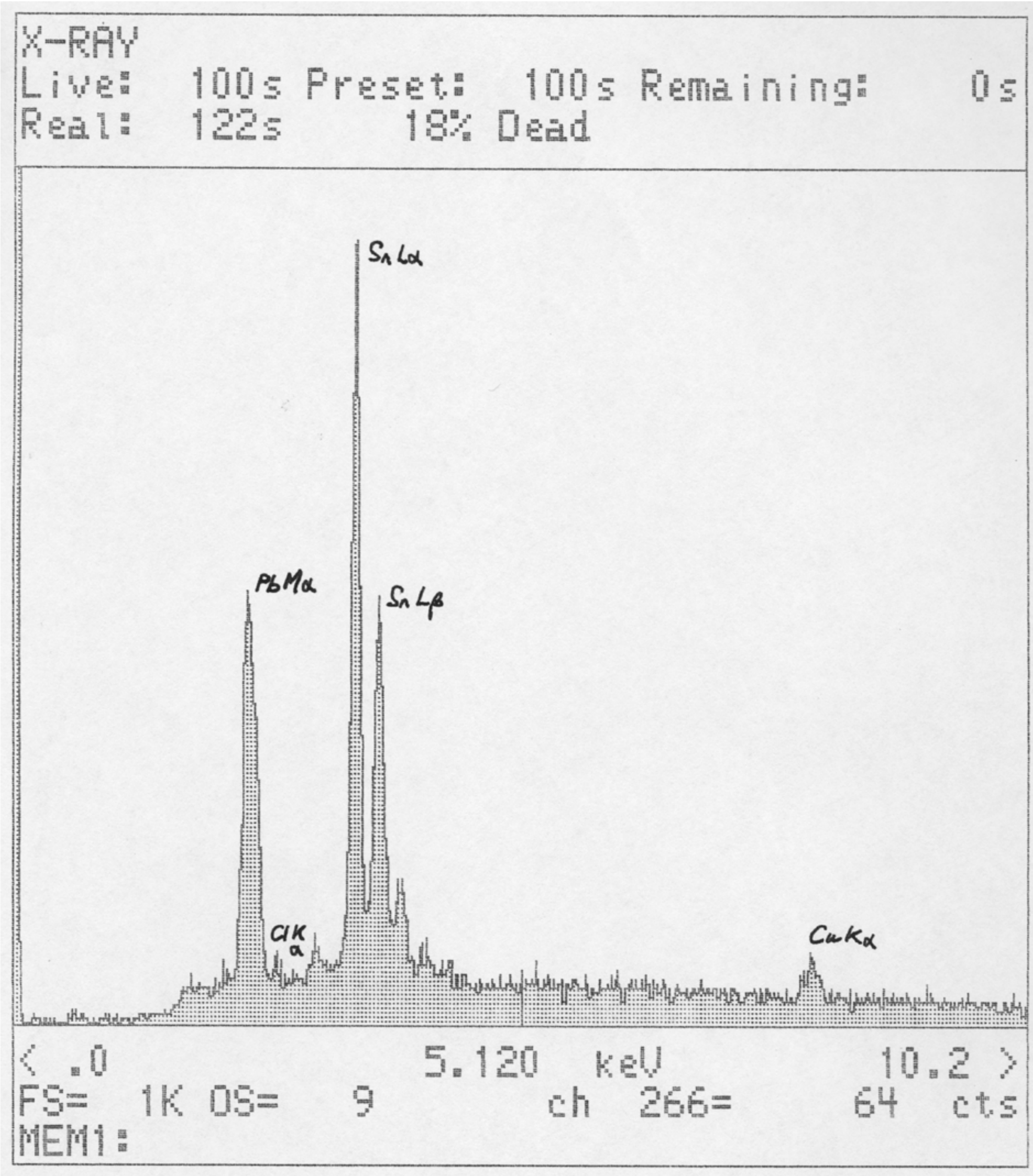
The great majority of the sample gave very similar X-ray spectra, a typical example of which is attached to this report. The principal variations were in the amount of copper, chlorine and earthy elements such as silicon present. The spectrum illustrated was chosen because it effectively shows just the metallic elements present – tin in the majority, lead, and a small amount of copper. The copper could have come from the penetration of the corroded sample by copper ions from another part of the stud, or by the presence of copper-tin intermetallics, formed either by copper diffusing into the lead-tin alloy if it was actually bonded to it, or by copper being a contaminant in the solder itself. The spectrum indicates an alloy like a lead-tin solder, but it is not possible to use the spectrum from the corroded metal to suggest the original Sn:Pb ratio as there are too many variables in the corrosion process.

Metallography

A typical area of the sample is illustrated in Figures 1 and 2 under normal incident illumination and under plane polarized light. The bulk of the sample exhibits a variety of shades of grey and brown from very pale to dark. This, in the writer’s experience, is very typical of corroded pewter. The bright spots within the structure are uncorroded intermetallic compounds of tin with iron or copper impurities in the alloy. These intermetallics can be very resistant to corrosion; the nature of their occurrence suggests that the copper alloy could have been a cladding rather than a thermally bonded plating. In the latter case the interaction of the substrate with molten tin will produce a complete corrosion-resistant layer of intermetallics and this appeared to be absent in this case.

Conclusion

The grey corrosion products appear to derive from a lead-tin alloy filling supporting the copper alloy cladding.



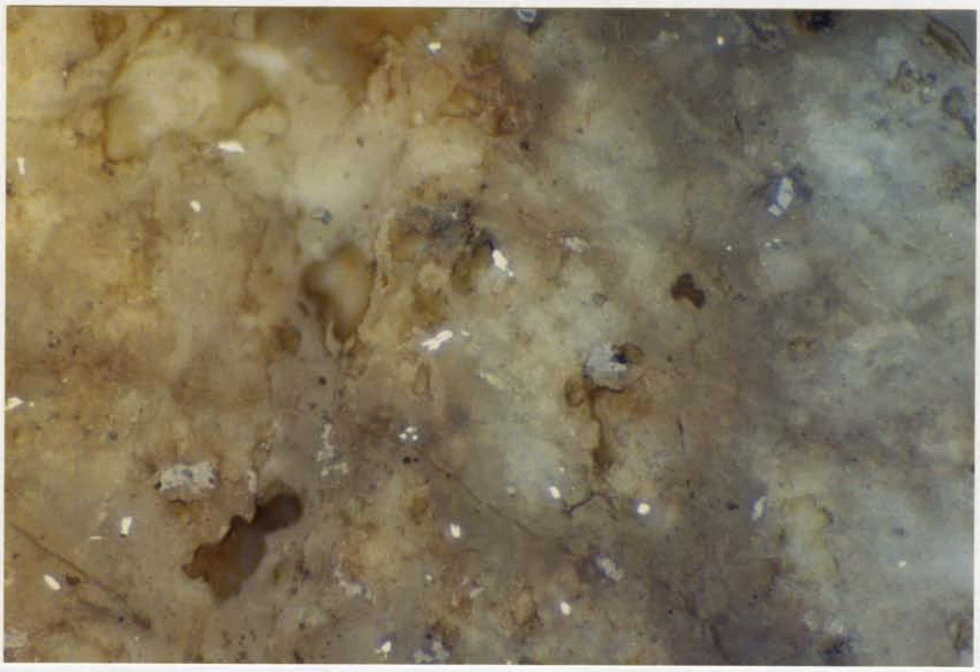


Fig. 1: #R1842, general view of corroded material with uncorroded intermetallic and (?)sulphide inclusions, unetched, x625

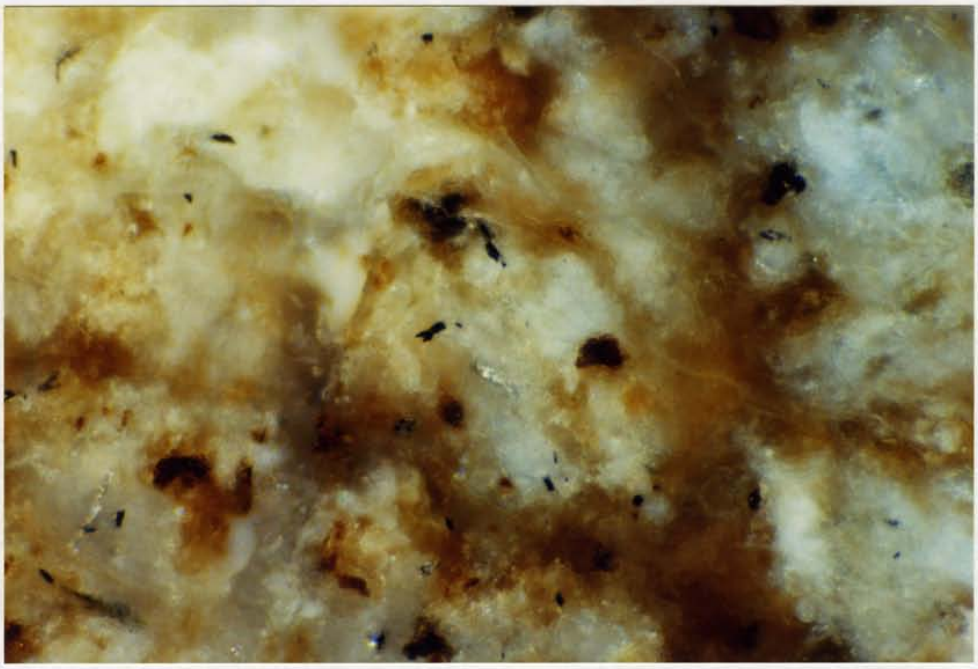


Fig. 2: #R1842, as Fig. 1 but viewed under plane polarised light; unetched, x625