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Analysis of a crucible sherd from Dwr-y-Felin School, Neath, (GGAT 674)

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Abstract

Assessment of archaeometallurgical residues from this site revealed a single crucible sherd from the 'industrial area'. The sherd showed no identifiable visible residues, so analysis of inner and outer surfaces was undertaken using a portable XRF system.

Analysis of the inner surface of the sherd showed high levels of lead and zinc, accompanied by low levels of copper and tin. The outer surface showed contamination by lead, but only trace levels of copper, zinc and tin.

The metal melted in the crucible would therefore appear to have been a leaded copper alloy – probably a leaded gunmetal (a quaternary alloy of copper, zinc, tin and lead). The nature of the material prohibits a detailed identification of the alloy employed. Leaded alloys are ideally suited to casting and were employed for a wide range of both military and civilian purposes during the Roman period.

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Methods

The analysed material was a single sherd of crucible from c133, of GGAT's project 674, Dwr-y-Felin School, Neath, Neath Port Talbot. During the assessment of archaeometallurgical residues from the site (Young 2013), it was noted that this sherd had no obvious preserved residues that might enable identification of the metal it had once contained. Examination by handheld XRF was therefore recommended.

The specimen was analysed on a purely qualitative basis using a Bruker Tracer III-SD portable X-Ray fluorescence spectrometer. The instrument was operated with the Bruker 'yellow' filter (300µm Al + 25µm Ti), at 40kV and 9.60 µA, with a filament current of 189 µA, for 100s.

The instrument was controlled by a PC running Bruker's S1PXRF with spectra stored as pdz files and csv files. The images presented in Figure 1 are produced from the csv output.

This project was undertaken for Martin Tuck of the Glamorgan-Gwent Archaeological Trust. The material derives from a gas main replacement project by Wales and West Utilities at Dwr-y-Felin School, Neath, Neath Port Talbot.

Results

The sherd is irregular in shape and measures approximately 23mm by 23mm on its outer face, but only a small area (approximately 10mm by 14mm) of its inner face survives. The outer part of fabric is dark grey, up to about 3mm thick, lightly vitrified and with the outer surface showing a small amount of dark glass, between protruding quartz grains. The inner part of the section, up to 5mm thick, is formed of less-altered material of a greyish buff colour. The inner face is very lightly vitrified. The fabric shows abundant voids representing moulds of fine organic temper. The fabric is quartz-rich, dominantly with a grain size of 100-200µm, but rarely up to 1mm.

The sherd is strongly concavo-convex, suggesting that is derives from a small (less than 60mm diameter) crucible, but provides little other information about the original morphology.

The pXRF traces are illustrated in Figure 1. Both analyses show substantial peaks for iron, probably present mainly in, or derived from, the crucible fabric. Other elements associated with the crucible fabric (rubidium, strontium and zirconium...) are present, but, for clarity, have not been labelled on the figures.

The inside of the crucible shows contamination by high levels of lead and zinc, with low levels of copper and tin. The outside of the crucible shows a lower level of contamination by lead and only trace levels of copper, zinc and tin.

Interpretation

The interaction between contaminating metals and technical ceramics has recently been investigated by Kearns *et al*. (2010). They showed that patterns of contamination may be complex, with zinc passing into the body of the ceramic as a vapour, lead reacting easily with silica when oxidised to form a slag, but with copper and tin often being preserved mainly in oxidised metal droplets.

In this instance, zinc from the charge has permeated the inner face of the crucible, along with lead (which is likely to be present mainly within the slight vitrification).

The low levels of copper and tin are consistent with the lack of visible residues. The lead-dominated contamination on the external surface is probably due to the reaction of the metal with the partially melted surface of the crucible, with the oxidised lead being trapped by, and mobile within, the superficial glaze.

The presence of lead and zinc at high levels, together with small amounts of tin and copper, suggests that the metal being handled in the crucible was a quaternary alloy of copper, tin, zinc and lead. It is not possible to be precise about the composition of the alloy, but it is likely to have been a leaded gunmetal, although a leaded brass with just a trace of tin is also possible, but unlikely (Dungworth 1997 indicates this alloy is very unusual in Roman artefacts).

Leaded gunmetal is a good, fluid, metal for casting and was widely employed in the Roman period for both civilian and military purposes. (Dungworth 1997). Dungworth's data show gunmetal being employed for 20-50% of artefacts from both forts and civilian sites in northern Britain, although much of this was not leaded (he did not give the proportion solely of leaded gunmetal). He suggested that gunmetal may arisen largely through mixing of bronze and brass during recycling and that lead may have been added to the recycled material to improve its casting properties. Gunmetals with a very high proportion of lead, however, have poor structural properties and can only be used for low-stress purposes.

References

DUNGWORTH, D. 1997. Iron Age and Roman copper alloys from northern Britain. *Internet Archaeology*, **2**.

KEARNS, T. MARTINON-TORRES, M. & REHREN, T. 2010. Metal to mould: alloy identification in experimental casting moulds using XRF. *Historical Metallurgy*, **44**, 48-58.

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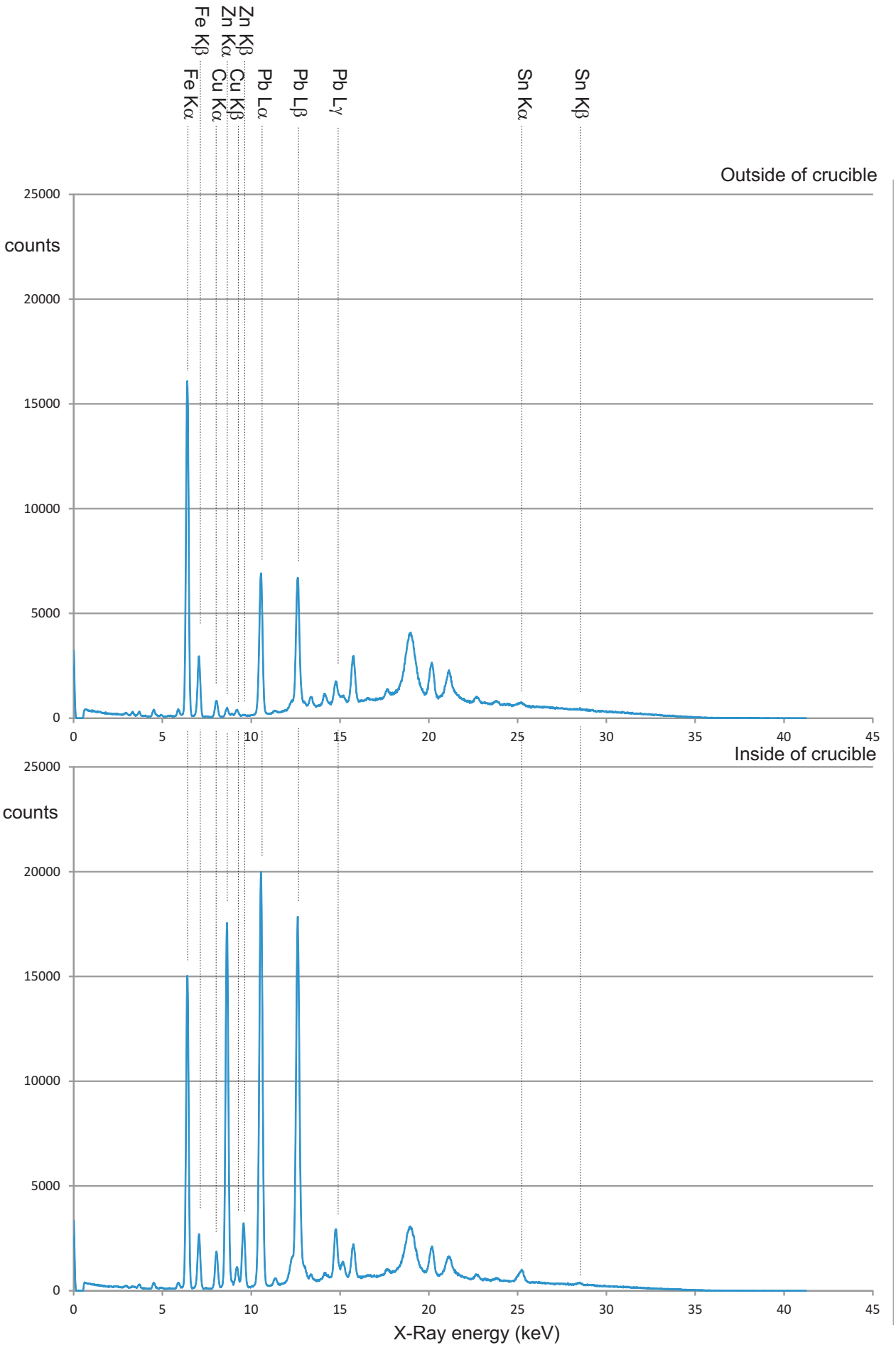
Figure 1


Fe Kβ
Fe Kα
Zn Kβ
Zn Kα
Cu Kβ
Cu Kα
Pb Lα
Pb Lβ
Pb Lγ
Sn Kα
Sn Kβ
Outside of crucible
counts
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
40
45
Inside of crucible
counts
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
40
45
X-Ray energy (keV)

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