Notes on the Sancta Maria 'crucibles'

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Methodology

There are 14 examples of refractory scorifers (vessels 'a' to 'n'), 1 example of the lower part of crucible (vessel 'p') and 1 very worn base, probably also from a large crucible (vessel 'o').

One of the scorifers is marked '2¼ inch Battersea Works [London?]'.

The analyses were undertaken with a Bruker Tracer III-SD portable X-Ray fluorescence spectrometer (instrument belonging to the Department of Archaeology, Cardiff University, and the National Museum Wales). 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 software. Data were exported as text files for further imaging and processing in Bruker's Artax software. Data are presented here as the net peak area for the principal peaks as reported by Artax. One spectrum (l-4) was undertaken (as a repeat of l-3) with no filter and for just 40s to gain a further impression of the lighter elements present in the ceramic.

The accompanying files include:

pXRF data table Swansea crucibles.xlsx – this contains sheets with the datafiles from S1PXRF, graphs of spectra (use filter function to switch individual spectra on and off), and a table showing selected net peak areas for the spectra processed using Artax. These net peak areas can be used in a very crude way to compare elemental variations across samples. The method of data acquisition and the nature of crucible residues means these spectra cannot be turned into quantitative results, but the 'comments' column on the areas table gives some expression of abundance.

archive of Artax output.xlsx – this contains all the results of the peak area calculations in Artax.

archive of pXRF data - Swansea crucibles – this contains copies of the S1PXRF datafiles.

Comments

For most of the scorifers the most significant element present is lead (except for vessel 'j' which may not have been used, or was used in some other way). The lead-based slags identifies the vessels as having been used in the 'fusion' or 'scorification' step of fire assay. This process uses lead to dissolve the precious metals from a sample, typically of ore. The silica (and fluxes if used) in the ore sample reacts with the lead to create a lead slag (which will also carry the base metals), and the molten lead absorbs the precious metals. The contents of the scorifer would be tipped into an iron mould, from which the lead 'bullet' could then be extracted from any adhering slag.

The precious metal is then extracted from the lead by using a second stage of ‘cupellation’ (in which the lead is oxidised to litharge, typically in a bone-ash cupel that will absorb the litharge, to leave the precious metals as small beads).

Scorifers are thus only a single use item and would be discarded after use.

The Battersea scorifer dates to post-1856.

Contemporary accounts of the process may be found in text-books of the period, including Rose 1898 and Eissler 1900.

Rose (1898, chapter 9) describes the assay process in some detail. Of the scorifers (which he terms crucibles) he states:

> *There are three shapes of clay crucibles in common use, namely the French, the Battersea, and the Colorado. The French pot differs from the others in the thickness of its walls near the bottom, and consequently it requires very careful annealing. The Battersea pot is of coarser texture than the others, having a larger percentage of sand in its composition. The Colorado crucibles, manufactured by the Battersea Company, are specially made for fusion in the muffle; the "20 gram" size is the most generally useful.*

Rose’s recipes for fusion include a variety of fluxes. The pXRF data acquired are not appropriate for the determination of the light elements common in these fluxes (typically borax, sodium carbonate and potassium carbonate). It would be possible to pursue investigation of the process employed here in more detail through the investigation of slag samples under the SEM to obtain more complete elemental analysis, if so desired.

The assay being undertaken here would have been of ores. Assaying of the precious metals themselves does not involve scorification. Analysis would have routinely been undertaken to determine the desirability of extraction of precious metals from the ores of base metals during their extraction, as well as of ores primarily extracted for precious metals. This technique would not be used for the determination of the base metal content (copper, zinc, lead etc) of their ores.

The variability of the ore being assayed has resulted in a variety of distinct slag compositions:

- vessels ‘b’, ‘d’, ‘e’, ‘g’, ‘k, ‘l’ show relatively high concentrations of copper

-vessels ‘l’ and ‘n’ shows elevated copper and zinc, with ‘n’ showing strongly elevated tin also.

- vessel ‘a’ shows strongly elevated levels of nickel

- vessel ‘c’ shows a very high concentration of iron

- vessel ‘f’ shows localised concentration of iron and zinc

- vessels ‘h’ and ‘m’ show only slightly raised levels of metals other than lead

The first two groups above may well be from assays of copper ores, but the other assays are less likely to be of copper ores.

The very worn crucible fragment (vessel ‘o’) shows elevated levels of calcium and the thin green glaze is probably a wood ash glaze. This does not provide evidence for the use of the vessel. No metals besides iron (probably from the fabric) show any degree of enhancement. The vessel may have failed before use.

The substantial crucible base, vessel ‘p’ shows an internal slag rich in lead, copper and slightly elevated in zinc. The external glaze is iron-rich. This probably suggests that this was employed for the melting of a leaded brass in a coke/coal fired furnace.

The assemblage would thus appear to be waste from an assay office, with the crucible finds possibly, if from the same source, suggesting an association with a brass foundry.

References

Eissler, M. 1900. *The metallurgy of gold. 5th Edition*. London.

Rose, T.K. 1898. *The metallurgy of gold*. London