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ROMAN AND MEDIEVAL CRUCIBLE SHERDS FROM LONDON

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Summary

Fifty-five Roman and sixty-two medieval sherds, from various sites in London, were analysed qualitatively by X-ray fluorescence to identify the metals melted in the crucibles from which they came. It was shown for both periods that a wide range of copper alloys was being used, both leaded and unleaded. There was also evidence for silver-working in both periods, but far more extensively at two of the Roman sites.

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A number of sherds thought to have come from crucibles were submitted for analysis; fifty-five were believed to be of Roman date, and sixty-two of Medieval date. Following a visual examination, all the sherds were analysed qualitatively by X-ray fluorescence (XRF).

Most crucible sherds have a glassy, vitrified layer on the outside, sometimes also on the inside, and this was true for many of the samples analysed here. The vitrification is formed as a result of the ceramic being heated to high temperatures, at which the clay minerals and temper are fluxed by the ash in the fire, and fuse together. Extreme vitrification has a bloated appearance.

Some of the sherds still have, or showed evidence for having had, a layer of less refractory clay which was often added to the outside of the crucible. This layer is easily distinguished from the more refractory clay of the crucible wall, as it is deeply vitrified, often of a different colour, and on some sherds has cracked off in places, leaving a clean and unvitrified surface. According to Bayley (1992), this outer layer may have been added in order to protect the crucible from the extremes of temperature, thereby prolonging its life. It would also have increased the thermal capacity of the crucible, giving the craftsman a slightly longer time in which to pour the molten metal before it resolidified.

Reducing conditions are necessary when melting metals so as to prevent their oxidation. This also means that the crucible will be reduced fired in the process, usually rendering the fabric light-grey to black in colour, as opposed to a red colour indicative of oxidising conditions.

The analytical results were recorded as the height of the major peak produced by each element of interest: copper (Cu), zinc (Zn), lead (Pb), silver (Ag) and tin (Sn). Gold (Au) was not detected on any of the sherds and so has been omitted from Tables 1 and 2. The actual peak measurements are not presented here since their exact values and proportions are not a direct indication of the amounts and hence relative adundances of the metals originally melted. The heights of the peaks are not only affected by the duration of analysis, but also by the size and shape of the sherd, its position in the unit during analysis, and the proportion of the examined surface covered by the metal-rich deposits. Since the XRF results acquired were only qualitative in nature, a level of interpretation is required to extrapolate back to an estimate of the original composition of the metal melted in the crucible. The interpretation takes into account the fact that lead and zinc tend to be over-represented, while silver and tin are under represented. The over-representation is a result of the relatively high volatility of zinc and to a lesser extent, lead; the metal diffuses into the crucible fabric and also becomes chemically bound into any slags formed (Bayley *et al.* 1991). Distortion also results from the analytical technique itself, as different elements fluoresce to different extents. In particular, elements whose peaks have higher

Table 1:- The Roman Crucibles

site	context	acc. no.	extra outer layer	Cu	Zn	Pb	Ag	Sn	metal melted
BIG82	6356	3542	yes	* *	* *	*			brass
CHL84	34	15	yes	* *	* * *	* *			leaded brass
FEN83	1932	982	yes	* *	*	* *			copper alloy
FEN83	2091	979		*	?	*			#
FEN83	2209	980	yes	*	* *	*			copper alloy
GPO75	588	4585		* *	*				brass?
GPO75	7046	4941		* * *	* *	*		*	gunmetal
GPO75	7047	4942		* *	* *	*		* *	gunmetal
GPO75	7635	3160		* *		* * *	*		silver
GPO75	7919	3213		?		*			*not a crucible*
GPO75	8312	3162	yes	*	* *	* *			copper alloy
GPO75	8862	3801							*not a crucible*
ILA79	182	549		*	*	*			*not a crucible*
ILA79	307	261	yes	* *	* *	* *	?	* *	leaded gunmetal
ILA79	863	563		*	*	*	* *		silver
ILA79	2246	760	yes	*	*	* *	* * *		silver
MLK76	U/S	735		* *	*	*	* * *	* *	silver
MLK76	916	1495	yes	* * *	* *	* * *		* *	leaded gunmetal
PDN81	52	171	yes	* *	* *	* * *		*	leaded gunmetal
PDN81	3196	1219		?		* *			*not a crucible*
PET81	274	133		?	* *				#
PET81	1648	1013		* * *	*	* *		* *	leaded bronze
PET81	1756	516		* * *	* *	*			brass
PET81	1817	517		?	* *				#
PET81	1817	519		* *	* *	*			brass
PET81	1823	520		* *	*	*			copper alloy
POM79	1383	521		*	* *	*			#
POM79	1823	518		* * *	* *	* *			leaded brass
POM79	1319	317							*not a crucible*
RAG82	1513	301	yes	* * *	* *	*		* *	gunmetal

site	context	acc. no.	extra outer layer	Cu	Zn	Pb	Ag	Sn	metal melted
SM75	1331	382		* *	*	* * *	* *		silver
SWA81	150	478	yes	*	* * *	*			copper alloy
SWA81	1902	3711		* *	*	* * *	* * *		silver
SWA81	U/S	4080				* *			*not a crucible*
SWA81	384	167		* *	*	* * *	* *	* *	silver
SWA81	384	235		* *	?	* *			copper alloy
SWA81	384	236							*not a crucible*
SWA81	384	237	yes	* * *	*	*	* * *		silver
SWA81	384	238		*		*			*not a crucible*
SWA81	384	4665		* *	*	*	* * *		silver
SWA81	2176	3714		* * *	*	* *	* *	*	silver
SWA81	2247	3715		* * *	*	* *	* *		silver
SWA81	3015	4081	yes	* *	*	* * *			leaded copper
WAT78	2548	1064	yes	* * *	*	* *			leaded copper
WAT78	2548	1067		* *	* *	* *		*	gunmetal?
WAT78	3925	438		* * *	*	* * *			leaded copper
		ER794		* * *		*		*	bronze
		ER1037	yes	* * *	*	* *			leaded copper
		ER1041		* * *		*		* *	bronze
		ER1054	yes	* * *		*		* *	bronze
		ER1054	yes	* * *	*	*			copper alloy
		ER1094	yes	* *	*	*			copper alloy
		ER1105	yes	* *	*	*		*	bronze?
		ER1120		* *	*	*			copper alloy
		ER1121							*not a crucible*

Key to Tables 1 and 2:-

* * *	strong signal	?	very weak/uncertain
* *	present	#	no reliable interpretation possible
*	weak signal		

energies are under-represented relative to the copper peak (e.g. silver and tin).

All the factors mentioned above have been taken into account in forming the interpretations appearing in Tables 1 and 2. Where possible, the probable metal alloy which had been melted in the crucible is named; 'copper alloy' appearing when no specific alloy is indicated, and '#' where no interpretation is possible.

Discussion of the Roman Sherds

A range of crucible sizes was indicated by the range in wall thickness (between 3 and 10mm), and inferred diameter estimations (generally between 70 and 100mm). Some of these diameters are fairly large, indicating large capacities, but it should be remembered that the whole crucible need not have been filled, only a small amount of metal may have been melted.

A few of the sherds were found not to be from crucibles. Nine of them showed no or very little evidence of a metal deposit present, although in a few cases this was the result of having been well cleaned following excavation. On visual inspection, ILA79, accn no 549 was seen to be a fragment of brick with mortar attached, which had, in antiquity, been heated strongly in a fire and so acquired a vitrified surface.

SWA81, accn no 4080 has a lead-glaze visible on the rim. Since glazed Roman pottery is uncommon and this particular sherd is unstratified, then it is more likely that it is medieval in date, and not related to any metallurgical process.

ER1041 is very different from other crucibles in that it has very thick walls (up to 30mm) and an internal diameter of about 40mm. Within the wall fabric are zones of differing levels of oxidation and reduction: the outside has been reduced, while the inside was oxidised. The whole fabric is heavily vitrified to the extent that it is vesicular and bloated in appearance. This is an indication that it was subjected to very high temperatures, with the high level of iron in the clay acting as a flux. If ER1041 was not a crucible, it might have been part of a 'tubular tuyere' - a replaceable block or tube of clay with a blowing-hole, which would have been placed in a hole in the hearth or furnace wall. It differs from other examples of tuyeres in that the diameter of the blow-hole, c.40mm, is very much larger than would normally be expected, and so it may have been used in a different way. On visual inspection, sherd PDN81, accn no 1219 did not appear to be from a crucible. It has red paint on the inside which the XRF identifed as being lead rich, therefore it probably came from a paint pot containing red lead (PbO) as the pigment.

WAT78, accn no 438 is a small sherd with a thin, red layer of vitrification over most of the inside, continuing onto parts of the broken edges, as though it had been heated to a high temperature after it had become broken. It is sometimes the case that sherds from broken vessels were reused in the assaying of silver. The high lead levels are typical of this use, and although no silver was present this sherd was probably part of a larger sherd reused for such a purpose.

GPO75, accn no 3213 gave little evidence for metals present in the vitrification which extends all over the broken edges of the sherd. This is an indication that the sherd was strongly heated in a fire at some point, although not necessarily as a crucible or for assaying.

It is interesting to note that a high proportion of sherds, (eleven of the forty-six coming from crucibles (24%)), showed evidence for having been used to melt silver. Six of the nine crucible sherds from SWA81 and two of the three crucible sherds from

Table 2:- The Medieval Crucibles

site	context	acc. no.	extra outer layer	Cu	Zn	Pb	Ag	Sn	metal melted
ACW74	2	37		* * *	*	*		* *	bronze
ACW74	2	45		*	*	*		*	copper alloy
BEV80	287	190		* *	*	*			*n/a (glass?)*
BIG82	2598	5753		*	* *	*			copper alloy
BIS82	525	433		* * *		* *		*	leaded bronze
BIS82	544	423		* * *	*	*		* *	bronze
BIS82	740	427		* * *		* * *			leaded copper
BIS82	769	426		* *		*			leaded? copper
BIS82	578	431	yes	* * *		* *			leaded copper (+Sb)
BIS82	1223	425	yes	* * *	*	* *		*	leaded bronze
BRI78	134	76		* *	*	* *		* *	leaded bronze
CUT78	101	379	yes	* * *	*	* *		* *	leaded bronze
CUT78	442	458		*	*	*		?	copper alloy
CUT78	881	140		*	*	*			copper alloy
CUT78	1047	171		*	*	*			copper alloy
CUT78	1068	461	yes	* * *	* *	* *		* * *	leaded gunmetal
CUT78	1083	377		* * *	* *	*		* *	gunmetal
CUT78	1083	1006		*	*	*			copper alloy
CUT78	1164	248	yes	* *	* *	* *		* *	leaded gunmetal
CUT78	1263	309		* * *	* *	*		* *	gunmetal
CUT78	1263	448		* * *	*	*		*	bronze
CUT78	1444	359		* *	*	*		* * *	bronze
CUT78	1579	308		* *	*	* *		?	copper alloy
CUT78	1579	620		* *	* *	*		* *	gunmetal
DUK77	84	5		* *	* *	* *		* *	leaded gunmetal
FEN83	2109	993		* * *	*	* *			leaded copper
GPO75	87	3731		* * *	* *	*		* * *	bronze?

site	context	acc. no.	extra outer layer	Cu	Zn	Pb	Ag	Sn	metal melted
GPO75	1377	1034		* * *	* *	* *		* *	leaded gunmetal
IME83	172	36		* * *	*	*		?	copper alloy
LUD82	609	9		* *	*	*		* *	bronze
MLK76	25	1096		* * *	* *	* *		* *	leaded gunmetal
OPT81	17	1325		* *	*	*		*	copper alloy
OPT81	25	1320		* *	*	*		*	copper alloy
OPT81	31	1322		* * *	*	* *		* *	leaded bronze
OPT81	42	1323	yes	* * *	*	*		* * *	bronze
OPT81	43	1318	yes	* *	*	*		* *	bronze
OPT81	45	1373		* * *	*	*		*	bronze
OPT81	47	1335		* *	*	*		*	copper alloy
OPT81	52	1317		*	* *	*			brass?
OPT81	54	1328		* *	* *	*	?	*	gunmetal / silver?
OPT81	54	1331		* *	* *	*		* *	gunmetal
OPT81	54	1332	yes	* *	*	*		* *	bronze
OPT81	54	1487				* *			*n/a (glass)*
OPT81	58	1334		* * *	* *	*		*	gunmetal
OPT81	68	1324		*	*	*			copper alloy
OPT81	74	1462							*not a crucible*
POM79	194	891		* * *	*	*		* * *	bronze
TL74	274	2768		*	*	* * *		*	lead
TL74	291	3176		* *	*	*	* * *	?	silver
TL74	2569	3175		*	*	*			copper alloy
		ER69	yes	* *		*		* *	bronze
		ER426		* * *	*	* *		*	leaded bronze
		ER460	yes	* * *	* *	*		*	gunmetal
		ER461	yes	* *	*	*		* *	bronze
		ER471A	yes	* * *	*	*		* *	bronze
		ER778		*	*				copper alloy

site	context	acc. no.	extra outer layer	Cu	Zn	Pb	Ag	Sn	metal melted
		ER849/7	yes	*	*				copper alloy
		ER849/10		* * *	* *	* *		* *	leaded gunmetal
		ER1140		* * *	*	* *		* *	leaded bronze
		ER1152		*	*	*		?	copper alloy
		ER1227		*	*	*			copper alloy
		ER1263	yes	* * *	*	* *		* *	leaded bronze

ILA79 had been used in this way.

Discussion of the Medieval Sherds

The measured sherd wall thicknesses, and inferred diameters indicated a wide range of crucible sizes. Compared with the Roman data, the medieval range in sizes includes larger crucibles; wall thicknesses generally range between 4 and 22mm, and diameters generally range between 50 and 220mm. One sherd, CUT78 accn no 1006 appears to be from a crucible with a wall thicknesses between 30 and 35mm, and a diameter of about 300mm. It is probably post-medieval in date, and could not have been used like these other crucibles, since its weight when containg molten metal would prevent it being lifted and poured. It was probably used for some other metallurgical process.

The two crucible sherds from ACW74 have been analysed previously by the Ancient Monuments Laboratory, and are discussed in Blurton, 1977. The results are not directly comparable since different machines were used and it is likely that different areas were analysed.

Of the sixty-two sherds submitted, four were found not to have originally come from metal-working crucibles:-

BEV80, accn. no. 190 consists of three oxidised sherds from a large vessel, (about 20cm in diameter), and constructed of a rough sandy fabric. It has an even, glassy layer on the inside of the pot, either from deliberate glazing, or possibly as a result of the pot having been used to melt glass.

OPT81, accn. no. 1487 is an oxidised base sherd from a vessel with an uneven and irregular layer of a high lead-glass on the inside. This is an indication that the pot from which this sherd comes from was used to melt glass of this type.

OPT81, accn. no. 1462 is a pot sherd with no evidence of any metal residue.

ER1140, <1>, is a small fragment of stone, with a metal-rich glassy layer on two faces. This may once have been part of a structure associated with metal working; the XRF results indicated that the metal melted nearby on one occasion was a leaded bronze.

Only one of the medieval crucible sherds, TL74, accn. no. 3176 showed conclusive evidence for having been used to melt silver. OPT81, accn. no. 1328 gave a very weak signal for silver, and is therefore inconclusive.

BIS82, accn. no. 431 gave signals for both arsenic and antimony in addition to the strong copper and lead peaks. Blades (1995) states that the presence of these two elements in substantial amounts (a few %) may indicate that the metal melted in them originally came from fahlerz ores. Alloys of this type of composition were common in the later medieval period.

Conclusion

The evidence from the XRF analysis of these crucible sherds indicates that a wide range of copper alloys were being used in both Roman and Medieval London, and while there is evidence for silver-working in both periods, it was more extensive in the Roman period, accounting for about 25% of the sherds analysed, as opposed to about 4% of the medieval sherds. Some of the Roman sherds may provide evidence for the assaying of silver.

These results suggest that copper alloys (bronze, brass, gunmetal, these three metals with added lead, and leaded copper) were used fairly equally in Roman London, with the unleaded copper alloys being more frequent. In contrast, in Medieval London bronze and gunmetals were being melted far more than brass, and there is less use of leaded alloys

At least one of the medieval sherds analysed gives direct evidence for glass melting taking place in London.

References

Bayley, J. (1992) *Non-Ferrous Metalworking from 16-22 Coppergate.* London: CBA. The Archaeology of York, Volume 17/7.

Bayley, J., Freestone, I., Jenner, A., and Vince, A. (1991) 'Metallurgy' in A Vince (ed), *Aspects of Saxon and Norman London 2: Finds and Environmental Evidence.* London and Middlesex Archaeological Society Special Paper 12, 389-405.

Blades, N.W. (1995) *Copper Alloys from English Archaeological Sites 400-1600 AD - An Analytical Study Using ICP-AES.* Unpublished PhD Thesis, Royal Holloway University of London.

Blurton, T.R. (1977) Excavations at Angel Court, Walbrook, 1974. *Transactions of the London and Middlesex Archaeological Society*, 28, 14-100.