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TECHNICAL ANALYSIS OF METALWORKING MATERIAL FROM PAKENHAM ROMAN FORT AND SMALL TOWN, SUFFOLK

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Summary

Qualitative X-ray flouresence analysis suggests that non-ferrous metalworking was being carried out at this site during the first century AD and possibly later. Most of this was bronzeworking but other alloy types, including silver, were also in use. Bowl-shaped crucibles were used to melt the copper alloys and there is evidence for casting in investment moulds.

Author's address :-

Catherine Mortimer BTech DPhil

Ancient Monuments Laboratory
English Heritage
23 Savile Row
London
W1X 1AB

Technical analysis of metalworking evidence from Pakenham Roman fort and small town, Suffolk

Catherine Mortimer

Background

Excavations on the route of the Ixworth Bypass in 1985 revealed evidence of military and civilian occupation dating to the Roman period. Technological material submitted for examination consists of 36 metallic items (fragments of castings, drops, splashes etc) and 9 ceramic items (parts of crucibles, moulds and, possibly, a piece of a tuyere). Most of the metalworking material analysed is from the civilian occupation, dating from the late first century to the fourth century AD (where datable), with the greatest density of dated finds in the late first century. Qualitative X-ray fluorescence analysis (XRF) was used to determine metal type in the first group of material and to detect metallic traces in the case of ceramic material.

Metal droplets, casting waste etc.

Most of the pieces in this category were not diagnostic. SF1219 and SF1616 are conical pieces with 'stalks' and appear to be metal sprues from a casting process. SF2612 and SF2589 are both parts of feeder systems, in the later case, appearing very clearly as elements branching from a central point. SF3517 is the sprue and part of a curved object; this casting seems to have failed miserably.

Most of the metal waste proved to be bronze (21 examples) but there were small numbers of other alloy types; silver (2 examples), copper (2), lead-tin (1), brass (1), leaded bronze (2), quaternary copper alloys (4) and copper alloys of unclear nature (3). The XRF results are tabulated below (Table 1).

Crucibles and moulds

The crucibles generally have a reduced appearance (ie a grey colour) and drops of slag on the outside. None of the fragments are large enough to be very helpful but, judging by SF2602 and SF2606, crucibles at the site included shallow bowl-like forms, comparable with Roman examples from Colchester (Bayley 1984, 49; Bayley 1985, MF 3E1) and Doncaster (Bayley 1986, 196, 199). SF2606 and SF2623 are pouring lips from crucibles. SF2546 is rounded and cup-like, with high levels of copper and lead within the matrix. It is thought not to be the base of a crucible, with remains of its bronze charge (J Bayley, pers comm) but is definitely associated with non-ferrous metalworking. The high levels of lead may account for the weight of this object.

XRF analysis of six crucible and mould fragments revealed traces of copper, zinc, lead and tin, in varying proportions (Table 2). Levels of metals detected were lower in the moulds than in the crucibles.

The detection of zinc, including large amounts of zinc in three cases (SF 2623, 3204 and 5234), is not surprising, despite the low frequency of brasses and other zinc-containing metals amongst the casting waste from this site. Zinc is a highly volatile element and even low levels of zinc in a copper-alloy melt may cause high levels to be detected in the crucible or mould concerned. Similarly lead is detected in nearly every used crucible and mould fragment, because it is a heavy element and therefore easily detected by XRF. Both lead and zinc form glassy phases and are therefore more likely to be detected in slags. Conversely tin is less likely to be represented, since tin is not volatile, does not form glass/slag easily and the tin peak is in a noisy part of the XRF spectrum.

Both SF2602 and SF2623 have slag inside. SF3203 may be part of a tuyere, but the diameter of the hole (40-50mm) is rather larger than normal. This piece is oxidized on the inside and reduced on the outside, with slagging. No non-ferrous metals were detected in the slag.

SF2617 is the upper part of an investment mould; the sprue and feeder areas are extant, as is part of the matrix for the object form itself, but the nature of the object cannot be determined from the portions remaining. The mould had been used - copper, zinc and lead were detected in the sprue area.

The results of this technical analysis suggest that non-ferrous metalworking was being carried out at this site. Most of this was bronzeworking but other alloy types, including silver, were also in use. Bowl-shaped crucibles were used to melt the copper alloys and there is evidence for casting using investment moulds. There are insufficient sample numbers and phasing information to detect changes in alloy use over time. It is possible that this material represents a single, first century metalworking episode with redeposition in later contexts, since third- and fourth-century crucibles are usually of a different design (more conical, see for example, Tylecote and Biek 1985, 64). Although piece moulds were commonly used at this period for casting small objects, larger objects such as statuettes were made using investment moulds (*op cit*, fig 38).

References

Bayley J 1984, 'Metalworking residues' *in* Drury P J, 'The Temple of Claudius at Colchester Reconsidered' Britannia XV; 49-50

Bayley J 1985, 'The technological finds' *in* Niblett R (ed) Sheepen: an early Roman industrial site at Camulodunum (CBA Research Report no 57, London); MF3:D11-E13

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Tylecote R F and Biek L 1985, 'Metalworking' *in* Draper J (ed), Excavations by Mr H P Cooper on the Roman Site at Hill Farm, Gestingthorpe, Essex (East Anglian Archaeology, Chelmsford); 60-64

Table 1. Qualitative XRF analysis of metal droplets etc.

SF	Date (Cent AD)	Elements detected	Comment
1266		Cu Pb Sn	Bronze
1268		Cu Pb Sn (tr Zn)	Bronze
1219		Cu Zn Pb Sn	Quaternary alloy
1343		Cu Zn Pb (?tr Sn)	Brass
1438		Cu (Zn Pb)	Copper (alloy?)
1518		Cu Zn Pb Sn	Quaternary alloy
1616		Cu Zn Pb Sn	Quaternary alloy
1630		Cu Sn	Bronze
1715	3rd/4th?	Cu Sn	Bronze
1796	2nd?	Cu Pb Sn	Bronze
2078		Cu Ag (tr Pb)	Ag-Cu alloy
2162		Cu Sn	Bronze
2391		Cu Pb Sn	Bronze
2399		Cu Pb Sn	Bronze
2446		Cu Pb Sn (?tr Zn)	Bronze
2472	late 1st?	Cu Pb Sn	Bronze
2479	late 1st?	Cu Pb (tr Zn)	Bronze
2558		Cu Ag (tr Zn, Pb, Au)	Ag-Cu alloy
2589		Cu Pb Sn	Bronze
2599	late 1st	Cu Pb Sn	Bronze
2612		Cu (tr Sn, ?Pb, ?Zn)	Copper alloy
2619	1st M	Cu	Copper
2710		Cu Sn Pb (tr As)	Bronze
2731		Cu Pb Sn (tr Zn)	Bronze
2763		Cu Pb Sn	Bronze
2778		Cu Pb (?tr Zn)	Copper alloy
2818		Cu Pb (tr Zn, Sn)	Copper alloy
2877		Cu Pb Sn (tr Zn)	Bronze
2913		Cu Pb Sn	Leaded bronze (high Pb)
3171		Cu Pb Sn (tr Zn)	Bronze
3023	late 1st	Cu Zn Pb Sn	Quaternary alloy
3024		Pb Sn	Lead-tin
3283		Cu Pb Sn (tr Zn)	Bronze
3327		Cu Pb Sn (tr Zn)	Bronze
3517		Cu Pb Sn (tr Zn)	Leaded bronze (high Pb)
3793		Cu Pb Sn	Bronze

Keys;

Date   M = military occupation

Metals Cu copper, Pb lead, Sn tin, Zn zinc, As arsenic, Ag silver
Au gold
tr = trace

Table 2 - Qualitative XRF analysis of crucibles, moulds etc

SF	Obj	Date-Cent AD	Area analysed	Elements det'd	Comments
2546	C	late 1st	inside	Cu Pb (tr Sn)	Mostly Pb
2602	C		slag	Cu Zn Pb Sn	
2606	C	late 1st	inside	Cu Zn Pb Sn	Mostly Zn,Sn
2617	M	1st M	[object area	?Cu	
			[sprue area	Zn (tr Pb)	
2623	C	late 1st	inside	Cu Zn Sn (?Pb)	Mostly Zn
3203	T?		slag	-	
3204	C	1st M	inside	Cu Zn	Mostly Zn
5234	C	1st M	inside	Cu Zn Pb	Mostly Pb,Zn

Object type

C crucible
M mould
T tuyere

Date

M = Military