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Summary

Excavation at a former telephone exchange recovered 51.6kg of 16th–17th century mould fragments used in the casting of copper alloys. A selection of 237g of material was received for analysis in order to determine the nature of the alloys being cast and what objects were being produced. Samples were analysed quantitatively (SEM-EDS).

Keywords
Copper alloy, Metal working non-Fe, Technology, Post-medieval

Archaeological Background

In July and August 2000 the redevelopment of a former BT telephone exchange in Taunton, Somerset (ST22802469) was subject to a rescue excavation performed by Exeter Archaeology. The north area of the site formed the main focus of the foundry where four pits contained finds associated with the production of copper alloy objects. Two of these pits (501 and 599) produced the majority of the mould fragments. Altogether 51.6kg of mould fragments were recovered. Contexts that contained large amounts of mould had no datable finds associated apart from 511, which contained five fragments of South Somerset coarse ware (circa 17th century). It has been suggested that the possible identity of the Taunton bellfounder is a George Purdue who operated during the late 16th century (Blaylock 2001). Bell founders would spend most of their time casting cauldrons, skillets and other similar items, the demand for bells not being consistent enough to support a business.

Research objective

The objective of this study was to determine what alloys were being cast and therefore what types of objects were being produced. Bells were cast from high tin bronzes (Tylecote 1986), domestic vessels were produced from mixed alloys often containing high levels of arsenic and antimony (Blades 1995).

Visual Assessment

A selection of material was received for analysis consisting of mould fragments, scrap and waste metal. Every piece of the assemblage sent for analysis was examined and its weight, colour and whether it was a spill or scrap was noted (see appendix 1). The fragments of mould all had grey / black inner surfaces (reduced fired) and red / orange outer surfaces (oxidised fired) as is normal for mould of this type (Bayley *et al* 2001). Whilst there was some metallic deposit of the mould this was found to be completely corroded.

The total weight of all the material sent for analysis was 182g.

Selection, sample preparation and method of analysis

Samples were taken from the scraps and spills using a hand held hack saw, then mounted in resin and polished to a 1-micron finish. Each sample was etched with ferric chloride and examined under a light microscope and a sketch and description of the microstructure was produced.

Further examination and analysis was carried out using a scanning electron microscope (Leo Stereoscan 440I) in backscatter mode. This provides an atomic number contrast image, allowing metallic droplets to be easily identified. The composition of the metal droplets was determined using an energy dispersive spectrometer (with Germanium detector) attached to the scanning electron microscope. They were collected at 25kV and 1.5nA for 50 seconds livetime and calibrated with a cobalt standard. The spectra were quantified using the Oxford Instruments SEMQuant software (ZAF correction procedure. A small area (typically 10 by 20 microns) was analysed on each metal droplet. Errors and the minimum detectable limit are set out in table 1.

Table 1 - Detection limits and errors for the metal droplets (MDL = minimum detectable level)

	Fe	Ni	Cu	Zn	As	Sn	Sb	Pb	Ag	Cl	Co
MDL	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.1
Error	±0.1	±0.1	±0.1	±0.2	±0.2	±0.4	±0.4	±0.4	±0.4	±0.3	±0.1

Results

Table 2 - Results of analysis from Whirligig Lane (not normalised)

Context	Sample no.	Spill or Scrap	S	Fe	Ni	Cu	Zn	As	Sn	Sb	Pb	Ag	Cl	Co	Total
550	1	Spill?	<0.2	<0.1	<0.1	73.5	0.2	<0.5	24.2	0.8	1.9	<0.5	<0.2	<0.1	100.6
502	1	Spill	0.5	0.3	<0.1	77.7	0.3	<0.5	14.9	2.1	7.6	0.2	<0.2	<0.1	103.5
515	1	Scrap	0.6	0.1	0.2	69.0	<0.1	1.6	5.5	10.0	8.7	<0.5	2.7	<0.1	98.3
515	2	Scrap	0.4	<0.1	0.2	71.6	<0.1	1.1	4.3	7.8	15.2	0.3	0.2	0.1	101.1
515	3	Scrap?	0.2	<0.1	0.2	75.9	<0.1	0.7	7.0	2.1	13.1	<0.5	<0.2	<0.1	99.2

The analysis of the copper alloy from context 550 (see table 2) shows it was a high tin bronze; the only post-Roman objects cast from this alloy are bells (Tylecote 1986). The metals analysed from contexts 502 and 515 contain too much lead to have been bell metal (lead dulls the sound). They would have been used for casting large objects, most likely cauldrons and skillets. The defining feature that links them is the high proportion of antimony and arsenic (with antimony the greater). This has been noted in many other studies of broadly contemporary copper alloys (eg Blades 1995, Dungworth 2001, Dungworth 2002 and Blair *et al* 1986).

Antimony increases the tenacity and hardness of copper, but if there is more than 0.2% present then when rolled the metal will crack at the edges (Gowland 1921). The alloy that was being produced would not have been fabricated by drawing or rolling. All of the copper alloys produced at Whirligig Lane (including the bell metal) would have been fit for casting only.

It has been suggested that the presence of antimony and arsenic at enhanced levels in the late medieval and early post medieval period are due to the use of antimonal sulphide ores found in Devon and Cornwall (Blair *et al* 1986). Another possibility (as this is a Europe-wide phenomenon) is a decline in quality of the copper produced from the Harz mountains (Germany) due to the use of deeper deposits as the oxide and carbonate ores from the surface were exhausted (Blades 1995).

Conclusion

There is evidence for the casting of two types of copper alloys at Whirligig Lane. One contained high levels of antimony, arsenic and lead as well as tin and was probably used for in the casting of cauldrons and skillets. The second is a bell metal, presumably used in the casting of bells.

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