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Summary

An assemblage of metal working debris from Eynsham Abbey, Oxfordshire, was assessed and analysed using XRF spectrometry. The assemblage came from the later phases of the abbey and suggests that following the dissolution of the monasteries the site was plundered for useful materials including metals.

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Metallurgical debris from Eynsham Abbey, Oxfordshire.

Roger C.P. Doonan

Introduction.

Excavations at Eynsham Abbey have produced evidence for both non-ferrous and ferrous metallurgy. The total sample of non-ferrous metallurgical debris was submitted for analysis at the AML. The assemblage was analysed using X-ray fluorescence spectrometry (XRF). The aim of the analysis was to identify the types of alloys and to comment on the technological activities that were responsible for the production of this debris.

Analytical considerations.

Over sixty chemical analyses of technological debris were performed using XRF. Operating conditions for the XRF were kept constant with all analytical determinations being made at 40 kV, 20mA, with a 3mm collimator.

Peak heights were recorded for the following elements copper, tin, lead, zinc, arsenic and antimony. The intensities of individual peaks were then categorised according to the following scheme, strong= +++, medium= ++, weak= +, trace=Tr and nd=not detected.

A comparison of the relative intensities of these peak height allows the general class of alloy to be identified. Details of such a methodology are given in Bayley (1992: 817-818). The classifications of copper alloys used in this report are: copper, tin bronze (an alloy of tin and copper), leaded tin bronze (tin bronze with additional lead, normally to improve castability), brass (an alloy of copper and zinc), leaded brass (brass with additional lead), leaded copper (an alloy of copper and lead), cauldron type alloys (quaternary alloys of copper, lead and some arsenic and antimony), gunmetal (a ternary alloy containing copper, zinc and tin) and leaded gunmetal (gunmetal with additional lead).

Results

The assemblage of metallurgical debris provided evidence for both ferrous and non-ferrous metallurgy. The evidence for iron smithing was limited. A few pieces of plate hammerscale were found amongst the fines from context 1632/-/- (SFNo 1172). The presence of hammerscale is indicative of the forging or repair of iron artefacts

(Tylecote 1987, Starley 1995). In addition, a single smithing hearth bottom was identified (SFNo 936 from context 980/B/-). This smithing hearth bottom proved to be unusual. The underneath of the hearth bottom appeared exceptionally smooth and close inspection showed that an external layer had been applied to it. A spot test with dilute hydrochloric acid caused effervescence which suggested that the smooth layer was some form of mortar. Because a smithing hearth bottom would not normally have a layer of mortar on the underneath it is highly probable that it had been incorporated in a built structure.

Table one shows the results of XRF analysis for the debris and includes an interpretation of what sort of alloy type is represented by the analysis.

A range of alloys are represented in the sample of debris. In the sample analysed, 95% of the alloys analysed were leaded copper alloys. By far the most common alloy type was leaded bronze (62%), followed by leaded gunmetal (16%), and leaded copper and cauldron type quaternary alloys both at approximately 10%.

Over 75% of analyses which represented leaded gunmetal compositions were derived from a single context (1632/-/-SFNo 1172). This sample weighed 275g and comprised various kinds of material. The commonest was slag (168g), derived from the melting of copper alloy. It is formed when fuel ashes flux the crucible fabric or the hearth/furnace lining. From the same context, copper alloy was found in two forms, spillages of metal (41g) and fragments of either sheet or broken vessel (25g). There was no evidence that the sheeting derived from fabrication processes. It is probable that this latter material represents scrap destined for melting. XRF analysis showed that the fragments of sheet metal were leaded gunmetal.

In addition to these categories there was 61g of non-diagnostic fines amongst which were identified pieces of plate hammer-scale (see above).

Although there was no evidence for crucible fragments, there was one find (EEA 91 1418/-/-)which is the added outer layer from a crucible, suggesting crucibles were used at Eynsham. It is 2-3mm thick and is heavily vitrified on one side whilst the other side is baked clay with impressions left by organic temper. Such outer layers are usually added in order to protect the crucible from extremes of temperature in order to prevent breakage due to thermal shock. Additional outer layers also increase the thermal capacity of the crucible which limits the melt cooling during pouring (Bayley 1992: 755).

Other notable specimens in the assemblage were large pieces of dross of considerable weight (up to 260g)(eg SFNo 1734: 2054/A/12). Such pieces contained very high levels of copper metal, estimated to be in the region of 85%.

Discussion

The assemblage of metallurgical debris from Eynsham is enigmatic and difficult to interpret in terms of an onsite metallurgical tradition. Whilst the presence of spilt metal with alloy compositions suitable for casting and the presence of slag suggests that copper alloy casting was practised, the total absence of crucibles and moulds does not support such an interpretation. This apparent contradiction suggests that other interpretations should be considered.

The presence of metallurgical debris in only the later phases of the site is evidence itself that the metallurgical practices were not part of an established tradition at Eynsham. The assemblage of material itself is somewhat peculiar and does not contain the full range of finds normally associated with copper alloy craft production.

Figure one shows that virtually all alloy compositions are leaded alloys. Such alloys are normally considered unsuitable for wrought manufacturing techniques. In part this can be seen as evidence for metallurgical activities at Eynsham being centred on melting and casting. However, the lack of crucibles, the later phasing of the debris and the presence of slagged hearth material suggests that the model best supported by the Eynsham assemblage is one centred on the recycling of scrap. Because the largest group of material is leaded bronzes and gunmetals with virtually no evidence for unleaded alloys, it suggests that these compositions are the result of mixing which occurred during the melting down of diverse copper alloy artefacts. The lack of evidence for crucibles and the late phasing of the material suggests that melting took place on a large scale, over a short period of time most probably in some kind of large hearth/furnace..

Debris (i.e SFNo 1734: 2054/A/12) which contained up to 85% copper and weighed 260g also suggests that this operation was not performed by a careful smith preoccupied with the efficiencies so often evident in other assemblages where metal has been melted (cf. Doonan 1997). The nonchalance which allowed such wastage was probably afforded because in comparison to the large volume of scrap metal to be melted down such losses were seen as insignificant.

The large scale remelting of scrap at the site may well have been a usual event which accompanied the dissolution of the monasteries. The compositional grouping suggests that tin bronzes and leaded bronzes were differentiated from brasses and leaded brasses and recycled separately although the gunmetal group may represent careless mixing of alloys or simply the recycling of gunmetal alloys.

It seems that in the later phases the abbey was perceived as a resource, much like a quarry, where valued materials could be obtained. No doubt this extended to building materials, as well as a wide variety of metals. The precise mechanisms of social negotiation by which these materials were taken from the site cannot be clarified through chemical analysis although the question remains pertinent to the fuller understanding of the technological processes which were used in the recycling episode.

Conclusions.

XRF analyses of an assemblage of metallurgical debris from Eynsham abbey has provided an insight in to the technological activities responsible for its production. The assemblage cannot be considered to derive from a tradition of metal craft production because the quality of waste, absence of crucibles and late single phasing of the debris suggests that the melting of metal took place under crude conditions, for a short period and with the use of a furnace rather than crucibles. This suggests that bulk recycling rather than production of artefacts was occurring.

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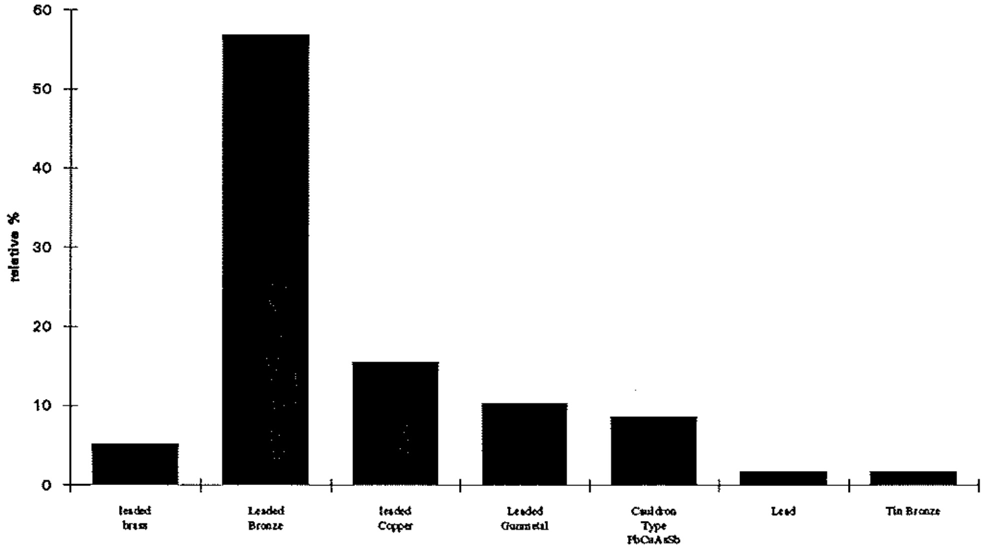

Figure 1 Histogram showing realtive frequencies of different alloy types in the Eynesham metallurgical assemblage.

Site/Yr	I.D	Context	LEVEL	Description	Cu	Pb	Sn	As	Sb	Zn	Alloy Type
EEA91	980/B/-	936	65.72	SLAG(?)	smithing hearth bottom						
EEA92	3712/-/-	1576	65.98	Cu Alloy ob	+++	++	+	nd	nd	nd	Pb Brz
EEA91	1551/B/1	1462	?	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA90	659/-/5	?	?0	Fe SLAG	tr	+	nd	nd	nd	nd	Pb Cu
EEA91	3622/-/1	?	?	SLAG	++	++	++	nd	nd	nd	Pb Brz
EEA92	3732/-/-	1597	65.92	Cu Alloy ob	+++	++	++	nd	nd	nd	Pb Brz
EEA92	3712/-/	1597	65.9	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA91	3521/-/-	1523	66.19	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA91	3622/-/1	1545	64.6	Cu Alloy ob	++	++	+	nd	nd	nd	Pb Brz
EEA91	3622/-/1	1543	64.8	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA92	3522/-/-	1566	65.83	Cu Alloy ob	++	+	++	nd	nd	nd	Pb Brz
EEA91	1766/-/-		?	Cu SLAG	++	+	+	nd	nd	nd	Pb Brz
EEA92	3622/-/-	1709	?	Cu Alloy ob	+++	+	++	nd	nd	nd	Pb Brz
EEA92	3724/-/1	1592	65.84	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA92	3613/-/-	1580	65.88	Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA92	3613/-/-	1562	66.08	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA91	1564/-/-	1177	66.865	Cu Alloy ob	++	+	nd	nd	nd	nd	PbCu
EEA92	3611/A/5	1548	65.34	Cu Alloy ob	++	++	nd	Tr	Tr	nd	Pb Cu AsSb
EEA92	1611/-/-	1182	66.66	Cu Alloy ob	++	+++	nd	nd	nd	nd	PbCu
EEA90	688/-/9(4?)	589		Cu Alloy ob	++	++	nd	nd	nd	nd	PbCu
EEA90	2104/-/1	586		Cu Alloy ob	++	+	nd	nd	nd	nd	PbCu
EEA90	659/-/5			Fe+Cu	+	+	nd	nd	nd	+	PbBrass
EEA90	495/-/-	429		Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA90	AREA14U/S			SLAG	+	+	+	nd	nd	nd	Pb Brz
EEA91	1418/-/-			lining+Cu	tr/+	++	nd	nd	nd	+	PbBrass
EEA90	535	278		Cu Alloy	++	+++	nd	nd	Tr	nd	PbCu
EEA91	3622/-/1	1542	64.75	Cu Alloy ob	+	+	++	nd	nd	nd	Pb Brz
EEA92	3614/-/1	1536	65.88	Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA92	3724/-/1	1594	65.86	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA91	3613/-/-	1532	66.05	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA90	766/B/?	465		Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA92	3613/-/-	1582	66.1	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz

Table One. Results of XRF analysis for the metallurgical assemblage from Eynsham Abbey.

(Key: +++=strong presence, ++=medium presence, +=weak presence, tr=trace, nd=not detected: Pb Brz=Leaded bronze, Pb Cu =Leaded copper, PbCuAsSb=Cauldron type alloys, PbGun=Leaded gunmetal, Sn Brz=Tin bronze)

Site/Yr	I.D	Context	LEVEL	Description	Cu	Pb	Sn	As	Sb	Zn	Alloy Type
EEA91	1551/B/2	1494		Cu Alloy	++	+	+	nd	nd	nd	Pb Brz
EEA91	1496/-/-	1864		Cu Alloy	++	+	nd	nd	nd	nd	PbCu
EEA91	1551/B/1	1465		Cu Alloy ob	++	+	nd	nd	nd	nd	PbCu
EEA90	139/-/-	1857		Cu SLAG	++	nd	+	nd	nd	nd	Sn Brz
EEA91		1186	66.63	Cu Alloy ob	++	+	++	nd	nd	nd	Pb Brz
EEA91	1404/-/-			SLAG	++	++	nd	Tr	Tr	nd	PbCuAsSb
EEA92	3732/-/-	1604	65.84	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz
EEA91	1632/-/-	1172	67.02	Cu SLAG	++	++	++	nd	nd	+++	Pb Gun
EEA91	1632/-/-	1172	67.02	sheet frag	++	++	+++	nd	nd	+++	PbGun
EEA91	1632/-/-	1172	67.02	molten blob	++	++	nd	nd	nd	+	PbBrass
EEA91	1632/-/-	1172	67.02	sheet frag	++	+	+	nd	nd	++	PbGun
EEA91	1632/-/-	1172	67.02	molten blob	++	++	+	nd	nd	+	PbGun
EEA91	1632/-/-	1172	67.02	slag	+	+	nd	nd	nd	nd	Pb Cu
EEA91	1632/-/-	1172	67.02	sheet frag	++	+	+	nd	nd	++	PbGun
EEA91	1632/-/-	1172	67.02	molten blob	++	++	+	nd	nd	++	PbGun
EEA91	3567/-/1	1522	65.94	Cu Alloy ob	+++	+	+	nd	nd	nd	Pb Brz
EEA92	3716/A/-	1583	66.02	Cu Alloy ob	++	+	++	nd	nd	nd	Pb Brz
EEA90	624			SLAG	+	nd	nd	nd	nd	nd	PbCu
EEA91	1505/-/-	1162	66.96	Cu Alloy ob	++	++	+	nd	nd	nd	Pb Brz
EEA90	U/S	39		CU ORE??	++	++	++	nd	nd	+	Pb Brz
EEA91	1404	1105	68.01	Cu Alloy ob	+++	++	+	Tr	Tr	++	PbCuAsSb
EEA91	U/S(area17)	1485		Cu Alloy ob	++	++	+	nd	nd	nd	Pb Brz
EEA90	2054/A/12	1734		Cu ORE??	++	+++	++	nd	Tr	+	PbCuAsSb
EEA92	3712/-/-	1578	65.85	Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA92	3732/-/-	1605	65.87	Cu Alloy ob	++	+	+	nd	Tr	nd	PbCuAsSb
EEA92	3724/-/1	1711		Cu Alloy ob	++	+	nd	nd	nd	nd	PbCu
EEA92	u/s area 17	1715		Cu Alloy ob	++	++	++	nd	nd	nd	Pb Brz
EEA91	3041/-/-	1314	66.4	Cu Alloy ob	++	+	+	nd	nd	nd	Pb Brz

Table One (Cont). Results of XRF analysis for the metallurgical assemblage from Eynsham Abbey.

(Key: +++=strong presence, ++=medium presence, +=weak presence, tr=trace, nd=not detected: Pb Brz=Leaded bronze, Pb Cu =Leaded copper, PbCuAsSb=Cauldron type alloys, PbGun=Leaded gunmetal, Sn Brz=Tin bronze)