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A preliminary report on the crucibles from Coppergate, York

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For the present the crucibles are being treated as one group with no divisions being made on either temporal or spatial grounds. When the relevant archaeological data becomes available further inferences may be drawn from the observations recorded here.

In summary it may be said that traces of gold, silver and copper alloys have been found on the crucible fragments and that some sherds are coated with what appears to be high lead glass, presumed to be deliberately made. The most frequently occurring crucible content is silver and the majority of these fragments are of the same fabric and form.

In studying the crucible sherds a number of variables have been considered. These are vessel fabric and form but also the content of the vessels, usually identifiable from traces left on the inner and/or outer surfaces of the sherds. It is these deposits which provide most of the evidence as to the use made of the vessels and hence indicate the crafts or industries being practised. The concentration of material suggests that at least the metal working was being carried out on the site. Confirmation will be provided if and when other metal working indicators such as moulds, scrap metal, part-made objects and tools are identified among the small finds. The crucibles are only part of the evidence for the relevant industries and a complete picture can only be obtained by considering all the relevant material.

The table (below) summarises the results of the examination of the sherds which are listed in A.M. Lab. No. order. The column headed 'Vessel type' includes information on both form and fabric which are related, as one might expect. Below the table are sketch drawings of the various types together with descriptive notes.

The column 'Metals found' indicates elements identified either visually or by x-ray fluorescence (XRF), the + sign indicating that qualitative XRF analysis was carried out on at least one area of the sherd. Elements written within brackets are present only in very low concentrations; they may perhaps best be interpreted as accidental contamination in antiquity. Some elements (eg iron and calcium) giving relatively strong signals by XRF have been omitted from the list as their presence is mainly due to the crucible fabric or adhering soil rather than to the crucible contents. The elements detected are listed in order of decreasing signal strength. If more of a given element is present, a larger signal will be detected but signal size is not directly related to composition as different elements fluoresce more or less strongly. The signal produced by a concentration of a certain element also depends on which other elements are present and in what concentrations. It should also be borne in mind that elemental distributions are not uniform; gold and silver in particular tend to occur in discrete blobs, far smaller than the area being analysed.

In general terms the analyses can be interpreted as follows, the indicator elements being gold (Au), silver (Ag) and copper (Cu). Where gold is identified it is the metal being worked, the other elements being alloyed with it, either deliberately or accidentally. Where silver is found (without gold) it is most likely that silver was being melted. When silver and copper are both identified on the same sherd it is probable that the copper was alloyed with the silver. Analyses of silver coinage of the late 9th and 10th centuries (McKerrell and Stevenson, 1972) shows that most of the coins from both Viking Northumbria and Anglo-Saxon England contained around 90% silver though some of the Saxon kings issued coins with as little as 50% silver. In all cases copper is the second most plentiful element present.

Where copper is detected (without either gold or silver) there are two possible interpretations. The first is that copper or one of its alloys (brass, bronze) was being melted and the second that silver containing some copper was being melted. This second possibility may sound unlikely but is quite possible because of the different ways that traces of silver and copper manifest themselves. Silver is usually present in the form of distinct blobs or droplets, sometimes metallic but sometimes in the form of silver compounds. Copper alloys may also be found as distinct droplets, again either metallic or corroded, but on this site copper was usually detected just as a red colouration in the vitreous surface of the crucible. This effect can be produced by quite low concentrations of copper in the glassy waste, the small amounts present in the silver being sufficient.

The other element that occurs frequently is zinc (Zn). This may be considered surprising but its presence is due, in part at least, to its chemical nature. Zinc oxide can act as a glass forming compound, becoming a structural part of the vitreous deposit on the crucible. In this way the presence of zinc, even in relatively low concentrations, is attested where other elements which cannot form glasses leave far smaller traces or even none. Zinc boils at a temperature well below the melting points of the alloys being worked on Coppergate and so would tend to be evolved from the melt and thus be free to diffuse into the crucible fabric or react to form a part of the vitreous coating.

Apart from the dish-form crucibles (see below) the only sherds where lead was detected in more than trace amounts were those with thick vitreous deposits which it is suggested were deliberately made glasses. Lead, like zinc, is a glass forming element so the general lack of lead suggests that it was being deliberately excluded from the metals being melted.

Bearing in mind the above comments on the interpretations that can be placed on the analytical results and observations, an outline of the industries and their relative importance can be suggested. The sherds can be assigned to the various processes as follows:-

Gold working	5%
Silver working	37%
Copper alloy working	23%
Glass working	7%
No evidence for use	24%

It can be seen that crucibles with traces of silver working are most frequent and this is therefore the major industry. Some of the 'copper alloy working' crucibles may also have been used for melting silver (see above) but some do contain blobs of copper alloys which indicates that these metals were also being worked. To decide which of the various alloys of copper were involved is a more difficult problem. The crucibles with blobs of copper alloy usually gave detectable signals for zinc, lead and tin so the question of alloy composition is an open one. Qualitative (or quantitative) analysis of any metal scrap found would help to resolve this uncertainty. Analyses of objects found would also be interesting but of less direct relevance to the metal working on site unless it could be demonstrated that they were made there.

That gold was being melted on a small scale is certain but what it was being used for is not known. Gold can be used as a metal in its own right or to embellish silver or copper objects by gilding them. It was not the major metal being worked but this would be unlikely even in a jeweller's workshop as the market for such precious objects must have been limited.

The high lead glass is somewhat unexpected and the justification for considering it to be of deliberate manufacture should perhaps be outlined. The majority of the crucible sherds examined had some trace of 'glaze' on their surfaces. This varied from a slight sheen through patchy or localised glassy areas to a complete vitreous coating. The outside was normally more heavily 'glazed' than the inside of the crucible and of the outside the base and lower parts of the walls were more affected than higher parts. Inside, 'glazing' is most often noted just below the rim. This sort of 'glaze' is due to the reaction of the silicate material of the crucible (sand and clay) with the ash from the fuel at the high temperatures in the fire where the crucible was placed to melt its contents. The areas most directly exposed to the fire are the most affected. The glass working crucibles on the other hand have the thickest deposits inside and the external glass is usually in the form of dribbles that have run down the side rather than thin layers that have formed in situ. On some of the fragments marks can be seen on the surface of the glass which suggest that some of it had been scooped up for use. In all cases lead is the major element with iron and /or copper also present. (Lighter elements such as sodium, potassium, silica and calcium must also be present as part of the structure of the glass but they were not sought in the XRF analysis.) The iron and copper are most probably responsible for the colours of the glass among which are red, black and dark green. This sort of glass would not have been used for making vessels or window glass but for small decorative objects such as finger rings, gaming pieces or beads. It would also have been suitable for use as enamel.

The dish form crucibles are something of an enigma. They, like the glass melting crucibles, have vitreous deposits containing lead. In addition there are blobs of metal trapped in the vitreous surface. In two cases (AM Nos 801107(1) and 801113) this metal is gold, in one case copper (AM No 801124(2)) and in the remaining example (AM No 801076(4)) probably copper though no metal could be isolated for analysis. The composition of the trapped metal seems to have a direct relationship with the quantity of lead present in the vitreous surface; the lead levels in the crucibles containing gold are far lower than in those containing copper or copper alloy. Similar though not identical crucibles to those containing copper have recently been found in Anglo-Scandinavian levels in Lincoln and in late Saxon deposits in Northampton. There are published parallels for this type from Fyrkat, a Viking fortress in Jutland (Roesdahl,1977). These are described as 'heating-trays' and it is suggested that they were used to hold precious metal objects being soldered(eg when filigree decoration was applied) as silver has been identified in some of them. The problem in accepting this interpretation is the relatively large quantity of lead present, however it is hoped that further investigations will throw more light on this problem and suggest a more plausible interpretation. One further sherd (AM No 801048) may also have been used as a 'heating-tray' though it is just a body sherd from a largish pot. Similarly re-used sherds are also known from Lincoln. The low lead, gold containing dishes may be similar in function to the shallow crucibles from Helgö some of which also contain gold (Lamm, 1977). Preliminary analyses suggest the lead content of the Helgö crucibles is low or non-existent.

Crucible form and fabric:

Crucibles are functional rather than decorative vessels and must therefore be made of a fabric that will stand the high temperatures to which they will be subjected. This refractory quality is of prime importance as a crucible made of a fabric which is too readily fluxed by the fuel ash or which softens below the melting point of the metal it contains is useless. Most of the crucibles here are made of a fairly fine ware, tempered with abundant though small (<1 mm), semi-rounded quartz grains with occasional other larger inclusions. I believe this fabric is known as Stamford ware but would like to have this confirmed by a 'pottery person' who is familiar with it.

In a few cases an extra layer of clay has been added to the outside of the crucible which is generally less refractory than the main crucible fabric and may have been applied for a number of reasons. The extra layer would protect the crucible from the fire, often itself becoming deeply vitrified. It would also increase the thermal capacity of the crucible so a longer time would elapse before the metal in the crucible solidified after it was removed from the fire. In some cases it may also be seen as a repair, made so a slightly cracked crucible could be reused. A few of the crucibles have extra clay layers inside, some in addition to extra outer layers. The inner lining are almost certainly repair jobs indicating that at least some crucibles were used more than once. This is demonstrated clearly in one example (A.M. No. 801035) where there are metal blobs between the lining and the crucible as well as on top of the lining.

The size of the crucibles is quite varied. The small, thimble shaped ones have a useful capacity of under 20 cc while the larger of the bag shaped crucibles would have held over 150 cc of metal. This would represent a laden weight of well over a kilogram which must have presented considerable problems in manoeuvring it safely out of the fire.

Parallels for the 'heating trays' are given above but there are also parallels for the metal melting crucibles. Waterman (1959,101) notes two from earlier excavations in York (one of these has a type B form) and considerable numbers have recently been found on the Flaxengate site in Lincoln. Most of these are bag shaped and the range of rim forms include types B and C. The size range is also similar to the range found on Coppergate. Similar vessels were also found in late Saxon deposits in Thetford.

Table: The crucible fragments

A.M. Lab. No.		Vessel type	Metals found	
801033	(1)	A 3	+ Cu Zn Au (Ag)	
	(2)	A	+ Au	
801035			+ Cu Zn (Pb)	
801036	(1)	? not crucible	+ Cu Ag	
	(2)	? not crucible	+ Cu Ag	
801037	(1)		+ Pb Cu (Fe Sn)	Glass
	(2)	E	+ Pb Fe Cu	Glass
801038		not crucible	+	
801039		F 7	+ Pb Fe	? glazed pot
801040	(1)		+ Pb Cu Fe	Glass
	(2)		+ Pb Cu Fe	Glass
801041			Cu	
801043		not crucible	+	white deposit
801044			+ Pb Cu Fe (Zn Sn)	Glass
801045		E	+ Pb Cu Fe Zn (Sn)	Glass
801047			Cu	
801048		H	+ Pb Cu Fe (Zn Sn)	? Glass/'heating tray'
801049		E	+ Fe Cu (Pb)	Glass
801050		X	Cu	
801051		X	+ Zn Cu Pb	
801054		?E	+ Pb Cu Fe	Glass
801055		?A	+ Zn Cu Pb Sn	
801056		A	+ Cu Zn Pb Ag Sn	
801058	(1)			
	(2)			
801059		A 3	+ Cu Zn Ag Au	
801060	(1)		Cu	
	(2)			
801061				sooty
801062		(7)		
801063		B 4 (6.7)		sooty
801064	(1)			
	(2)			
801065	(1)	J 4 (5)		
	(2)		+ Zn Cu Ag	
	(3)			
	(4)		Cu	
	(5)		Cu	
	(6)	(7)	Cu	
	(7)		+ Cu Ag	
	(8)		+ Zn Cu Ag	
801066				? unused
801067			+ Cu Zn Ag	
801068	(1)		+ Zn Cu Ag	
	(2)			
801069		B	+ Cu Zn Ag	
801070	(1)	J 4		
	(2)		Ag	
801071	(1)	C 4-5	+ Ag	
	(2)	C		
801072	(1)		Cu	
	(2)	B	+ Zn Cu Ag	
801073			+ Zn Cu Ag	
801074			Cu	
801075		J 4 (6)	+ Cu Zn	

A.M. Lab. No.		Vessel type	Metals found	
801076	(1)		Cu	
	(2)		+ Zn Cu Ag	
	(3)			
	(4)	DX 5.5	+ Pb Cu (Zn)	
801077	(1)		+ Zn Cu Ag	
	(2)		+ Zn Cu Ag	
801078			Cu	
801079				
801080	(1)	B 6	+ Zn Cu	
	(2)	B		
	(3)	B 4		
	(4)	B	Cu	
	(5)	B		? unused
	(6)		+ Cu Zn Ag	
	(7)		+ Cu Ag (Zn)	
	(8)		Cu	
801081	(1)	B 3.5	+ Cu	
	(2)	B 7	Cu	
	(3)			
801082				
801083	(1)	B 5	Cu	
	(2)		+ Zn Cu Ag	
801084	(1)		Cu Ag	
	(2)		+ Zn Cu Au	
801085	(1)	B 6-7	Cu	
	(2)		+ Cu Ag	
	(3)		Ag Cu	
	(4)		Ag Cu	
	(5)		Ag Cu	
801086				
801087		C 3-4	+ Zn (Cu Pb)	
801088	(1)	B 5	+ Zn Ag (Cu)	
	(2)		Ag	
801089			Cu Ag	
801090			Cu	
801091	(1)	B	+ Zn Cu Ag	
	(2)		Cu	
801092	(1)			
	(2)		+ Zn Ag (Cu)	
801093	(1)	(9)	Ag	
	(2)		Cu	
801094			Ag	
801095			+ Ag	
801096			+ Ag	
801097		B 4.5	+ Cu Ag	
801098				
801099	(1)			
	(2)			sooty
801100			+ Zn Cu Ag	
801101			Ag	
801102			+ Zn Cu Ag	
801103			Ag	
801104			Cu Ag	
801105			+ Fe Pb Cu Zn Sn	Glass
801106		B		
801107	(1)	D 4-5	+ Pb Cu Zn Au	
	(2)	X		
	(3)	J		
	(4)		Cu Ag	

A.M. Lab. No.		Vessel type		Metals found	
801107	(5)			Cu Ag	
	(6)			Ag	
	(7)			+ Au Cu	
	(8)				
	(9)				
	(10)				
	(11)				
801108				+ Cu Zn Ag Pb	
801109		C		Ag	
801110					? unused
801111	(1)			Ag	
	(2)	A	2-3	+ Cu Zn Pb (Ag Sn)	
801112				Cu	
801113		D	?4-5	+ Cu Au Pb	
801114		C	4		
801115				Ag	
801116				+ Cu Zn	
801117	(1)	A	3		
	(2)	A	4		
801118		C	4-5	+ Zn Cu Ag (Pb)	
801119	(1)			Cu	
	(2)			Ag	
801120		C	(7)	+ Zn Cu Ag	
801121		C		Ag	
801122		X		+ Zn Cu Pb	
801123		EG		?Ag	
801124	(1)	C			
	(2)	D	?8	+ Pb Cu Zn Sn	
801125		C	4	Cu	
801126	(1)			+ Zn Cu Ag	
	(2)			Cu	
	(3)			Ag	
	(4)			Ag	

The numbers in the 'Vessel type' column are approximate internal rim diameters and the numbers in brackets are the maximum external diameters.

Key to vessel types (see also illustrations)

A These are hand made, thimble shaped crucibles with thin walls (c. 2 mm) which become thinner at the rim. Some have triangular mouths. Maximum diameter is c. 3 cm. The fabric is almost completely vitrified so it is almost impossible to describe its original appearance.

B These are bag shaped or bi-conical in form with a spout pinched out of the rim which is thicker than the walls and flat topped. They are wheel turned but the bases are hand finished, the flat bottom of the turned pot being rounded out by hand. The bases are of irregular thickness, sometimes thicker and sometimes thinner than the walls which average 3 mm.

C These have the same general shapes as type B and are made in the same way but the rim is different, being round edged and of the same thickness as the walls.

Both B and C types are made of a reduced fired 'Stamford ware' type fabric as are the other sherds with nothing written in the 'vessel type' column.

D These dish form crucibles are not a uniform type. Size, thickness and fabric all vary. They are all round with a concave upper surface and a matching, convex, lower one. All are reduced fired .

E Large, flat bottomed vessels in a variety of fabrics, all fired white or grey.

F This sherd contains little temper and has a beaded rim.

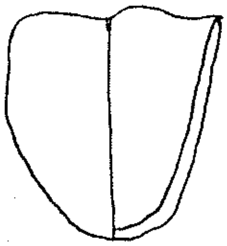
G A very much coarser fabric than the rest of the sherds.

H Less temper than the majority of the sherds.

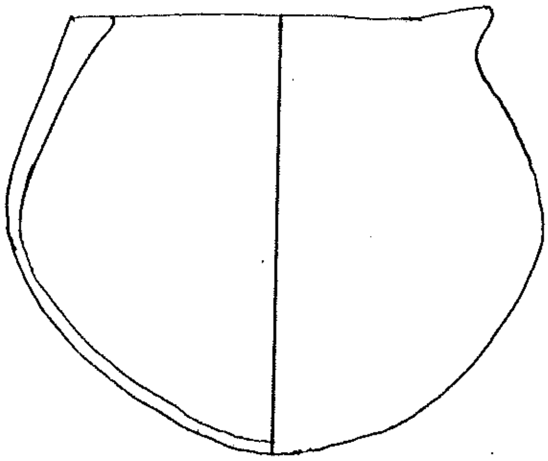
J These have fairly thin walls (2-3 mm) which bulge out from a round edged rim of the same thickness as the walls. The fabric is similar to that of types B and C.

X Not 'Stamford ware'.

Crucible types (sketch drawings; scale 1:1)

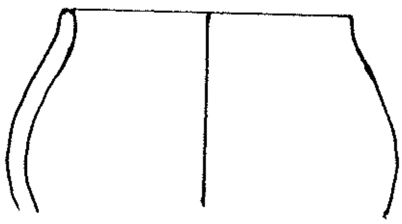


Type A - 801056

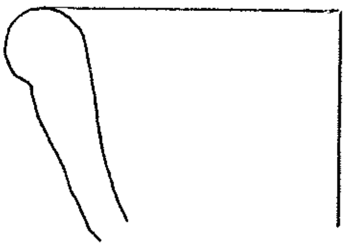


Type B - 801063

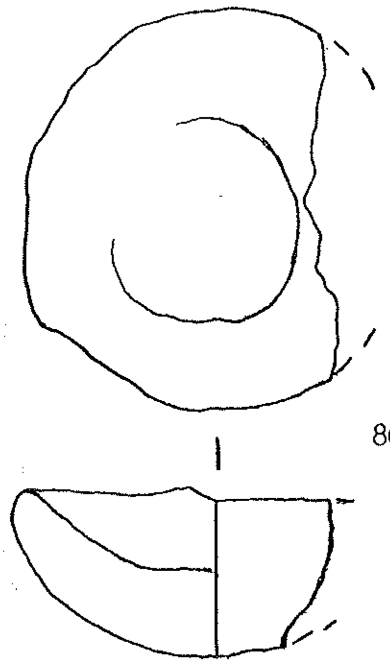
Type C - 801114



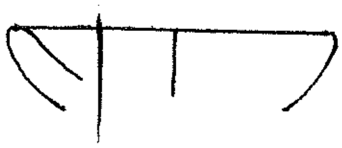
Type J - 801075



Type F - 801039



801076 (4)



801113

Type D (2 examples)

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Roesdahl, E (1977) Fyrkat: En jysk vikingsborg, II Oldsagerne og gravpladsen.

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Waterman, D (1959) Finds from late Saxon, Viking and early medieval York. Archaeologia 97, 59-106.

All the finds from other sites are material I am or have been working on. At present none of this has been published .