COPPERGATE MATERIAL

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# Viking glassworking: The evidence from York

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York is one of the major cities of northern England; it has been occupied to a greater or lesser extent since its foundation by the Romans in the first century AD. Recent excavations in the city carried out by the York Archaeological Trust at 16-22 Coppergate have produced deep deposits of Viking date and, among the finds from the site, there was abundant evidence for a whole range of manufacturing industries including glassworking (Hall 1984, Bayley 1983). This is an exciting discovery as not much is known of where glass was made at this period; there is little comparable material from the rest of England and not a lot more from continental Europe. Other sites of similar date which have produced evidence for glassworking are shown in Fig 1 and are discussed below.

## Glass making

Before considering the finds from Coppergate in detail it is necessary to understand the techniques that were being used by the craftsmen as without this background it is not possible to identify the processes being carried out. Glassworking is a blanket term used to cover two distinct processes, both the manufacture of glass from its raw materials and its forming into whatever objects are required. Broken and scrap glass, known as cullet, can be remelted and new objects made from it; this glass

melting is far less complex than glass making and was probably more widely practised in antiquity, if only on a small scale. The glassworking evidence from Coppergate suggests that soda glass was both made and formed into objects and, in addition, glass with a very high lead content was also melted and may have been made there too.

In modern glassmaking the raw materials are mixed together and heated to a very high temperature, around 1500 C, which allows them to react quickly and easily to form the glass metal which is then cooled to its working temperature of just over 1000 C and formed into objects. The high temperatures produce a very fluid melt so gas bubbles rapidly rise to the surface and impurity particles either sink or float and are easily separated from the metal.

In antiquity the maximum temperature obtainable in the furnace was only just above the working temperature of the glass which therefore could not be made in the modern way as it would then have been very imhomogeneous, full of bubbles, impurities and part-reacted raw materials. Instead, glass was made in two stages. First the raw materials, silica (usually in the form of sand) and an alkali, were mixed together and heated at a relatively low temperature (around 700 - 850 C) to allow the reaction between them to begin. This fritting allowed the evolution of gases but was a solid state process; no melting took place. When the fritting had gone as far as it could the frit was ground up and put into crucibles and melted at around 1000 C. Some cullet was usually added at this second stage as it eased and speeded up the production of workable glass.

This early method of making glass is known not only from archaeological discoveries and manuscript illustrations but also from the writings of craftsmen such as Theophilus (translated by Hawthorne and Smith 1979). He devotes a whole book of his treatise De diversis artibus to glass working and describes all the steps from building a furnace onwards. His description of fritting is clear and gives some idea of the time required for this operation (Book II Ch 4):

> "... take two parts of the ashes ... and a third part of sand, collected out of water, and carefully cleaned of earth and stones. Mix them in a clean place, and when they have been long and well mixed together lift them up with the long-handled iron ladle and put them on the upper hearth in the smaller section of the furnace so that they may be fritted. When they begin to get hot, stir at once with the same ladle to prevent them from melting from the heat of the fire and agglomerating. Continue doing this for a night and a day."

He also describes making crucibles and using them (Book II Ch 5):

> "When they are dry, pick them up with the tongs and set them in the red-hot furnace ... Pick up the fritted mixture of ashes and sand with the ladle and fill all the pots with it in the evening. Add dry wood all through the night, so that the glass, formed by the fusion of the ashes and sand, may be fully melted."

## Soda glass making at Coppergate

The material that survives is quite varied but can only be a small proportion of what originally existed. The site has

been intensively used from the 9th century onwards and each rebuilding meant the destruction and levelling of the structures of the previous phase of occupation.

Little of the glassworking furnace survived in situ; there was an area of intense burning, paved with re-used Roman tiles and around it many threads and blobs of glass, the waste from glass blowing. A thermo-remnant magnetic date suggested the furnace was last used towards the end of the 9th century. Many pieces of stone and re-used Roman brick and tile which must have been part of the furnace structure were also found, most of them partly vitrified or covered with glassy deposits.

Large numbers of crucible fragments coated with glass were also found. They are from relatively large, wheel-thrown jars with everted rims and occasionally have a slip applied to their outer surfaces. The fabric is fine and fires either buff or dark red. No known contemporary pottery is at all similar so it is thought that these may be re-used Roman cremation urns whose normal grey colour has become oxidised in the glass furnace. Most of the sherds have just a thin, even coating of natural coloured glass on their inner surfaces though one complete base contains a pool of of glass about a centimetre deep, the last of a melt that was not worked but was allowed to cool in the pot. The glass on a few of the sherds is true (cobalt) blue rather than natural blue-green in colour.

Some of the sherds have on their rims or outer surfaces deposits which superficially appear to be impure or part-made glass with frequent non-vitreous inclusions. This may be glass gall that was scraped from the surface of the melt to allow the

glass blowers to get at the refined glass metal below. There are also a few separate pieces of similar appearance but these are probably just fragments that have become detached from the pots during burial. One larger piece however is rather different, being part-made glass on the upper surface but underneath almost pure, unreacted white sand. This is interpreted as evidence for fritting; it is part of a batch that was being fritted and got too hot and so was discarded when the frit was transfered to the crucibles for founding.

Numerous small fragments of Roman glass were also discovered during the excavations and though this cullet was probably added to the batch, it was only a part of the glass being worked as both the overheated frit and the glass gall indicate that at Coppergate glass was being made from raw materials rather than just remelted.

Comparative material

Early medieval soda glass working is thought to have been carried out at Glastonbury, Jarrow and Southampton as well as at York (Bayley 1982).

At Glastonbury the remains of two or three features described as 'furnaces' were found and are thought to date to the 9th or 10th century (Radford 1961). Among the associated finds were fragments of pot with glass adhering to them (Harden 1971) and other pieces of fired clay that were vitrified or had glassy deposits on them. The quantities of waste recovered were far less than those from Coppergate but the range of materials represented is similar.

There is documentary evidence for glassworking at the monastery at Jarrow which flourished from the late 7th to 9th centuries (Cramp 1969) and hundreds of pieces of window glass have been found there (Cramp 1975). However, the only material remains of glassworking are a single sherd which is interpreted as coming from a crucible used to melt alkali glass (Bayley 1984), and that comes from a probable 10th century layer though it may be residual.

Excavations at Southampton have recently produced several sherds which are probably from glass melting crucibles and are of middle Saxon date; they are being studied by Mike Heyworth and John Hunter at Bradford University.

It should be noted that only at Coppergate is there positive evidence for the manufacture of glass from raw materials, though this may be because the quantity of waste recovered was so much larger than for the other sites.

High lead glass working

Glass containing a high proportion of lead was made and used in rather different ways to soda glass as its properties are not the same. The most obvious difference is its density which is around 5-6 gm/cc, over double that of ordinary glass. Because of its high lead content it softens at a lower temperature and so is easier to both make and work. It also has a high refractive index, which gives it an almost gem-like quality, making it well suited to the manufacture of trinkets such as rings, beads and gaming pieces. Theophilus (Book II Ch 31) describes making finger rings of this glass but his descriptions

of its manufacture have not survived although they are known to have existed. Another early medieval treatise, attributed to Heraclius, De coloribus et artibus Romanorum (translated by Merrifield 1967), does however contain similar information. There is a description of "How glass is made of lead, and how it is coloured:

> Take good and shining lead, and put it into a new jar, and burn it in the fire until it is reduced to powder. Then take it away from the fire to cool. Afterwards take sand and mix with that powder, but so that two parts may be of lead and the third of sand, and put it into an earthen vase. Then do as before directed for making glass, and put that earthen vessel into the furnace, and keep stiring it until it is converted into glass. But if you wish to make it appear green, take brass filings, and put as much as you think proper into the lead glass."

The evidence for the working of high lead glass at Coppergate is less extensive than that for soda glass; it comprises solely the sherds of pots that were used to melt the glass. They are small bowls, all of the same general form and size, with uneven deposits of glass up to several millimeters thick on their inner surfaces. Marks on the surface of the glass show where some was scooped out as it solidified. It is all very dark greenish-black in colour and analysis has shown it to contain copper as well as much lead. It is possible that the lead glass was made at Coppergate as Heraclius describes, though the finds only prove that it was melted there and formed into objects.

## Comparative material

Two other cities in England, Gloucester and Lincoln, have produced good evidence for high-lead glassworking (Bayley 1982). In both cases the finds are more varied than those from Coppergate though in many other ways comparable. In addition, another site in York has produced sherds with deposits similar to those from Coppergate (Bayley 1986) and at Jarrow there are a few sherds with thick, translucent yellow glassy deposits on them which are rich in lead and may be indicators of the working of high-lead glass (Bayley 1984).

Excavations of 10th century contexts in Gloucester produced fragments of crucibles containing translucent yellow high-lead glass, pieces of cullet and two lumps of vesicular, lead-rich material, thought to be glass at an intermediate stage of manufacture (Bayley 1979).

In Lincoln, late 10th century deposits on the Flaxengate site (Perring 1981) produced crucibles with both translucent yellow and green high-lead glass deposits as well as part of a rod of green glass and an imperfectly made finger ring of yellow glass. The nearby Holmes Grain site produced a piece of yellow cullet. Thus Lincoln, like Coppergate, has evidence for the working but not necessarily the manufacture of high-lead glass.

## Conclusion

All the finds described here, except those from Glastonbury, have been discovered or identified in the last ten

years. This sudden increase is due partly to chance in the siting of excavations but partly to an increasing awareness among archaeologists of the information that can be obtained from industrial wastes by scientific investigations. It is to be hoped that as excavations continue yet more evidence for Saxon and Viking glassworking will emerge so our knowledge and understanding of it can continue to expand. The importance of the finds from Coppergate as part of this enlarged vision lies not only in their secure archaeological context and dating but also in the (relatively) large quantity and wide range of materials present.

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Full details of the Coppergate finds are to be published in the series The Archaeology of York. The Flaxengate finds will similarly appear in The Archaeology of Lincoln series.

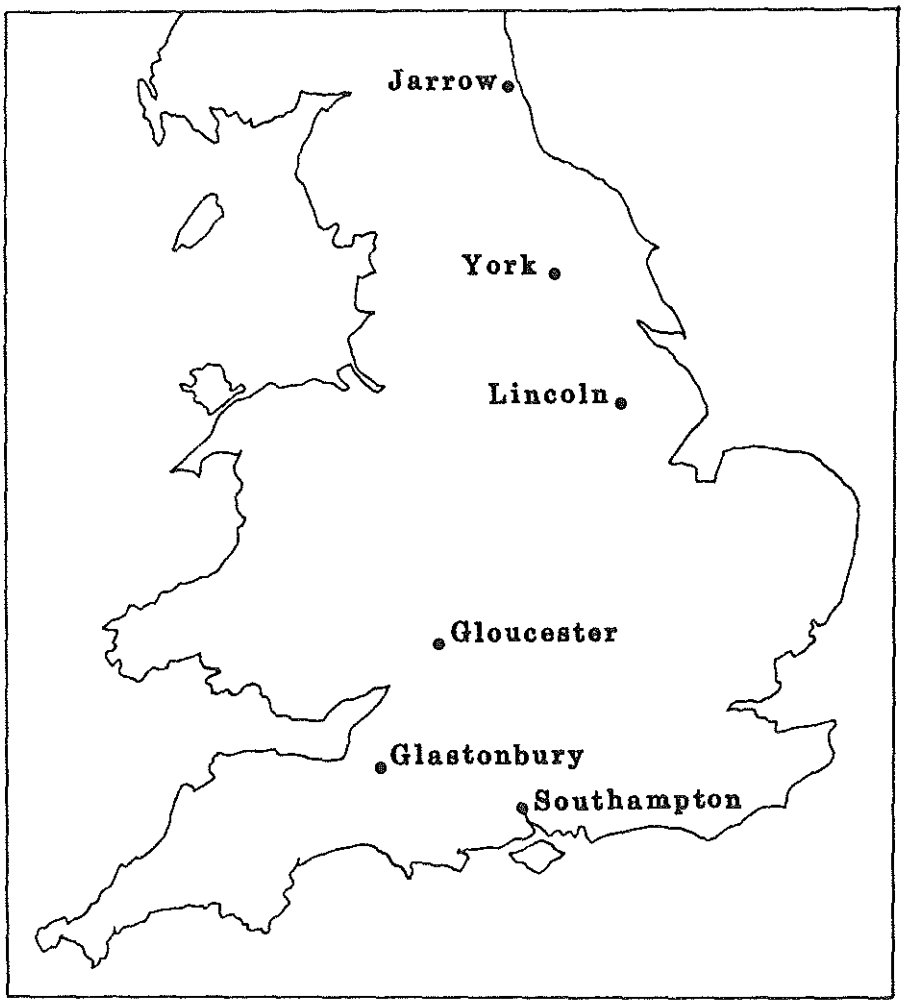


Fig 1 - Map of England showing the sites mentioned in the text.