THE EVIDENCE FOR THE PRODUCTION OF GLASS IN ROMAN BRITAIN

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Introduction

Discoveries from Wilderspool (May 1904, p. 37-53), Caistor by Norwich (Atkinson 1932, p. 109) and elsewhere have long indicated that a glass industry existed in Roman Britain, and much new evidence has come to light in recent years. This has included furnace sites and associated finds, and assemblages of material in rubbish deposits which, although not associated with a furnace, appear to have been derived from a glass house. This paper gives a general overview of all this evidence with the exception of the new discoveries in London which are dealt with elsewhere in this volume (Shepherd and Heyworth). Much of this material comes from excavations which are currently being prepared for publication, and full information will appear in those reports. Brief details of these sites are given in Appendix A and places mentioned in the text are located on Fig. 1.

The sources of evidence for glass production may be summarised as the ancient literature, epigraphy and archaeological remains. Only the last of these is relevant for the study of the industry in Roman Britain, as no literary accounts or inscriptions (except as mentioned below) survive. The base patterns containing the letters CCV which are found on some square and rectangular bottles (Price 1978, p. 70) are sometimes thought to represent the initial letters of *colonia Claudia Victricensis* (modern Colchester) and thus to indicate manufacture there, but this interpretation is questionable.

The types of archaeological evidence likely to be available from glass house sites are well illustrated by late medieval illustrations such as the Mandeville miniature (BM Additional Manuscript 24189, Folio 6, illustrated in Vose 1980, Fig. 5). They may be divided into five categories. These are deposits of raw material and glass frit, furnaces and annealing ovens, crucibles and the glass in them, tools, and glass waste from the production process. Much of the evidence from Britain consists of isolated finds, so each category will be reviewed separately, before looking at the complete assemblages from sites where material was found in situ associated with a furnace.

Raw materials and glass frit

The basic raw materials for the manufacture of Roman glass are sand, sodium and lime. Deposits of these on a site should only be interpreted as the raw materials for glass production if they are found in an undoubted relationship with other evidence for it. No such deposits were found on either of the sites where there is in situ evidence of glass working (Mancetter and Leicester). At Wroxeter (Viriconium Cornoviorum) a small excavation at the side of a road to the south-west of the town revealed an area of hearths and the type of glass waste associated with vessel blowing. This waste appears to be in situ at the edge of a glass working site. White sand was also found, though subsequent chemical analysis has indicated that this was extremely unlikely to have been raw material for the glass produced (Sanderson et al. 1984, p. 60).

In antiquity the initial stage of glass making was to frit the sand and the alkali. This involved heating them together at a low temperature for a long period, before the resulting frit was ground up and melted to form glass. A lump of frit is more likely to be recognised as evidence of glass production if found on an archaeological site than, for example, deposits of sand, but such finds are rare. The only possible example of Roman date appears to be that found at Coppergate, York (Bayley 1987, p. 249 & 254).

There is no reason why each glass house must have made its glass from the basic raw materials; some may have worked from lumps of glass produced elsewhere. A triangular piece of glass 20 mm thick found at Culver St., Colchester may be evidence for such a practice (Fig. 2.1). It has one smooth and glossy surface and one pitted one and may have been produced by pouring molten glass into a tray. It is tempting to interprete this as part of a glass ingot but as no similar lumps have been found in Roman Britain, this interpretation must remain tentative.

It is likely that much of the glass worked in Roman Britain was made from re-cycled vessel fragments. Literary sources indicate that cullet was deliberately collected during the Roman period (Leon 1941), and such a practice would explain why so few restorable broken vessels are found in most military and civilian contexts in Britain and elswhere in the western provinces (Price 1987, p. 201). The large deposits of glass found in pits at the canabae legionis at Nijmegen have been interpreted as cullet for use in glass making (Isings 1980, p. 281). The large numbers of vessel fragments found in the glass working assemblage at Mancetter suggests that cullet was the raw material for the industry there as well, and a similar phenomenon was also observed at Leicester, Wroxeter and Sheepen, Colchester. Another collection of cullet appears to have been found at the General Accident site at York where a group of vessel fragments of fairly uniform size had been partly melted in controlled conditions. It may be, therefore, that basic raw materials were seldom present on glass working sites.

Furnaces and annealing ovens

The furnace is the most likely part of a glass working site to be recognised archaeologically, though it will only have formed a relatively small part of such a site as the glass vessel forming process took place outside it. Some early representations of glass furnaces show the annealing oven forming the upper part of the furnace (*A travers le verre* 1989, Pl. II 445, 50, 51), but this would not be recovered from excavation where only the ground plan could be expected.

Apart from the recent discoveries in London, six furnaces associated with glass production have been recorded. Of these the earliest record occurs in the seventeenth century when the antiquary John Conyers indicated that there was a furnace in London near the Fleet Ditch (Burnby 1984, p. 68).

The furnace (fig. 3, p. 30) at Mancetter is the best preserved example in Roman Britain and has the most complex history. Mancetter was the site of one of the main industries producing mortaria in Roman Britain (Hartley 1973, p. 42), and the glass furnace was found during excavations of the pottery kilns. The furnace is approximately circular with a flue to one side. It was made of clay and had been re-lined three times. In its final phase it had a floor of tiles and was oval internally. One of the most noteworthy features about this structure was that it was very small. In Phase I it had an internal diameter of 0.8 metres but by Phase 3 this had been reduced to 0.51 by 0.34 metres. There was no obvious structure that could be interpreted as an annealing oven in the vicinity, and the small size of the furnace itself would appear to preclude the possibility that the oven was above it. That the furnace had been used for glass production was

shown by the dribble of glass adhering to the final lining and the wasters, moiles and other glass waste found in its vicinity (see below). Cullet found with it suggested it had been in use during the mid second century, though from its stratigraphical position it may have been of mid second century date or later.

The association between pottery kilns and glass furnaces is also recorded at Castor, Water Newton where in the eighteenth century E.T. Artis recorded a furnace with a crucible containing glass (1828, Pl. XXV, 4-5). It is noteworthy that glass waste found in a pit at Sheepen, Colchester was also in the middle of an area of kilns (Allen 1983: Appendix 1).

A furnace similar in shape and size to the one from Mancetter has also been found at Leicester which was the main town of the civitas Corieltauvi (Coritani). It was found in one of the shops associated with the forum in the centre of the town. A quantity of glass waste found with it suggested that it may have been used in the production of glass vessels (see below), silver cupellation may also have been carried out (Wacher 1974, p. 353).

These furnaces would have required crucibles in which to melt the glass. The furnace found at the Roman town of Caistor by Norwich, by contrast, appears to have been a tank furnace. It was rectangular and measured at least 1.33 by 0.63m. Its lower part had been the furnace with a secondary floor above it. Above this floor a band of fused glass c. 25 mm wide adhered to the side of the structure (Atkinson 1932, p. 109-110, Pl. VA). On stratigraphical grounds it post-dated the early fourth century.

Glass furnaces have also been recorded at Wilderspool (May 1904, p. 37-58), but the precise status of these is open to question as none are recorded as being directly associated with melted glass. The assemblage of glass from the site, however, does indicate that some form of glass working was being carried out. Fragments from a glass furnace have also been noted at Silchester but there are no records of where in the town they were found, or what type of furnace they came from (Boon 1974, p. 280).

Crucibles

The size of the furnaces at Mancetter and Leicester indicates that they would have only held one crucible. Too few examples have been found to generalise on the size and shape of these.

The crucible recorded in the furnace at Castor was flowerpot-shaped, and a block of glass found at Castor from the base of this or a similar crucible has retained an approximate base diameter of 150 mm. A similar fragmentary crucible has also come from Silchester (Boon 1974, p. 280). These appear to have been purpose-made containers, although domestic pottery was sometimes used. Fragments from a third century flanged, oxidised bowl containing a thick layer, of blue/green glass have been recovered from Deansway, Worcester. The crucible fragments recovered from Coppergate, York may also have been of domestic pottery (Bayley 1987, 249, Figs 2 & 3).

Tools

Tools and other equipment attributable to glass working have not been found on Romano-British sites with the possible exception of flat slabs of stone at Wilderspool that may have been used as marver blocks (May 1904, p. 50). A similar scarcity also exists in the rest of the Roman world. To a certain extent this is not surprising. By analogy to modern practice, it is likely that some tools were made of wood and these would not normally survive. Others such as iron shears and pincers may survive but can have other uses, and when found in isolation are not necessarily indicative of glass vessel production. The one tool unique to this industry is the blowing iron but very few of these have been recognised from the Roman period. The only examples known are the blowing irons found with pincers, moiles and cullet at Merida, Spain (Price 1974, p. 82, Fig. 5), and that from Salona (Auth 1975, p. 167).

Moiles, other glass waste and wasters

The commonest indications of glass working are fragments of glass waste. Under normal glass house conditions the majority of these would have been re-melted and used again, so the volume of those found need not be directly related to the scale of production on the site from which they are derived. It is possible to distinguish eight different types of glass waste which have been grouped into four categories.

The first category consists of the fragments called moiles, which are the waste from around the end of the blowing iron. Two different varieties of moiles have been distinguished. Cylindrical moiles are commonest. Most have a diameter of 20-30 mm, are full of bubbles and/or impurities and sometimes have ridges in relief on the interior. Two different types of 'rims' occur regularly; one has a sharp edge often with the appearance of a concave bevel towards the interior (Fig. 2.2), the other appears to have been compressed (Fig. 2.3). These moiles are the waste glass left on the blowing iron after the paraison had been detached. It seems likely that fragments with a sharp edge are from the end around the blowing iron, and those with the compressed edge are from the opposite end, closest to the paraison, as the compression may have occured when the blowing iron was put down. It is probable that these came from vessels with hot finished rims as these would have been removed much closer to the blowing iron. Cylindrical moiles have been found in large numbers in the assemblages from Mancetter, Leicester and Wroxeter, and also in the assemblage of glass waste from Sheepen, Colchester.

Lid-like moiles are cylindrical in their upper parts and expand out to wide lower bodies which have cracked off edges (Fig. 2.4 - see also Price 1975, Fig. 4 for examples from Merida). They come from vessels on which the rim was cracked off after annealing, and represent the portion of the paraison between the blowing iron and the final rim. A vessel from Trier, published as a flask, appears to be an annealed paraison for a hemispherical cup which still has the lid-like moile attached (Goethert-Polaschek 1977, p. 153 no. 917, Taf. 59). A second moile of this variety from Trier was found as part of the grave goods in an inhumation belonging to the first half of the fourth century (Goethert-Polaschek 1977, p. 252 no. 1485, Taf. 16.176d). The only lid-like moile to have been identified from Britain comes from Culver St. Colchester, though a fragment in the Sheepen Colchester group may have come from another. This scarcity may in part be due to the difficulty of recognising examples broken into small fragments.

The second category consists of three types of waste that appear to be the regular by-products of particular processes. One, which may be called a roundel, is circular or oval with a diameter of c. 10 mm (Fig. 2.5). These have convex, shiny upper surfaces and concave, irregular lower surfaces which often incorporate impurities. The process represented by these is not immediately apparent. Fragments with pincer marks and a chipped edge (Fig. 2.7) are the waste from attaching thick trails of glass and may be associated with the production of handled vessels. The third type of waste consists of a fragment with circular base with a diameter of c. 20 mm, which has been drawn out and twisted in its upper parts. The under surface of the base is concave and sometimes has impurities (Fig. 2.8). It is possible that this twisted waste comes from the production of handles or of twisted rods, though it may also have been removed from other products. This is the rarest of these three types of waste. It has only been found in one of the waste assemblages discussed below (Wroxeter), though isolated finds have been found at Culver St. Colchester and Churchgate, Leicester (Jewry Wall Museum no. 116/1962).

The third category consists of three types of waste that may be viewed as more accidental byproducts. They consist of the trails and thin rods that form when molten glass drops off the gather; the rounded (Fig. 2.6) and fractured lumps created by plunging blowing irons or the contents of crucibles into water; and the miscellaneous melted and heat affected lumps that cannot be more closely defined.

The fourth category of waste is vessels that became distorted during manufacture and were discarded (wasters). The assemblage at Mancetter included such misshapen and very bubbly vessel fragments, but none of the other sites dealt with in this paper have produced such wasters.

These four categories of waste have different levels of importance for interpreting an assemblage in which they occur. The moiles definitely indicate the occurrence of glass blowing. The second category indicates that glass working was taking place. The types of waste in the third category, however, could be produced accidentally, and the same is true of 'wasters' as vessel fragments can be distorted by heat accidentally and not just during manufacture. If these criteria are applied to the assemblages recovered, it becomes apparent that only at Mancetter, Leicester, Wroxeter and Colchester (Culver St. and Sheepen) is there any evidence for the blowing of glass vessels. No moiles have survived in the assemblage from Wilderspool or that associated with the tank furnace at Caistor by Norwich. The glass in those assemblages included melted lumps but not the more diagnostic fragments belonging to the second category of waste. Glass melting was clearly carried out at these sites but for what purpose is not known. The situation is complicated at Wilderspool because the assemblages contain some very bubbly and distorted base fragments which it is tempting to interprete as wasters. They suggest that glass vessel blowing may have been taking place in the vicinity, but on their own are not sufficient proof of this.

The glass working sites at Mancetter, Leicester and Wroxeter

Of the sites mentioned so far, the industry can only be studied *in situ* at Mancetter and Leicester, and it is instructive to compare their assemblages. That for Wroxeter has also been included in the comparison because though no furnace was found, it seems likely that the material could have been *in situ*.

At none of the sites were there either raw materials or frit, and at all three the industry appeared to be working with cullet. Nor were any glass working tools or crucibles found, although at Mancetter and Leicester it is clear that crucibles must have been used. This absence presumably indicates the removal of the crucibles and tools when the furnace was abandoned.

Only at Mancetter were wasters present which indicated the range of vessels being produced. These included rim fragments from collared jars (Isings 1957, Form 67b/c) and small jars with funnel mouths, and bases from base rings perhaps from jugs or bowls (Fig. 2.9-13). Very bubbly blue/green body fragments also suggested that some of the vessels were decorated with trails. The cylindrical moiles indicate the colours of the vessels being produced on the three sites. In each case most of the production was in blue/green glass. At Mancetter there was also some production in colourless and in yellowish glass, and at Leicester colourless vessels were made. At Wroxeter there are some indications of production in light green and yellowish glass, but the evidence for this is inconclusive.

The different types of glass waste (other than wasters) recovered from these sites are summarised in Table 1. It is noteworthy that the total amounts recovered, measured by weight, are not great. This presumably reflects the fact that, as noted above, under most circumstances this waste would have been re-cycled and not discarded to form part of the archaeological record.

The composition of the waste assemblage is not the same on the three sites. Those from Mancetter and Wroxeter are similar in that the moiles make up approximately one-third of each and examples of waste from the second category are relatively uncommon. At Leicester this second category is much more strongly represented, with approximately equal amounts of roundels and

1	2	3	4	5	6	7	Total Weight	
36%	5%	1%	0%	8%	18%	32%	c. 1.2 kg	
15%	18%	18%	0%	4%	13%	32%	c. 0.5 kg	
37%	2%	1%	5%	17%	19%	19%	c. 1.0 kg	
	1 36% 15% 37%	1 2 36% 5% 15% 18% 37% 2%	1 2 3 36% 5% 1% 15% 18% 18% 37% 2% 1%	1 2 3 4 36% 5% 1% 0% 15% 18% 18% 0% 37% 2% 1% 5%	1 2 3 4 5 36% 5% 1% 0% 8% 15% 18% 18% 0% 4% 37% 2% 1% 5% 17%	1 2 3 4 5 6 36% 5% 1% 0% 8% 18% 15% 18% 18% 0% 4% 13% 37% 2% 1% 5% 17% 19%	1 2 3 4 5 6 7 36% 5% 1% 0% 8% 18% 32% 15% 18% 18% 0% 4% 13% 32% 37% 2% 1% 5% 17% 19% 19%	

Table 1: Types of glass waste present at Mancetter, Leicester and Wroxeter

1: Cylindrical moiles - 2: Roundels - 3: Pinched and clipped fragments - 4: Twisted fragments

-5: Lumps with rounded surfaces -6: Rods -7: Miscellaneous Lumps

clipped fragments perhaps reflecting that they were both associated with the same production process.

The reasons for the differences in the assemblage compositions are not clear. It may be that the different proportions reflect the production of different types of vessels. The possiblity that they indicate chronological differences in workshop tradition can also not be ruled out. The Wroxeter assemblage is of late first or second century date and the Mancetter assemblage may be dated to the mid second century. The glass waste from Sheepen, Colchester, which has an overall composition similar to that from Mancetter, is thought to date to the mid second century or slightly later (Allen 1983, p. 772). The Leicester assemblage, by contrast, is later and probably of third century date. More dated glass waste assemblages are needed before interpretations can be made.

Conclusions

Although the evidence for the glass industry in Roman Britain is scattered and fragmentary, it is possible to draw some general conclusions from it. It is clear that glass vessels were being produced in Roman Britain, though it is difficult to judge how widespread such production was because by its very nature much of the evidence has not reached the archaeological record. One of the most diagnostic classes of evidence is glass waste, but under most circumstances this will be re-cycled. This is very unlike the situation in the pottery industry, for example, were wasters from the kiln have to be discarded as they are of no use. To continue the comparison between the pottery and the glass industries, it is also much more difficult to locate Roman glass house sites than it is to locate kiln sites. Not only will there be an absence of the equivalent of a dump of wasters, but the furnace itself will be much smaller than a kiln. It is probably not without significance that all the furnaces that have been located have been accidental discoveries, in the sense that in none of the cases was the site was being excavated in the expectation of finding a glass house. In these circumstances, though the surviving evidence is fragmented, it may be a reflection of a thriving glass industry in Roman Britain.

The locations of the furnace sites are very interesting. It seems reasonable to expect evidence of glass production at towns like Colchester, Wroxeter and Leicester where there will have been a sizeable market for the finished goods. Glass working at small sites such as Mancetter and Wilderspool is superficially more puzzling, but there are grounds for thinking that influences other than the presence of a market may have affected the choice of these locations.

In three cases (Mancetter, Castor and Sheepen Colchester) there is a certain association of glass furnaces with pottery kilns. Such an association would have much to commend it. Glass production needs good supplies of raw materials and fuel, as well as a good access to a market. Pottery is also a high temperature industry and wherever kilns are located there is likely to be a good supply of fuel. The pottery industry needs good access to its markets and a glass house located in the vicinity could make use of the marketing system used for the pottery, whether or not this is envisaged as the regular consignment of large loads to traders, or visits from itinerant pedlars replenishing their stock, or some other mechanism. It has already been noted that, the glass houses in Roman Britain were probably making use of cullet as one of their main supplies of raw materials, and it is possible that the same traders or pedlars who sold the vessels may also have been involved in the collection of cullet. This would thus have been returned to the glass houses through the agencies that were also distributing the vessels.

If this model is correct there may have been many small scale glass production sites associated with pottery industries. It is important that archaeologists excavating kiln sites are aware of this possibility, as the recognition of glass production waste may alert them to the presence of further glass houses in the future.

Appendix A : Unpublished sites mentioned in the text

The excavation reports of following sites are currently being prepared for publication, and full details of the glass assemblages will be published in those.

- Colchester, Culver St. Excavations in 1981 - 1985 by the Colchester Archaeological Trust.

– Leicester, Blue Boar Lane. Excavations by Mr. J. Wacher in 1958 (Journal of Roman Studies 59 (1959), p. 114) currently being prepared for publication by Mr. N. Cooper of the Dept. of Archaeology University of Leicester.

– Mancetter, Warwickshire. (Sites 7 and 7/20) Excavations by Mrs. K. Hartley in 1964-5 and 1969-71. A brief note about the furnace is given in Vose 1980, p. 132-3.

 Worcester, Deansway. Excavations in 1989 by the Archaeological Section of the Hereford and Worcester County Council.

Wroxeter. Excavations in 1972 by Dr. J.
Haughton. Brief notes in Britannia, IV, 1973, p. 287
and West Midlands Archaeological News Sheet.
16, 1973, p. 17

Acknowledgements

Much of the work for this paper has been undertaken by the Romano-British Glass Project, funded by Historic Buildings and Monuments Commission (England). Access to the glass from Wilderspool and Caistor by Norwich was arranged by Mr. A. Leigh of the Warrington Museum and Art Gallery and Miss B. Green of the Norwich Castle Museum respectively. Mrs. K. Hartley, Dr. J. Haughton and the Archaeology Section of the HWCC made available the material from their excavations in advance of publication. Mr. N. Cooper gave us much help with the glass from Leicester, and Dr. D. Allen discussed with us the assemblage from Sheepen, Colchester. We are greatly indebted to all these individuals and organisations for their co-operation. HEMC also wishes to thank Mrs. F. Pate for help with the translation of the paper delivered in Rouen.

Abstract

The evidence for glass working and the production of glass vessels in Britain during the Roman period is reviewed. Five categories of archaeological evidence from glass houses are identified - raw materials, furnaces, crucibles, tools and glass waste. The last category is divided into eight different types, some of which are diagnostic of glass blowing. It is suggested that there may have been many small scale glass production sites associated with other high temperature industries such as pottery, and often using cullet as the raw material.

Résumé

Les témoins du travail du verre et de la production de vaisselle de verre en Angleterre durant la période romaine sont passés en revue. Cinq types de vestiges archéologiques provenant d'ateliers de verriers sont identifiés : matières premières, fours, creusets, outils et déchets de verre. La dernière catégorie est divisée en huit types différents dont certains sont en relation directe avec la technique du soufflage.

Nous suggérons qu'il a pu y avoir beaucoup de sites de production du verre de petite dimension, qui utilisaient souvent du groisil comme matière première et qui étaient associés à d'autres arts du feu comme la poterie.



Fig. 1 : Location map of sites mentioned in the text (1 - Caistor by Norwich. 2 - Castor, Water Newton. 3 - Colchester. 4 - Leicester. 5 - London. 6 - Mancetter. 7 - Silchester. 8 - Worcester. 9 - Wilderspool. 10 - Wroxeter. 11 - York).



Fig. 2 : Examples of glass waste.



Fig. 3 : The glass furnace at Mancetter (scale in imperial measurements).