Historic England

Medieval and Early Post-Medieval Glassworks

Introductions to Heritage Assets

Summary

Historic England's Introductions to Heritage Assets (IHAs) are accessible, authoritative, illustrated summaries of what we know about specific types of archaeological site, building, landscape or marine asset. Typically they deal with subjects which have previously lacked such a published summary, either because the literature is dauntingly voluminous, or alternatively where little has been written. Most often it is the latter, and many IHAs bring understanding of site or building types which are neglected or little understood.

This IHA provides an introduction to medieval and early post-medieval glassworks. A medieval glassworks was an industrial site where glass was made from raw materials, and where either glass vessels, or window glass, or both, were made. Descriptions of the asset type and its distribution and development are included, along with a brief chronology. A list of in-depth sources on the topic is suggested for further reading.

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Front cover
Miniature from 'Sir John Mandeville's Travels', probably in Bohemia, early 15th century. This painting shows the whole glassmaking process. At bottom right, a boy either stokes the furnace with wood fuel, or rakes out ash, through an arch. To his left, a glassblower gathers glass from the crucible visible within the furnace, and to his left a blower blows glass on a 'mavering slab'. At bottom left another worker adds or removes vessels from an annealing kiln attached to the furnace, while behind the furnace someone, perhaps the owner, exercises quality control. In the background workers may be digging sand.

Introduction

Glass has long been prized for its utility and beauty. It can be made into vessels of all kinds, and in windows it has the valuable properties, in a temperate climate, of keeping the rain and wind out while letting light in. Glassmaking, meaning the production of glass starting from raw materials, needs to be distinguished from glassworking, where glass, perhaps in the form of chunks of raw glass, or recycled glass from elsewhere, is worked into artefacts.

Bronze Age glass artefacts are very rare, but glass was worked in Britain in the Iron Age, although the glass was probably made elsewhere. There is also evidence for trade in chunks of raw glass and recycled glass in the Roman period and glassworking took place in Roman Britain, particularly in London and a number of other urban and military settlements. It was used for jewellery, vessels and windows.

In the early medieval period (AD 410-1066) there is some archaeological evidence for glassworking and also some contemporary written evidence. In the 7th century Benedict Biscop, the founder of Monkwearmouth and Jarrow monasteries (now in Tyne and Wear) sent for French glassmakers, and a century later the Abbot of Jarrow asked continental contacts for help, as the English were 'ignorant and helpless in that art'. The remains of glassworking furnaces dating from this period were discovered under the cloister at Glastonbury Abbey (Somerset).

Glassmaking in the Middle Ages, the principal subject of this Introduction, seems to have been fully established in England by the end of the 13th century. Most of the raw materials required, principally silica (sand or crushed pebbles) and plant ashes to make the glass, and clay to make the pots in which the glass was made, are widely available, and it was the presence of suitable woodland for fuel that was the principle determinant of location. That said, glassmaking is a highly skilled art, and it may have been the presence of expert workers which accounted for the persistence of the industry in particular areas, sometimes for centuries.

The era of wood-fired glassmaking in England, from the late 13th to the early 17th century, is traditionally divided into two periods. The earlier is associated with native English glassmakers (albeit using techniques originally derived from the Continent), and this ended at some point in the 16th century. That was around the time of the arrival, in the 1560s, of immigrant glassmakers, principally from the Low Countries, Normandy and Lorraine, who used different techniques and produced different types of glass. There remains considerable debate about this transition.

The use of wood as a fuel in the industry came to an end in England in 1615, when its alleged scarcity led to a Royal proclamation specifically forbidding its use. Thereafter glassworks were fuelled by coal (apart from an apparently successful experiment with Kimmeridge oil shale in 1618), and a very different industry emerged.

Glassworking sites, that is sites where glass was re-melted and made into artefacts, rather than made from raw materials are not dealt with here.

Figure 1
A modern glassblowers' workshop. The worker on the left is taking a 'gather' of glass to be blown on the metal mavering slab. Note the single 'glory hole' in the furnace (Georgian Crystal, Tutbury, Staffs, closed in December 2011).

1 Description

A medieval glassworks was an industrial site where glass was made from raw materials, and where either glass vessels, or window glass, or both, were made. The main components of such a site were melting furnaces, annealing kilns, waste tips, and associated structures (the actual process of glassmaking is described in greater detail below).

Sites exist as earthworks, or with upstanding remains, or as spreads of characteristic material, especially glazed crucible fragments and glazed brick or stone, in ploughed fields or disturbed ground.

The output of these sites can be divided into window and vessel glass; some furnaces, but not all, could produce both. Window glass could be produced either as 'crown' glass, where large discs of glass were made, or 'cylinder' glass, where cylinders were blown which could then be flattened out to make flat sheets.

All the known wood-fired glassmaking sites in England belonged to the northern European forest glass industry, which produced 'forest' glass, usually with a green tinge, for both windows and for vessels. There was a different tradition of Italian origin whose product was a clearer, uncoloured 'crystal' glass which had great prestige. This crystal glass was only made in England at the end of the period and its production was confined to London, and it is not dealt with further here.

2 Distribution and Chronology

In terms of distribution, wood-fired glass furnaces were found within areas that were historically well-wooded, primarily the Surrey-Sussex Weald where 48 sites are known, and Staffordshire where 18 furnace sites have been identified in Bagot's Park (near Abbots Bromley, north of Rugeley), and another 15 sites elsewhere in the county. These remained the main areas of glassmaking through both the Middle Ages and during the later 'immigrant' periods after the arrival of continental glassmakers in the 1560s. Conversely, other wooded areas (for instance, the Chilterns) had no glassmaking tradition.

Another twelve sites are known elsewhere in England. Some of those sites were, or may have been, associated with major ecclesiastical projects. The 9th or 10th century glass furnace

Figure 2
Furnace 15a at Bagot's Park in Staffs, which had been almost completely ploughed out. Nevertheless, sufficient thermoremanent magnetisation survived in the subsoil to provide a date of 1270 to 1320 AD at the 95% confidence level, and the overlying ploughsoil contained many fragments of crucible and debris.

remains found at Glastonbury were clearly associated with the abbey there, and a 'glashous' is mentioned in 15th century cathedral accounts at Salisbury. The scheduled glassmaking site at Glazier's Hollow, Delamere, Cheshire, may be 15th century, and may have a connection with the Cistercian Abbey of Vale Royal. There is good documentary evidence for a glassmaker in Inglewood Forest in Cumbria in 1316-1317 and again in 1330-1331, which suggests a fairly well-established work; here no ecclesiastical association is known.

The later period of glassmaking began with the arrival in England of Jean Carré and the grant of 1567 to him and to Anthony Becku, both originally from the Low Countries, of the exclusive right to make window glass. Carré brought glassmakers over from Lorraine to the Weald, from where they spread throughout England. Documentary evidence shows that they were subsequently located in Buckholt in Hampshire, Rye and Northiam in Sussex, Newent and Woodchester in Gloucestershire, Knole Park in Kent and possibly in Warwickshire. They also migrated to the Eccleshall area in Staffordshire, where there had previously been no glassmaking, and to the Bagot's Park area in the same county. It remains unclear whether or not there was still a thriving English industry at Bagot's Park when the immigrants arrived.

3 Development of the Asset Type

While there have been relatively few recent excavations of glassmaking sites, a number of key investigations can be cited. In the 1930s a late 16th century site was excavated in Bishop's Wood, near Eccleshall, Staffordshire; this site is scheduled and can be seen as an upstanding structure, although somewhat restored beyond its form when found. It is known to be associated with the later 'immigrant' glassmakers referred to above.

Also in Staffordshire, in the 1960s, David Crossley excavated Site 4, one of the group of sites in Bagot's Park, and in the same county a site with three melting furnaces was excavated at Little Birches, Wolseley, in 1991-1992. One of the furnaces there was roughly contemporary with the Bagot's Park site and dated from the early to mid-16th century, and another of the three was dated on the basis of pottery to the 13th or 14th century.

Figure 3
Little Birches, Wolseley, Staffs, under excavation 1992. The 16th century Furnace 1 and its annealing furnace are seen in the background, and the two large quarter-sectioned tips are associated with it. Downslope, to the left, is the much earlier Furnace 4, dating from the 13th or 14th century. A further furnace was subsequently found nearby.

In the Surrey-Sussex Weald one site, Blunden's Wood, Hambledon, Surrey, was excavated in the 1960s and dated to the second quarter of the 14th century. Another site in Surrey was excavated between 1965 and 1973 at Knightons, Alfold; this dated to the middle of the 16th century.

Between 1967 and 1971 furnaces were excavated in the North Riding of Yorkshire at Hutton Common and Rosedale: these dated from the latest period of wood-fired glassmaking in the late 16th century.

It is rarely possible to directly associate a site identified archaeologically with a documented one, even in the later periods. Crossley has listed those in the Weald where such association might be made, but not one Staffordshire site of the earlier period can be directly associated with a known glassmaker, despite the fact that the documentation is reasonably extensive.

Process

In order to understand the archaeological components of a glassmaking site it is necessary to comprehend the process of glassmaking. In medieval northern Europe glass was made of silica, alkali and lime. The silica can be derived from sand or crushed pebbles but has a high melting temperature and alkali is needed to lower this. The alkali, and probably the lime, are derived

from the ashes of plants (bracken and beech were widely used); the lime in the ashes helps improve the durability of the glass.

The first stage of production was the low temperature heating of the raw materials, a process known as fritting. This produced a partially reacted frit which could then be melted at a higher temperature to produce workable glass. Scrap glass, called cullet, could also be added to the melt. The melting took place at a high temperature in large ceramic pots called crucibles or glass pots. The glass melt was held at a high temperature and gathers of viscous molten glass were removed by the glassworkers and blown into whatever shape was required. Once blown, the glass needed to be cooled at a controlled rate, a process known as annealing, which allowed internal stresses to be released without shattering the item.

The melting furnace was at the heart of the process. In the forest glass industry it consisted of a masonry structure, usually roughly rectangular in plan and with an arched roof, with openings at around ground level at one or both ends to allow fuel to be put in, ash to be removed and air to be admitted. A furnace might last from nine months to two years, and one of the two at Little Birches appeared to have been rebuilt during its use. Inside the furnace, two platforms ran the length of the interior, known as sieges, with a fire trench in between, and upon these sat the crucibles in which the batch materials were melted. The crucibles were critical to the process; the heat and the need to contain large quantities of molten glass put a great strain on them and they often broke.

Crucible fragments are very characteristic of glassmaking sites and are a reliable indicator that some form of glassmaking or glassworking has taken place. Furnace 1 at Wolseley, dating from

Figure 4
Little Birches, Wolseley, Furnace 1. Note the circular impressions of crucible bases on the sieges, and the central trench between the sieges choked with spilt glass waste. There would have been six crucibles in all.

Figure 5
Bishop's Wood, Eccleshall. A site dating from the post-1580s period of 'immigrant' glassmaking, with four crucible bases still in position on the sieges, either side of the central trench.

the early to mid-16th century, probably held six crucibles, whereas the later 16th century furnace at Bishop's Wood, near Eccleshall, Staffordshire, had clearly held four crucibles.

At Little Birches, Furnace 1 was about 4.3 m long, whereas the Bishop's Wood furnace was only about 1.3 m long. Both Furnace 1 at Little Birches and Furnace 4 at Bagot's Park had pairs of postholes at either end, presumably part of a structure covering the whole furnace.

The late sites at Hutton Common and Rosedale both held only two crucibles, and they both had 'wings' extending away from the main furnace. The period 1 furnace at Hutton had no wings, but two, one each at opposite corners, were added when it was reconstructed in period 2. Rosedale had four wings, one at each corner, from its original construction. The purpose of these wings is not precisely known, but they may have housed subsidiary functions such as annealing.

In addition, Rosedale may have had evidence for the initial treatment of the raw materials of glassmaking, in particular, for fritting.

Furnaces were mainly built of stone, the surface of which would fuse in the high temperatures within the structure. This vitrified stone is found in large quantities over glassmaking sites and in the waste tips and, together with crucible fragments, is highly characteristic of glassmaking sites generally. Brick or fired clay was also used in furnace construction; furnace 1 at Little Birches, for example, had the remains of a brick arch at one end. Furnaces rarely survive much above siege height, although note should be made here of the remarkable survival of a glass furnace with its arched roof near Shinrone in County Offaly, Ireland. In many cases the only part of the furnace to survive is the base of the central flue, surrounded by reddened subsoil from which it is often possible to obtain an archaeomagnetic date.

Figure 6
Little Birches, Wolseley, Furnace 1. The large pair of post-holes, with a corresponding pair at the other end, should be noted. The bricks and stone slabs at the near end of the furnace form the base of the stoke hole (or ash-raking hole).

Figure 7
The remains of a 17th century glass furnace in County Offaly, Ireland. The stoke-hole (or ash-raking hole) is the arch to the right at the end of the furnace. The sides of the furnace have collapsed, to reveal the siege platform within.

Glass was gathered from the crucibles by the glass blowers through 'glory holes' in the furnace, and although these were above siege height and do not survive archaeologically their covers are sometimes found on glassmaking sites in the form of parts of large clay slabs around 250 mm square.

Once the glass had been blown, either as window or vessel, it was necessary to anneal it in an annealing furnace. At Little Birches, this consisted of a separate stone structure about 1.6 m square, with an opening which had been blocked by bricks, and at Rosedale there seem to have been two. It is not clear how these functioned: possibly they were used in the same fashion as bread ovens, being heated up, then filled with the glass, blocked up, and then allowed to cool gradually. As noted above, in later furnaces the annealing may have taken place in the wings, and in some earlier furnaces it might have been attached to the main melting furnace.

Figure 8
Little Birches, Wolseley, Furnace 2. The annealing furnace associated with Furnace 1. Note the bricks on the left side, which presumably blocked the access to the furnace when last in use.

Glassmaking sites tend to have large quantities of waste products. At Little Birches two tips related to Furnace 1 contained around 93 cubic metres of material (around 100-150 metric tonnes), a mixture of charcoal, ash, crucible fragments, and glass waste ranging in form from frothy black 'dross' or scum removed from the initial glass melt to broken fragments of blown glass. There were also distinct layers of burnt clay and stone fragments which had evidently resulted from reconstruction or repair of the furnace.

Blown glass is found on glassmaking sites, but its interpretation needs to be treated with caution. Firstly, its occurrence is highly variable. Within the site at Little Birches, for example, over 35 kg of blown glass was found on the south part of the site associated with the 16th century furnace, but only nine fragments were recovered from the north part of the site associated with the 13th or 14th century Furnace 4. Conversely, around 60 per cent of all the crucible fragments found at Little Birches were associated with Furnace 4. Secondly, it is not always clear whether the glass found is the product of the site which has been discarded for some reason, or is 'cullet', that is scrap glass bought to the site for remelting, but discarded for some reason. At Little Birches the painted and coloured glass found clearly fell into the latter category, and the large amount of crown fragments found were evidently made on site but then thrown away. A further 6.1 kgs of glass, apparently made on site, were found buried in a pit, presumably with the intention of being recovered at some point. A very typical find on glassmaking sites is the 'moil', the collar or ring of glass left on the blowing iron once the blown object has been removed, and various forms of drips, trails and beads of glass can be found which are a product of the blowing process itself.

Sites can be tentatively ascribed to either the earlier or to the later, 'immigrant' post-1560s, periods through the type of glass produced,

but this needs to be confirmed through other techniques before identification is certain. In general, the later sites seem to produce a harder and more resistant glass which survives better.

It is important also when dealing with glassworks to be aware that any particular site might have been the location of several furnaces of different periods. At the excavated site at Little Birches, Wolseley, for example, there were three melting furnaces a few metres apart, but one was at least a century earlier than the others.

One site at Bagot's Park showed clear evidence of having been occupied by glassmakers of the later, 'immigrant', period (at this location, later than 1585), but it was only a few metres from the earliest dated furnace in the Park, which was in use in the second half of the 13th century. This tendency to revisit locations, often after several centuries, seems to be characteristic, and can serve to confuse the archaeological record.

Figure 9
Bagot's Park, Staffs. A typical ploughsoil assemblage of glassblowing debris. This type of hard, resistant glass is usually associated with the post-1560 'immigrant' glassmakers. Earlier furnaces tend to have less glass, possibly because it does not survive well.

Figure 10
Bagot's Park, Staffs, Site 3. Crucible fragments from a site dating from around 1500. Note the glass still adhering to the crucible bases at top left and top right, and the variety of rim forms seen from just one furnace.

4 Further Reading

Chapters 10 and 11 of J Blair and N Ramsey, *English Medieval Industries* (1991) provide a good introduction to medieval glassmaking, and chapter 11 of D Crossley, *Post-Medieval Archaeology in Britain* (1990) discusses the post-1500 period.

A slightly wider perspective is supplied by R Hurst Vose, *Glass* (1980).

In terms of the excavations and investigations noted above, the reader is referred especially to:

Staffordshire

The excavation and dating of the Bagot's Park furnaces is covered in D W Crossley, 'Glassmaking in Bagot's Park in the Sixteenth Century', *Post-Medieval Archaeology* 1 (1967), 44-83 and C Welch and P Linford, 'Archaeolomagnetic Dating of Medieval and Tudor Glassmaking Sites in Staffordshire, England', *Annales du 16e Congrès de l'Association Internationale pour l'Histoire du Verre* (2005), 210-13.

The excavation of another smaller group of Staffordshire furnaces is reported in C Welch, 'Glass-making in Wolseley, Staffordshire', *Post-Medieval Archaeology* 31 (1997), 1-60.

The later period in Staffordshire is covered by T Pape, 'Medieval Glassworkers in North Staffordshire', *Transactions of the North Staffordshire Field Club* 68 (1933-4), 74-121.

The Weald

E S Wood, 'A Medieval Glasshouse at Blunden's Wood, Hambledon, Surrey', *Surrey Archaeological Collections* 62 (1965), 54-79, and the same author's 'A 16th-century Glasshouse at Knightons, Alfold, Surrey', *Surrey Archaeological Collections* 73 (1982), 1-47, together discuss the significant excavations of furnaces in the Weald.

The whole Wealden industry is discussed in G H Kenyon, *The Glass Industry of the Weald* (1967).

With respect to the technical aspects of glassmaking and the archaeological evidence derived from it the reader is referred to Archaeological Evidence for Glassworking; Guidelines for Best Practice

5 Where to Get Advice

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