

## INTRODUCTION

The Nailsea Glassworks has been noted as one of the most significant glassworks in the UK, so a review of the technology employed is appropriate. It is also believed that the New House Cone was the last to be built in the UK.<sup>1</sup>

It is clear from his patent of 1805 (see Part 1) that Lucas was conducting experiments at Nailsea, in the production of cylinder glass especially, that were ahead of the generally accepted chronology. It is doubted that much of interest will now ever be verified or disproved, due to the loss of the bulk of the firm's records during the 1939-45 war in an air raid on Plymouth<sup>2</sup>. They had, ironically, apparently been sent there for safekeeping. [Chance, 1968, gives Bristol, rather than Plymouth.]

Fortunately, one of the partners, C T Coathupe, in 1836-7 kept a small notebook, and even more fortunately, having been apparently discarded in a cupboard, it was eventually recognised for what it was and as a result we have an intriguing snapshot of the production processes, and more. It is reproduced, as an up-to date transcript, in Appendix 1. Reference will be made to this in due course. The accuracy of the original transcription was questioned, with justification.

Reference will occasionally be made to the BRO copies of the plans of the glassworks dated to the 1830s, and also that of 1870. These have already been reproduced earlier, but are again reproduced here, the latter with its schedule, as Appendix 4 and Appendix 5 respectively, for greater convenience. (In the text, building numbers referring to the 1870 plan are enclosed thus:- { }.)

Appendix 6 considers the chemistry, and will give the formulae for, and derivation of, some of the terms commonly used. In this way general readers will not need to be distracted by this detail. In association with this is Appendix 7, from Gareth Hatton for the English Heritage Centre for Archaeology, Portsmouth. It was debatable whether this should be associated with the archaeology or the technology, but it was felt that it had greater relevance to the latter.

Francis Mountain, probably working at Nailsea from the mid-1850s, wrote a "History" of the works in 1915, when he was aged 72. This is reproduced from SMR 2397 papers as Appendix 8. Appendix 9 give some information on the Frisbie furnace feeder, while Appendix 10 is a letter to H St George Gray from John M Eyres, at the works as a young man through most of the 1860s. Eyres and Mountain have not been quoted extensively, as it was felt that by including their notes verbatim they would make a much more coherent body of evidence. There is part of an autobiography by Eyres, reproduced as Appendix 1 in Part 4, as it has more "people" information than technical.

A formal glossary has not been included, but some terms will be explained in the body of the text, where appropriate. Allen, p.58 and Vose, p.196 each have one. Vose refers to British Standard 3447:1962 (*Glossary of Terms used in the Glass Industry*) and also to the *Standard Definition of Terms Relating to Glass and Glass Products (American Society of Testing Materials C162-71)*.

It is intended in this section to follow a chronological path as far as possible, starting with a brief look at the origins of glassmaking.

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<sup>1</sup> T Bowen, *pers. comm.*

<sup>2</sup> Vincent, p.19

## **1. HISTORICAL NOTES**

### **Prehistoric**

The information in this chapter is derived largely from Vose, R Hurst, 1980, Harden, D B, 1968-71, and Adkins, L & Adkins, R, 1998. It is necessarily somewhat superficial, only aiming to give a general background.

Broadly speaking it seems that glass, initially in the form of a glaze on pottery, appeared in China in their Bronze Age, somewhere around 2000 BC, and even earlier in the Near East, the third millennium BC being quoted by Harden and Vose. In this case it was in the form of beads. A very large lump of blue glass dated to c.2000 BC (Harden) from Eridu in Mesopotamia is taken as evidence that the manufacture of glass was taking place there “many centuries before the earliest known factories in Egypt in the latter half of the 18<sup>th</sup> dynasty.” The earliest vessels appear to come from the Asiatic Near East in the late 16<sup>th</sup> century BC, about a century before they appear in Egypt.

Production then spread through the islands and to Greece and the Aegean area, and was apparently flourishing until the 13<sup>th</sup> century BC. It then appears that there were a series of problems in the area, and glass production dwindled, the reason given being economic and market failure as a result of “the downfall of the rich monarchies and their cultures.” Harden, 1968. It seems that production of small items continued to keep the techniques alive, namely, building round a core using a trail of molten glass, casting in open or closed moulds, shaping from a solid block, and building from sections of rod in a mould and heating to fusion.

This continued from the late 9<sup>th</sup> to earlier 4<sup>th</sup> centuries BC, when glass vessels again came in to production on the Syrian coast and in Mesopotamia. There is also some evidence of an Italian industry in the 8<sup>th</sup> century BC. No vessels were yet blown.

From about this time there is evidence of glass beads being imported in to Iron Age Britain from the continent. It also appears that blocks of glass as a raw material were also imported in the late Iron Age, but no evidence seems to have been found of manufacturing artefacts from this glass in Britain.

With the start of what has been called the Hellenistic age in the later 4<sup>th</sup> century BC, there was still no real change in techniques, and this state of affairs continued for a further three centuries. There were improvements in the techniques and increasing sophistication in the design and manufacture of the products of the industry. Now the main production areas seemed to be the Syrian coast and Alexandria. Sometime towards the end of the 3<sup>rd</sup> century increasing demand from Rome led to glass production starting in Italy, but it seems it was Alexandrian-led.

The archaeological evidence shows that in the latter half of the 1<sup>st</sup> century BC glass-blowing was invented, and that it occurred in Syria. By the 1<sup>st</sup> century AD Syrians had settled in northern Italy, and it appears that they continued to import Syrian sand.

### **Roman**

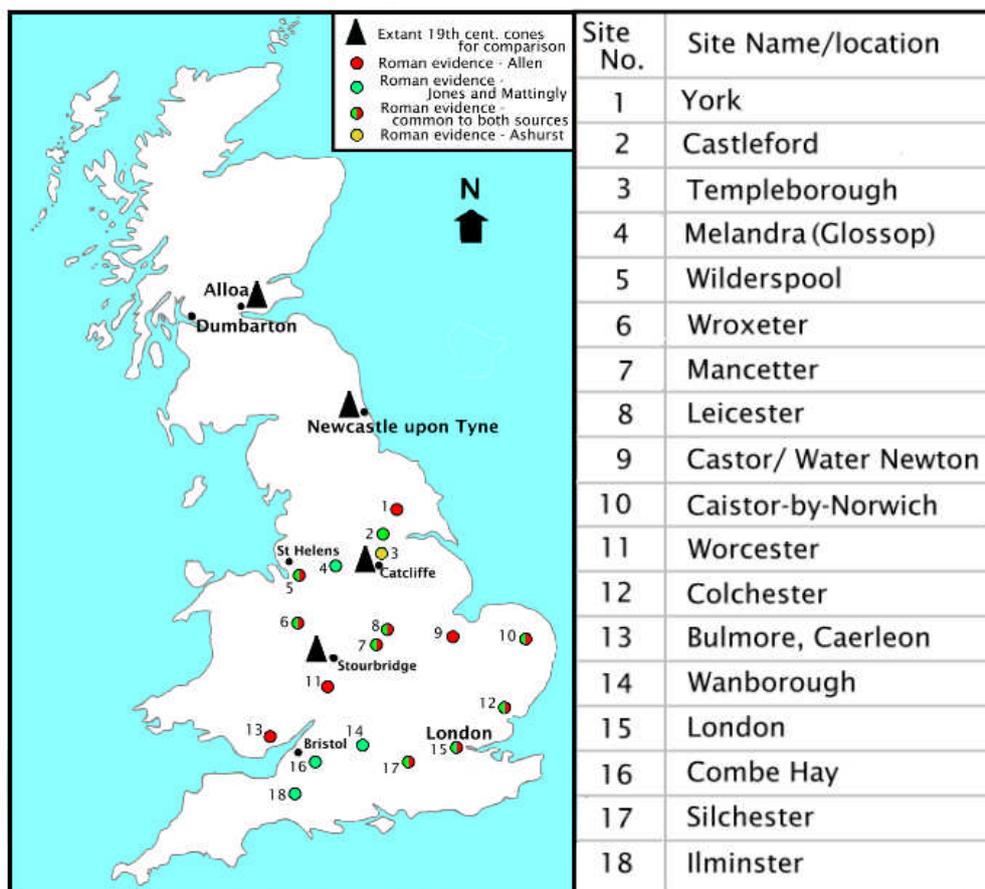
The expansion of the Roman empire, and the undoubted technological skills developed in the culture ensured a rapid expansion through the then known world, taking an Eurocentric view. As well as free-blown vessels, mould-blown vessels also came in to being, with the advantage to the latter that certain surface decoration could be integral with the mould. [The glass blower introduced the blowpipe, with an appropriate gather of hot glass on the end, into a suitable multi-part mould, and blew the bubble of glass to expand to fill the mould.] Indeed, very soon some mould-blown vessels were appearing with the maker’s name incorporated in the mould and therefore on the finished product. It appears that the Egyptians persisted for some time

with their traditional techniques, until the 2<sup>nd</sup> century AD at the earliest.<sup>3</sup>

By the middle of the 1<sup>st</sup> century AD mould blowing was well established in northern Europe<sup>4</sup>. In time, Roman glassware achieved a high degree of sophistication and complex forms were created.

There is evidence of glass manufacture in Britain in Roman times, broadly speaking from the start of the 2<sup>nd</sup> century AD on present data, although the production seems to have concentrated on simple blown shapes and window glass. It appears that the window glass was at first cast in plates, but during the 2<sup>nd</sup> century AD, “but not widely adopted until 300 AD”<sup>5</sup>, the practice was introduced of forming a larger bulb and swinging it to and fro to form a cylinder, which was then cut open and flattened to form panes.

The sites at which evidence has been found are shown in Figure 3.1, below. The data derive from Allen, 1998, p.15, Ashurst, p.7, and Jones & Mattingly, 2002, p.216.



**Figure 3.1: Roman sites in Britain with evidence of glassworking/production - compiled from Allen, 1988, Ashurst and Jones & Mattingly, 2002**

The positions shown in Figure 3.1 are necessarily approximate, given the scale. The attribution of the evidence for the inclusion of these sites is given in Table 3.1 below. By way of amplification, Templeborough is on the south-west of Rotherham, Wilderspool is on the south side of Warrington, Caistor-by-Norwich is more usually associated with Caistor St Edmund, while Bulmore, now little more than a name on the 1:50000 OS map, is the site of a fortlet and

<sup>3</sup> Vose, R Hurst, 1980, p.43

<sup>4</sup> Allen, D, 1998, p.11

<sup>5</sup> *Ibid.*, p.56

settlement a couple of kilometres east of Caerleon, itself the site of a legionary fortress. The remainder are locatable using a reasonably large-scale road atlas gazetteer.

**Table 3.1 - Romano-British glassworking sites – evidence for**

Site	Author	Evidence
York	Allen	Crucible fragments
Templeborough	Ashurst <sup>6</sup>	Furnace, glass drips, runs & clippings
Wilderspool	Allen Jones & Mattingly	Possible glass furnaces “At least five glass furnaces & probably one annealing oven”
Wroxeter	Allen	Sand for glassmaking, glass-blowing waste
Mancetter	Allen	Furnace, glass-blowing waste
Leicester	Allen	Furnace, glass-blowing waste
Castor/Water Newton	Allen	Furnace and crucible
Caistor-by-Norwich	Allen Jones & Mattingly	Tank furnace “Relatively small number of furnaces, annealing ovens and working hearths”
Worcester	Allen	Crucible fragments
Colchester	Allen	Glass-blowing waste
Bulmore, Caerleon	Allen	Glass-blowing waste
London	Allen Jones & Mattingly	“more than 16 sites associated with glassworking, including furnaces, glass-blowing waste” “Glass factories ... existed on the south side of the forum.”
Silchester	Allen	Furnace and crucible fragments

### Post-Roman

For Britain there was a marked decline in the use and quality of glass once the period of Roman cultural and political ascendancy declined. For the rest of the world, the same step-change did not necessarily occur, and the picture becomes rather more complex. However, we will now focus largely on Britain where Saxon glassware is known, but many of the better pieces are largely believed to be continental imports. It appears from Harden, 1971 that Anglo-Saxon glasses were to be found in Britain from the 5<sup>th</sup> century AD through to the 7<sup>th</sup>. For example a specific type of glass cup, known as “bag-beakers”, from their shape, were produced in Kent, from the 6<sup>th</sup> century AD, but no production site has been identified.

<sup>6</sup> Although his identification of Templeborough with Roman “Morbium” is not supported by either Rivet & Smith, 1981, or the OS Map of Roman Britain, 1994

He refers to documentary evidence, subsequently confirmed by excavation, that in 675 AD and in 758 AD continental glassmakers were invited to Monkwearmouth to make lamps and vessels as well as window glass, although again, while the production area has been identified, no furnace remains appear to be known. However, there is some evidence from Glastonbury Abbey that “window glass was being made in Britain towards the end of this period.”<sup>7</sup> Harden, 1971, p.87, amplifies this information, and additionally mentions vessel glass in this context, thought to be 9<sup>th</sup>–10<sup>th</sup> century. By this time, some secular buildings were utilising window glass, which seems to have been made by the cylinder method.<sup>8</sup>

It appears that about this time, in the north and west of Europe, the Roman use of soda-lime glass was abandoned, and potash became the more common alkali, rather than soda. However it seems that in the Near East, under Arab influence, the use of soda-glass continued, and for some time that area led the field in both the artistic and technical aspects.

### Medieval

Adkins and Adkins state (p.195) that in the early part of the period window glass continued to be manufactured by the cylinder method, but crown glass manufacture was introduced, probably from Normandy, at some time. From the 13<sup>th</sup> century both forms of manufacture are found in Britain. However, Ashurst, p.38, writing about the early (mid-late seventeenth century) South Yorkshire glassworks production of window glass states [but gives no authority] that, “It was made in the traditional ‘crown’ glass method of the Lorrainer immigrants (as opposed to the alternative cylinder method of the Normandy immigrants).” Vose, p.60, gives exactly the opposite attribution to Ashurst, [again giving no authority] adding Burgundy and the Rhineland to Lorraine as cylinder glass specialist areas. Burgoyne & Scoble, p.3, similarly attribute the Lorraine glassmakers (who apparently settled in the forests of the Weald some time after 1567) with using “a blown cylinder method known as the broad glass process.” Without trying to resolve the difference, as not directly relevant here, this is therefore a suitable point at which to describe both processes, not in detail, but sufficiently for the methods to be understood.

The ‘cylinder’ method of glass manufacture, which has also been referred to above as starting in Britain in Roman times, is not the later form of cylinder glass, but its antecedent. Indeed, it is described by some writers (e.g. Burgoyne and Scoble, p.3) as the “Broad Glass” technique. It is also known as ‘muff’ glass because of the resemblance to a lady’s muff. Briefly, it involves creating a cylindrical bubble by initially ‘gathering’ a suitable blob (the ‘gather’) of molten glass on the hollow tubular blowing iron, or pipe, blowing and marvering<sup>9</sup> and then repeating the operation until a suitable sized gather had been made. It would then be blown out to enlarge it. With repeated re-heating, blowing and being swung to and fro the required length and diameter would be achieved. It would then be pierced at the end and opened out, and after further manipulation, including shearing along the length, it would be flattened and allowed to anneal. Apparently the technique was “virtually obsolete in Great Britain by 1700.”<sup>10</sup> This seems to be because there were often distortions in the glass, and it could be affected on one side by the surface on which it was left to flatten.

Figures 3.2 and 3.3 below illustrate the process, recreated with slight variations, by Harry Prior, assisted by Andrew Hay, at the English Antique Glass works at Bordesley Hall, near

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<sup>7</sup> Adkins, L & R, 1998, p 164

<sup>8</sup> *Ibid.*

<sup>9</sup> “Marvering” is rolling the gather of glass on the end of the blowing iron on a smooth iron plate, the “marver”, to get the required initial form. Also used to combine e.g. different coloured glasses in to a homogenous form.

<sup>10</sup> Burgoyne and Scoble, p.4