Innovation in later medieval urban metalworking

Justine Bayley

Abstract

Archaeological excavations provide a valuable source of information about medieval metalworking. Most metalworking (apart from smelting) was carried out in towns. From the 13th century there were a number of changes in metals technology; some archaeological evidence for these developments in England is presented.

Introduction

There are three main strands of evidence for medieval metalworking: medieval documents, medieval technical treatises, and finds from archaeological excavations. Combining information from all these sources gives an understanding of the processes that were used and a broader view of the capabilities of medieval craftsmen and women.

General surveys of historical sources are provided by various contributors in Blair and Ramsay's (1991) *English Medieval Industries,* while among the better-known treatises available in modern translations are Theophilus' *De Diversis Artibus* (Hawthorne and Smith 1979) and Agricola's *De Re Metallica* (Hoover and Hoover 1950), though neither was written in or about England. Archaeological finds were the basis for *The Prehistory of Metallurgy* (Tylecote 1986) and for *Medieval Industry* (Crossley 1981), but the lack of more recent syntheses means that many finds have yet to become widely known, a situation which this volume of *Historical Metallurgy* will begin to remedy.

Finds from English sites demonstrate a continuity of practice from the mid and late Saxon period through to around the end of the 12th century; the Norman conquest was a political rather than an economic watershed. From the 13th century there were changes in the organisation of metalworking, with more centralisation of production and the setting up of guilds in towns to exercise control or protection. The increased concentration of individual crafts in particular streets or areas in towns means that randomly-sited excavations rarely find much evidence of later medieval metalworking, a rather different picture from that of earlier periods. There are also differences in the scale of operation of the crafts or industries and in the types of objects being manufactured. Both these changes mean that the nature of the manufacturing debris that is found has some notable differences from that of the earlier medieval period.

Lead, tin and pewter working

Lead was used in large quantities in the construction of stone buildings, but the only evidence that is normally found for this lead-working is solidified spillages and splashes of molten metal, sometimes associated with burnt areas described as hearths (*eg* in St Peter's Church, Barton on Humber (Webster and Cherry 1979, 239)). Large lead ingots are occasionally found (*eg* Wright 1987, Fig 52), and it is these that were the raw material transported from production areas like Derbyshire to where they were worked. Lead from dismantled buildings was melted down for re-use, most notably during the dissolution of the monasteries and other religious houses in the 16th century, and archaeological evidence for this in the form of lead waste is also found.

Lead and pewter trinkets are known from the later 10th century (Bayley 1992a, fig 340) as are antler moulds for casting them (Newman 1993). However, from the 13th century a far larger range of trinkets, especially pilgrim badges and ampullae, became common. These were cast in piece moulds made of fine-grained stone, with lead pegs to correctly locate the two valves (Fig 1 and Homer 1991, fig 22). The solid badges were normally made of pewter while hollow ampullae were slush-cast from tin.

Pewter vessels were cast from the late 13th century onwards and Homer (1991) suggests a range of mould materials were used, though bronze moulds were normal from the later 14th century. No early moulds have survived, probably because of the value of the metal, which would have meant they were re-cast in new shapes when styles went out of fashion.

Crucibles and moulds

The size of crucibles used to melt copper alloys gradually increased through the medieval period (Fig 2). In the 10th-11th century they were typically globular and 60-

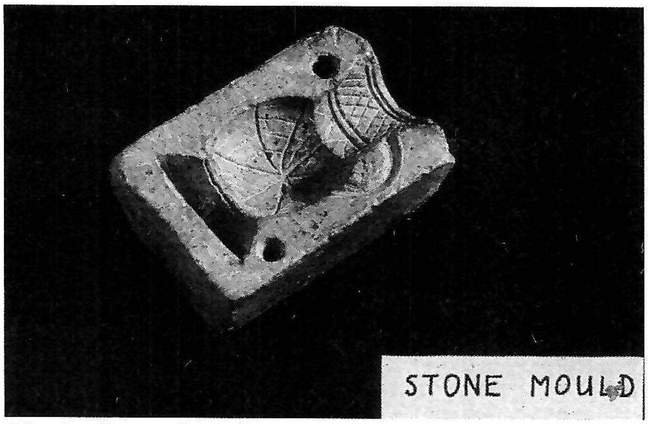

Fig 1: One valve of a stone mould from Hereford for slush-casting tin ampullae. Note the two holes to take locating pegs. Length 57mm.

80mm in diameter, while by the 13th century shapes were more usually hemispherical and diameters had increased to up to 200mm, though smaller sizes were still common. From the 14th century deeper, thick-walled, flat-bottomed forms became common and continued in use into the 17th century and beyond (Bayley 1992b). In the post-medieval period graphitic clays were sometimes used to make crucibles, another development that is still current today.

The earlier, round-bottomed crucibles would have been stable when bedded into a charcoal fire while flat bases were better on a flat surface and so suggest a changed hearth or furnace design, perhaps with a grid on which the crucibles sat. Archaeological evidence for hearths rarely survives, but the Tudor examples found in Legge's Mount at the Tower of London were designed to operate with flat-bottomed crucibles which were found with them (Parnell 1993, Fig 40).

The larger crucibles indicate an increase in the quantity of metal being melted and cast, and mass-production of a sort was certainly practiced; larger numbers of small copper alloy objects were made. Examples of this are strips of unfettled buckle castings (Fig 3) and the multi-piece stacked clay moulds for casting them, such as the examples from Coventry (Wright 1987) and London (Armitage *et al* 1981). Qualitative analyses suggest that from the mid 13th century brass or zinc-rich gunmetal was normally used for small objects such as these (Heyworth 1991).

Large copper alloy castings

Increased availability of metal and growing technical competence led to the production of more large castings, especially from the 14th century onwards. There were three main groups of products, church bells, church fittings such as lecterns, and cooking vessels such as cauldrons and skillets. Although bells had been made

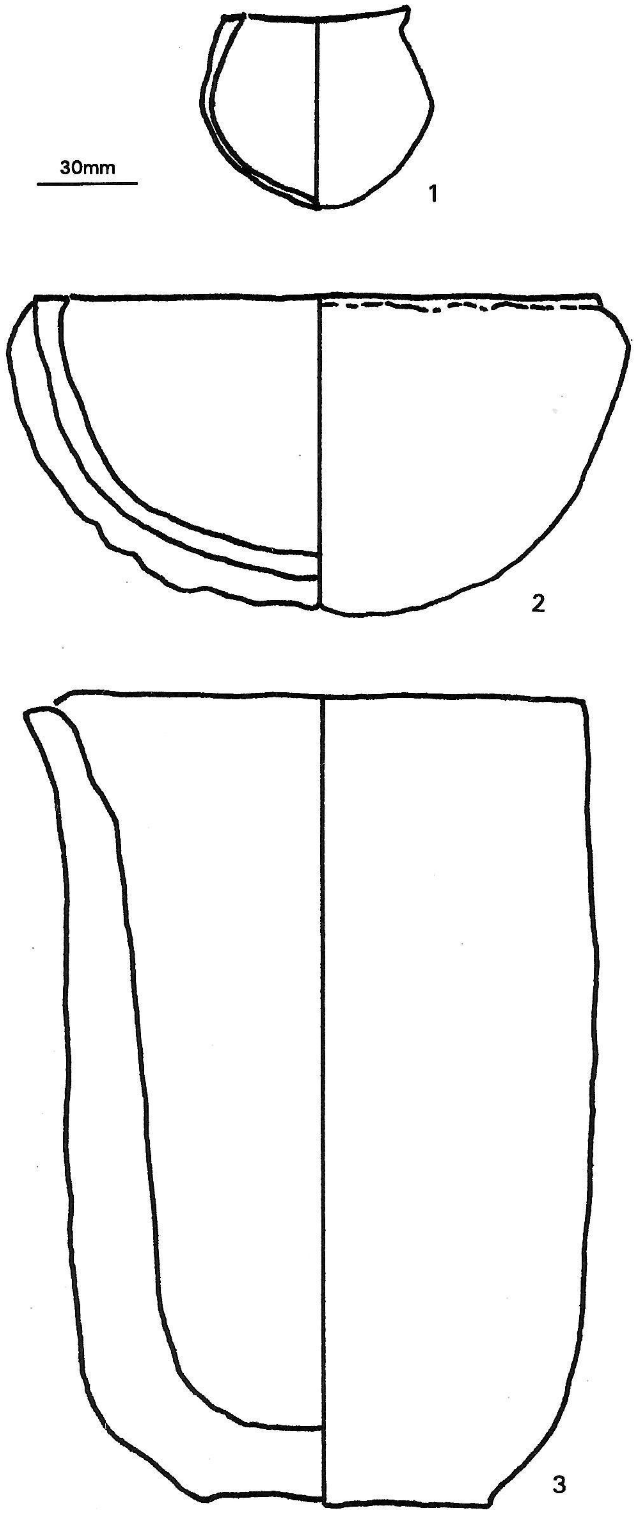

Fig 2: Sketch drawings of typical medieval crucibles. 1: 10th century, 2: 13th century, 3: 16th century.

from as early as the 10th century (Bayley *et al* 1993a), their typical composition of bronze with 20-25% tin and a percent or two of lead did not evolve until the 12th century (*ibid,* table 4) when their shape also changed to the flared mouth which is still used today. Domestic vessels on the other hand were normally heavily leaded copper alloys with little tin and percentage levels of

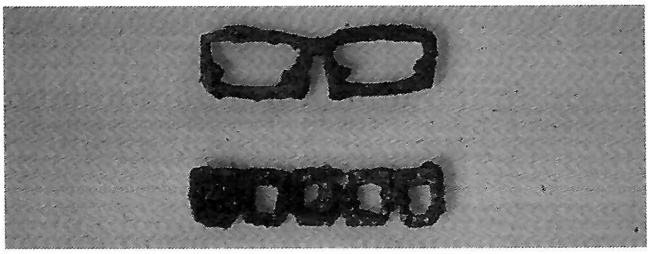

Fig 3: Unfettled buckle castings. The strip of five is 71mm long.

arsenic and/or antimony (Brownsword 1981, Blades 1995). More decorative objects were cast, particularly in the Meuse valley in Belgium, from zinc-rich copper alloys made there (Day 1990; see also de Ruette's paper, this volume). Those that survive most frequently in Britain are monumental brasses, though lecterns, church candlesticks and decorative vessels such as aquamaniles are also known. The only objects that have been analysed in large numbers are monumental brasses (Cameron 1974, Calver 1990) and these show a trend with time away from quaternary alloys towards fairly pure brass (Fig 4).

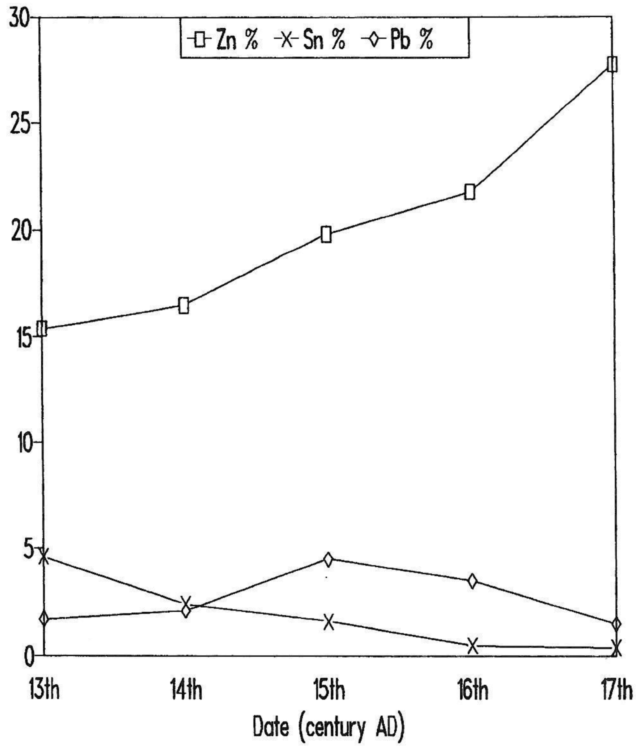

Fig 4: The composition of monumental brasses (data from Cameron 1984).

The main archaeological evidence for the production of large castings are quantities of fired clay mould fragments, normally described as 'bell-mould' whatever the form of the casting. Often they are found backfilled into bell pits where the mould had stood while the molten metal was run down into it from a reverberatory furnace where it had been melted (see papers by Blaylock and Taylor in this volume for details of this process). Typically the mould fragments are 25-40mm thick, oxidised-fired on the outside and reduced-fired inside, sometimes with a fine clay slip on the inner surface. If only small fragments survive, it is not possible to reconstruct the form of the casting and in these cases the composition of adhering metal waste is the only indicator of the type of casting being made (Bayley *et al* 1993b). In a few cases where the mould survives better, the object can be reconstructed and the way it was made identified. An example is a nearly complete cauldron mould from Prudhoe Castle, Northumberland (Figs 5-6) where it can be seen that the outer part of the mould (cope) was divided vertically into two parts, and that these were then luted together and the rim sealed on to the core. The cauldron was cast upside down, probably by feeding the molten metal down one or more of its three feet, though this part of the mould was not reconstructable.

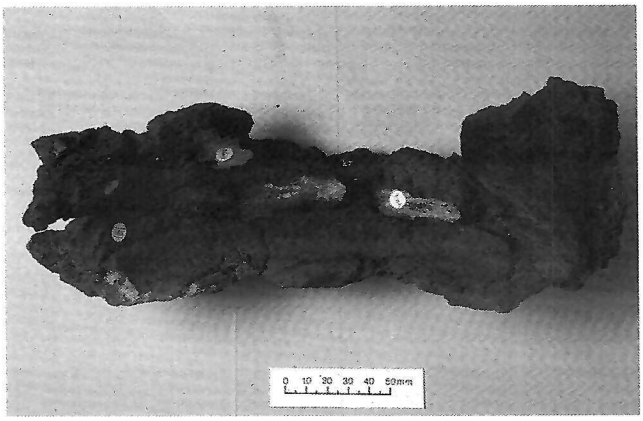

Fig 5: Part of the rim of the cauldron mould from Prudhoe Castle.

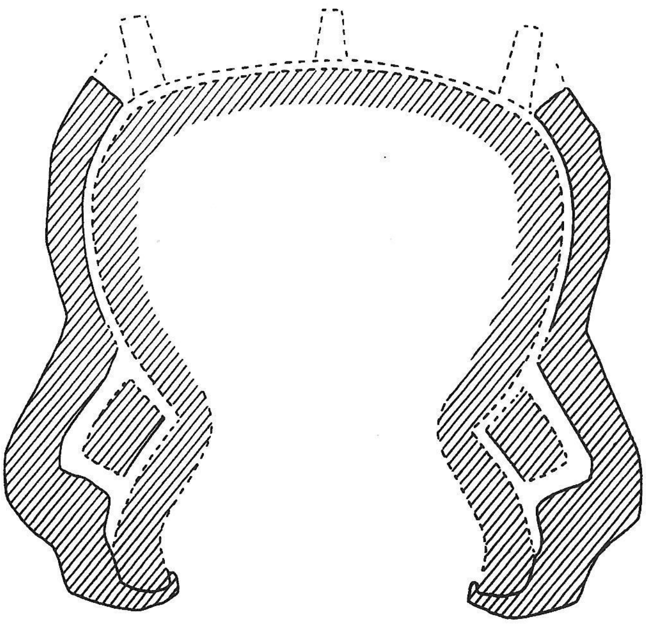

Fig 6: Diagrammatic reconstruction of the cauldron mould. Rim diameter c.200mm.

Precious metal working

The purity of precious metal was always important, so evidence of assaying and refining as well as fabrication is found (Bayley 1992c). Separating precious metals from base ones was achieved by cupellation. The metal to be refined was melted with an excess of lead; this was oxidised, forming litharge (lead oxide), which both oxidised any base metals present and dissolved these oxides, separating them from the silver or gold.

Small-scale cupellation was carried out on shallow dishes known as tests or cupels with diameters of 30-50mm. Up to about the 12th century these cupels were always ceramics; some were purpose-made dishes but sherds from broken pots were also used (*eg* Bayley 1992a). Bone ash was also used for making cupels because, unlike clays, it did not react with the litharge but absorbed it, providing better separation and thus more accurate assays. The earliest surviving bone ash examples from Britain are 16th-century finds from the Tower of London (Fig 7); broadly contemporary examples are known from other European countries (Rehren, this volume). There are no British archaeological finds of cupels for the period between the 12th and 16th centuries so we do not know when the change from ceramic to bone ash took place, though Agricola and Ercker, both writing in the 16th century, describe bone ash as the normal material and thus probably not a recent innovation.

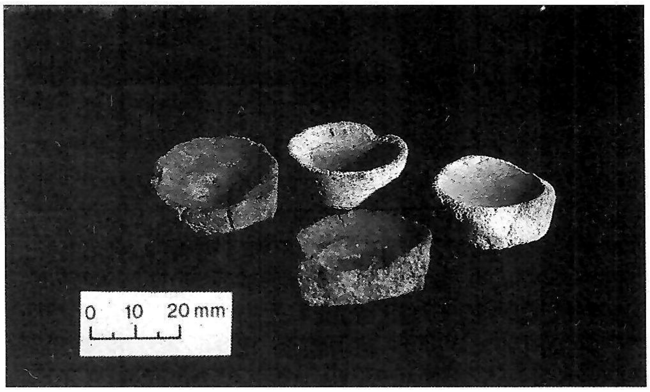

Fig 7: 16th century bone ash cupels from the Tower of London. Diameter 30mm.

Parting, the separation of silver from gold, is the other precious metal refining process used in medieval times. Two solid-state parting processes are described by Theophilus (Hawthorne and Smith 1979) and Agricola (Hoover and Hoover 1950) but archaeological evidence for only one, the salt process, has yet been found. Parting vessels as early as the 1st century AD are known from Britain (Bayley 1991a) and the process continued in use here until at least the 13th century (Bayley 1991b). Some time in the later medieval period a new process, acid parting, was developed. In this the silver in a gold-silver alloy was dissolved in nitric acid, separating it from the gold which was not affected. Nitric acid was produced by distilling vitriol with saltpetre. This process developed in the 14th century but there is no evidence that the earliest finds of distillation-apparatus in Britain, which date to the 15th century, were used in this way (Moorhouse 1972). However, excavations on several 16th and 17th-century sites in London have produced ceramic cucurbits which had been used in the production of nitric acid; most have superficial deposits of iron oxide, a by-product of the distillation of vitriol (Fig 8). The excavations in the Tower of London which produced bone ash cupels also found a number of dishes which had contained solutions of metals, almost certainly direct evidence of acid parting.

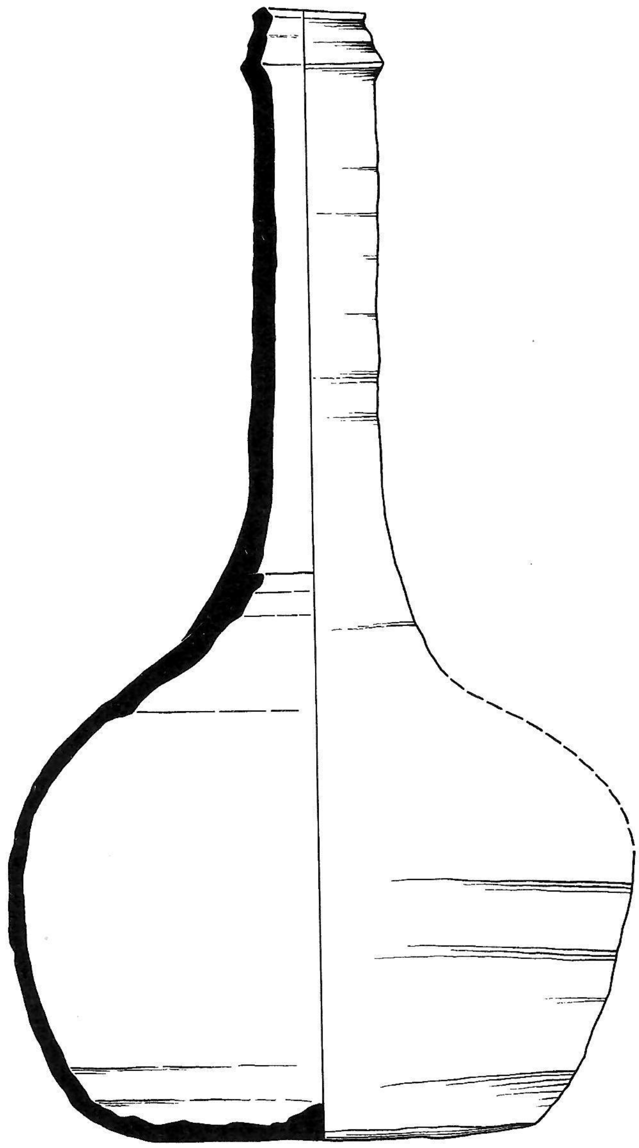

Fig 8: Distillation vessel from the Tower of London. Height 480mm.

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The author

Justine Bayley has worked at the Ancient Monuments Laboratory since 1973 and became head of its Technology Section in 1981. She has published widely on aspects of Roman and medieval metal and glass working and has jointly edited *Historical Metallurgy* since 1990.

Address: Ancient Monuments Laboratory, English Heritage, 23 Savile Row, London W1X 1AB.