Appendix 1: analysis of bronze pin fragment

by Peter Northover

A sample about 3 mm in length was cut from the tip of a bent fragment of pin shaft. It was hot-mounted in copper-filled acrylic resin, ground and polished. Analysis was by electron probe microanalysis using the CAMEBAX automated instrument in the Department of Materials, University of Oxford. Analyses were made over a 50 µm square at each of three locations. The results together with their means are set out in Chapter 7, Table 20. There was some difficulty in finding three representative areas for analysis given the state of corrosion of the samples; it is possible, therefore, that lead and sulphur are underestimated. The detection limits are 0.01–0.02 weight % for most elements, except for lead and gold where the limit is 0.03–0.04%, and arsenic where it is around 0.10%. This is because of the routine used to avoid interference between the lead Lα and Kα lines in the X-ray spectrum, using instead the lead Mα and arsenic Kβ lines. A more sensitive analysis of arsenic is possible with the microprobe but it was not necessary in this case.

The alloy used is medium tin, low lead bronze. Leaded bronze was adopted in southern England at the start of what is conventionally the late Bronze Age, the Wilburton period, roughly the 10th century BC. Use of leaded bronze persisted in the succeeding Ewart Park period, lasting until or near the end of the 8th century BC, after which lead use declined rather rapidly. However, leaded bronze was never absolutely universal within this period; for example, lead-free bronze was retained for some wrought products such as sheet. Moreover, it appears that only certain industries, such as those producing Yorkshire and South Welsh socketed axes, regularly made heavy additions of lead to their bronze. In many cases, as is almost certain here, the lead is residual from the scrap used to cast the pin.

The impurity pattern, with As, Sb, Ni, Ag as the principal impurities and with Sb≥As and Sb≥?0.5% is designated 'S' in a scheme of labels devised for Bronze Age metal groups (Northover 1980; 1982). This was the composition type most characteristic of the Wilburton industry (Northover 1982), and its use persisted into the Ewart Park period. The ultimate origin of the copper in the alloy is in the Alps of central Europe. As time went on the use of other metal types diluted the 'S' composition so that to some extent antimony contents of 0.5% or above tend to be earlier rather than later in the Ewart Park period. However, metal of this type still entered the country, albeit at a decreasing rate, mainly through the E coast and perhaps the Thames estuary and valley.

Indeed, along the Thames and its tributaries we must consider whether this order of impurity was in fact the norm for much of the Ewart Park period. A number of examples are known from Petter's Sports Field, Egham (Needham 1990). Nearer Reading, the sickle and chisel from the Oxford Archaeological Unit's excavations at Wallingford are very similar in composition to the pin we are considering here. Up the Cherwell valley the Marston St Lawrence hoard also has very similar compositions, but these are for a demonstrably early Ewart Park assemblage (Brown and Blin-Stoyle 1959). We can say, then, that the composition of the pin is typical of Ewart park metalwork in the central Thames Valley, and might possibly be earlier rather than later in that period.

The sample was also examined metallographically, both as polished and after etching in an acidified aqueous solution of ferric chloride diluted with ethanol. Very extensive corrosion had destroyed much of the structure, with most lead and sulphide inclusions removed. Where sound metal existed etching revealed a fully recrystallised equiaxed grain structure with annealing twins; there was insufficient metal for an adequate determination of grain size, but this appears to be in the range 30–40 µm. There is some light cold work, indicated by straight slip traces; no αδ eutectoid or coring was observed.

The pin shaft had been cold worked and annealed, possibly through a small number of cycles, with a final cold reduction probably less than 15%. Annealing times and temperatures had been sufficient for the homogenisation of the bronze, say 650–700°C. Although the pin in its final state has been cold worked it has not, as might have been expected, been significantly hardened and would still have been easily bent.