Metallographic examination of seven Iron Age ferrous axeheads from England
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Abstract
Two socketed and five shaft-hole ferrous axeheads were examined by metallography and electron probe microanalyser. Specimens from the cutting edges revealed low carbon compositions although two and possibly a third showed evidence of secondary (surface) carburization. All had been cooled naturally during their final heating cycles.

Introduction
Ferrous axeheads from the pre-Roman Iron Age in Britain are divided according to the means of hafting into socketed and shaft-hole types. A study by Manning and Saunders (1972) describes the examples known at the time (21 socketed and 7 shaft-hole) and discusses their provenances and dating. There are a few more recent discoveries, five of which are included here.

This article synthesises the results of metallographic examination (VF) and microanalysis (CIS) of specimens from the cutting edges of two socketed, looped axeheads and five shaft-hole axeheads (Table 1, Fig 1). Three were sampled by other workers and were re-examined for the present study. Two of these axeheads (Nos 6 and 7) were originally investigated principally for element composition (Ehrenreich 1985, HNY33a and B5a). The other (No 4) was originally sampled for analysis of corrosion products (Miller et al in Field forthcoming) and the metallographic results will be more fully published in the archaeological site report together with two other axeheads (Nos 3 and 5) sampled from the same site (Fell in Field forthcoming).

The majority of the Iron Age axeheads from Britain (including three reported on here) are casual finds and their dating is unclear. Of great interest therefore is a recently obtained radiocarbon date of a sample of the wooden hafting from the socket of axehead No 2, dated to 2480±50 BP (OxA-6216), which calibrates at 2 sigma to the 8th-5th centuries BC (Hedges et al 1997, 250). Socketed axeheads, which are either looped or unlooped, are generally thought to be earlier forms mimicking bronze examples of the Late Bronze Age. It has been suggested that the shaft-hole axe was a late introduction, probably as a consequence of Roman contact (Manning and Saunders 1972, 282), although Irish examples have been ascribed to the earlier Iron Age (Scott 1990, 49). Until further examples of both types are recovered from more clearly datable contexts, chronological sequencing remains uncertain.

Methods
The axeheads were sampled through their cutting edges at positions selected with reference to X-radiographs, and incorporate corrosion layers where present (Nos 1–5). The samples were mounted in longitudinal orientation to provide cross-sections of the cutting edge, ground and polished to 1/4μm fineness according to standard metallographic procedure and etched with 1% nital. Microhardness measurements are Vickers Pyramidal values (averaged) obtained using a 0.2kg load. Carbon content was estimated optically from the proportion of pearlite present (carbides). Grain size was estimated with an eyepiece graticule at x100 magnification.

Minor and trace elements were analysed using the Cameca SEMPROBE wavelength dispersive analytical scanning electron microscope (Research Laboratory for Archaeology and History of Art, Oxford). The specimens were digitally mapped for phosphorus to determine the positions to be fully analysed. Once selected, small areas free of non-metallic inclusions, typically 30 x 40μm or less across, were analysed for the minor and trace elements (Si, P, S, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As) in the metal, using 100nA current and 100s counting times for all elements. At least eight different positions per specimen were analysed.

Only elements P, S, Co, Ni, Cu and As were detected consistently at levels above the detection limits of the microprobe. Thus, the data set is directly comparable with earlier electron microprobe studies of British artifacts (Salter and Hedges 1979; Ehrenreich 1985). The reason for the use of the extended element set is two-fold. Even though most of the additional elements do not normally occur at levels above their detection limits, elements such as Si and Mn do give an indication of invisible sub-surface