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Radiocarbon Dating of Iron Artefacts

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Iron artefacts are generally dated by association or on stylistic grounds. This may not give a true indication of the date of manufacture, or may not be possible if the piece is out of context, ambiguous in style, or a copy. Obtaining a direct date on the artefact would be preferable.

During the processes of manufacture, carbon is incorporated into the iron from the fuel source. If the fuel is of a material containing contemporaneous carbon, i.e. has an ambient radiocarbon signature, e.g. charcoal, then we may reliably radiocarbon date the artefact by extracting this carbon. Care must be taken, however, to ensure that re-working has not introduced multiple sources of carbon that would give an erroneous date. Detailed chemical analysis must precede radiocarbon analysis.

Sample size is determined by carbon content, and before the advent of accelerator mass spectrometry, several tens of grams of carbon were required for radiocarbon dating (van der Merwe, 1969), prohibiting this method except for high-carbon cast-irons and bulk samples, e.g. caches of nails. AMS permits the analysis of sub-gram pieces of iron (Cresswell, 1991), thereby permitting the analysis of museum pieces with only minimal loss of material, and small fragments of iron recovered from archaeological sites. A few examples illustrate these points:

1. Stylistically, an iron dagger held at the Royal Ontario Museum, Toronto, Canada, resembled one held at the Massachusetts Institute of Technology, as well as a number of bronze daggers dating from the first millenium BC. By extracting the 0.3%, by weight, carbon from about a gram of iron from the hilts of the daggers, radiocarbon dating confirmed their antiquity and contemporaneous origins (Cresswell, 1992).

2. The origins of crucible steel date back at least to the first millenium AD. Direct dates on small samples excavated from Swahili siltes in Kenya (Kusimba, et al, 1994) and from Sri Lanka give ages in accord with occupation of the regions, with the oldest steel samples thus far dated from Kenya from the 7th to 8th century AD.

3. The suggestion of Norse iron being worked in North America came from radiocarbon dating of over 30g of an iron bloom discovered in the collections of the Smithsonian Museum, and associated with excavations relating to the voyages of Sir Martin Frobisher, in his search for the North-west Passage in the 16th Century (Sayre, et al., 1982). More detailed, depth analysis of an additional bloom from the site, however, revealed surficial contamination, apparently from re-heating in a coal-fired hearth, resulting in anomalously old ages for the near-surface samples. While there is still debate regarding the true origin of the bloom (Harbottle, et al., 1993), the dates from the interior samples gave credence to the Elizabethan origin for the bloom's manufacture (Cresswell, 1992).

4. The ability of AMS to allow sampling of small fragments proved fruitful when analysing composite axe heads associated with European-Native Indian trading in the 19th Century. Dating of separated iron strips, welded together to form the eye, indicated that many of the axes were the result of significant re-working of iron from quite different origins, many being much younger than hoped, as they included strips of iron from coal-fired furnaces.

In addition to the usefulness of radiocarbon measurements on small iron artefacts, the above illustrate some of the pitfalls associated with this method. The recent use of coal as the combustion and reducing agent in iron production provides both a useful diagnostic for the recent manufacture of iron, and an inconvenience when trying to date samples from the last few hundred years, and when dealing with re-worked samples. Carefull metallographic and chemical examination must precede the more expensive radiocarbon analysis. For older samples, where it can be demonstrated that the organic material incorporated into the iron had a contemporaneous radiocarbon signature, real dates may be obtained from less than a gram of iron.

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