

# 4 CONCLUSIONS AND AGENDA

## 4.1 Conclusions

The preceding parts of this document have described the resource, the approaches to investigation, and given some case studies of how archaeometallurgical data can be used within broader archaeological or historical contexts. The examples above should alert archaeologists at all levels within the profession to the potential of using the archaeometallurgical resource more fully in pursuit of the past and its people.

Because of the nature of the archaeometallurgical resource, good interaction between archaeometallurgists and other heritage professionals is needed — and this should result in a fuller understanding of the contribution of metals and metalworking to the lives of past peoples. In only a relatively small number of projects will metallurgy drive the activity; in a much larger number the archaeometallurgical component of a project may be perceived as tangential to the main undertaking, but may none the less have the potential both to enhance understanding of the immediate project and also feed into broader issues of the past use of metals. Such potential will only be realised through the full integration of archaeometallurgical investigations within all stages of projects; in particular archaeometallurgists should be involved throughout and not solely as post-excavation specialists.

This document has been able to look at this particular aspect of human history in more detail than in the regional and period-based archaeological research frameworks. It must be remembered however that this agenda is also very wide ranging, with enormous temporal and geographical diversity. Realization of the potential of archaeometallurgy must involve close dialogue between technical specialists and those engaged in investigating broader social context. The need for such a dialogue is not unique to archaeometallurgy, but is common to the application of scientific approaches within archaeology.

The future of archaeometallurgy lies, therefore, in a

more synthetic approach to all archaeology at all levels. It also needs archaeometallurgists to have better communication with the rest of their profession, both field archaeologists and other specialists. The realization that archaeometallurgists can and do work with sites and landscapes as much as laboratory studies, and that context and proximity are as crucial as chemistry and structure, are important developments in this discipline. Many of the topics identified in this research agenda are technical ones, but access to the landscapes, sites and artefacts that can and will provide the material on which work is needed will only come through collaborative working. We hope our colleagues across the archaeological community will agree with many of the priorities identified below, and will work with us to achieve some of the goals we have identified.

## 4.2 A research agenda for archaeometallurgy in Britain

The identification of priority areas for research involves both consideration of multi-period issues and those which apply to particular periods of the past. The following list is therefore divided along these lines, facilitating comparison and integration with the Regional Archaeological Frameworks whilst also identifying over-arching themes. In Scotland a more limited review has been undertaken (Hunter *et al* 2006), and its priorities, mainly for non-ferrous metals before AD 1100, should be considered alongside those given below. There are also many other topics where new knowledge would be welcome, so opportunities should be grasped when they offer themselves.

### Multi-period themes

- Develop holistic approaches to the description and interpretation of landscapes associated with metallurgical activity. Mining, ore beneficiation, smelting, fuel supply, transport, metalworking, associated industries (eg ceramics), metal artefact production and distribution may all occur, situated within complex social and geographical contexts which may be largely unrelated to metallurgy.

- Consider the environmental setting and implications of metalworking. This may include heavy metals and other traces in peat profiles and alluvial sediments, as well as conventional pollen analysis.
- Undertake elemental and isotopic analyses of groups of metalwork with regard to artefact style, date and geographical distribution. Much pioneering work has already been undertaken on Bronze Age copper alloys, but this needs extension to other materials and periods.
- Broaden archaeometallurgical understanding through the identification and investigation of sites with unusual or innovative processes, and sites where the archaeometallurgical residues of poorly-understood processes may be investigated.
- Further investigate the radiocarbon dating of iron.
- Revolutionize our knowledge by identifying at least one early production site for each of the major non-ferrous metals, and preferably one from each relevant region (see Fig 2).
- Set alongside cognitive approaches to the archaeology of metals, that look at the mind-set and understanding of the past metalworker, modern scientific investigation of what was going on.
- Develop research approaches to the processes of invention, innovation, and technological progress, as exemplified by metals.
- Consider metalworking techniques and practice in Britain in relation to continental Europe. Differences as well as similarities are important; existing assumptions on the direction of any influence should be critically examined. For the post-medieval period look beyond Europe.
- Consider relationships between metalworking traditions in England, Scotland and Wales without assuming a uniform pan-British tradition.
- Investigate the relationships between metalworking and other pyro-technologies such as glassmaking.

### Prehistoric topics

- Develop techniques to identify prehistoric mines in the absence of stone hammers and, more generally, to date ancient mine workings.
- Seek evidence for prehistoric lead mining, particularly in the Mendips, mid Wales and Derbyshire.
- Reasons should be sought for the fluctuations in prehistoric use of gold.
- Identify the mechanisms that brought brass to Britain in the later Iron Age; analyses of finds from well-dated contexts may assist in this. The spread and development of the use of brass require clarification.
- Investigate the relationships between site types, the types of artefacts manufactured and the techniques

used, particularly for bronze-working in the Iron Age.

- Investigate and date the beginning of iron technology in Britain.

### Roman topics

- Investigate whether specific alloys were selected for different types of objects or different methods of manufacture, and whether date or place of manufacture affected the alloys used.
- Identify where the raw materials for making Roman copper alloys came from.
- Establish whether brass production and use retains its strong administrative/military link throughout the Roman period.
- Investigate regional patterns of copper alloy use and their changes through time in non-Romanised parts of the British Isles.
- Clarify the nature, status and sources of the industries working in lead, tin, pewter and silver.

### Early medieval topics

- Clarify the role of brass in the early medieval period: the case for discontinuity or decline.
- Investigate the nature of primary metal production in post-Roman societies.
- Investigate continuity versus replacement for iron technology and production in the early medieval period, particularly comparing different areas of the British Isles.
- Develop provenancing tools to clarify the nature of trade in metals both within the British Isles and with external areas.
- Further investigate the nature and production of early medieval steel.

### High medieval topics

- Look for evidence of copper production and use; attempt to bridge the medieval gap
- Document the changing technologies of lead and silver production throughout the medieval period
- Investigate medieval steel—did it come from bloomeries or from alternative technologies?
- Investigate the early spread of industries associated with iron into the coalfields.
- Investigate the range of ironmaking in the later Middle Ages in relation to both continental developments and to patterns of secular and monastic control and capital.

### Post-medieval topics

Synthetic accounts of historical metallurgy are usually structured round known individuals, places and

processes. However, in a startlingly high proportion of cases there is currently no physical evidence for key developments which drove and responded to the Industrial Revolution, so the comparison of data from the historical record (even for relatively recent sites) with the archaeological record needs to be made, both for structures and archaeometallurgical residues. The understanding of different scales of operation and the organisation of industrial activity needs also to be improved. Archaeological recording of later 19th-century and 20th-century remains should be given priority, as they are often vulnerable to remediation of contaminated land and 'environmental restoration'. Rapidly changing technology makes it surprisingly difficult to move beyond the conventional historically-led interpretations.

The following lists indicate particular priority areas, first in the study of iron forges:

- The development of finery forges in the 15th–18th centuries.
- The development of puddling and associated technologies in the 18th century.
- Experiments with coke in the 17th century.
- Early cementation steel furnaces from the 17th century.
- The development of wire drawing and other secondary iron industries.
- 19th-century ironworks, especially the foundry and forge sectors.

and in the production of non-ferrous metals, away from the major centres:

- Identification and recording of copper production sites in Cornwall, to complement the better-known tin and silver ones.
- The 17th-century development of reverberatory furnace technologies for non-ferrous ore-roasting, calcining and smelting.
- Location of brass and copper production sites dating before the 18th century, and recording of 18th- and 19th-century brass production sites outside Bristol.
- Lead production sites of the modern period, particularly the urban lead-processing industries

### 4.3 Towards a strategy for archaeometallurgy in Britain

The widespread adoption of best practice with respect to archaeometallurgy is necessary to further the aims expressed in the research agenda above. This includes the appropriate integration of prior understanding of the archaeometallurgical potential of a site or land-

scape during the planning process, engagement with suitable archaeometallurgical specialist advice both during excavation and subsequently, and provision of scientific analysis of archaeometallurgical materials at a level appropriate to the project.

Current advice on best practice can be found in a number of places, especially in some of the documents listed under 'Further reading' below, on the website of the Historical Metallurgy Society ([hist-met.org](http://hist-met.org)), and elsewhere. Some points have been highlighted in the text above, and it is worth re-iterating them here as they are basics that experience shows are often overlooked or ignored for too long:

- Metalworking landscapes are often too extensive and diffuse for scheduling; consideration needs to be given to integrated management and protection policies.
- Some SMRs/HERs would benefit from specific enhancement of data from metallurgical sites.
- Excavation of redundant industrial sites provides an opportunity to match documentary sources with archaeological reality.
- Record adequately and fully publish all metallurgically-important sites whose preservation cannot be guaranteed.
- Involve an archaeometallurgist from the very beginning of all projects.
- Use systematic fieldwalking to locate ironworking sites in fields under cultivation.
- Routinely use geophysical methods in prospecting for metallurgical sites.
- Excavation should only be carried out if the site is threatened or in response to unresolved issues raised in this research agenda.
- Make efforts to ensure adequate resources for both fieldwork and post-excavation study for all projects that are undertaken.
- Because of the likely size of features, brown-field sites require area excavation and appropriate sampling and collection policies (see Dungworth and Paynter 2006).
- Developer-funded projects should include the costs of relevant archaeometallurgical laboratory work.
- Analyses of metal artefacts should be undertaken to answer specific archaeological questions.
- The analysis of objects is a crucial part of understanding working practices, skills bases and technology, and needs to be conducted on a sufficiently large scale.
- Specialists undertaking laboratory work must be provided with appropriate archaeological information, such as contexts, phasing, dating, plans, etc.

- Publish promptly the results of all archaeometallurgical investigation (whether field- or lab-based).

#### 4.4 National and regional research frameworks

Many national and regional research agendas have either been undertaken or work on them is in progress. Conventional publication is sometimes in summary form with supporting detail on the Web, while other are available only on the Web or in both formats. Most have at least some mention of metals and metalworking but it was the uneven nature of this coverage which prompted the production of this volume. The references below do however provide a complementary series of visions of the place of archaeometallurgy in the wider archaeological picture.

##### National agendas

The Prehistoric Society set up a working party to identify strategic areas central to future research on the British Iron Age. Their report includes sections on metal objects and metalworking (Haselgrove *et al* 2001, 21–2 and 26–7).

A session on ‘Romano-British research agendas’ at the 1999 Roman Archaeology Conference grew into a publication (James and Millett 2001) including papers on a range of thematic topics, but with barely a mention of metals or metalworking.

A conference organised by the Association for Industrial Archaeology was designed to formulate a research framework for industrial archaeology (Gwyn and Palmer 2005). The papers focus on the social and economic context of technical innovations and most can therefore be seen as defining and describing the archaeology of the industrial period rather than the technological details of metallurgical and other industrial processes.

The proceedings of a conference to develop a research framework for Welsh archaeology has been published (Briggs 2003). Considerable further details, subdivided by period and region, are available at [www.archaeoleg.org.uk](http://www.archaeoleg.org.uk).

In Scotland work on a full research frameworks exercise is only now getting under way but a recent paper by Hunter *et al* (2006) has looked at the evidence for metalworking before AD 1100.

##### English regional agendas

For the South West the resource assessments, agendas and strategy are available at: [www.somerset.gov.uk/somerset/cultureheritage/heritage/swarf/](http://www.somerset.gov.uk/somerset/cultureheritage/heritage/swarf/)

The resource assessment notes the lack of pre-medieval evidence for metal production and contrasts this with the widespread use of these metals. Tin is likely to have been exploited since the Bronze Age but there is no direct pre-medieval evidence. The evidence for Roman exploitation of Mendip lead is largely restricted to ingots. The history of iron exploitation in the Forest of Dean is still poorly understood with no certain pre-Roman sites and the number of well-dated Roman sites is still too small to see how the industry developed. It is often suggested that later activity will have removed the earlier evidence for metal production but recent work suggests that this is overly pessimistic. The presence of hammerstones in museum collections could point to very early mining sites. The surviving earthworks and buildings of medieval and later industries form a major resource, especially where they can be linked to documentary evidence.

For the South East there are several sub-regional assessments: Greater Thames Estuary, Thames-Solent, Surrey and South-East (which covers Kent, Surrey and Sussex). The relevant websites are:

[212.67.202.196/~teprep/dev/documents/uploaded/document/GreaterThamesResFrame.pdf](http://212.67.202.196/~teprep/dev/documents/uploaded/document/GreaterThamesResFrame.pdf)

[www.buckscc.gov.uk/bcc/content/index.jsp?contentid=-222423834](http://www.buckscc.gov.uk/bcc/content/index.jsp?contentid=-222423834)

[www.surreycc.gov.uk/sccwebsite/sccwspages.nsf/LookupWebPagesByTITLE\\_RTF/SURREY+ARCHAEOLOGICAL+RESEARCH+FRAMEWORK?opendocument](http://www.surreycc.gov.uk/sccwebsite/sccwspages.nsf/LookupWebPagesByTITLE_RTF/SURREY+ARCHAEOLOGICAL+RESEARCH+FRAMEWORK?opendocument)

[www.kent.gov.uk/serf](http://www.kent.gov.uk/serf)

For London there is a published volume (Nixon *et al* 2002) that says little about metalworking, except in the prehistoric period when it mentions examining iron deposits and evidence for prehistoric bronze casting in Surrey.

Details of the regional research framework for the East of England are available at [www.eaareports.demon.co.uk/research\\_framework](http://www.eaareports.demon.co.uk/research_framework). A research assessment (Glazebrook 1997) and a research agenda (Brown and Glazebrook 2000) have been published and both are available at [www.eaareports.demon.co.uk/research\\_and\\_archaeology.htm](http://www.eaareports.demon.co.uk/research_and_archaeology.htm). The proceedings of a review conference are due to be published in 2008; some chapters are available at [www.eaareports.demon.co.uk/framework\\_review.htm](http://www.eaareports.demon.co.uk/framework_review.htm).

For the East Midlands the resource assessments, agenda and strategy are available on-line at:

[www.le.ac.uk/archaeology/research/projects/eastmidsw/index.html](http://www.le.ac.uk/archaeology/research/projects/eastmidsw/index.html), and the latter has been published (Cooper 2006). They note the likelihood that the region had an important iron industry which may extend into the pre-Roman era but that early evidence is limited. There is abundant evidence for Roman iron smelting but there is a need for better dating. The assessment also recommends work on the lead industry of Derbyshire.

For the West Midlands most of the papers presented at the preliminary seminars are available at:

[www.arch-ant.bham.ac.uk/research/fieldwork\\_research\\_themes/projects/wmrrfa/seminars.htm](http://www.arch-ant.bham.ac.uk/research/fieldwork_research_themes/projects/wmrrfa/seminars.htm)

For Yorkshire there is a document that primarily consists of a very thorough resource assessment (Manby *et al* 2003). Among other things, it notes the lack of: systematic scientific study of Bronze Age copper alloy objects; direct evidence for Roman lead production (despite finds of ingots); evidence for metalworking in contrast to the extant high-quality metalwork of the post-Roman period; a modern synthesis of the Yorkshire lead industry; and publication of the evidence for iron mining.

For the North East the resource assessments are available at:

[www.durham.gov.uk/durhamcc/usp.nsf/pws/Archaeology+-+Archaeology-Projects-Regional+Research+Framework](http://www.durham.gov.uk/durhamcc/usp.nsf/pws/Archaeology+-+Archaeology-Projects-Regional+Research+Framework) and a research strategy has been published (Petts and Gerrard 2006). The assessments regularly stress the lack of evidence for metal production and recommend: full metallurgical analysis of all early Bronze Age metal artefacts; geophysical survey and field survey (for example on bloomery sites) with excavation and C-14 dating; geochemical survey and fieldwork in the north Pennines to locate traces of lead and silver working; the need to integrate documentary, archaeological and scientific evidence for the lead-silver industry. The extant physical remains of the historic lead industry are identified as a major resource.

For the North West the resource assessments, agendas and strategy are all available at:

[www.liverpoolmuseums.org.uk/mol/archaeology/arf/](http://www.liverpoolmuseums.org.uk/mol/archaeology/arf/)

The documents stress that pre-medieval metal production sites are virtually unknown and identify priorities: the need for the analysis of metalwork, including trace element and lead isotope analysis; examining river silts for evidence of past mining activity; the need for syntheses of existing work on industrial centres; extending geophysical survey for iron smelting sites (from the Lake District and Castleshaw valley); and further investigation of the copper mining at Coniston (where there

is documentary evidence for German miners).

A research assessment is also being undertaken for Hadrian's Wall. Documentation is available at:

[www.durham.ac.uk/archaeological.services/research\\_training/hadrianswall\\_research\\_framework/](http://www.durham.ac.uk/archaeological.services/research_training/hadrianswall_research_framework/)

## 4.5 Further reading

The many references in the text provide further information about specific topics. A more general introduction to archaeometallurgy in Britain is provided in the books below. The headings indicate the type of information included in each group.

### General introductions to past metallurgical processes, structures and finds

Craddock P T 1995, *Early metal mining and production* (Edinburgh).

Crossley D W (ed) *Medieval industry* (London: CBA Res Rep 40).

Day J and Tylecote R F (eds) 1991, *The industrial revolution in metals* (London).

McDonnell J G 2001, 'Pyrotechnology', in D R Brothwell and A M Pollard (eds), *Archaeological Sciences* (Chichester), 493–505.

Singer C, Holmyard E J, Hall A R and Williams T I 1954–58, *A history of technology*, 5 vols (Oxford).

Tylecote R F 1986, *The prehistory of metallurgy in the British Isles* (London).

Tylecote R F 1992, *A history of metallurgy*. 2nd edn (London).

### Advice on how to excavate archaeometallurgical sites, identify finds from them, and take samples

Bayley J, Dungworth D and Paynter S 2001, *Archaeometallurgy*. EH Guidelines 2001/01 (London).

Dungworth D and Paynter S 2006, *Science for historic industries: guidelines for the investigation of 17th- to 19th-century industries* (Swindon).

HMS archaeological datasheets ([hist-met.org/datasheets.html](http://hist-met.org/datasheets.html)).

### Examples of technical and scientific investigations of artefacts

Bayley J and Butcher S 2004, *Roman brooches in Britain: a technological and typological study based on the Richborough collection* (London: Society of Antiquaries Res Rep 68).

Bowman S (ed) 1991, *Science and the past* (London).

Fell V, Mould Q and White R 2006, *Guidelines on the X-radiography of archaeological metalwork* (Swindon).

Hodges H 1964, *Artifacts* (London).  
Lang J and Middleton A 2005, *Radiography of cultural material* (London).  
Tylecote R F and Gilmour B J 1986, *The metallography of early ferrous edge tools and edged weapons* (Oxford: BAR BS 155).

### Introduction to and explanations of scientific techniques

Andrews K and Doonan R 2003, *Test tubes and trowels: using science in archaeology* (Stroud).  
Bachmann H-G 1982, *The identification of slags from archaeological sites* (London: Institute of Archaeology Occ Pub 6).  
Henderson J (ed) 1989, *Scientific analysis in archaeology* (Oxford: OUCA Monograph 19).  
Pollard M, Batt C, Stern B and Young S M M 2007, *Analytical chemistry in archaeology* (Cambridge).  
Scott D 1991, *Metallography and microstructure of ancient and historic metals* (Los Angeles).  
Tite M 1972, *Methods of physical examination in archaeology* (London).

### Synthetic texts on particular topics

Barraclough K C 1984, *Steelmaking before Bessemer: i: Blister steel: the birth of an industry, ii: Crucible steel: the growth of an industry*, 2 vols (London).  
Cleere H F and Crossley D W 1995, *The iron industry of the Weald*, 2nd edn (Cardiff).  
Craddock, P T, 1998. *2000 Years of zinc and brass*, 2nd edn (London: BM Occ Pap 50).  
Gerrard, S, 2000. *The early British tin industry* (Stroud).  
Kiernan D T 1989, *The Derbyshire lead industry in the sixteenth century* (Chesterfield).

Newman P (ed) 1996, *Mining and metallurgy in south-west Britain* (Matlock).  
Schubert H R 1957, *History of the British iron and steel industry* (London).

### Examples of good practice

Astill G G 1993, *A medieval industrial complex and its landscape: the metalworking watermills and workshops of Bordesley Abbey* (York: CBA Res Rep 92).  
Bayley J 1992, *Non-ferrous metalworking at 16–22 Coppergate* (London: The Archaeology of York 17/7).  
Belford P and Ross R 2007, 'English steelmaking in the seventeenth century: the excavation of two cementation furnaces at Coalbrookdale', *Historical Metallurgy* 41(2), 105–123.  
Burnham B and Burnham H 2004, *Dolaucothi-Pumsaint: survey and excavations at a Roman gold-mining complex 1987–1999* (Oxford).  
Symonds J, O'Neill R and Jessop O 2007, 'What can we learn from the excavation and building recording of cutlery sites in Sheffield?', *Post-Medieval Archaeology* 40(1), 214–218.  
Timberlake S and Prag A J N W 2005, *The archaeology of Alderley Edge: survey, excavation and experiment in an ancient mining landscape* (Oxford: BAR BS 396).

### Archaeometallurgical journals

Journals that specialize in archaeometallurgy, or regularly contain relevant articles:  
Archaeometry, Archeosciences, Bulletin of the Peak District Mines Historical Society, Bulletin of the Wealden Iron Research Group, Historical Metallurgy, Journal of Archaeological Science, Metalla (Bochum), Post-Medieval Archaeology.