Book reviews

Dolaucothi-Pumsaint: survey and excavations at a Roman gold-mining complex 1987–1999 by Barry and Helen Burnham (plus contributors). *Oxbow Books, 2004. xii + 339pp, 306x216mm, 207figs, 37 tables, ISBN 184217 1127, £60-00 h/b.*

The gold mines at Dolaucothi, and the adjacent Roman fort at Pumsaint, have been well known in the archaeological literature for many years. The orthodox interpretation, developed by Professor Barri Jones and co-workers in the 1960s and 70s (*eg* Jones and Lewis 1971), regards the whole 'early' mining complex of leats, opencuts, washing tables, and underground workings as being of Roman date, though Jones' excavation evidence for this dating has never been published. More recently, opinion in the mining-archaeology community has questioned the wholly-Roman dating of the mines on two fronts: firstly, the possibility of pre-Roman mining, potentially extensive has been raised by comparison with the large-scale Bronze Age mining now known in Wales at sites such as Cwmystwyth and Great Orme; and secondly, similarities between many elements of 'Roman' Dolaucothi and medieval and early post-medieval mining and ore dressing in England have been noted, raising the possibility that some at least of the visible archaeology is post-Roman.

The publication of the Burnhams' monograph therefore forms a major contribution to an important debate within the archaeology of mining and metallurgy. After a short introduction, the meat of the volume consists of four chapters on fieldwork by the Burnhams in the 1980s and 90s, each containing specialist sub-reports; the first and third of these form major excavation reports, while the second and third will be of most interest to readers of *Historical Metallurgy*. The volume then concludes with an 'overview of the 1987–99 survey and excavations'. Frustratingly, recent landscape surveys, and reassessments by a French team stressing the case for Iron Age mining, are briefly mentioned but not included in the volume.

The core chapters form full detailed excavation reports, with context descriptions, plans, and sections reproduced in detail. These, plus the hardback format, doubtless account for the price – at one level, this is not unreasonable for a heavily-illustrated 350 page hardback, though at another level the policy of publishing excavations at this level of detail and cost is certainly unfashionable. Whatever one's views on that policy, it does have the virtue that all of the Burnhams' evidence is laid out for scrutiny in detail, including the crucial dating evidence.

The fort excavations broadly confirm Jones' interpretation of a 1st century fort succeeded by a smaller fortlet, itself abandoned by *c*120AD; a remarkable sunken-floored timber building or cellar is of later date (the pottery and C-14 evidence being hard to reconcile). Finds included bloomery smithing slag, and a probable blowing-hole collar (reported on by Peter Crew); they also include post-medieval smithing slags and a triangular iron/steel block, from features probably relating to the early phases of the modern village.

The chapter on the leats contains the results of sections across the Gwenlais leat (partly formerly identified as the upper part of the Annell leat), with valuable environmental data. Jones had previously obtained C-14 dates of around 800AD for upper silting of this leat, strongly supporting a Roman origin; unfortunately the precise linkage of the 'Gwenlais leat' to Dolaucothi remains unclear, Burnham rightly stressing the need for full surveys of the leat systems.

The key section for most HMS members, however, will be the report on the Carreg Pumsaint excavation. This excavation was sited near the mouth of the main opencast, between a large conical mound (tentatively identified in the literature as a motte) and an area convincingly identified from field survey as the site of a water-powered stamping mill (the 'Carreg Pumsaint' itself being a classic stamp-mill mortar-base) – a medieval date was therefore very much a possibility. The excavation revealed a deep and complex sequence consisting of a Phase I of mine-spoil dumping (perhaps into an even earlier opencast, though the sequence could not be bottomed in the available space) overlain by a Phase II of stamping and ore-dressing wastes (alternating crushed quartz and shale and fine clay slimes, up to 0.75m thick), and a Phase III of 19th and 20th century deposits relating to the final reworking of

the mine. While the excavation and presentation of the evidence are exemplary, and the scientific analysis of the processing wastes is an important pointer to a very under-studied subject, the broader interpretations are, to this reviewer, problematic.

Firstly, the so-called motte (composed of Phase I mine spoil, with no surrounding ditch, but with a probable spiral ramp) is dismissed as a 'conical spoil heap'. At one level this is almost certainly true; but as any excavator knows, spoil is not moved uphill without a good reason, and this reason (whether pragmatic or otherwise) is not discussed. With no apparent topographic constraints on flat tipping, possible parallels (ranging chronologically from Silbury Hill to late medieval viewing mounds) surely need discussion, and other interpretations might range from defence, observation or secure storage (does a motte have to have a ditch?) to a symbol of control or an element of designed landscape. Secondly, while the Burnhams are clearly very familiar with the literature on Roman gold-mining, they do not engage fully with the extensive recent work on tin extraction in Devon and Cornwall (whose parallels to the Dolaucothi evidence are briefly, and rightly, acknowledged to be close), and not at all with the equally-extensive post-medieval and industrial archaeology literature on mining and ore-processing; the discussion and terminology would have been greatly enriched if these strands had been brought in.

The third, and most crucial, problem is the dating. Despite the large-scale and careful excavation, the only artefacts recovered from phases I and II were a fragment of rotary quern/crazing stone (with parallels both in Roman mining in Spain, and in late medieval tin mining in Devon and Cornwall), a stone disc or counter, and a whetstone. The authors therefore rely heavily on two C-14 dates; of 43BC–AD331 from phase II, and of 925–427BC from Phase I (both calibrated, at 2σ). Here is a major problem. While the stratigraphic context of each date appears secure, the origin of the charcoal does not – the likelihood of old wood, and/or of redeposited charcoal is not discussed and appears high. To this reviewer, the authors' carefully-argued case that the mining and ore-processing (including, probably, the water-powered stamp mill) are of Roman and earlier date is therefore given only weak support by the C-14 dates. While the Burnhams' interpretation is probably the 'best fit' to the available data, the possibility of a later date, with older charcoal incorporated into the sediments, surely remains all too wide-open.

In conclusion, one can do no better than to quote the authors' own words (p330): 'As with so much archaeological research, this volume is a staging post in a journey with more questions than answers'. The Burnhams have strengthened but not proved their case for a Roman (or earlier) rather than medieval date for the conical tip and the water-powered stamping mill. Dolaucothi cries out for further research; this reviewer would add to the authors' excellent priorities (p330–31) the use of ground penetrating radar to investigate the natural and artificial bedrock topography beneath the archaeological deposits, and a much fuller engagement with the literature and specialists on medieval and later mining.

David Cranstone

Technology of early historical iron production in the Netherlands by Ineke Joosten. *Institute for Geo- and Bioarchaeology, Vrije Universiteit, Amsterdam, 2004, x+133pp, A4, 57 figs, ISBN 90-77456-02-3. €30 p/b including postage. Order from the Institute, email: geobioarcheologie@falw.vu.nl.*

Roman iron production in Britain: technological and socio-economic landscape development along the Jurassic Ridge by Irene Schrüfer-Kolb. *Archaeopress, Oxford (BAR BS 380), 2004, 184pp, A4, 63 figs, 15 tables, ISBN 1-84171-669-3. £32-00 p/b.*

There are many parallels between these two books which are based on postgraduate research into archaeological evidence from specific regions, including archaeometallurgical analysis of smelting waste, and consider ironworking technology in a wider context. Yet despite these similarities in the aims of the authors, the tools that they employ and the presentation of the results, the books are very different.

In the British book, Schrüfer-Kolb builds on previous research (Condron 1996 and 1997) into Roman small towns in the East Midlands, which included consideration of industrial activity, but here ironworking is the main focus and analyses of ironworking waste are included. The author indicates early on that she intends to set ironworking in a wider context, considering technology, the landscape, other industries, socio-economic and cultural factors, organization and infrastructure. Similarly, the Dutch book follows on from earlier work (Elburg 1992), investigating the technology and organization of early iron production in the central and eastern parts of the Netherlands. This book focuses on three main areas: Romano-Barbarian smelting in the Vecht area, and early medieval iron production in the Veluwe and Monterferland areas. Joosten aims to explore the wider context of the smelting technology, as

well as the technology itself. The environmental impact of ironworking, the organization of iron production on different scales and socio-economic factors are all considered.

Both authors provide background information on the smelting process, furnace types and how they operate. Schrüfer-Kolb clearly appreciates the problems of matching detailed furnace typologies with poorly surviving archaeological remains and discusses the issue intelligently. However, there are also comments that are muddled or misleading, such as one about the use of natural draught smelting furnaces. She provides a comprehensive summary of archaeological evidence for iron production from East Midlands sites, including mining, ore processing (roasting *etc*), smelting and primary and secondary smithing. Joosten also provides background information on the technology of iron production in her research area, although with a greater emphasis on the reactions taking place within the furnace and the relevant science. Again, there are descriptions of different furnace typologies and the types of waste generated by iron production: the inclusion of photographs and illustrations made this section particularly helpful and informative. She outlines the history of iron production over five millennia, and this is also clear and nicely illustrated, and comprehensively reviews early iron production in the Netherlands.

Both authors provide further essential background information by discussing the raw materials likely to have been used in smelting and to have contributed to slag formation in their respective regions, including the ore, charcoal and material used to construct the furnace. Joosten focuses mainly on two types of ore: bog iron ore and rattlestone ores, and gives detailed descriptions of each. Schrüfer-Kolb discusses the geology of her research area and gives a comprehensive description of the potential ore sources.

The identification, description and distribution of ironworking sites in the East Midlands make up a fairly large proportion of *Roman iron production in Britain*. The author was hampered by the inconsistent terminology adopted in the literature, but has clearly devoted a great deal of time to deciphering it, producing distribution maps of different types of ironworking. She refers to this information when touching on subjects such as the relationship between the location of smelting sites and local geology, whether ore was transported far and whether ore processing took place at the mining or smelting sites, if at all. A gazetteer of sites is provided. The author then looks for links between ironworking and other industries, an interesting topic, mentioning the use of slag as trituration grit on mortaria from the Nene valley, and smithing-themed decorations on pottery. The shortcomings include muddled terminology, particularly in the section on non-ferrous metalworking, and some unsupported conclusions.

A number of techniques is used in both studies to analyse ironworking waste from selected sites. In each case the authors had the forethought to analyse for trace elements and to include samples of ore and furnace lining as well as slag, but the differences between the two books are particularly apparent with the selection and treatment of samples and the approach to the analyses and scientific data. Joosten describes how the slag from each site was reviewed so an impressive 175 representative samples could be selected for analysis. Detection limits are given for each element and technique, and the results for standards are compared against the known compositions. Overall, the data is handled very confidently. In contrast, Schrüfer-Kolb analysed standards, but the results are not given, analytical problems are not elaborated upon, and she appears less confident handling compositional data. The number of samples analysed from each site is small, impacting on how representative the analyses are for the site as a whole.

Both authors outline the archaeological evidence of ironworking for the sites used as case studies. The information is less comprehensive for the British sites, perhaps reflecting the partial nature of the archaeological investigations at those sites, but as a result the reader is left with little idea of the scale of the ironworking. The dating and identification of features is sometimes unconvincing, examples being a smelting furnace assumed to either pre-date or post-date the occupation of a structure because of the risk of fire, and a single piece of slag identified as bloom refining waste without explanation. Joosten is able to provide more information about the scale of slag production for the sites included, either in terms of an estimate of the number of furnaces, the amount of slag or both. She also provides a brief description of the surrounding settlements and how the smelting activity was dated.

Both books attempt to link the composition of the ore to that of the slag. Unfortunately, Schrüfer-Kolb appears to disregard the geological information from earlier in her book when interpreting the analyses, and an 'East Midlands ore' is discussed as if there were one mineralogical and compositional type: a sideritic ore. Although she suggests that the different phosphorus contents of the slag analysed in the study may potentially indicate

different ore sources, she does not follow this through and other parts of the discussion are less insightful. A rich ore sample is dismissed as unrepresentative with no explanation, and differences in slag composition are in some instances prematurely attributed to changes in smelting technology without considering other factors such as the variability of both furnace conditions and compositions of the raw materials used. In contrast, Joosten successfully identifies chemical characteristics of the slag and ore that can be used to link the two, demonstrated most elegantly by a bivariate plot of phosphorus versus manganese. She also stresses that the results are supported by the types of ore noted amongst the waste from the sites, and known from the geology of the area.

Both authors use mass balance equations to investigate the formation of slag and yield of iron. The results of these calculations vary widely depending on the compositions used for each component, the ore and furnace lining in particular, and depend on those compositions being representative for the site – but Schrüfer-Kolb has few samples to rely on and Joosten combines compositional data for material from different sites. As a result, although considerable space is devoted to it, the results are less convincing than other methods of data handling employed by the authors. The mass balance approach also forms the basis of Joosten's argument that at Ooster Dalfsen lime flux was added to the smelt in the form of mollusc shells, as mass balance calculations fail to reconcile the elevated lime content of the slag from this site with the low lime concentrations of the raw materials chosen as representative. However, ore and furnace lining samples from Ooster Dalfson do not appear to have been analysed so the data used in the calculations are from elsewhere. As the author states that no mollusc shells were found in the slag or anywhere at Ooster Dalfson, compositional information for ore and furnace materials from that site is required for the fluxing argument to be convincing. This also impacts on the discussion of the yield of iron from ores at different sites and periods.

Both authors go on to discuss the organization of iron production. Schrüfer-Kolb uses a model for degrees of industrialization, modified from one used by Condron. In practice it is difficult to fit many sites to the model confidently because of the incomplete or vague information available; there are few estimates of the scale of working and often the nature of the ironworking is unclear. The author's detailed discussion of various possibilities is nonetheless thought-provoking although the ambiguous use of the term 'iron production' for all aspects of ironworking throughout the book, including mining, smelting, and primary and secondary smithing, is particularly frustrating here. In the Dutch book the basis for the conclusions are a combination of documentary and archaeological evidence, the latter including the scale and period of production, whether settlements were situated near to smelting works, and where the bloom was processed. For the most part this was persuasive, though rather brief. More detailed discussion of the suggestion that blooms from a large-scale Romano-Barbarian smelting site were worked into bar elsewhere would have been useful.

In each of the books, the authors attempt chronological and regional comparisons of their results. Schrüfer-Kolb makes comparisons with other areas of England where substantial evidence of Roman iron smelting has been recovered. The discussion includes interesting theories but these are undermined by some contradictory statements, such as referring to ore as both impure and rich, and hasty conclusions, for example attributing reductions in the scale of ironworking in the Weald and Forest of Dean to the exhaustion of resources. However, Joosten is able to demonstrate changes in the types of furnace and ore used over time and in different areas: Romano-Barbarian smelting in the Vecht area using slag pit furnaces and bog iron ore contrasting with early medieval iron production in the Veluwe and Monterferland areas using slag tapping furnaces and 'rattlestone' ore.

The authors take a refreshingly holistic view of their subject and demonstrate that there are potentially great gains to be made through such an approach. Both books represent an impressive amount of research. *Roman iron production in Britain* contains information for those interested in the East Midlands area or the Roman period, in particular the gazetteer and to some extent the compositional data. Interesting ideas on the distribution of smelting sites and their contexts are presented but currently there is insufficient data to test these theories. There are many possible ore sources in the region and the task of establishing ore-slag relationships is in itself a substantial research project. In this respect the work would have benefited from reference to the very informative, although unpublished, study of ores and slags in the same area by Fells (1983), who describes the mineralogical and chemical differences between ore sources and the composition of the resulting slags. The book is not a good overview of the technology of iron production in the area because some of the statements it contains are confusing and confused; whilst the author debunks some myths on the subject, she perpetuates others.

A considerable proportion of *Technology of Early Historical Iron Production in the Netherlands* is devoted to archaeometallurgical analysis of waste from specific sites and its interpretation. The information provided by the latter allows the author to draw conclusions about the types of furnace and ore used in different areas and periods, and present these concisely. The compositional relationships between ore and slag, and the demonstrable changes over time in the raw materials and furnace types used for smelting, are particularly interesting; the context and organization of iron production are considered more briefly. The book is nicely produced and will appeal to anyone involved with these subjects.

Sarah Paynter

India's legendary wootz steel: an advanced material of the ancient world by Sharada Srinivasan and Srinivasa Ranganathan. *National Institute of Advanced Studies and the Indian Institute of Science, Bangalore, 2004, v+146pp, 240x180mm, h/b, 65 figs (many in colour). No ISBN, no price stated.*

This is an idiosyncratic and engaging study of a material with a fascinating metallurgy and history. The book is often discursive but never dull! It was commissioned by Tata Steel to commemorate the centenary of the death of J N Tata, founder of Tata Steel, the first modern indigenous steel-making firm in India and now one of the world's major producers, and also the centenary of the birth of J R D Tata, founder of the National Institute of Advanced Studies in Bangalore.

Dr Srinivasan studied engineering physics in India and archaeometallurgy at the Institute of Archaeology in London, where her PhD was on the metallurgy of South Indian bronze images, and she has also published many papers on other aspects of Indian metallurgy (*eg* Srinivasan and Glover 1995). Prof Ranganathan was at the Banaras Hindu University and latterly at the Indian Institute of Science, specialising in physical metallurgy and the history of science in India. Thus between them the authors have a wide range of expertise in both materials science as well as historical metallurgy.

The book is rather difficult to categorize. I suspect it was intended for a non-specialist readership, but it does contain a wealth of information on all aspects ferruginous, from the formation of iron atoms in stars to the current prices realized by Damascus swords in auction at Christies. There are also background sections dealing with the story of iron around the world as well as with the basic metallography of iron and steel. Naturally the book concentrates on India, with a great deal on the production and history of crucible steel. Much of this concerns the patterned Damascus blades, explaining the origin of the patterning in the steel as well as their role in India's history.

Crucible steel and the Damascus patterned blades generated a great deal of interest in Europe and latterly North America, from the 16th century onwards, with numerous scientific investigations and even more attempts to replicate the blades. This aspect is especially well covered in this book, often revealing the trouble that scientists and smiths alike had understanding or working the metal.

The book is generally well produced and the text is backed up by a comprehensive bibliography as well as many excellent diagrams and tables. To leaven the phase diagrams and micrographs there are also a series of artistic recreations of historic scenes featuring iron and steel by Paul Fernandes that compliment the lively and informative narrative.

Paul Craddock

European Metals in Native Hands: Rethinking Technological Change 1640–1683 by Kathleen L Ehrhardt. *The University of Alabama Press, Tuscaloosa AL, 2005, 272pp, 155x232mm, ISBN 0-8173-5146-9, $29-95 p/b.*

Not only are we fortunate to find out in this study that the anthropology of metal-based technology in North America is still alive and well, but Ehrhardt treats us to a carefully-constructed, in-depth study of copper-based artefacts from the period of early contact between Native Americans and Europeans. Some important work has been done in recent years to identify European trade metals from protohistoric Native American sites through chemical analyses, but Ehrhardt goes far beyond this. She provides a systematic analysis of material selection, production, use and discard – a technological system (after Kingery 1993) – that is firmly set within a broad social context during this period of time. She also seeks to define a technological style (after Lechtman 1977) of her study area in order to obtain 'a holistic view of technological activity in which both the material and nonmaterial cultural patterns that underpin, sustain, and potentially transform technological and social life are revealed' (p33).

To do this, Ehrhardt analyses a large sample (n=806) of copper-based objects excavated from well dated, domestic contexts at the Iliniwek Village Historic Site in

Clark County, Missouri. This is where the protohistoric Illinois people lived and adapted to the gradual influx of European trade goods, visits by French priests, explorers and traders, and stresses from surrounding Native cultures. She uses an appropriate array of methodologies to obtain a richly textured view of the Illinois' response to European metals within their socio-cultural setting, including archaeological excavation, history, archival work, and metric analysis of the objects. She also conducts chemical (PIXE) analysis on 75 of the objects to determine that native copper, smelted copper, and brass occurred at Iliniwek. Ehrhardt follows up with metallographic work on these objects to examine the manufacturing history of different object types made of different copper-based metals.

Ehrhardt focuses on a number of research questions as the foundation of her study. What types of copper-based artefacts are found at Iliniwek, both in terms of composition and function? To what extent did the Illinois transform these materials and what tools and skills were involved? Were there any cultural preferences for one type of material during production and use? What were the functions and meanings of the different object types found, including those that were discarded? What insights are revealed about the possible changes between the production and use of native copper in prehistoric times and protohistoric production and use of European metals? She answers all of these with very plausible explanations based on her interdisciplinary methodology.

I found a number of Ehrhardt's findings to be particularly interesting and hope that she and other researchers follow up on these in the future at other late prehistoric and protohistoric sites in the region. All of the smelted copper and brass objects, the vast majority of the total examined, functioned as personal adornment, while only two native copper objects identified served utilitarian purposes. Also, the Illinois produced the items of adornment, including tinkling cones, beads, clips, perforated pendants and wire, using secondary manufacturing techniques. Pieces of kettle traded into the area were re-used by cutting or shearing them into workable preforms or blanks. The Illinois then shaped objects by bending, folding, punching, and rolling around a mandrel using cold working, annealing, and some hot working. Unfortunately, Ehrhardt is as yet unable to comment on the social organisation involved in producing and distributing the ornaments at Illiniwek and, perhaps, beyond. Who were the metal workers? What were their roles in the community?

Another result of the current research is the lack of strong indications that either smelted copper or brass was preferred as ornaments. This surprised me since smelted copper has essentially the same colour as native copper, a material that had significant socio-cultural meaning to many different Native American prehistoric cultures. In fact, there were several copper-based objects recovered at Illiniwek that were coated in red ochre. Ehrhardt concludes that the Illinois widely utilized European copper-based metal for aesthetic and symbolic display that made use of the metals' multiple properties of colour, sound, movement, and reflection. While her arguments and data are convincing for the context of the Illinois, the reader should be forewarned to ignore Ehrhardt's comments on possible analogous meanings of copper from African cultures. The socio-cultural contexts are just too different to be useful in this study.

Finally, a considerable number of the objects found at Illiniwek were blanks and scraps that were probably discarded in refuse pits. This suggests that a steady and reliable supply of the metal had occurred in 1640–1683 and resulted in its lower social and economic value. However, historical evidence indicates that the Illinois traded copper-based metal to tribal groups who lived in the interior and had little exposure to Europeans and their material goods. More research is critical to better understand metal discard at Illiniwek.

I highly recommend this book to everyone interested in the breadth of eye-opening insights that are possible through careful, interdisciplinary analysis of metal selection, production, use and discard in past societies. The only notable setback in this book is the small size and poor quality of the micrographs for use by archaeometallurgists. Unfortunately, this is common to a number of publishers.

Terry Childs

References

Condron F M 1996, Roman small towns in the East Midlands: a regional study of settlement development and interaction, unpublished PhD thesis, University of Leicester.

Condron F M 1997, 'Iron production in Leicestershire, Rutland and Northamptonshire in antiquity', *Trans Leicestershire Archaeological and Historical Society* 71, 1–18.

Elberg M A 1992, The technology of early iron production in the central and eastern parts of the Netherlands, ROB Amersfoort/ Universiteit Utrecht (Internal Report).

Fells S, 1983, The structure and constitution of archaeological ferrous process slags, unpublished PhD thesis, University of Aston in Birmingham.

Jones, D B G and Lewis, P R 1971, *The Roman Gold Mines at Dolaucothi* (Carmarthen).

Kingery W D 1993, 'Technological system and some implications with regard to continuity and change', in S Lubar and W D Kingery (eds), *History from things: essays on material culture* (Washington, DC), 215–230.

Lechtman H 1977, 'Style in technology – some early thoughts', in H Lechtman and R Merrill (eds), *Material culture: styles, organization, and dynamics of technology* (St Paul), 3–20.

Srinivasan S and Glover I 1995, 'Wrought and quenched, and cast high-tin bronzes in Kerala State, India', *Historical Metallurgy* 29(2), 69–88.