Book reviews

The Archaeometallurgy of the Asian Old World edited by V C Pigott. *University of Pennsylvania Museum (University Museum Monograph 89, MASCA Research Papers in Science and Archaeology 16), Philadelphia, 1999. vi + 210pp, 280 x 215mm, 37 figs, 29 tables. ISBN 0-924171-34-0. $42-00 (hb).*

This well-presented volume derives from the Fourth USA-USSR Archaeological Exchange/Symposium: The Development of Ancient Metallurgy in the Old World, held in September-October 1988 in Tbilissi and Signaghi, Georgia. Apart from the delay in publication, there is a divergence of titles between the conference and the book, narrowing the original concept. This was to have presented an overview of archaeometallurgical developments in the Old World, both in regions accessible in the West, and those in the former Soviet Union. What is presented here is a book on the archaeometallurgy of the southern part of Asia, and this is made up of contributions written long after the conference, between 1996 and 1998.

The volume lacks full length contributions on the early metallurgy of countries such as Armenia, Georgia, Uzbekistan, and Russia, due to manifold (political and language) problems. However, at least abstracts are added at the end of the book (Appendix I) which were originally published in 1989 by Avilova and Terekhova in Russian. They have been translated by H N Michael. We can read short versions of contributions by well-known authors such as Abramishvili, Apakidze, Chernykh, Inanishvili, Mudshiri, Pitskhelauri, and Ruzanov. Here, we can only suspect the enormous importance and input which metal production in countries of Middle Asia and the Caucasus may have had on the cultures in the Near and Middle East. Fortunately, a number of contributions on Georgia have been published now elsewhere (Kavtharadze 1999), or are in press (Gambaschidze *et al* 2001). For problems of the Bronze Age Circumpontic and Eurasian Metallurgical Provinces, we may refer to Chernykh's book published in 1992.

The book is divided into seven chapters, which follow the introductory comments by the editor. He presents an over-regional outline of the crucial stages of the development of metallurgy, the transition periods from one metal or material, respectively, to the next. There are over-regional parallels: The use and treatment of native copper, arsenical copper metallurgy, the development of tin bronze metallurgy, and, finally, the coming of the age of iron. As the editor writes, he does not want to review all the literature related to these problems here, but the reader will value this short overview, which presents both some essentials from the papers that follow and further information.

In Chapter 1, James D Muhly deals with copper and bronze in Cyprus and the Eastern Mediterranean. He describes the problem of the spread of arsenical copper over the Old World (and beyond) during the Early Bronze Age. He suggests that it was probably produced by smelting arsenic-containing copper ores rather than by adding native arsenic to molten copper. Regrettably the discussion lacks the contributions of colleagues from Georgia: it would be valuable to see whether the rich occurrences of realgar and orpiment (arsenic-sulphides) at Racha, a locality at the southern slopes of the Great Caucasus, were used during this period. A large number of copper objects with very high arsenic contents have been found in present-day Georgia, and it would be peculiar if the striking red outcrops had not attracted the ancients. Tin was introduced to Cyprus during the Early Cycladic III/Middle Cycladic I. The metal was imported to Cyprus via Anatolia, where it arrived from an overland route from Syria, Mesopotamia and finally Afghanistan. Tin bronzes in the north Aegean, however, probably derived from the same source, but coming from the Black Sea. If this hypothesis is true, we badly need more knowledge from Georgia. It was probably this region which served as a trade route. Tin is known in Georgia, but, unfortunately only from later periods. The author suggests that gold instead of tin was exploited at Kestel.

Chapter 2 by Jane C Waldbaum is dedicated to the coming of iron in the Eastern Mediterranean. It provides a summary of 30 years of archaeological and technological research, and the author addresses all the crucial questions related to the beginning and the spread of iron metallurgy. Still unsolved for iron is that crucial point in archaeometallurgy: how to distinguish

transitional periods, *ie* the coming of new materials or metals. This is true for native and arsenical copper, accidental and deliberately produced tin bronzes, meteoritic and smelted iron. Waldbaum summarizes the present state of knowledge, but we can clearly recognize that archaeometallurgy here is still in its infancy. As to the question why iron finally replaced bronze, she presents again the three well known hypotheses: the first arguing that iron spread due to a shortage of tin (easy to refute), the second that it was steel instead of iron which replaced bronze, and finally using arguments of a fuel shortage (which is not convincing at all). The second seems to be the most interesting, as many of the earliest iron objects in the Mediterranean (set out in the appendix) consist of steel instead of ferritic iron (as convention dictates). This observation is supported by numerous finds from early iron-production sites in Middle Europe. Future analytical investigations may perhaps show that carburization might be an even better feature for distinguishing between meteoritic and smelted iron.

Chapter 3 by T Stech is on aspects of early metallurgy in Mesopotamia and Anatolia. The availability of raw materials in these regions is in sharp contrast. While the first has plenty of ore deposits, the latter is completely lacking in any metal. The author reports on the result of the Mesopotamian Metal Project of the University of Pennsylvania and provides a useful overview, comparing the development of metallurgy in these two regions. The beginning of metallurgy in Anatolia is marked by the appearance of native copper; more than 100 objects were found at Cayönü or Asikli, surely because of nearby sources of native copper in both cases, and their accidental use while searching for malachite. In Mesopotamia, by comparison, only a few objects of native copper have been found.

There is little metal production during the 5th and early 4th millennia in Anatolia and in Mesopotamia, in contrast to Iran. Was lead smelted before copper? Finds from Yarim Tepe I indicate this. Stech turns to the problem of arsenical copper, which appears at the beginning of the Bronze Age during 4th/early 3rd millennia BC all over the Near East: was it deliberately produced, or is it an unintentional alloy? In Anatolia this alloy occurs for a long time side by side with tin bronze. The question of its origin remains open, as everywhere. The earliest tin bronzes were found at Early Dynastic I Kish, but they are in the majority at the Royal Cemetery of Ur. At Troy, tin bronze was found from the Early Bronze Age II. The most probable source of the tin is Afghanistan, where a large number of ore deposits are known next to those of gold and lapis lazuli. It is this assemblage that was found at Ur.

While Stech and Waldbaum have focused their contributions mainly on discussions of metal objects, Pigott gives an enlarged view of technological aspects of the development of metal production on the Iranian Plateau in Chapter 4. Similar to Anatolia, this part of the Old World is rich in ore deposits (shown in several maps) and the roots are also deeply embedded in the Neolithic. The use of metals starts in close context with malachite—the main material for shaping beads and pendants. Pigott stresses the importance of crucible smelting in the early stages of metallurgy, as indicated by finds of sherds at numerous localities, *eg* from Tal-i Iblis. At first sight, the crucible shown from this site might be a bit unusual, but compared with recently excavated finds from the EBA site at Jebel Hamra Ifdan, Feinan, Jordan (unpublished data San Diego/Bochum) its shape does not seem impossible. Highlighted are two major ore deposits: the copper mining district at Veshnoveh and at Anarak, where Talmessi probably played a supra-regional role due to its rich resource of native copper high in arsenic, from the beginning of metallurgy. Of special interest is Susa (which should be included to better understand the Iranian developments). For the Bronze Age, the author presents examples from Tepe Hissar, Shahr-i Sokhtar and Shahdad, where copper was smelted inside the settlements in domestic contexts. Smelting of mixed oxidic and sulphidic ores played an essential role and is indicated by chemical equations. The coming of iron is discussed in the last part of this paper. Among the earliest iron objects in Iran are the Luristan daggers from the 11th century BC. In the 9th century BC, iron was produced in quantity, as shown by finds of 2000 iron objects at Hasanlu. Pigott doubts whether primary steel production was the key for the spread of the new metal. He suggests that new social structures developed in the Iron Age II and later were the reason for mass production in iron (and bronze as well).

Chapter 5 by J M Kenoyer and H M-L Miller reports on metal technologies of the Indus Valley: tradition in Pakistan and Western India. This contribution covers a timespan from 6500 to 500/300 BC with a primary focus on the Harappan Phase (2600-1900 BC), *ie* the chapter mainly deals with the metallurgy of copper. The authors try to provide a broad overview of a huge area which, from the archaeometallurgical viewpoint, has too many question marks. This is not only noticeable in the discussion of analytical data from a variety of sources (some are presented in the Appendix). Here,

they doubt the quality of the data, as often no detailed information on the methods used is available. It is surprising how many early objects were manufactured from relatively pure copper with only low concentrations of arsenic. The overview of potential sources shows the lack of information for this aspect, which is also true for other regions. It is interesting that they leave the possibility open that arsenical copper objects could have been made by adding arsenical ores deliberately to copper. It is regrettable that the Georgian contributions are not available: this is of major importance in a country which has numerous deposits of rather pure arsenical minerals which were available in ancient times and possibly were exploited due to their striking colour. The chapter on metal processing fills a serious gap in field evidence and scientific work on furnaces, crucibles, slags. More evidence seems to be available on final metal treatment such as casting and shaping. The authors finally discuss the role of metals during the Harappan Phase.

Chapter 6 by G L Possel and P Gullapalli covers the Early Iron Age in South Asia. This epoch, which starts in the first half of the first millennium BC, is characterised by four archaeological assemblages (Gandharan Grave Culture, Painted Grey Ware, Pirak Assemblages and Megalithic Complex) which are discussed in detail archaeologically. Extensive tables with radiocarbon data are listed in the appendix. The roots of iron metallurgy are suggested to be in copper smelting. This hypothesis is probably not wrong. At least we know from numerous archaeological finds (see Yule 1989 for Indian copper-iron objects) and from an increasing number of smelting experiments that copper smelting very often was (and is) connected with the precipitation of iron. The authors list iron or iron-containing objects from eight Bronze Age sites, and even from earlier sites iron artefacts are known. It is probably rash, however, to create a 'ferrochalcolithic period'. The manufacturing techniques of iron objects can be reconstructed by a limited number of metallographic analyses. They comprise the working of mild (primary produced) steel welded to high-carbon steel since *c 1000* BC. There is evidence of carburization and quenching some hundred years later. The reconstruction of a smelting furnace excavated at Naikund has parallels with well known types of the Iron Age in Middle Europe. The authors finally discuss whether the Iron Age might be defined more closely to its technical capabilities rather than to other cultural factors. The question is left open, and there is no answer yet on diffusion or indigenous invention.

Chapter 7 by B Bronson is entitled The Transition to Iron in Ancient China. It starts with the (rather peculiar) statement that bimetallic objects of meteoritic iron and bronze were found between 1500 and 771 BC in China. Unfortunately, no details are mentioned as to how the meteoritic iron could be identified. The earliest finds of iron objects from the 7th to the 3rd century BC are listed in three tables; 8th/7th century BC objects are often from insecure archaeological contexts. The expansion of iron use was in the 4th and 3rd centuries BC and is accompanied, as in the western part of Asia, by mass production of bronze. The objects are mostly composed of cast iron, and, most interestingly, no actual examples of bloomeries or bloomery slags are known in China. The floruit of iron is dated to the 2nd and 1st centuries BC. This is later than in many other countries, but from then onwards ironmaking in China had little in common with the rest of the world: white cast iron might have been the first type of iron known in China east of Xinjiang, and low-carbon iron was the output of fineries rather than bloomeries. One of the amazing observations is that there is no evidence in South Asia that local peoples made cast iron before the 17th century AD. China's iron technology never penetrated India or Africa, still less Middle Europe.

Pigott's book provides a useful compilation of the archaeometallurgy of South Asia. It is to be recommended for students and scholars interested in the field, especially for those working in archaeology. The reader will recognise that the pioneering work of Bachmann, Maddin, Tylecote, Wertime and others is still valid, but in some places, old suggestions should be removed from the literature, *eg* the peculiar smelting furnace from Shahdad (and Rothenberg's Chalcolithic smelting furnace as well). The book addresses basic problems and shows some are unsolved, *eg* the old problem of arsenical copper. Here, one misses solutions, new views, and the input of modern investigations in the literature, especially from the scientific part of archaeometallurgy. This is a weakness of Pigott's book: what almost all chapters have in common are, on the one hand, claims that 'much has to be done' in order to clarify the today's problems in archaeometallurgy but the scientific input is insufficient. Archaeometallurgy still needs rigorous scientific input, not only to clarify the provenance and production technology of tin, one of today's hot topics. Even after decades of research on copper, neither its sources nor its early technology are explored sufficiently. In addition, the questions how and why the utilisation of new materials arose (copper, arsenical copper, tin bronze, meteoritic iron, steel *etc*) still need to be answered. Ancient technologies are often

oversimplified and cannot sufficiently be described by chemical equations but there really is more to it than chemical analyses, and 'scientific' archaeometallurgy has improved considerably. It is a pity that Muhly criticizes some chemical analyses of metal objects that sum up far above 100 weight % (even up to 238!!), and it is simply wrong that Omani ores are free of arsenic, just to give two examples of problems in communication. But I am convinced that a closer co-operation between scientists and archaeologists in the future, an intensified interdisciplinary work, and the training of students (and scholars) in archaeological science, will contribute much to solving these problems and questions.

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Archaeology and Conservation in Ironbridge by Richard Hayman, Wendy Horton and Shelley White. *Council for British Archaeology (Research Report 123), York, 1999. xvii + 221pp A4, 172 figs. ISBN 1 902771 05 2. £28-00 (pb).*

This handsome, well-produced and generously-illustrated publication studies, in its own words, 'six of the key archaeological monuments in Ironbridge'. All of them are held in trust by the Ironbridge (Telford) Heritage Foundation, a body established, with a Government 'dowry' when the Telford Development Corporation was wound up, in order to insulate the nationally and indeed internationally important sites from resourcing problems in the future.

This report is to be seen as a timely and essential tool to assist with the effective management of the sites and is most certainly to be welcomed and applauded.

The layout of the report is straightforward and therefore easy to follow. After a general introductory chapter, each site has a chapter with an introduction, the documentary evidence, the site, and its interpretation. These chapters are comprehensively illustrated with photographs, maps and line drawings. Towards the end of the book threads are drawn together with contextual chapters on the coalfield, the iron industry, and the place of art as a resource. Finally, there is a review of techniques and discussion. The report reads well in its own right, and provides ready access to the extensive bibliographical sources for this most important and extensively researched area. One might ask what more can be said.

There is an important matter which the authors do not address. It is the question 'where does history begin?', an issue much discussed during the recent English Heritage *Power of Place* initiative. The missing narrative is the pioneering story of the development of the Gorge during the 1970s and 1980s. Inescapably, this period is referred to, and not altogether positively, because, by today's standards, the approach to the archaeological evidence was too often neither structured nor adequate. For example, in the case of the Bedlam furnaces, where investigation was carried out, the result was a dubious interpretation which was actually published in this Journal. Similar issues are perceived by the authors with regard to the Upper Furnace and its cover building and to the Hay Inclined Plane—'unfortunately the archaeological evidence that could substantiate this is mostly lost' (p74).

But there is a history here which is worth reciting. The Ironbridge Museum experience was like nothing which had gone before it. Comparable 'Open Air' museums in UK, at Beamish, Weald and Downland, or St Fagan's, were 'green field' developments. Ironbridge Museum not only focused on the eponymous structure, but also much of the realization was to be based on the consolidation and display of important but largely ruined archaeological monuments in situ. No other organization outside the DoE or the National Trust was in that sort of business, certainly on the scale envisaged. And because of the need for an effective income stream, much of the work was, in today's parlance, 'developer led'.

Even the experienced national organizations had, at that time, not fully squared up to the concept of detailed recording as part of the process of consolidation and

display. There were certainly state-of-the-art excavations at guardianship sites. Ironically, and close to Ironbridge, at Wroxeter, Philip Barker set an outstanding example, but there the relationship of the excavation work to conservable remains was unclear and it was, after all, a Roman site. It was not seen as entirely relevant, but it was seen as hungry of time and money, both of which were scarce at Ironbridge. In reality, the case for applying archaeological excavation techniques on industrial archaeological sites had still to be made, although pioneers, notably David Crossley, had been excavating with impressive results since the 1960s. A paper by this reviewer, published in 1978 in *Industrial Archaeology Review*, drew attention to the problem.

Until the 1980s, the pace of change could not be forced from the centre, because of the lack of an effective set of controls. The 'old' Ancient Monuments Act, based on the statute of 1913, with its deference to owners, did not require a 'consent' procedure. That all started with the implementation of the current, 1979 Act in 1981. MPP and PPG 16 quickly followed as corollaries. As a result, any work on any scheduled site can now be informed and directed in a manner undreamt of before 1981, and that was when much of the work at Ironbridge was carried out.

Seen in this context, the early development of the Ironbridge Museum is the more remarkable, for what it achieved and with such little significant loss. But the narrative briefly outlined above should properly have been included in the preface to the report and not in this review. It is, after all, another pioneering episode in the continuous history of this fascinating area.

Peter White

Copperopolis: Landscapes of the early industrial period in Swansea by Stephen Hughes. *Royal Commission on the Ancient and Historical Monuments of Wales, Aberystwyth, 2000, x + 358pp, 270 x 245mm, 338 figures. ISBN 1-871184-17-7. Price £38.30 (incl postage) from RCAHMW, Crown Building, Plas Crug, Aberystwyth SY23 2HP.*

The first chapter of this substantial and well-illustrated book is a comprehensive description of the early Swansea industries, of which copper smelting was perhaps the most important, although coal mining must also have a strong claim. It was the copper industry that made Swansea different from other South Wales ports in the 18th and 19th centuries. It caused the expansion of a small seaside resort and in the end produced the worst area of industrial dereliction in Britain. Omitted, surprisingly, is the Port Tennant Works. This was built in 1852 to refine 'Chili bar'–blister copper from Lambert's Chile copper works. It processed copper and sold it in the best possible market: Swansea. It was closer to Swansea than most. The Cape Horners which brought the Chili bar must have docked in Swansea. It foreshadowed the demise of smelting in Britain, but was demolished to make way for the King's Dock in 1904. An otherwise good account is marred by some factual errors. Half a paragraph is based on pewter being a copper-lead alloy, when it is in fact an alloy of tin and lead. Later in the chapter we are told that the tinplate works used tinned steel strip from Port Talbot. Tinning was the last process at the tinplate works. There is a claim that the introduction of the copper blast furnaces reduced sulphur emissions. The Gerstenhofer kilns that really caused the reduction are referred to in Chapter 7.

The following chapter is an account of the closely-related transport and power requirements of industry. The river Tawe, which provided transport for the establishment of the copper-works, was used until after the building of the railways, for the movement of seaborne goods. The copper-works were built on the W bank and on a short stretch of the E bank where there was suitable land. N-S communications other than by river were very poor. Many of the early copper works drew their coal from mines in the slopes above them. On the E bank the mines were some distance away. This led to early development of 'wooden railways', possibly with guide flanges from the beginning. When these wooden tracks were converted to iron is not clear, but the Swansea area was amongst the first to do so. By the middle of the 18th century, tramroads, some of which have become today's roads and footpaths, ran from many of the mines down to the river or to the works. It was in this difficult terrain that the earliest canals were built: short canals took the coal to the river or the works, one on each bank. These ended underground, and there were other 'boat levels' in this very wet ground, seemingly predating better-known examples. The main N-S link beyond the river navigation came in 1794-8 with the building of the Swansea canal. The railways caused a major change in the transport pattern when they opened up the SE bank of the Fendrod Stream. Building-land away from the main river could then be used by the zinc, iron and steel, and other new industries.

The second half of this chapter covers the water requirements of the works. Some leats ran for many

miles, and some were quite large. Often the leat was reused several times, but few mill-pools were built. The canals were also used as leats, and at least one leat seems to have been used as a canal. The network of natural and artificial waterways is detailed in the text. This is an excellent account of a difficult subject.

The third chapter is devoted to the achievements of architects and engineers, mostly self-taught, who built the infrastructure, the works, the machinery and some of the public and domestic buildings of the town and the valley.

The fourth chapter, by far the longest, is an examination of the industrial housing provided by different industries. The needs of coal and copper brought about different settlement patterns. The treatment of the types and standards of housing provided by industrialists and by the workers is comprehensive, starting with early colliery housing and extending to the houses of Vivianstown. It concludes that, overall, the provision by industrialists was at least up to contemporary standards and often better. It was superior to much of the speculative workers housing in Swansea town. To some extent this was attributable to the need of works proprietors to sustain their reputations. The second part of the chapter assesses the impact on the landscape of the planned settlements belonging to the copper-works. It continues with an account, necessarily brief, of the domestic arrangements of the coppermasters, and concludes with an assessment of the impact of the copper industry on the lives of the people of Swansea.

Chapter five, devoted to institutions, begins by examining the provision of schools. On the whole, the works and Chapel schools seem to have been of at least a satisfactory standard for the time. The motives of industrialists for provision of schools were in part paternalistic, but also to secure an educated work-force. The best schools, like the best housing, were provided by works with resident managing partners. The building and refurbishing of Anglican churches is examined. There were four reasons why churches were built in the period: as family memorials, for the proprietors, for the workers, and for the town and general populace. Once again, support was dependent on the interest of a resident partner. Although the industrialists contributed generously, they did not always pay for the church. Some buildings were not completed, and the debts often took congregations many years to clear. There is a substantial account of the work of the architects of the numerous nonconformist chapels, although not every building could be covered, because of the numbers that were built and rebuilt. Chapels were largely financed by workers: many of the earliest were built by the worshippers themselves, at low cost. In contrast to Anglican churches, chapels were regularly full to overflowing, despite their often considerable size. As congregations became larger and more affluent, they were able to employ professional help, and the later chapels dominated the townships they served. The nonconformist tinplate manufacturers who followed the copper magnates gave generously to fund such buildings as the 'cathedral of non-conformity' Tabernacle in Morriston.

Chapter six is a detailed account of the development of the Landore area and the surviving remains.

In conclusion, the author discusses the reclamation of the area, which was accompanied by the destruction of many sometimes ugly but historically very significant remains. He compares Swansea with other industrial areas, and concludes that local entrepreneurs were more aware of their social responsibility than in most other districts. I cannot pretend that this is a readable book, and the typographical and other minor errors hardly help. However, as a comprehensive and copiously-illustrated industrial history of the Swansea Valley, you will find nothing better.

Peter Hutchison

The ferrous metallurgy of early clocks and watches: studies in post medieval steel edited by M L Wayman. *British Museum (Occasional Paper 136), London 2000. iv + 216 pp, A4, 133 figs, tables, appendix, glossary, index. ISBN 0-86159-136-4. £22-50 (p/b).*

Between the 16th and the 19th centuries the development of timepieces placed new demands on the makers of steel, to produce material of improved homogeneity and to strive for better methods of heat treatment. The aim was, in part, to improve durability, but also to give more predictable behaviour during machining to ever-finer tolerances. The development of sophisticated watches during the 18th century made the achievement of uniform quality particularly important.

This well-illustrated volume comprises six chapters, essays by different combinations of collaborators with the editor and originator of the project, Michael Wayman. The introduction is divided into two sections. The first aims to outline the post-medieval evolution of clocks and watches, but in fact only covers the changes from medieval practice which occurred in the 16th

century, concentrating on the final development of the verge escapement. In this section the authors give only outline attention to later developments, which were to make possible the precision work of the 18th century makers of chronometers. The second section, however, is an excellent succinct outline of iron smelting and steel making processes, in terms which pose few problems to the non-specialist. It is particularly recommended for its guide to heat treatments, with an explanation of terms.

The second chapter elaborates on this metallurgical outline, concentrating on types of steel, emphasising the importance of natural (bloomery) steel at the beginning of the period, and the various forms of carburization, from case hardening to cementation. The Asian forms of crucible steel are outlined, as a contrast to the methods of Benjamin Huntsman. This is followed by a chapter comprising examination of 31 components from seven 16th century clocks, whose structural parts were of iron, but which employed steel for gears, arbors and springs. Chapter four concentrates on springs; attention is given to 18th century developments in spring manufacture, and to the problem of distinguishing replacements from originals. This topic is expanded by the inclusion, as an appendix, of Blakey's illustrated text 'Art of Making Watch Springs'. The fifth chapter comprises reports on the metallurgical examination of components from five high-quality 18th century watches, introduced by a succinct outline of the changes which brought timepieces to a new level of precision, a consequence of the need to develop a marine chronometer.

The final chapter goes some way to widen the discussion, drawing parallels with the use of steel in swords, armour and knives. It cautions against assuming too ready an acceptance of crucible steel in the 18th century, with a reminder that its attraction was at least as much for its appearance as for its physical properties. It has indeed been shown elsewhere that even on its home ground, in Sheffield, makers of blades were reluctant to adopt Huntsman's steel until late in the century.

This is a pioneering publication, confirming in detail what has often been indicated in outline, that for much of the period 1500-1800 the requirements of the clock and watch maker exceeded the capability of the steel industry. There is however another relationship, which deserves to be mentioned here and was of growing importance in the 18th century, between the improving quality of steel and the development of industrial machinery. In textile production, for example, mechanization was held back by lack of precision in engineering, rough-running machines being incapable of spinning thread without breakage or of weaving fine cloth. Precision here was as vital as in the production of timepieces, and high quality steels were important not only for machine-components but for the tools used in their manufacture. It is significant that at the end of the 18th century textile-mill machinery was often known as 'clock work', indicating where contemporaries saw the source of mechanical innovation.

David Crossley

The archaeology of mining and metallurgy in South-West Britain edited by P Newman. *Issued as Mining History: Bulletin PDMHS, vol 13(2) and as an HMS Special Publication, 1996. ii + 167pp, A4, many maps, figures and plates. ISSN 1366-2511. Price not stated.*

A glance at the contents page of this volume gives the first indication of the range and scope of the conference that it records. One could be forgiven for thinking that a publication entitled *The archaeology of mining and metallurgy in South-West Britain* would be concerned primarily with the renowned tin and copper industries of Cornwall and Devon. This is not the case here. The geographical coverage of the papers presented extends from North Somerset and the Mendips to the Dorset coast and down, through Devon, to the west of Cornwall. The range of topics covered is equally comprehensive, incorporating stone quarrying, coal mining, iron exploitation, silver and lead mining, exploitation of micaceous hematite and a variety of subjects relating to tin and copper mining and smelting.

With 24 papers, all abundantly illustrated, it is not possible to consider each contribution individually. However, taken together, the papers represent a statement of current work when the conference took place in 1996. They also reflect the motivation and impetus behind much of the work and it is both telling and refreshing that issues of site and landscape management and presentation, widening access and local participation rank alongside more customary academic research.

In terms of current work, the papers cover a number of recent surveys of field evidence for mining, quarrying and metal production across the region, including stone quarrying in Dorset (Stanier, Phillips), the collieries of North Somerset (Gould), iron working on the

Blackdowns (Griffith and Weddell) and on Exmoor (Wilson-North), mining and streamworks on Dartmoor (Newman) and Bodmin Moor (Herring), and engine houses in South Devon (Nance and Nance). The presentation of many of these field studies is enhanced by excellent survey plans, notably those produced by the Exeter office of the RCHME (now English Heritage) and those by Gerrard in his comprehensive overview of the 'early' (in this instance AD1000 to AD1700) tin industry of the region. In particular, the RCHME has gone on from this conference to carry out many more detailed surveys of mining and metal production sites which, for those who work in the region, is providing a consistently high-quality database that both acts as a valuable research tool and is used to inform landscape management issues. From a personal point of view, contrasting the annotated plan of the Goonzion Downs lodeback workings (Gerrard on p 70) with the aerial view of iron ore extraction pits on the Blackdowns (Griffith and Weddell on p 32), while the former is probably ultimately more informative, the latter has far greater impact and gives the reader an opportunity to make comparisons with similar features seen in the field. Large-scale mining sites really do benefit from aerial photography.

Many of the remaining papers deal with more detailed studies of specific locations or types of field evidence, artefactual or structural. These range, chronologically, from an account of recent work on the Roman exploitation of lead/silver ores at Charterhouse-on-Mendip (Todd) in Somerset to the still-active De Lank granite quarry in Cornwall (Stanier). Along the way we have a report on the field evidence for medieval technological innovation (Claughton), three papers on aspects of medieval and early-industrial tin mining and smelting (Gerrard, Greeves and Smith), a fascinating account of the production of slag building blocks as a by-product of the copper smelting industry at Hayle in Cornwall during the 18th century (Ferguson) and a systematic review of the construction and function of the archetypal Cornish engine house (Brown). Artefacts are represented by a detailed technical study of iron ropes and their contribution to the development of mining technology (Morgan) and a short but valuable account of the 42 tin ingots recovered by divers from Bigbury Bay on the south Devon coast in the early 1990's (Fox). The dating of these ingots, a number of which are now on display in the Royal Albert Memorial Museum in Exeter, remains unresolved, with the author of the paper suggesting anything from the 5th century BC to AD600.

Two papers describe the activities of local interest groups. The first deals with the adit clearance project of the Cornwall Mining and Caving club at Polgooth (Russ and Morton) and the second with the restoration of the above-ground structures at Kelly Mine on Dartmoor (Roberts). The spirit of participation demonstrated in these two papers reflects a changing emphasis in archaeology from exclusivity to inclusion, to use current terminology. The same shift of emphasis has also led to the recognition that the historic landscape is an important cultural resource. In turn, areas of mining and industrial activity are increasingly seen as historic landscapes in their own right, even if now they fall within designated National Parks or Areas of Outstanding Natural Beauty. Three papers in this volume describe some of the curatorial responsibilities of investigating, managing and presenting industrial landscapes. On Exmoor, understanding the nature of the archaeological record in a relatively unexplored area is identified as the essential prerequisite to good management (Heal). From Dartmoor we learn about the practicalities and funding of management and conservation work, including the contribution made by local enthusiasts (Griffiths), and from Cornwall issues of health and safety associated with industrial sites are added to the list of management concerns (Sharpe).

It is significant that in all the wealth of information contained in this volume one episode in the region's metallurgical past remains under-represented and thus presumably under-investigated. That episode is of course the prehistoric origins of metallurgy in the South West. Apart from the work at Charterhouse-in-Mendip, only one paper deals with this subject (Craddock and Craddock) and that is a revision of a paper first presented in 1992 and is concerned primarily with evidence drawn from elsewhere in the British Isles and further afield. It does, however, suggest areas for future investigations and ways in which evidence can be interpreted or reassessed. In this one field the South-West still falls behind other parts of the country, which is perhaps inexcusable given that there is no lack of local expertise or curiosity—as demonstrated by this conference.

My only criticism is of the inconsistent quality of the print (of my copy at least). It gives the volume an amateurish appearance which belies the quality of the information it contains. In contrast, all of the illustrations, including many halftone plates, are of exceptional quality.

This volume is for anyone with an interest in the

industrial past of the South West region, in particular its physical remains. It also provides a valuable starting point for any student wishing to undertake research in the mining and metallurgy of the South West. It tells you what has been done, by whom and where, and indicates what remains to be done—the first questions any student should ask. Finally, it should be in the libraries and on the bookshelves of every agency and professional involved in and serious about environmental and historic landscape management in this part of the world.

Gill Juleff