Abstracts

GENERAL

Anon. "Gold" is a many-alloyed thing. *Technology & conservation,* 1977 **2** (3) p. 10.

A diagram illustrates color characteristics of metal as a function of alloy concentration. The metal should also be evaluated in terms of the legal requirements of alleged country of origin; data are provided.

AATA

J. Bayley. What's what in ancient technology: an introduction to high-temperature processes. In. *The archaeologist and the laboratory,* Research report (Council for British Archaeology) no. 58 1985, P Phillips (Ed) 41–44.

Interest tends to focus upon the process rather than the period in the examination of industrial remains. End products of high-temperature processes include metals, glass, ceramics, and lime plasters and mortars. Alkali, iron, or lead silicates are indicators of various manufacturing processes, which are briefly described.

AATA

M Brand, G Gerrans, K McCarogher, and C Pool. From Plato to Pofadder: zinc today and through the ages. *Spectrum,* 1991 **29** (2) 17–22.

Article briefly explains history of zinc use and gives current industry applications. Gives five demonstrations of zinc properties which can be used in a classroom setting. These are: the oxidation of zinc, galvanizing iron wire, reacting Zn^{2+} ions with S^{2-} ions, commercial dry cells, and the reaction of zinc and manganese dioxide in a dry cell. Information on the occurrence and mining of zinc in South Africa is given with detailed explanation of the electrowinning of zinc from zinc sulphide. This process accounts for 80% of current world production.

AATA

V F Buchwald. Meteoritter—nøglen til Jordens fortid [Meteorites—keys to the earth's past]. 1992, 247 pp, Viborg: Gyldendal.

This book concerns itself with all aspects of meteorites; historical records, finds in Scandinavia and other parts of the world, their composition and mineralogy. There are chapters on tectites, chondrites and iron meteorites as well as one on the amuletic and practical uses made of them. It is lavishly illustrated with diagrams, plates and micrographs, some in colour, and also contains analytical data which could be of use to archaeometallurgists wanting to know if an object is made of meteoric iron.

JB

G Devoto. Le tecniche orafe antiche (nel riconoscimento di falsificazioni archeologiche). [Ancient goldsmith techniques used in the discovery of archaeological fakes] *Acta geoArcheologica urbica* 1990, **1** (2), 24–26.

The author presents an overview of some basic technologies of ancient goldsmithing, discussing particular treatments and technological features in order to discriminate genuine artifacts from fakes. The discussion takes into account thin sheets in gold, silver, and electrum, describing the complex process of hammering-heating used by ancient goldsmiths.

AATA

L Goulpeau. Le magnétisme rémanent des monnaies. [Remanent magnetism in coins] *Mélanges offerts au docteur J.-B. Colbert de Beaulieu, directeur de recherche honoraire au Centre national de la recherche scientifique,* C Bemont, J Bousquet, and P Naster, Eds 1987, pp 419–428.

The method has been applied to struck coins, less for dating purposes than for understanding the physics of the solid; but cast coins should also be examined.

AATA

S La Niece. Silver plating on copper, bronze and brass *Antiq J,* 1990 **70**), 102–14.

A study of silvered items of all periods which reviews the current knowledge of the history of silvering techniques and uses metallography and analysis to examine a large number of plated objects. The main methods of silvering copper, bronze or brass are identified and described, and their historical occurrence is outlined. Methods of distinguishing between the various silvering techniques are discussed.

BAB

L H Nelson. How hand-wrought nails were made from bar iron in the 18th century. *CRM bulletin: a National Park Service technical bulletin,* 1991 **14** (4), pp. 18–19.

The author of a standard reference on nail chronology describes and diagrams the production of nails based on archaeological evidence and 16th- through 18th-century technical references. The description begins with iron bars hot rolled into nail plates which were cut in a slitting mill into nail rods. A blacksmith then forged nails individually from convenient lengths of rod by heating one end, hammering it to a point on the anvil, nicking the rod at proper nail length, reheating it, inserting the point into a heading tool, twisting off the excess rod, and hammering the exposed end to form the head. A diagram illustrates the materials and tools employed in each step.

AATA

J P Northover. The complete examination of archaeological metalwork. In proceedings. *The archaeologist and the laboratory,* Research Report (Council for British Archaeology), no. 58 1985, P Phillips, ed. 56–59.

Presents an overall approach to archaeometallurgical work in the context of an excavation or research project. The methodology includes ways of developing the external and internal examination of metalwork, the back-up that must be provided via experimental physical metallurgy, and ways in which the conclusions may be presented. The questions asked by the archaeologist are compared to those asked by the metallurgist.

AATA

W A Oddy. Vergoldungen auf prähistorischen und klassischen Bronzen. [The gilding of prehistoric and classical bronzes.] In book. *Archäologische Bronzen, antike Kunst, moderne Technik,* H Born, Ed 1985, 64–71.

A short history of the gilding of bronze objects. The beginnings of this technique in the prehistoric Near East is described in comparison to the geographically isolated China, and is followed through late Roman classical times. All the scientifically proven techniques are dealt with, e.g., foil-gilding, gold leaf gilding, diffusion bonding, the

cold mercury method, and fire gilding. The classical literary sources as well as the more recent natural science analysis methods are discussed.

AATA

W A Oddy. An Outline of the Technological History of the Plating of Gold on to Silver or Copper in the Old World. *Endeavour,* 1991, **15** (1), 29–33

In the Old World, gold was used for ornamental purposes as a symbol of wealth. The physical properties of the metal enabled it to be easily hammered into thin sheets and this led to the application of gold to the surface of base metal objects in order to improve their appearance and enhance their apparent value. Gilding technology developed from the simple wrapping of gold leaf to the surface in a number of ways. Eventually fire-gilding was developed, and was used for 1500 years until supplanted by electroplating. This is an informative and authoritative review (23 references) from the Department of Conservation of the British Museum.

GB

J E Rehder. Iron versus bronze for edge tools and weapons—A metallurgical view. *J. of Metals*, 1992, **44** (8), 42–46.

Discusses the processes which were used to fabricate iron and bronze edge tools and particularly weapons. It seems likely that in both iron and bronze weapons' hard cutting edges were produced by cold work, and in this respect iron would be as good if not superior to bronze. The ability to harden the edges of iron tools by quenching and tempering was not widely exploited, and the reasons for this are discussed. The greater stiffness of iron and the ability to hammer weld and hot forge the metal made it superior to bronze.

APG

W Rostocker, and J R Dvorak. Some experiments with co-smelting to copper alloys. *Archeomaterials,* 1991, **5** (1), pp 5–20.

Can various minerals be smelted together to produce copper alloys? The potential for cosmelting of different minerals to produce mixed alloys is expressed by subtracting the free energies of the reactants from the free energies of the reaction products. When the difference is highly negative, it is likely that cosmelting will work. After discussing the theory, the authors recount their experiments on cosmelting to produce the copper-arsenic alloys, tin bronzes, and brasses. The feasibility of cosmelting of the copper-nickel alloys has been demonstrated before. Sulfur can be a reducing element in cosmelting, and some of the cosmelts produced with sulfide minerals have extensive sulfides of various elements included in the metal, along with thick sulfide matter on the surface. A test smelt of malachite with galena yielded copper with a high lead content, present as lead sulfide in the interdendritic phase; the authors conclude that galena can simply dissolve in molten copper. Structures of the cosmelted alloys produced are nicely illustrated by metallographs.

AATA

K. Ruthenberg. Entwicklung der Bronzeanalyse von den Anfängen bis zur Gegenwart. [The development of bronze analysis from the beginning up to the present day]. In. *Archäologische Bronzen, antike Kunst, moderne Technik,* H Born, Ed 1985, 190–197.

As early as the 18th century, M H Klaproth, who later became Berlin's first chemistry professor, experimented on some ancient objects, principally coins. The most common analytical methods available then and still in use up to the start of this century were those which involved the use of solutions. The work of E. von Bibra deserves acknowledgement; in 1869, he compiled most of the previously known methods, and included many of his own. Although the answers to many archaeological queries were sought at this early stage with the available methods, little other than the definition of copper alloys was discovered. The introduction of physical methods, from the mid-20th century onwards, helped make studies more comprehensive. The work done by the groups of Sangmeister and Craddock have laid a sound foundation for the further use of natural science techniques in archaeological studies.

AATA

J V Thompson. Silver mining by older methods, *Engng. Mining Jrnl.*, 1991 **192** (6), 39–41.

The ancient silver recovery methods, including the Patio process, are described. Where possible, chemical equations are presented to describe the processes.

JKA

G Zimmer. Schriftquellen zum antiken Bronzeguß. The casting of bronze statues as described in classical literature. In. *Archäologische Bronzen, antike Kunst, moderne Technik,* H Born, Ed. 1985, 38–49.

Texts referring to bronze casting which are found in classical literature do not provide a full account of the technique used, but at the most inform about singular aspects of this important craft. The information conveyed is influenced by the fact that the texts were written by authors who belonged to another social status and were their observations of processes which influenced the technical procedure. The use of literary sources can therefore be seen not as an interpretation of the technique used, but as a method of verifying and enhancing the archaeological findings. The most important texts are those which describe factors which either directly or indirectly affected the technical development of bronze castings, for example, the staffing and working conditions in the foundry and background information as to commissioning of the bronze.

AATA

BRITAIN AND IRELAND

J K Almond. Chemistry and the production of metals in *Milestones in 150 years of the chemical industry*, (eds.) P J T Morris, W A Campbell and H L Roberts 1991 (Royal Society of Chemistry Special publication no.96), pp 161–180.

After noting the expansion in the quantities of metal produced world-wide, from c 3 million te in 1841 to more than 825 million te in 1989, and in the numbers of metals produced industrially during the same period, twelve applications of chemistry to metal production since 1841 are outlined. Eleven of these relate to practical techniques, as follows: refining crude molten iron by blowing air through it, removing silver from molten lead by addition of zinc, removal of phosphorus from molten iron by use of lime, production of liquid aluminium by electrolysis of alumina dissolved in fused fluorides, production of alumina trihydrate from bauxite by hot aqueous sodium hydroxide, concentration of gold from ores by aqueous alkali cyanide, separation of nickel from copper by use of carbonyl compounds, production of zinc by leaching oxidised minerals with aqueous sulphuric acid, reaction of calcined dolomite with silicon at 1200–1400°C under vacuum to yield gaseous magnesium, reaction of titanium tetrachloride with either sodium, calcium or magnesium to yeild titanium, and use of anion-exchange resins to concentrate and purify uranium compounds from large volumes of weak solutions resulting from leaching. Of these applications, eight were made in the 75 years between 1841 and 1915, while the other three had taken place by 1955, which clearly suggests that the most active development period in this field was the second half of the 19th century. Henry Bessemer's work c 1855–1860 in refining molten iron by blowing air through it is briefly described, and the subsequent developments in 'converting' processes are noted. A twelfth application of chemistry whose introduction is summarised is theoretical in nature; this is the concept of 'free-energy diagrams'. First shown in an elegant and clear diagrammatic way in 1944 by H J T Ellingham. Biographical notes are given on Ellingham, and on F D Richardson, who took up and extended the method of presenting thermodynamic information about the likely yield from chemical reactions in particular circumstances. It should be noted that Dr John Percy qualified in medicine in Edinburgh, and not where stated on p 161.

Author

Anon. Making a century-old bark sea-worthy and see-worthy again. *Technology & conservation,* 1989. **10**, (1) pp 8–10.

The *Elissa*, an iron bark or barque, had begun her career in 1877 as a 19th-century squarerigger but underwent four major transformations; in 1988, work was undertaken to restore her original appearance and function. Extensive rebuilding was necessary to guarantee the soundness of the ship's bottom; this was determined by ultrasound studies of the plates. Laboratory studies of welding procedures were performed to determine how this method would work on the wrought iron plating (riveting was not feasible). The work done in Greece to enable her to be towed to Galveston, Texas, is summarized as well as the subsequent work in Galveston. The fire security systems which have been installed are described.

AATA

S F Badham. London standardisation and provincial idiosyncrasy: the organisation and working practices of brass-engraving workshops in pre-reformation England *Church Monuments,* 1990 **5**, 3–25.

Puts forward an analysis of the brass-engraving industry from the stylistic evidence of the engravings themselves. It is suggested that the end of the London monopoly can be seen in the 1460s as provincial centres of manufacture increase in size and number. An incidental, reciprocal effect of this approach has also been to expose weaknesses in current stylistic evidence. The article covers workshop organisation before the 1460s and in late fifteenth century London, the growth of provincial centres of engraving in the late fifteenth century AD, designers, workshop organisation in the provinces, the nature and use of patterns, and training practices in the fifteenth and sixteenth centuries. Early sixteenth century London workshops are considered, although for such an interesting and important period in the industry evidence is scarce.

BAB

J Bayley, and S Butcher. Romano-British plate brooches: composition and decoration *Jewellery Stud.* 1989, **3**, 25–32.

A study of the relationship between alloy composition, decoration and typology. Over half of the plate brooches analysed were of a mixed alloy containing zinc, tin and lead with copper. Almost all plate brooches show at least one sort of applied decoration, often *champlevé* enamel. There are suggestions with some of the enamelled brooches that those of British origin can be distinguished from those of continental origin on the basis of their composition. Includes an appendix giving the 'Analytical results'.

BAB

J Berners-Price, R G Houghton and J S Hodgkinson. Cuckfield furnace site survey 1989. *Wealden Iron*, 1991, 2 ser, **11** 7–9.

Minor revisions are required to a previously published survey of this typical Wealden furnace site.

BAB

R Brownsword. The Warwick Castle cauldron. *Medieval Archaeol,* 1991, **35**, 114–18.

Analysis of the cauldron indicates that it is likely to date from *c* AD 1400 as it is a heavily-leaded bronze with a high tin content. It is unique in having four arms round the circumference which probably rested on a frame straddling the fire. It is compared both compositionally and typologically with other cauldrons from Trinity Hospital, Leicester and Lacock Abbey, Wiltshire.

BAB

R Burt. Cornish company records in the Guild Hall Library, City of London. *J Trevithick Soc,* 1992, **19**, 32–43.

The Guild Hall Library houses archives which include considerable details of all companies whose shares were quoted on the Stock Exchange from the second quarer of the 19th century. The Economic History Department at the University of Exeter has undertaken a survey of these company records and has produced a listing of mining records for the whole of the UK. An appendix summarises the information available for Cornish copper, tin and lead mining companies for the period 1824–1914.

JB

R Brownsword and R F Homer. The Norwich Castle flagon. *J Pewter Soc,* 1991, **8** (2), 62–5.

A flagon recovered from the castle well is described. Decoration on the zoomorphic handle suggests it dates from the fourteenth century, but its place of origin is unknown. Its composition is compared with other contemporary pewter objects.

BAB

H Clyne. Dating furnace slag. *Wealden Iron Res Group Newsl.* 1991, **14***, 3–4.

An outline of the process of dating furnace slags by thermoluminescence, which is shortly to be used on the Wealden material.

BAB

R Creed and A Coult. Steeltown the story of the men and women who built an industry (Scunthorpe). (Cherry Burton, Beverley: Hutton Press, 1990).

Both technical history of Scunthorpe's iron and steel companies, and social history associated with them, are recorded.

JKA

N Crummy, M Archibald, M Hammerson,M Winter, P Crummy, R Goodburn, R Reece, R Kenyon, J Bayley and J A Davies. The coins from excavations in Colchester 1971–9. Colchester archaeological report, no. 4, Colchester Archaeological Trust, Colchester, 1987.

Over 3,000 coins were found in the period reviewed and a number of contributors examine different aspects of them, with particular attention to irregular issues of Claudius, in the 3rd century, and Constantinian. Topics discussed in individual chapters include: the coins as dating evidence, the treatment of the Celtic coins, the Roman coins, the Claudian coins and their analyses, the barbarous radiates and the Carausian-Allectan series, the Constantinian copies, and medieval and some early postmedieval coins and tokens. All post-Roman coins and tokens are summarized and the hoards considered.

AATA

G Egan and F Prichard. Dress accesories *c*.1150–*c*.1450. London: HMSO for the Museum of London, *Medieval Finds from Excavations in London,* 1991, **3**, 410 pp.

The third of the thematic volumes on medieval finds from excavations in the City of London. As in the two previous volumes the emphasis is on finds from the waterfront area, where metals and organic materials have been preserved in exceptionally good condition. Initially, the 'Dating and context of the finds' is briefly discussed by Geoff Egan (1–12), followed by a discussion of the 'Alloy nomenclature' used to describe the object compositions by Justine Bayley (13–17). After 'The metal dress accessories – some observations' by Geoff Egan (18–34), the individual categories of finds are discussed in detail with catalogue entries for nearly 2,000 objects. The range of items discussed include girdles, buckles, strap-ends, mounts, combinations of diverse strap fittings and possible ensuite items, brooches, buttons, lace chapes, hair accessories, plus, beads, chains, pendants, finger rings, bells, purses, cases mirrors, combs, cosmetic sets, and needlecases. The composition of the objects is discussed in 'Metallurgical analysis of the dress accessories' by Mike Heyworth (387–95), which suggests that a range of alloys were available and widely used through the late twelfth to early fifteenth centuries in London. The 'Conservation' of the objects, including the organic components, is described by Rose Johnson (396–9), which covers issues of selection and storage, examination and analysis, treatment and storage.

BAB

R A Fairbairn. An 18th century lead smelt mill at Blackhall, Hexhamshire, Northumberland. *British mining*, 1991, **43**, 47–52.

Papers preserved in the Northumberland Record Office provide documentary evidence for a late-17th century lead-smelting mill with two hearths at Blackhall in South Northumberland. The last record

of the mill being worked is 1778. At the site a low mound is surrounded by a spread of slags. A random fragment of glassy black slag has been found to contain 8.7% Pb and 9.3% Zn; a fragment of vitreous grey slag has reported 4.3% Pb and 2.8% Zn; while a piece of 'dull black slag with bubbles' contains 4.0% Pb and 10.5% Zn.

JKA

J Greenwood, The industrial archaeology and industrial history of south-eastern England: a bibliography, 1990, Kewdale Press.

The 5151 numbered entries are listed under a broad geographical classification which starts with 'south eastern England in general', and proceeds through the counties of Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Essex, Hampshire, Hertfordshire, Kent, Norfolk, Oxfordshire, Suffolk, Surrey and Sussex. Within each geographical class are sections on various industries, which in some cases include those of metallurgical interest such as 'iron and steel', 'gold working' (Norfolk), 'pewter' (Norfolk), 'engineering', 'aircraft manufacture' (Hampshire, Hertfordshire, Kent). An author index and a subject index are provided, the latter supplementing the headings set out in the contents table to guide readers to topics that include airships, ballbearings, bellfounding, clock and watchmaking, needle industry and razor blades.

JKA

T Greeves. Adventures with fiery dragons—The Cornish tinner in Devon from the 15th to the 20th century. *J Trevithick Soc,* 1992, **19**, 2–17.

The paper concentrates on the evidence for the physical presence of Cornish miners in Devon and makes frequent reference to Record Office papers which demonstrate this. The historical links between the two counties are complex and have social, technological and archaeological dimensions.

JB

T Greeves. Blowing and knocking – the Dartmoor tin mill before 1750. *Dartmoor Magazine,* **23**, 1991, 18–20.

The remains of over one hundred tin mills which mostly operated within the date range *c* AD 1450–1650 are listed and their general characteristics are described.

BAB

R Hayman. Working iron in Merthyr Tydfil, (Merthyr Tydfil Heritage Trust, 1989).

Section heads are: the technology of the iron industry, the growth of Merthyr's iron industry, living and working in Merthyr, competition and decline.

JKA

J S Hodgkinson. Two Wealden wrought iron hammers. *Wealden Iron,* 2 ser, 1991, **11**, 9–11.

Brief report on two wrought iron hammer heads found in Crawley and Wadhurst.

BAB

R F Homer. The medieval pewterers of London, *c* 1190–1457. *Transactions of the London and Middlesex Archaeological Society*, 1985, **36**, 137–163.

Mainly on documentary sources, but includes consideration of manufacturing techniques.

AATA

D R Hook, and S P Needham. A comparison of recent and analyses of British Late Bronze Age goldwork with Irish parallels. *Jewellery Stud*, 1989, **3**, 15–24.

A simple and convenient classification of bracelets has been developed, based largely on band cross-sections and terminal forms. A range of bracelets from Britain and Ireland were analysed using X-ray fluorescence and their specific gravity was measured. The defined morphological groups could not be distinguished compositionally. It is suggested, on archaeological grounds, that the southern British bracelets were of local manufacture, and that influences came from both Ireland and the continent. The details are given in appendices: 'Typological breakdowns' (21), 'List of Class B1 (Potterne type) and related bracelets' (21–2), and 'Results table' (22–3).

BAB

T Kearney. Painted red a social history of Consett 1840–1990. (Consett, Co Durham: DCA, 1990).

Archival material has been drawn upon generously, and the text of this social history is accompanied by numerous illustrations which are reproduced to good advantage. This is essentially a view from 1990. In an account of such a community, whose reason for existence was the iron-and-steel works (which closed in 1980), of necessity some aspects of the local industry feature in both text and pictures.

KJA

D W Kelley. Charcoal and charcoal burning. Book. Shire albums, no. 159, Shire Publications Ltd., Aylesbury (1986).

Describes the technology from pit kilns and earth-covered heaps to 19th-century brick kilns, mobile iron retorts, etc. There are Roman and medieval records, but peak production was in the 17th–18th centuries.

AATA

J M Lewis , R Brownsword, E E H Pitt. Medieval "bronze" tripod ewers from Wales. *Medieval archaeology,* 1987, **31**, pp 80–93.

Identified six complete 14th-century vessels and fragments of a seventh as layers or ewers for hand-washing. The Lombardic French inscription on one, made in London, suggests a connection with bell founders. The alloys were analyzed and there is a list of comparable vessels from Britain and northern Europe.

AATA

P Mayer. Calstock and Bere Alston silver-lead mines in the first quarter of the 14th century. *Cornish Archaeol,* 1990, **29**, 79–95.

Records of activity spanning some fifteen years which left little in the way of impact on the landscape and was probably wound up once local supplies of wood were exhausted.

BAB

G McDonnell and D Cranstone. Steelmaking at Derwentcote. *Engl Heritage Conserv Bull,* 1991, **15**, 6–8.

The cementation furnace at Derwentcote was taken into care by English Heritage in 1985. The excavation and conservation of the site are described, together with analyses of slags and samples of bar iron found. The furnace reconstruction is now complete and the site is interpreted for the visitor.

BAB

R Morris and R Fitzgerald. Hunslet Mill, Leeds: the case for conservation. *Landscape*, 1988, **9**, 96.

The building, one of the first to use I-section iron beams, was recently upgraded to Grade II and efforts are being made to save it.

AATA

N S Ryan. Fourth-century coins finds from Roman Britain: a computer analysis. 1988, BAR British series, no. 183, British Archaeological Reports, Oxford.

The aim was to establish a coin database for a large number of excavated sites; to describe and pattern the chronological and spatial distribution; to find explanations, and assess the range and limits of inference; and to assess the use of computers in this work and their integration into the research process. The results justified the hypothesis that it was Imperial policy that determined the flow of coin. For each issue there was one primary and one or two secondary mint sources. There are variant patterns between towns, not yet understood; in the countryside, different patterns are shown by

temples as against villas and other buildings. The concentration of rural wealth into fewer hands, with consequent decline of some buildings, is clear. Some general trends of survival characteristics of coin issues can be traced.

AATA

C Mortimer. A descriptive classification of early Anglo-Saxon copper-alloy compositions: towards a general typology of early medieval copper alloys. *Medieval Archaeol,* 1991, **35**, 104–7.

It is suggested that definitions of alloy types should vary according to the context, but within each project must be clearly defined. Analyses of Anglo-Saxon cruciform brooches are used to illustrate the method for forming an alloy classification.

BAB

Edwin A. Shearing. Cast Iron Canal Aqueducts. *J. Rly. & Canal Historical Society*, 1991, **30** (6), 284–286.

Describes and discusses a previously unrecorded example on the Shropshire Union canal at Shushions. Also quotes documentory evidence for the renewal of the cast iron trough of the Chirk aqueduct in September 1869.

APG

R C N Thornes. West Yorkshire: "a noble scene of industry": the development of the county, 1500 to 1830. Book. 1981, West Yorkshire Metropolitan County Council, Wakefield.

Includes chapters on textiles, iron and coal, minor industries such as leather, brick, and glass, and transport Presents plans of workers' housing.

AATA

B Walters. A major new Roman-period industrial settlement near Newent, West Gloucs. *Dean Archaeol,* 1991, **3**, 1990, 26–9.

Documentary sources had indicated that some form of iron working took place in or near the town, possibly near to where Roman coins and pottery had previously been found. Aerial photography revealed a backfilled clay extraction pit and investigations in the area south east of the town produced evidence of smelting and smithing activity as well as pottery production and possible tile production.

BAB

G Williams. The decline of Great Work and the formation of Wheal Reeth Tin Ltd. *J Trevithick Soc,* 1992, **19**, 55–85.
The chequered history of Great Work Mine from 1873, when underground activity ceased, is told. There were periods of limited production, various accidents and attempts to develop the workings, until in 1943 the mine finally closed. Tin was the main metal sought though tungsten and tantalum were also found.

JB

A J Wilson. The professionals the Institution of Mining and Metallurgy 1892–1992. 1992. London: The Instn. of Mining and Metallurgy. 348 pp.

A fast-moving succession of incidents involving individual members of the Institution is combined with general background information to build up this centenary history in 18 chapters. As the title suggests, it is essentially about specific people and their actions in the mineral industry.

JKA

EUROPE

Anon. Metallurgy on the territories of Poland. Stowarzyszenie Inzynierów i Techników Przemyslu Hutniczego w Polsce. Katowice 1992, pp 368.

The volume published for the 100th Anniversary of the Association of the Engineers and Technicians of Metallurgical Industry in Poland contains the outline of the history of smelting the iron, copper, lead, zinc, aluminum and silver in this country. The history of refractory materials, fuel (mostly coke), metallurgical machines and equipment and the education of metallurgists is included too.

JP

L Borelli Vlad and A Guidi Toniato. The origins and documentary sources of the Horses of San Marco. *The Horses of San Marco, Venice,* 1979, 127–136.

Early studies that attempted to identify the place of origin of the sculpture were contradictory and tended to be repetitions of popular traditions. During the Age of Enlightenment, the approach to provenance took a scientific bent and examinations of casting techniques and of their actual condition were carried out. These arguments are reviewed.

AATA

L Borelli Vlad. The photogrammetric survey and the contour map of the surface of Horse "A". *The Horses of San Marco, Venice,* 1979, 160–169.

General background is given regarding the uses of photogrammetry. One of the Horses is analyzed using this technique. It may be possible to determine whether the same molds were used to cast the equivalent parts of each horse. The survey can be used to measure the structural deformation. There are about 100 repairs on this horse alone, patches which preceded the original gilding. The problem centered mainly with the nature of the alloy. Corrosion products differ depending upon the part of the horse; those on repairs have formed a harder bronze which is less rich in copper. Bronze and copper nails have also been used to fill in holes.

AATA

V F Buchwald. A metallurgical study of 12 prehistoric bronze objects from Denmark. *J Danish Archaeology,* 1990, **9**, 64–102.

Ten neolithic or earliest Bronze Age axes and two lurs (musical instruments) were examined metallographically and analysed using SEM/EDAX. The results were compared with those from synthetic alloys of similar compositions. Ten pages of micrographs of the structures seen in both modern and archaeological material are presented. The properties of the alloys and the effects of cold working are described and illustrated. The variations in composition are discussed.

JB

G Frigerio, and M Leoni. Foundry techniques used in casting the Horses of San Marco. *The Horses of San Marco, Venice,* 1979, 178–179.

The internal gates support the view that the Horses were cast by an indirect lost-wax technique. Radiography has revealed those areas where the inlets were attached. Gilding, an application of gold leaf with a mercury amalgam, was analyzed by spectroscopy.

AATA

H Göldner. Studien zu rhein- und moselfränkischen Bügelfibeln. [Studies of bow brooches from the Frankish Rhine and Moselle.] 1987. Marburger Studien zur Vor- und Frühgeschichte, no. Bd. 8.

Technological discussion and computer treatment of data for knobbed, square-headed, and other brooches with catalog.

AATA

V D Gopak, V M Goryunova: Černyy metall ranneslavyanskich pamyatnikov Dneprovskogo Levobrezhiya. [Iron artefacts from the early Slavic sites on the left bank of the Dnieper]. *Sovetskaya archeologiya* 1991, 235–245.

From materials by the late A E Goryunov there were investigated many iron objects of the post-Zarubincy culture date (1st half of the 1st millennium AD up to the 9th century). Sites like Kartamyshevo, Shmirevo, Kolodezhnyj Bugor, Chitcy etc. yielded wrought iron objects or artefacts made of heterogeneously carburized steel; combining of iron and steel by welding was relatively rare, with a lack of standardized schemes.

CPSA

M F Guerra, F Beauchesne, and J N Barrandon. Caractérisation par activation neutronique des fibules d'Argentomagus. [Neutron activation analyses of brooches from Argentomagus]. *Revue d'archéométrie: bulletin de liaison du Groupe des méthodes physiques et chimiques de l'archéologie,* 1990, **14**, 99–107.

Describes a new irradiation device which allows bulk nondestructive neutron activation analysis (NAA) of small objects. For this site, preliminary results allowed identification of a change of alloy from bronze to brass for the manufacture of brooches.

AATA

E Hamilton. Metallurgical analysis and the Bronze Age of Bohemia: or, are cultural alloys real? *Archeomaterials,* 1991, **5** (1), pp 75–89.

The central, if implicit, assumption behind the work of most researchers in archaeometallurgy is that the elemental composition of metal artifacts has meaning; a particular composition is characteristic of a certain time period, culture, or artifact type. How to establish characteristic elemental patterns, however, has received less attention. Here is employed a graph method for presenting impurities first developed by H T Waterbolk and J J Butler (1965). In this context, six copper-based objects from the Bronze Age in Bohemia were analyzed for composition by particle-induced x-ray emission (PIXE) and examined metallographically. The Early Bronze Age artifacts were moderate-tin bronzes (tin ca. 8%) with one low-tin (0.44%) impure copper. Significant amounts of arsenic, antimony, and silver were also present. They were cast and annealled to various extents. The Late Bronze Age artifacts were also moderate-tin bronzes (tin 6.5% and 9.8%) with some arsenic, and antimony, low silver (ca. 0.11%) and significant nickel (0.82% and 0.64%). One was cast and annealled, the other simply cast. Decoration on one was probably produced by a tracer and punch. The graphical method for examining the composition provides good differentiation between the two artifact groups.

AATA

W-D Heilmeyer. Neue Untersuchungen am Jüngling von Salamis im Antikenmuseum Berlin. [A recent analysis of the sculpture of a youth from Salamis, in the Antikenmuseum, Berlin]. In *Archäologische Bronzen, antike Kunst, moderne Technik, H Born, Ed. 1985, 132–138.*

Gamma radiography, carried out in 1984, on the sculpture of a youth from Salamis, now in the Antikenmuseum in Berlin, has demonstrated that it consists of nine individually cast pieces which were later soldered together. The ridges inside the sculpture made visible on these excellent x-ray plates, allow conclusions to be made about the construction of the core and wax mold for casting. Although made up of nine individual pieces, the material shows an almost total uniformity. A new method to measure thickness, computer tomography, has been tested on another bronze belonging to the Antikenmuseum, the Archaic head from Kithira.

AATA

D Hook. Appendix: scientific analysis of the copper-based medals. *A catalogue of the French medals in the British Museum.* 1982 and 1988, 305–312.

Over 120 copper-based medals forming part of the French medals collection of the British Museum were analyzed by means of x-ray fluorescence spectrometry. The accuracy of the method is discussed, and unusually high trace elements are reported. The results indicate the types and ranges of alloys, copper, bronze, brass, and gunmetal, for three categories of medals, as follow: 26 struck medals, 97 cast medals, and 8 gilded medals. The presence of lead is noted as higher in later copies of cast medals. Conclusions are drawn on the date and place of manufacture of the medals, and it is ascertained that the mode of manufacture, whether striking, casting, or gilding, imposed constraints on alloy compositions. The matter of attribution is studied as well. It is hoped to include these results in a larger database with the aim of outlining workshop practices to enable the differentiation between original medals and aftercasts or copies.

AATA

E Huysecom, J Wargnies and H G Bachmann. Le dépot de statères celtiques unifaces—type Scheers 24—du "Mont d'Or" (commune de Leuze-en-Hainaut). [The hoard of Celtic uniface staters of Scheers type 24 from Mont d'Or, Belgium.] *Archaeologica belgica,* 1987, **3**, 101–116.

Study of the hoard included the cataloging and mapping of numerous, scattered British sites with these coins, many with die links to the Continent. Coin analyses were performed. The hoard gives no assistance with chronology, but shows very high technical skill in engraving and metallurgy. The British distribution looks more like deposits made by immigrants than by traders.

AATA

D Kuck, J Röttger and H-E Bühler. Results of smelting tests in the reconstructed copper smelter of Fischbach/Nahe, *Erzmetall.*, 1991, **44** (9), 463–468.

In the Mosel-Saar-Nahe area numerous coppper-ore pits and foundries had been exploited in the Middle Ages. Since it was our wish to document the ancient technique of mining, we started in 1975 to open up the former leading Hosenberg mine, and made it accessible to visitors. Since 1986 we have been seeking to revive also the dressing of ores and the smelting technique of the time before 1800. The former Fischbach copper-smelting plant was reconstructed according to historical documentation and to descriptions given by Agricola (1556) and Gurlt (1877). For the dressing of ores a combined wet/dry stamp mill, two washing troughs, and two roasting stalls were constructed. Smelting was done in pit furnaces with air supplied by bellows. Tests of smelting copper-bearing ores in the furnace according to the medieval model led to a result which is reported. (A dimensioned section of a 'Schachtofen' is included).

CPSA

M L'Hour. Un site sous-marin sur la côte de l'Armorique: L'épave antique de Ploumanac'h. [An underwater site on the Armorican coast: the ancient wreck of Ploumanac'h.] *Revue archéologique de l'ouest* 1987, **4**, 113–131.

A wreck found in 1983 in the Sept Iles had 271 lead ingots, many with inscriptions relating to the *civitates* of the Brigantes and Iceni, the latter not previously noted for lead-dealing. Dating is problematical and hopes for archaeometric dating of associated tiles were not realized, partly because of the uncertainties of the marine environment.

AATA

F Ladeuze, L Dejonghe and F Pauquet. Historique de L'exploitation des gisements plombo-zincifères de l'Est de la Belgique: le rôle de la "Vieille-Montagne", *Chronique de la recherche minière,* 1991, no. 503, 37–50.

Vieille-Montagne constitutes an important mining and metallurgical group devoted to zinc and lead. The company had its origin at the ancient zinc mine situated at la Calamine, on the Liège to Aix-la-Chapelle road. During several centuries this deposit provided the calamine for brass industry in the Mosan region and the Aachen area. At the beginning of the 19th century the mining company became a metallurgical enterprise under the management of J-J-D Dony, from Liège, who developed the 'Liège' or 'Belgian' process for producing metallic zinc. During the 19th century, Vieille-Montagne became the leader of the European zinc industry and the main pioneer for the marketing and promotion of the metal

and its products through the world. Its activities rapidly spread to other countries of Europe, and in N. Africa. The present note relates the history of the zinc industry in the ancient Duchy of Limburg, from its origins to the present day.

Authors

C Landwehr. Bronze grec original, moulage en plâtre et copie romaine en marbre. [Original Greek bronze, plaster mould, and Roman marble copy.] In *Pierre éternelle, du Nil au Rhin: carrières et préfabrication* M Waelkens, Ed, 1990, 143–161

The exact copying of ancient artwork was introduced by the Romans in the 1st century BC, and it rapidly became an important industry. The examination of many examples of unfinished work indicates the similarity of the techniques used, and some are still in use in the 20th century. These techniques involve a system of frames or scaffolding, rulers, compasses, or calipers, and puntelli, or reference points, punched out of the new marble at measured intervals. The area between these holes was later hacked away, free hand. The Roman technique for producing plaster molds for casting bronzes is detailed as well, from the preparation of the original Greek bronze to the casting of the numerous parts and the mounting. In spite of the high degree of sophistication of these techniques, however, no Roman bronze copy or copies of a particular Greek work have ever been identified. In conclusion, it is suggested that the concept of Roman copy might need reevaluating.

AATA

M Leoni. Metallographic investigation of the Horses of San Marco. *The Horses of San Marco, Venice,* 1979, 190–199.

Brief presentation of the results of the metallographic investigation of the two Horses on the left of the group(as viewer faces sculptural ensemble); includes the metallographic and thickness measured for casting various sections. The study also includes the metallographic and thickness measurements of Horse B and the radiographic examination of parts of Horse A. The alloying elements and principal impurities agree with the results of analyses of 1815 and 1842. Galvanic corrosion is taking place on the alloy surface. Some aspects of the casting technique can be determined through radiographic examination.

AATA

M Leoni. Observations on ancient bronze-castings. *The Horses of San Marco, Venice,* 1979, 180–181.

Chemical composition is of limited importance in assessing the casting method since significant variations in metals may be due to the phenomenon of segregation. Nondestructive methods of analysis will be affected by corrosion products on the surface. Nevetheless, knowledge of preferences for particular alloy compositions during specific historical periods, and of their production using existing metallurgical practices, helps to place a sculpture within a general historical context.

AATA

M Leoni. Techniques of casting. *The Horses of San Marco, Venice.* 1979, 170–177.

Several methods of casting are described: the Cellini method; indirect casting using concave sections; modern casting with gelatine or silicone rubber molds. Defects originating from the casting method used on the Horses of San Marco are identified; there was a good deal of original repair, the methods of which are described; these surface flaws are described.

AATA

J E Levy. Metalworking technology and craft specialization in Bronze Age Denmark. *Archeomaterials* 1991, **5** (1), 55–74.

Surveys what is known about bronze production technology in Bronze Age Denmark (ca. 1800–500 BC), and adds to the body of work the elemental and metallographic analyses of five objects from the science museum, Discovery Place, in Charlotte, North Carolina. Alloys are all tin bronzes, and range from 1.9 to 22% tin and 0 to 4% lead, with one spot of repair solder containing 9% lead. Some of the alloys are also high in bismuth. Manufacturing and decorating techniques include casting, hammering (especially to harden cutting edges), annealing (somtimes locally), riveting with hammered rivets, chasing, embossing, raising (repoussé), and engraving. Metalworking tools and sites, manufacturing techniques for gold, craft specialization and models for it, and previous work in attempting to source the ores used and the questions of trade versus indigenous production are also covered. The author concludes, "It is likely that metalwork was practices by part-time specialists in diverse circumstances. Diversity of source material and manufacturing technology characterizes the metallurgy in Bronze Age Denmark."

AATA

J Luštík, L'U Mihok and L Olexa. Metalografický rozbor bronzových predmetov z Nižnej Myšle. [Metallographic analysis of bronze objects from Nižná Myšl'a.] *Archeologické rozhledy,* 1991, **43** (1), 138–144.

Metallographic microscopy, scanning electron microscopy, and x-ray energy dispersive microanalysis were used for analyzing 12 bronze objects, dating to ca. 1700–1400 BC, from Nižná Myšl'a, Slovak Republic, Czechoslovakia. The objects studied were made of tin bronze; the content of tin decreased during the period 1700–1400 BC. Bronze objects made during the period 1500–1400 BC contained arsenic and sulfur. Tin was found in 11 objects and its content varied from 5.0 to 39.9 percent mass. The content of arsenic found in four objects varied from 0.6 to 2.0 percent mass. Sulfur found in seven objects varied from 0.1 to 1.3 percent mass.

AATA

L Mihok. Archaeometallurgical research in Czechoslovakia in 1989. *Archeomaterials,* 1991, **5** (1), pp 111–115.

Reviews archaeometallurgical studies in Czechoslovakia as reflected in 14 contributions (all in Czech) published in 1989. The work covers a broad spectrum from Eneolithic copper axes through copper alloys in Czechoslovakia to early blast furnaces and experimental iron metallurgy using ancient techniques.

AATA

W A Oddy, L Borelli Vlad, and N D Meeks. The gilding of bronze statues in the Greek and Roman world. *The Horses of San Marco, Venice,* 1979, 182–187.

Various early methods of gilding are described which involve physical attachments. By the 3rd century fire- or mercury-gilding was the standard method of coating copper alloys or silver with gold, and this technique remained in use until the invention of electroplating in the mid-19th century. Mercury has been identified by analyses on only one gilt object from the 1st century in the British Museum's collection of late Greek and early Roman antiquities. For common objects, gilding was done by diffusion bonding or use of an organic adhesive. Mercury gilding is most easily accomplished only on a high purity copper alloy. The San Marco Horse was subjected to x-ray diffraction analysis with scanning electron microscopy to examine the gold amalgam with a gold leaf overlay; it cannot be determined when this latter work was done or whether it may have been a treatment for weathering. The difficulties of casting a 98% copper alloy place the work in the later Roman imperial period.

AATA

J Piaskowski. Metallurgy and foundry In: *The history of technology in early Poland.* Polish Akademy of Sciences. Institute for the History of Science, Education and Technology. Warsaw 1992, 17–135 [In Polish].

The techniques used in metallurgy and the foundry on the territory of Poland from the beginnings to 1800 were described. The smelting of iron and steel, pig iron and the smelting of lead containing silver were included. The silver was extracted from the lead and copper. The founding of bronze and pig iron was presented.

Author

J Piaskowski. Influence of the type of iron ore on the quality of metal produced in territory of Poland in Antiquity and Middle Ages. *Wiadomości Hutnicze* 1987, **43** (10), 368–373.

Information about the iron ores and the statistical characteristics of chemical composition of bloomery slags found in several ancient and mediaeval metallurgical centres on the territory of Poland is presented. This shows that the phosphorus content in the slags was selected to determine the quality of metal smelted.

Author

J Piaskowski. The metallography of the first indirectly smelted iron and steel found on the territory of Poland. *Sibrium* 1989, **20**, 191–199

The results of metallographic examinations of a large sword, a misericord and a spear-head found in Danzig, dated 14th to 15th cent. A.D., made of indirect smelted iron and steel were presented. The characteristics of chemical composition and slag inclusions content were compared, as criteria for distinguishing indirectly and directly smelted iron and steel.

Author

J Piaskowski. The technology of iron implements on the territory of Poland in the Late La-Tene and Roman period from 2–1st. cent B.C. to the 5th cent.A.D. *Materialy Archeologiczne* 1991, **26**, 41–51.

Summary of the results of metallographic examinations of 917 iron implements from 188 archaeological sites on the territory of Poland is presented. Statistical characteristics of the chemical composition of irons and slags from several metallurgical centres are calculated, based on the analyses of 382 fragments of slag from 161 archaeological sites. The technology in main metallurgical centres is described.

Author

J Piaskowski. The technology of mediaeval iron implements from Wawelhill. *Studia do dziejów Wawelu* 1991, **5**, 55–92.

The metallographic observations, qualitative and quantitative chemical analyses, measurements of microhardness and Vickers hardness of 22 iron implements from Wawel-castle in Kraków (Xth-XIIIth cent. A.D.) were carried out. A key and probably one iron knife, were cemented: seven knives and one spear-head were welded from iron and steel: three knives were pattern-welded. All instruments were heat-treated. The technology of pattern-welding was described.

Author

J Riederer. Die Analyse der Metallfunde des urnenfelderzeitlichen Depots von Crévic, Lothringen. [Analysis of metal finds from deposits of the time of the urn fields at Crévic, Lorraine]. *Acta praehistorica et archaeologica,* 1991, **22**, pp. 83–84.

Atomic absorption spectrometry was used to analyze 30 bronze objects from a Bronze Age hoard (Bronze final IIb-IIIa), discovered in western France near Nancy. All but one consists of pure tin bronze with tin content between 2–12%. The one pendant with an exceptional composition contains 16% zinc, 10% lead, and 4.5% tin. From the archaeological evidence, there is no doubt that the pendant is part of the hoard.

AATA

M De Ruette, M Dupas, G Genin, L Maes, L Masschelein-Kleiner, and I Vandevivere. Étude technologique des dinanderies coulée. L'oeuvre de Guillaume Lefèvre (synthèse). [Technological study of cast brassware. The work of Guillaume Lefèvre (synthesis)]. *Bulletin (Institut royal du patrimoine artistique) = Bulletin (Koninklijk Instituut voor het Kunstpatrimonium),* 1988–1989, **22**, pp 104–160.

The purpose of this study is to characterize as accurately as possible the design and production methods of brass casting. Several pieces of church furnishings were available from a single atelier, that of the founder Guillaume Lefèvre, and date to the beginning of the 15th century, 1476. Items included both authenticated and attributed pieces: two pascal candlesticks, a choir candlestick, a baptismal font, and a holy water basin. A summary history is provided concerning Lefèvre, his foundry, and its production. Physical and technological descriptions of each of the works are provided; metal analyses were performed and the results recorded (composition of the alloy was determined by atomic absorption spectroscopy, and analysis of the core is given). These data are assessed to formulate an interpretation of Lefèvre's working methods.

AATA

D A Scott, and J Podany. Ancient copper alloys: some metallurgical and technological studies of Greek and Roman bronzes. *Small bronze sculpture from the ancient world: papers delivered at a symposium,* 1990, pp 31–60.

A collection of Greek, Roman and Etruscan bronzes in the J. Paul Getty Museum were examined by x-radiography, atomic absorption spectrophotometry, optical microscopy, and scanning electron microscopy. Unusual hexagonal grains on the surface of a bronze Roma are described, techniques of casting-on and the use of tenon-jointed limbs for a bronze incense burner are examined. Fibrous, whisker-crystals on a bronze Togate were shown to be malachite. Casting technology of a Greek bronze herm was examined and the objects were analyzed for 14 elements by atomic absorption.

AATA

D A Scott. Technological, analytical, and microstructural studies of a Renaissance silver basin. *Archeomaterials,* 1991, **5** (1), 21–45.

An elaborate and important silver basin, dating from about 1625 and made from a design attributed to Strozzi, is in the collections of the J. Paul Getty Museum. Visual and x-radiographic examination showed that several cast components were added to the worked basin and that solder of two different types was employed to attach some of these additions. Modern solder containing about 20% cadmium, was used for later repairs. Other attachments were made mechanically, either with hand-cut screws or with split pins. The basin is made of an annealed silver-copper alloy, depleted in copper at the surface, and low in gold and platinum. The gold content (32 ppm) is low enough to support the hypothesis that silver from the mine of Potosí in Bolivia could have been the source. Silver from Potosí did reach Genoa. All of the evidence derived from the study is consistent with the basin having been made in 17th-century Genoa. The lead isotope ratios were also determined.

AATA

H Unglik. Structure, composition, and technology of late Roman copper alloy artifacts from the Canadian excavations at Carthage. *Archeomaterials,* 1991, **5** (1), 91–110.

The Canadian excavations of the Northern Sector of Carthage brought to light a large variety of copper alloy objects dating to the late Roman period, 5th to 7th century. Metallographic examination and semiquantitative x-ray fluorescence analyses were conducted on the copper alloy objects, together with quantitative scanning electron microscopy-based x-ray microanalysis of selected bronzes and brasses. The structures of the artifacts revealed that the techniques used to manufacure them were predominantly casting, annealing, hot working, and cold working. These methods were used selectively depending on whether the material was bronze or brass, indicating that Carthaginian smiths understood the technological variations of the two alloys. The Carthaginian brasses all contain approximately the same amount of zinc (ca. 15%), but the bronzes have variable tin (3–16%) and lead (0–20%) contents. In addition to brass and bronze, iron was worked at Carthage; the metals were sometimes combined to create bi-metallic artifacts.

AATA

ASIA

K T M Hegde. An introduction to ancient Indian metallurgy. (Bangalore: Geol. Soc. of India, 1991), 86pp.

There is evidence for copper smelting in India by c 1500 BC, and for iron production before 750 BC. By 600 BC iron technology was

spread over much of the subcontinent; by the 4th century BC India was renowned for its steel. At some time between 250 BC and 1 BC India developed the technique to distil zinc from its oxide, and this metal was used to make brass containing 10–12% Zn, which possessed a golden-yellow colour. The contents are divided into three chapters: copper, iron, and zinc and brass.

JKA

D Keys, Monsoon winds helped forge the swords of Islam. *Indep. on Sunday*, (27 Octr 1991).

In Sri Lanka, 110 km east of Columbo, investigators have recorded 800 furnaces, each one equipped with a funnel system to channel 80 km wind into it. Each furnace could yield 23 kg of iron daily during the annual two-month production season. It is suggested that most of the product was supplied to Arab armies.

JKA

R A Mashelkar and J V Rajan. Chemical engineering developments in India, in *One hundred years of chemical engineering,* (ed) N A Peppas (1989) Dordrecht: Kluwer Academic Publishers, 153–222.

Includes a brief survey, pp 165–173, of the processing of ferrous and non-ferrous metals', with diagrams of apparatus used to obtain the metals mercury (the valuka yantram), iron (exemplified by a furnace of South India), copper (a reducing furnace and a smelter at Khetri), and zinc (the koshthi apparatus and a distillation furnce at Zawar as delineated by Paul Craddock).

JKA

W A Oddy. Gilding of metals in Japan. *Conservation news* (UKIC) 1991, **45**, 37–38.

Reports on traditional methods of gilding in Japan, as demonstrated by Yasunosuke Morimoto, Kyoto, and Ueno of Osaka. Techniques of urushi leafing and application of gold leaf to a copper surface which has been amalgamated with mercury are illlustrated.

AATA

J Piaskowski. Technical Studies on High Nickel Irons, with Special Reference to the Indonesian Kris. *Archeomaterials* 1992, **6**, 35–52.

The Indonesian kris is distinguished by the elaborate patterns produced on its high nickel iron surfaces, particularly the blade. The process of making the blades has been directly observed, but metallographic studies enhance the information derived in the field. It has generally been assumed that Indonesian kris technology appeared in the 14th or 15th century, but new information indicates that it was known in Europe before the 4th century A.D., perhaps as early as the 7th–4th centuries B.C.

Author

S G K Pillai, R M Pillai and A D Damodran. Ancient Metal-Mirror Making in South India. *J. of Metals*, 1992, **44** (3), 38–40.

A detailed description of the traditional methods of casting and polishing copper/30% tin (speculum metal) mirrors as used in Aranmula today.

APG

C L Reedy. 'Medieval bronzes of the Himalayan mountain kingdoms', *(Journal of metals)*, 1991, **43** (12), 6–9.

JKA

C M Wai and K T Liu. The origin of white lead – from the East or West. *Journal of chemical education,* 1991, **68** (1), 25–27.

Authors examine ancient and medieval Chinese literature dealing with processes of making white lead and compare them with those processes known in Europe. White lead is chemically either $2PbCO_3$. $Pb(OH)_2$ or $Pb_3(OH)_2(CO_3)_2$. The oldest commercial process in Europe, known as the old Dutch process or Dutch stack process, is described. *Hu* powder is described in a Ming Dynasty technical book, *Tien Kung Kai Wu*, dating from 1637. The *Pen Tshao Kang Mu* (1596) describes production of *Fen hsi*, the toxicity of which is noted in regard to workers *Fan Tzu Chi Jan* documents the production of a white powder from metallic lead. Processes described in Theophrastus, Pliny, and Galen are reviewed. The vinegar process is not likely to have originated in the East.

AATA

THE AMERICAS

M C Gill. The diffusion of ore-heath smelting techniques from Yorkshire to the Upper Mississipi Valley lead region, *British mining*, 1991, **43**, 118–128.

Three recent studies of early lead mining in the Upper Mississipi Valley region of the USA have shown that many Swaledale families were involved in the area. This paper discusses the impact of these families on lead mining around Dubuque (in Iowa) and in the neighbouring states of Illinois and Wisconsin, and also discusses the interesting period of prolonged stagnation of techniques resulting from the area's frontier conditions. The latter ended with an influx of mainly European miners in the late 1820s.

Author

R B Gordon. The origins of Early American crucible steelmaking: little competition to the Sheffield Masters. *JOM: the journal of the Minerals, Metals & Materials Society,* 1991, **43** (2), 36–43.

Although the United States manufactured iron goods of high quality, the steel used was imported from Sheffield, England until late in the 19th century. American steelmaking attempts produced steel that was unreliable for three reasons: the lack of sulfur-free and phosphorus-free iron ore, unsuitable crucibles, and the handicap of inexperienced workmen. The Adirondack region of upstate New York yielded the most suitable ore and the direct-reduction smelting process, or American Bloomery process, was developed to produce low-phosphorus iron. American steel industry did not thrive, however, until skilled steelmakers were recruited from Sheffield. The article contains a great deal of detailed information on manufacture techniques used in Sheffield and the United States.

AATA

D A Scott. Technical examination of some gold wire from pre-Hispanic South America. *Studies in conservation,* 1991, **36** (2), 65–75.

Some nine fragments of gold wire from pre-Columbian South America are examined by optical microscopy, metallography, scanning electron microscopy, electron microprobe analysis, atomic absorption spectrophotometry, and optical emission spectrophotometry. The wires examined include examples of hammered gold wire, block-twisted wire, and strip-twisted wire. Cast gold wire, made by the lost-wax process, was commonly employed in both the Muisca and the Sinú cultural areas of ancient Colombia. Very fine rectangular gold wire, 12 μ by 40 μ in section, was made in the La Tolita-Tumaco area and an early example is dated to about 325 BC. This wire may have been made by cutting fine hammered gold foil. Apart from the cast examples, all the gold wires examined were made in native gold alloys which are typical for the Colombian Ecuadorian area.

AATA

AFRICA

A J Leroy. Palabora—not just another copper mine, *Minerals industry internat. (Bull. IMM)* 1992, 14–19.

Includes section on 'historical activity'. Carbon-dating evidence indicates that copper tools and ornaments were made from Palabora

ores in the 8th century AD, when furnaces and techniques used were similar to those in Spain and Cyprus. Smelting of copper and iron went on at Palabora for 1000 years, but then ceased. A European explorer visited the site in 1868; by 1901 it was clearly identified as a potential major source of minerals. In 1930 phosphate mining was unsuccessful, but in 1938 vermiculite began to be worked. In 1951 Foskor launched a successful government-sponsored phosphate-production project; at the same time uranium mineralisation was found to be too low in grade for exploitation. Rio Tinto and Newmont companies became attracted to Palabora in the early 1950s; after considerable work and expenditure, production of copper re-commenced in 1966, the project then envisaging a milling rate of 30 000 te/day of ore to yield 62 000 te/year of copper over a mine life of 26 years. The smelter used a conventional coal-fired green-feed reverb. furnace, three Peirce-Smith converters, two anode furnaces and an anode-casting wheel. Converter gases were treated in a sulphuric-acid plant. An electrolytic copper refinery was soon added, and a succession of improvements and expansions enabled copper production to increase to 130 000 te/year by 1980, all refined to cathode grade. Among the other mineral products from recent working at Palabora has been pellet-grade magnetite.

JKA

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The Editors

Mining and trade throughout the ancient world with particular reference to Cornwall

This is the first comprehensive account of the early mining and trade of tin, that rare and highly prized metal so vital to the development of bronze-using civilizations.

The introduction gives a brief account of the geological occurrence of tin and the nature of its use in antiquity, particularly its importance in the development of the copper–tin alloy bronze.

The principal aim of the main text is to describe the tin occurrences in Africa, Asia, and Europe, and the archaeological evidence for their exploitation.

The final and longest part of the book deals with Cornwall. After an account of the geological nature of the deposits and the evidence for the early exploitation of the tin lodes, the author details the alluvial or 'tin stream' deposits and the way they were worked.

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