Abstracts

GENERAL

D R Cooper. The art and craft of coinmaking: a history of minting technology. Spink & Son Ltd., London, 1988. 264 pp.

A technical history of coin production up to the present day. Describing the development of engineering techniques, it also contains notes on particular personalities.

BAB

F D'Aversa, M Ferretti, P Moioli and R Scafé. A multi-gamma attenuation technique for the quantitative characterization of archaeological metal alloys. In *Science, technology and European cultural heritage: proceedings of the European symposium, Bologna, Italy, 13–16 June 1989*. N S Baer, C Sabbioni: and A I Sors, eds, 1991. 579–582.

Describes an absolute and nondestructive analytical technique that can be used, in combination with x-ray fluorescence, for the quantitative characterization of archaeological metal alloys. The method is based on the measurement of the average gamma ray absorption coefficient of the sample that is, for homogeneous materials, a linear function of the component concentrations. The average gamma ray absorption coefficient of different types of ancient metal objects was measured by means of a ^{133}Ba source; the concentration of the alloy components was then derived by solving the resulting system of equations by means of a weighted least squares technique.

AATA

G Demortier. Ancient gold solders: what was chrysocolla? In *Archaeological chemistry IV*, Advances in chemistry series, no. 220, R O Allen, Ed, 1989, 249–263.

Arguments are presented for reconsidering the meaning of the name chrysocolla, used in ancient textbooks on metallurgy, and for identifying chrysocolla as cadmium sulfide (greenockite), a yellow natural mineral. Several results from thousands of nondestructive analyses by proton-induced x-ray emission (PIXE) of solders on gold artifacts cannot be interpreted if chrysocolla is either green copper carbonate (malachite), as generally assumed until now, or blue hydrated copper silicate, the mineral now called chrysocolla. Several paragraphs of 33rd book of *Natural History* of the Pliny the Elder (1st century) are critically analyzed in light of these analytical results.

AATA

R M Ehrenreich (ed.). Metals in society: theory beyond analysis. MASCA Research Papers in Science and Archaeology 8, II, 1991, 92 pp.

Includes: A P Cartney: Canadian Arctic Trade Metal: Reflection of Prehistoric and Historic Metalworkers, 26–43. Canadian Eskimos' different sources of iron (Thule culture and subsequent Inuit and Alaska populations) and mechanisms of exchange and purchase. The role of the epi-metallurgy. M N Geselowitz, T R Wetscott and D Wang: For Want A Nail: Archaeometallurgy and Dating in Historical Archaeology, 45–55. An unusual look into the production of early American nails until the 18th century. S T Childs: Iron as Utility or Expression: Reforging Function in Africa, 57–67. Basing on results of some metallographic investigations of artefacts from Zaire, the author tries to see the blacksmith's approach to manufacture of utilitarian and symbolical objects (axes), both in the past and in the recent time. The expressive objects are worked roughly. However distingushing them in the archaeological material is fraught with problems. R M Ehrenreich: Metalworking in Iron Age Britain: Hierarchy or Heterarchy? 69–80.

CPSA

N D Meeks and P T Craddock. The detection of cadmium in gold/silver alloys and its alleged occurrence in ancient gold solders. *Archaeometry*, 1991, **33**, 95–107.

Refutes recent claims that cadmium occurs in ancient gold solders but has previously been missed by analysts. Evidence is presented to show that cadmium would have been detected if present and concludes that the lack of reported analyses show that the presence of cadmium in gold artifacts is likely to indicate a modern copy or repair. Also discusses ancient recipes for solders and rejects suggestions that the ancient gold solder chrysocolla, described by Pliny the Elder should be identified as the cadmium mineral greenockite.

BAB

M R Pfeifer, J-C Lavanchy and V Serneels. Bulk chemical analysis of geological and industrial materials by X-ray fluorescence, recent developments and applications to materials rich in iron oxide. *Journal of Trace and Microprobe Techniques* (OSA) 1991, **9**/2–3, 127–147.

Analytical practice with the X-ray fluorescence analysis as applied at the Centre d'Analyse minerals, Université de Lausanne, Switzerland. For iron-rich materials such as copper and iron slags or iron ores there are 14 major and 16 trace elements programmed (example: an early medieval bloomery slag from Boécourt, Jura). The calibration is based on 20 international standards.

CPSA

BRITAIN AND IRELAND

D K Brown. Early Welding for the Royal Navy. *J Naval Engineering* 1992, **34**(1), 218–227.

Both the British and US design departments took a keen interest in arc welding during World War I and, in collaboration, made considerable advances. Little was achieved in UK warship building yards during the twenties or early thirties, but an increasing amount of welding was used in cruisers, particularly in Chatham and in the Ark Royal at Birkenhead. In 1936 the first all-welded ship for the R N, Seagull, was built in Devonport. During the war, progress was more rapid and both Chatham and Vickers made considerable advances in submarine prefabrication. The Loch Class frigates were designed for prefabrication which was successful though there was still considerable opposition to welding.

Author

P T Craddock. Copper production in the Bronze Age of the British Isles. *Bulletin of the Metals Museum*, 1992, **18**, 3–28.

Discusses the evidence for early copper mining in the British Isles including tools and smelting processes.

JL

A Hartmann, T Barrass, H Schickling and J Taylor. Einige Ergebnisse der spektrochemischen Analyse von irischen Goldfunden. [Some results of the spectrochemical analysis of Irish gold finds] *Ogam: tradition celtique*, 1965, **17**.

The analytic examination of about 500 prehistoric Irish gold finds shows that these finds can be divided on the basis of their composition in clearly different groups, and that these single material groups correspond to prehistoric types of finds. For comparison, Irish gold from the Wicklow Mountains was brought in to indicate that only very few of the prehistoric finds of gold in Ireland were from locally mined gold. Comparative analyses of gold finds from the Urnfield period of Central Europe confirm the conclusion that in the Late Bronze Age period of Ireland, the gold used on a large scale was the same as that of the Urnfield period of Central Europe. In the same period, one can see as well in Ireland, as in Central Europe, that a mixture of copper alloy was added to the gold intentionally, probably in order to give the alloy a reddish tint.

AATA

A Macgregor and B Spencer. An ampulla mould from Pirton, Worcestershire. *Journal of the British Archaeological Association*, 1986, **139**, 194–199.

A fine example of a 13th-century limestone mould for a cruciform ampulla made of tin or tin alloy. General history and use of these moulds are discussed.

AATA

T Murdoch, J Clark, C Ellmers, C Jones, C Gere, V Cumming and A Jobbins. Treasures & trinkets: jewellery in London from pre-Roman times to the 1930s. Museum of London, London, 1991, 208 pp.

Resulting from the 1989 exhibition of the Museum of London's jewellery collection this catalogue brings together articles from the Museum's specialists as well as independent experts. The first section on the jewellery trade in London comprises appraisal of craftsmanship during the Saxon and medieval periods, developments from the late 15th century to 1800s and 19th century. Section two, Symbol and Association in London Jewellery, opens with Romano-British jewellery which explores the style and composition of the jewellery and its potential to reflect cultural and economic trends. Deals with jewellery from the 15th century to 1800s and 19th century. Section two, Symbol and Association in London Jewellery, opens with Romano-British jewellery which explores the style and composition of the jewellery and its potential to reflect cultural and economic trends. Deals with jewellery from the 15th century to the Victorians including inscriptive and documentary evidence that specifies the symbolic meaning of various stones and stone combinations, while From the Middle Ages to the Victorians looks at evidence for the relationship between dress and jewellery. The final section: Catalogue: jewellery in London from pre-Roman times to the 1930s includes the origins of the jewellery collection and manufacturing sections concerning metals, enamel, glass, other materials, and the retail trade. There are two appendices, Posy Ring Inscriptions and Gem Testing, and a glossary.

BAB

P Wilthew. Metallographic examination of medieval knives and shears. In: J. Cowgill, M. de Neergaard and N. Griffiths: *Knives and Scabbards, medieval finds from excavations in London.* 1987, 62–74.

Nine medieval knives and four shears investigated metallographically — principally steel cutting edges welded on iron backs, with two exceptions of inferior quality. Heat treatment applied in majority of cases.

CPSA

EUROPE

J A Allendesalazar, C Doncel Rasillo and A Jove I Melero. El soldat de plom: et taller Ortelli, motles de pedra. [The lead soldier: the Ortelli workshop, stone molds]. Catàleg del Museu d'Arts, Industries i Tradicions Populars, no. 1, Ajuntament de Barcelona, 1991, 181 pp.

Surveys the manufacturing history of toy soldiers in Europe from the end of the 18th century to the mid-19th century and the Ortelli workshop, opened in 1828 in Barcelona. Describes all sizes and types of molds used for the toy part of the Ortelli collection owned by the Museum of Popular Arts and Traditions of Barcelona. Information is given on the process of fabrication and on the conservation of the stone molds, including cleaning, consolidation with Paraloid B-72, reintegration with stucco, and storage.

AATA

A L and N Møller Andersen. Pattern welded swords of the early Iron Age. *Eksperimental Arkaeologi studies i tecknologi og Kultur.* Historisk-Arkaeologisk Forsølgscenter Lejae, 1991.

A preliminary report on setting up a model of the technology involved in the making of pattern welded provincial Roman swords 200–400AD. The model is based on reconstruction experiments carried out at the Museum of Prehistory Moesgård and at the Historical-Archaeological experimental centre at Lejre. The Lejre experiments, together with new analyses of swords from the rich weapon offerings in the Illerup Valley, East Jutland, have led to a suggested reclassification of these swords based initially on the type of production technology involved.

JL

A Anteyns. Nachodka na Stupelskom gorodišče. [A find from the Stupelskoye hillfort, Lithuania], *Briva Daugava* 1991, 2.

Two pattern-welded lance heads from Lithuanian hillforts are reported. The piece from Stupelskoye, although not explicitly so described, is a secondary use of an older pattern-welded object, which deserves attention.

CPSA

Anon. Minera Helvetica 1992. *Schweizerische Gesellschaft für historische Bergbauforschung* **12**a (Fribourg), 1992, 71 pp.

Contents: V. Serneels: La sidérurgie ancienne en Suisse: Histoire d'un recherche [The ancient metallurgy of iron in Switzerland: History of investigation], 3–10. Pioneering personalities: Quiquerez, Pelet, Guyan; C. Duplain: Underweiler-village du fer, 11–21. A post-medieval iron working village. J. Tauber: Zum Stand der Eisenarchäologie im Kanton Basel-Landschaft [The state of investigation of iron metallurgy within the Canton Basel], 22–30. Minepits of Holznacht, old mining at Lausen, excavation of a 10th century AD village with a sunken-floored smithy, 2 t of iron slag, PCB cakes. C. Doswald: Bohnerzbergbau an Scherzberg (Kanton Aargau) [Bohnerz mining at Scherzberg], 31–38. Post-medieval iron ore mining, 17th–18th centuries. C. Doswald: Die Eisenverhüttungsanlage von Kaisten-Seehübel], 39–50. A high medieval iron ore roaster near an abandoned iron smelting work, presumably 15th century and later. F. Hofmann: Geologische und lagerstättenkundliche Grundlagen der historischen Eisenerzeugung in der Region Schaffhausen [Outlines of the geology and deposits related to historic iron production in the Schaffhausen region], 55–65. Characteristics of Dogger oolithic ores, Bohnerze, Pseudobohnerze, and magnetites.

CPSA

Lima Och Transtrand. Ur två socknars historia 1. Myrjärn och smide. Lima and Transtrand — history of two parishes 1: Iron and blacksmiths]. Malung 1982.

The chapters written by N. H. Matsson discuss the blacksmith's work with documentation of smithies, working tools, material used and techniques applied. J.-E. Patterson makes remarks on local bloomery production from bog ores in the light of the process as described by Ole Evenstad in the 18th century. B. J. Ericson (Mrs) describes some industrial enterprises in the region, including hammer-mills. All this ethnographic data illustrates the traditional iron making and working in Scandinavia.

CPSA

J. Bentini, E. Corradini, E. Antonacci, L. Follo, G. Gualandi, and R Rosati. The ancient bronze statuettes in the Estense collection in Modena: from analysis to restoration. In: *Science, technology, and European cultural heritage: proceedings of the European symposium, Bologna, Italy, 13–16 June 1989.* N. S. Baer; C. Sabbioni and Andre I. Sors, Eds, 1991, 757–760.

The Estense collection of bronzes was gathered in the 15th century in Ferrara by the Estense dukes who were interested in antiquities. This interest was also diffused in the greater Italian and European courts during the age of Humanism and the Renaissance. During the 17th–18th centuries, the collection was housed in the Galleria dei Disegni e delle Medaglie in the Ducal Palace, but it was transferred to Modena, Italy, when this town became the new capital. The most important acquisition was the Obizzi collection, which arrived at Modena thanks to Maximilian of Hapsburg, the restoration in 1822. The Estense collection is very interesting because it shows different types of bronzes from the Bronze Age to the inclusive Roman Age. This research had the purpose of analyzing the alloys of some Etruscan, Italic, and Roman bronze statuettes from this collection.

The analyses presented here prove that some statuettes are not ancient. The structure of some bronzes were examined under the metlalographic microscope and a more suitable technique of conservation was selected. Finally, all analyses were collected in a computer for data processing.

AATA

D. Baatz, A. Hauptmann and R. Maddin: Die schweren Eisenträger von der Saalburg — Zur Form, Funktion und Metallurgie. Heavy iron beams from the Saalburg — their shape, function and metallurgy]. *Saalburg Jahrbuch* 1991, **46**, 25–40.

Roman iron beams are among the heaviest and largest archaeological iron finds. At Saalburg were found 43 huge iron blocks and fragments, total weight 1.3 t, dating from the 2nd century AD. As their counterparts from Britain, Gaul, Germania Inferior and Superior, they were used as structural beams and hoists in the heating system of the *thermae*. They are made of a very badly welded and consolidated iron, penetrated with slag and cavities. Two annexes: 1 List of European finds ;dating: 2nd–3rd centuries AD); 2 Interim report on section of beam 11112 from Limeskastell Saalburg (by A. Hauptmann and R. Maddin): huge ferritic grains, 0.3–0.48% P, silicate iron slag — not fully consolidated bloomery iron.

CPSA

J. K. Bjorkman Second Millenium B.C. Prices of Iron and Copper. *Nouvelles Assyriologiques Brèves et Utilitaires* 1989, **1**, 12–13.

Scepticisim on the economic value of some early cuneiform texts alluding to prices of iron, incl. the mathematical text YBC 4698 (iron to copper as 1:90) and a text by Isin II (iron dagger for two shekels of silver).

CPSA

G F Carter and H Razi. Chemical composition of copper-based coins of the Roman Republic, 217–31 BC. In *Archaeological chemistry IV*, Advances in chemistry series, no. 220, R O Allen., ed. 1989, 214–230.

Reports the analyses of 22 coins from the years 217 to 31 BC of the Roman Republic by x-ray fluorescence for iron, cobalt, nickel, copper, zinc, arsenic, silver, tin, antimony, and lead. No evidence was found for widespread remelting of coins. The early coins are remarkable for their relatively high cobalt contents. Several coins have exceptionally high lead, arsenic, or antimony contents. Generally, the compositions of these Roman Republican coins are very different from those of Roman Imperial coins. Although few coins were analyzed, their compositions correlate reasonably well with time. Further analyses are required to determine whether composition varies with denomination and whether coins may be dated to within a few years by their chemical compositions. Microstructures of two Roman Republican coins containing lead are presented.

AATA

L Eschenlohr and V Serneels. Les bas fourneaux mérovingiennes de Boécourt, Les Bouliers (Ju/Suisse). [Merovingian bloomeries at Boécourt, Les Bouliers, Jura, Switzerland]. *Cahiers d'archéologie jurasienne*, **3**, Porrentury 1991, 143 pp. In cooperation with B Giltpold.

This is one of the best monographs devoted to the description and analysis of an excavated iron works. Contents: 1 Présentations du site (topography, mining, the bloomery site, dating); 2 La végétation et le charbon (palynology showing the predominance of Abies, Alnus, and Fragus, palaeobotany of charcoal;) 3 Les mines et le minerai (hematites-and-goethites, and pisolithic ore with 55–64% Fe_2O_3, simple mining methods; shafts and galleries are of post-medieval date); 4 Les bas fourneaux (a pair of stone-set low-shaft furnaces, bellows-blown, slag-tapped; reconstruction); 5 Functionnement des bas fourneaux (charges, lining, products, slags); 6 L'atelier de réduction (stratigraphy, volume of debris, development of workshop); 7 L'exploitation: approche quantitative (quantification of production parameters, consumption); 8 Les scories en forme de calotte (PCB-cakes used as building material for furnace, 2 analyses, interpretation: rehearing slags in secondary positions, having been produced in the vicinity — in no case bloomery waste); 9 Conclusion. Bibliography. Annexes 1 — 3. It is estimated that 125–150 smelts were carried out, delivering more than 1 t of iron (ca 5–6 ton of slags) over 315 working days with a minimal crew of 3 men. The furnace type resembles strongly some of the installations discovered at Bellaires. It belongs to intensively working small-scale production sites, one of several in the Jura. Date: 6th–7th centuries AD.

CPSA

M Fansa (ed). Experimentelle archäologie, Bilanze 1991. Archäologische Mitteilungen aus Nordwestdeutschland, Beihaft 6, Oldenburg 1991.

Includes: Early iron smelting: R Pleiner. Bemerkungen zu einigen Schmelzversuchen in frühmittelalterlichen Renöfen in der Tschechoslowakei, 323–329. Two experimental smelts pointed to the problem of primary carburization of iron in a bloomerey (Želechovice type) and to the successful tapping of slag (Blansko type), after V. Souchopová. From the experimental activity at Zethlingen are described experimental smelts in a slag-pit furnce — R Leineweber. "Langobardenwerkstatt Zethlingen" — Lebendiges Museum mit archäologischen Experimenten nach Grabungsbefunden des 2.-4. Jh.s. in der Altmark, 119–129 (slag-pit blocks successfully made).

CPSA

M P Fernández-Bolaños and M I Herráez Martin. Conservation and restoration of the sword of Boabdil, King of Granada. In *Conservation of the Iberian and Latin American Cultural Heritage: preprints of the contributions to the IIC Madrid Congress, 9–12 September 1992,* H W M Hodges, J S Mills, and P Smith, Ed 1992, 38–41.

This piece is a sword of the type known as *jineta*, dating from the late 15th century, which belonged to Boabdil, the last member of the Nazari dynasty to reign in Granada. The sword has a steel blade and the hilt is made of silver, silver-gilt, enamel, and ivory; the embroidered leather scabbard and fragments of the silk strap are also extant. Describes the history and technology of the sword, its state of preservation, and the process of restoration.

AATA

K Füryová, M Míčeck, L' Mihok and Š Tomčo. Začiatky železiarstva vo východnej čiasti Gemera v stredoveku. [Beginings of ironworking in the eastern part of Gemer in the Middle Ages] *Zborník Slovenského národného múzea. Arch. 1*, 1990, **85**, 107–144.

Publication of two semi-embanked bloomery works of the 11th–12th centuries AD, excavated at Gemerský Sad, SE Slovakia. Each bloomery was equipped with two shaft furnaces leaned against the workshop wall. Bloomery 2, having been extended during its function, had traces of six more hearths occuring in the floor, which represent the remains of disused furnaces. Flat reheating hearths were revealed in workshop 1. The analysed slag is low in wüstite. Samples of magnetite and hematite were found, the latter having been presumably used in smelting operations.

CPSA

N H Gale, and Z A Stos-Gale, Bronze Age archaeometallurgy of the Mediterranean: the impact of lead isotope studies. In *Archaeological chemistry IV*, Advances in chemistry series, no. 220, R O Allen, Ed 1989, 159–198.

For more than 50 years, it has been a goal to use scientific methods to establish which ore deposits were the ultimate sources of the metals from which Bronze Age metal objects were made. Solution of this problem would allow ancient trade routes and cultural contacts to be established. Approaches based solely on trace element analyses have largely failed, and, in many cases, have resulted in achaeological confusion. Success necessitates an approach that takes into account metallurgy, ore deposit geology, and isotope geochemistry, especially lead isotope studies. The methodological background and the success that have been attained in solving this problem are discussed against the background of archaeometallurgical investigations into the sources of silver, lead, and copper in the Bronze Age Mediterranean.

AATA

R Gebhard. Aus der Werkstatt eines Feinschmiedes — Zum Depotfund von Ošaniči bei Stolac in Jugoslawien. [Finds from an ancient metalworker's workshop — the hoard from Ošaniči bei Stolac in Yugoslavia], *Zeitschrift für schweizerische Archäologie und Kunst-geschichte* 1991, **48**(1) 2–11.

A hoard consisting of metal raw-material and semiproducts and of some smithing tools: 3 anvils (one small, in bronze), hammers, chisels, two wire-irons and a clasping device thought to be another wire iron; [this type is interpreted also as a kind of vice for holding thin rods, R P]. Date 2nd century BC.

CPSA

D Glumac (ed). Recent trends in archaeometallurgical research, MASCA Research Papers in Science and archaeology, Vol. 8, Part I, Phildelphia 1991, 82 pp.

Contents: P D Glumac and J D Todd: Early Metallurgy in Southeast Europe: The Evidence for Production, 8–9. Copper mining and smelting in the 5th/4th millenia BC, problems of tin admixtures. C. R. Hoffmann: Bronze, Iron, and Lead: Iron Age Metallurgy in Mallorca, Spain, 21–31. First iron objects from San Matya apper in the 8th century BC (knives, small objects). S T Childs: Iron and copperin Central Africa, 33–46. Metallography of several iron objects (wedge, knife, 1000–1500 AD), from Zaíre, as a part of a more numerous series; fold-welding, faggoting, steel reinforcement. D Killick: The relevance of recent African iron-smelting practice to the reconstruction of prehistoric smelting technology, 47–54. Recently organized smelts of iron ore in traditionally designed furnaces and manned by successors of smelters give important information on the bloomery process. Geographiccal distribution of various furnace types in Africa. R M Ehrenreich: Archaeometallurgy and archaeology: Widening the scope, 55–61. More than 900 metallographically examined iron objects from central southern England (not published until now in detail) indicate that the local Iron Age production of iron was not much influenced by Roman practices, even in subsequent centuries; improvements take place on a limited scale. There is some evidence for the use of cobalt-enriched material. The author calls for models elucidating the impact on the society and strongly criticizes archaeometallurgy as not serving the needs of so-called mainstream archaeology (which seems to be unreasonable). M N Geselowitz: Iron and society in prehistoric Slovenia: Anthropology and the history of technology revisited, 63–68. Some reflections concerning the mechanism of adoption of iron in Slovenia during the Hallstatt period which was enabled by a variety of civilization factors; the development of the technology of iron must have been accompanied by the simultaneous rise of other economic activities. M E Hall: A metallographic study of some Irish iron artifacts, 69–82. Examination of 8 implements from two medieval Irish sites (differing in quality and technology within each set) contributes to and continues the work by Brian Scott.

CPSA

G Godefroy, and R Girard. Les orfèvres du Dauphiné du Moyen Age au XIXe siècle: répertoires biographiques, poinçons, oeuvres. [The goldsmiths of Dauphiné from the Middle Ages to the 19th century: biographical repertories, punch marks, works]. Librairie Droz, Geneva, 1985, 587 pp.

This region, around Grenoble, south of Lyons and between the Rhône and the Alps, was the location of about 15 different goldsmithing centres over the centuries. This is a thorough repertory of the masters, with information on their identity and the course of their careers, photographic reproductions and drawings of their hallmarks, with their names on metal plates called plaques d'insculpation, and a description of their production from the Middle Ages to the 19th century. At that time, the profession suffered a decline compared to its former importance, especially in the Middle Ages and Renaissance, when religious fervor inspired lay patrons in their generosity towards the Church and its treasures. Processional crosses and reliquaries, candelabra and chalices were produced. The Renaissance was marked by the production of gold medals, and everyday precious objects, such as spoons and forks, oil cruets, trays, beverage containers, mustard cups, salt and sugar shakers, snuffers, and rings. Processes identified are hammering, forging, melting, engraving, appliqué, chasing, and chiseling. The objects were made of gold, silver, gilded silver, and vermeil.

AATA

W U Guyan. Das Mittelalterdorf Berslingen bei Schaffhausen. Ausgrabungen 1968–1970. [The medieval village Berslingen near Schaffhausen]. *Zeitschrift für schweizerische Archäologie und Kunstgeschichte* 1991, **48**(4), 193–234.

Excavations of an Alamanian village established in the 9th century AD. During the phase of 11th–12th centuries Dogger iron ores were smelted within the area: remains of a bloomery furnace and layers of slag, and a roasting place were discovered.

CPSA

A Hauptmann and O Mai. Chemische und mineralogische Untersuchungen an Schlacken aus Colonia Ulpia Traiana. [Chemical and mineralogical investigation of slags from Colonia Ulpia Traiana], In: *Spurenlese — Beiträge zur Geschichte des Xantener Raumes.* G Precht and H-J Schaller, eds. Köln-Bonn, 1989, 93–104.

The paper presents results of detailed chemical and mineralogical analyses of iron slags (mostly PCB-cakes) from the 1st and 2nd centuries AD layers of the Roman site of Colonia Ulpia Traiana (Xanten) on the lower Rhine. With one exception (D-719 with high manganese content) all the slags are interpreted as smithing slags, which fits with the type of settlement.

CPSA

J Henning. Schmiedegräber nördlich der Alpen — Germanisches Handwerk zwischen keltischen Tradition und römischem Einfluss. [Smith's graves north of the Alps — A Germanic craft as influenced by Celtic and Roman tradition]. *Saalburg Jahrbuch* 1991, **46**, 65–82.

A treatise on European graves equipped with blacksmith's tools, dating from the La Tène (47 items), Roman (31 items from Germania Libera, 11 from Roman provinces) and Merovingian periods (28 items). Within his sociological framework, the author points to the fact that over 50% of Germanic so-called blacksmiths' graves were equipped with weapons: the craftsmen must have been personally free, at least in considerable number. Celtic and Roman tradition tin the tool kits.

CPSA

E Hjärthner-Holdar. Järnets och järnmetallurgins introduktion i Sverige. [The introduction of iron and iron metallurgy to Sweden] 1993. *Aun* **16**, Uppsala, 206 pp.

This thesis deals with the introduction of iron and iron metallurgy in Sweden. The work examines the introductory phase of iron-working in Sweden against an Eurasian background. It is more than a possibility that iron was produced in Sweden during the Late Bronze Age. Both production sites and iron objects which indicate this have been found. There are 34 sites with traces of iron-working, i.e. slag and furnaces and 76 sites that have yielded early iron artifacts. Both slag and ore have been analysed. The sites have been dated by the use of several unrelated methods typology, stratigraphy and radiocarbon measurements

Author?

H-J Höper. Damaszenerstahl — eine alte Schmiedetechnik. [Damascene steel — an ancient blacksmith's technique]. Westfalen-Lippe, 1987, 67 pp.

Commentary and set of 24 slides depicting some pattern-welding blades, various stages of manufacture of replicas (faggoting, twisting, welding) and some fakes made by punching the pattern onto blade surfaces. It should be mentioned that the techniques described, on pages of this little volume, are solely the welding together of iron and steel components (pattern-welding).

CPSA

J Humpert. Eine römische Strasse durch den südlichen Schwarzwald. [A Roman road through the southern Black Forest], Archäologische Nachrichten aus Baden 1991, **45** 19–32.

A sword-shaped iron bar of the La Tène period type found at Unterbränd-Dittishausen in the Breisgau, Germany, in the remains of a Roman road.

CPSA

M Járó and A Tóth. Scientific identification of European metal-thread manufacturing techniques of the 17th–19th centuries. *Endeavour*, 1991, **15**(4), 175–184.

The elaborate embellishment of textiles by the incorporation of fine metallic threads, especially threads based on silver or gold, was well established in classical times. This article discusses how the nature of the techniques used for making the threads in a particular artifact can be deduced from detailed physical analysis of the threads themselves.

AATA

A Jockenhövel In: **Die Vorgeschichte Hessens** [Prehistory of Hessen]. F-R Herrmann and A Jockenhövel eds. Theiss, Stuttgart, 1990.

The La Tène period chapter contains data of ironworking in that time (pp 288–292). Although there is not yet any evidence for local iron smelting, important finds are indicating iron working and trade: hoards of iron bars (Gernsheim-Allmendfeld–bi-pointed ingots, Niedenstein-Wichdorf, Bad Nauheim or Haiger-Kalteiche (sword-shaped bars) or Oberursel-Oberstädten (ploughshare bars inserted to a bundle) and blacksmith's tools (Bad Neuheim).

CPSA

A Jockenhövel: Archäologische Untersuchungen zur Eisenverhüttung im Dietzholztal. [Archaeological investigations into the iron smelting in the Dietzhölztal, Germany]. In: *Heimatjahrbuch für den Lahn-Dill-Kreis 1992*, 162–167.

Another survey with recent results of the research project in the Lahn-Dill iron production district. Industrial recycling of slags in the past; an ore dressing place A 68; a bloomery work B 88 with a furnace and slag debris at Burbachtal (13th century AD).

CPSA

I Keesmann (ed.) Symposion archäometallurgie von kupfer und eisen in Westeuropa [Archaeometallurgy of copper and iron in western Europa]. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 1988 (1991), **35**, 481–704.

The volume includes papers given at the Mainz symposium (12–15 Sept. 1986). I Keesmann: Zum Mainzer Symposion, 483–486; Items relating to iron: Ph. Andrieux: Problème et dynamique des structures de production métallurgique: le fer, 486–495. The performance of certain types of protohistoric bloomery furnaces as shown by experiments; M-L Hillebrecht: Holzkohlen als Informations-quelle der Archäometallurgie — Ergebnisse aus Untersuchungen im Bereich der Harzregion, 495–505; J-P Jacob — M Mangin: Programme Mines et métallurgie en Franche-Comté, France — présentation et premiers résultats, 505–510. A survey as in 1988; F Golschani — B E Hellermann (Mrs) — I Keesmann: Schlacken der Eisenverarbeitung von Toscanos und Morro de Mezquitilla, Provinz Málaga, 550–552. The specimens are identified as iron working or smithing slags; I Keesmann — S Rieckhoff-Pauli (Mrs): Eisenverarbeitung in der spätkeltischen Siedlung Regensburg-Harting, Oberpfalz, 553–556. Iron-working debris with elevated CaO and K_2O contents. H Geisler: Untersuchungen zur latènezeitlichen Eisenproduktion im Raum Kelheim (Niederbayern), 556–559. Remains of La Tène period and medieval iron works; F Fröhlich — G. Endlicher: Eisenschlacken aus der Umgebung von Neu-Ulm: mineralogische und chemische Untersuchung, 559–560. Analyses of slags from Roman castella, smithing waste. E Lavielle et al.: Caractérisations de matériaux métalliques et scories issues des ferriers de la Montagne Noire, 560–564. A furnace bottom (ca AD 280) analysed, showing remains of metallic iron; C Forrières — J-P Pelet: La métallurgie de fer à Bliesbruck, Moselle, vicus gallo-romain du Ier au 3e siècle, 564–565. Already published as a monograph, see Comm. 42, AR 41, 1989, 331; O. Höckmann: Eisennägel von spätrömischen Rheinschiffen aus Mainz, 565–574; H. Weiland — J-J Bunge: Metallkundliche Untersuchungen an Nägeln der Römerschiffen von Mainz, 574–585. Variation of C-content in Roman ship-nails. Some experiments about the carburization and decarburization of iron stock according to its position in the smith's hearth; W. Birke — M Mangin — I Keesmann: Gallo-römische Eisengewinnung im Morvan, Frankreich, 597–601. Slag sites in the plateau of Thoste (incl. medieval localities); R Pleiner: Spätkaiserzeitliche und völkerwanderungszeitliche Stahlklingen aus Nordostböhmen im Lichte der Metallographie, 602–611. Advanced techniques appear during the Migration period; H E Kolb — W Brockner: Archäometrische Untersuchungen an Grabungsfunden der frühmittelalterlichen Herrensitzen Düne/Osterode, 611–620. Slags from 12th–14th centuries; P Benoit et al.: Archéologie et paléometallurgie des sites de Minot et Fontenay en Bourgogne, 620–638. Slag and an iron bloom analysed; G Sperl: Möglichkeiten zur Rekonstruktion der urzeitlichen Hüttenprozesse des Kupfers und des Eisens aus Schlackenuntersuchungen am mittelalterlichen Beispiel Feistawiese, 639–641. Some calculations of the yield of bloomery process. I Guillot et al.: Études paléométallurgiques comparatives d'outils miniers du XVème et du XVIème siécles, 641–655. Manufacturing technique and repairs of picks. Y Zippert (Mrs) — G Müller: Mineralogische Untersuchungen an spätmittelalterlichen Eisenschlacken aus der Grabung "Barkhof" im Schieder, Kreis Lippe, 655–664. 14th–15th centuries AD PCB-slags and bloomery wastes investigated. U Thiemann — I Keesmann: Chemische und mineralogische Untersuchungen von Eisenschlaken aus Waldalgesheim, Kreis Mainz-Bingen, 686–688. Smithing slag undated.

CPSA

A Knaack. Ausgrabungen auf einem kaiserzeitlichen und slawischen Siedlungs- und Eisenverhüttungsplatz bei Repten, Kr. Calau. [Excavation of a Romano-Barbarian and Slavic settlement and bloomery site at Repten, Calau Distr., Germany], *Ausgrabungen und Funde* 1991, **36**(2), 75–91.

Geophysical prospection revealed an area with iron slags submitted later to archaeological excavations (1985–1989). There were discovered a part of a Romano-Barbarian settlement with 18 slag-pit furnaces; stratigraphically later, in the same place, there were traces of a Slavic bloomery production: 7 furnace hearths, 6 reheating pits, clay tuyeres, and a slag heap (16 m^2). The article presents only the preliminary data.

CPSA

H L Knau: Vom Rennfeuer zum Osmund — Neuere Forschungen zur Frühgeschichte des Eisens. [From bloomery to Osmund iron — Recent research into the early history of iron]. *Der Märker* 1992, **41**(3), 107–111.

Reconnaissances and excavations by M Sönnecken led to the recognition of an important iron bearing region in the Sauerland, W Germany, with a main concentration around Altena (11th–13th centuries) which gradually shifted direction south up to the border with the Siegerland. After 1200 AD a new type of iron smelting appeared, represented by the Massenhütten, equipped with the Flossöfen, precedessors of the blast furnace, producing cast iron. Heavy bloomery-like slags at these sites are, in fact, finery slags. Steel, converted from cast iron, used to be worked, after 1400, in hammer-mills denoted as Selbsthämmer. In the author's view these produced a sort of osmund soft steel, which become a general term for finery iron in Europe.

CPSA

R von Laere. Laatgotisch versierd mesheft uit de abdij van Sint-Truiden. [Knife handle of late Gothic style from the abbey of Saint Trond]. *Limburg*, 1989, **68**(3), 151–154.

Provides a material and iconographic description of the metal object, decorated with a finely incised relief, and provides a chemical analysis of the material. The handle originates from the southern Netherlands and may be dated to the first quarter of the 16th century.

AATA

T Lutz. Die alte Flammofen-Giesserei in Königsbronn: ein Industriedenkmal im schwäbischen "Rivier." [The old flame-furnace foundry in Königsbronn: an industrial monument in the Swabian production region]. *Denkmalpflege in Baden-Württemberg,* 1990, **19**(4), 162–166.

Historical survey of an old flame-furnace foundry for the smelting and working of iron ore in Königsbronn, Brenztal, Baden-Württemberg. The casting-house, with its well-preserved equipment, will be protected as evidence of industrial and technical development, and opened to the public as a museum.

AATA

R Maddin — A Hauptmann — D Baatz: A metallographic Examination of Some Iron Tools from the Saalburgmuseum. *Saalburg Jahrbuch* 1991, **46**, 5–23.

Fourteen Roman iron implements like axes, scythes, files, chisels, adzes have been examined by standard metallography. They originate from two Roman fortresses on the Limes: Zugmantel and Feldberg (dating of finds: 2nd century or 200 AD). Welding-on of hard carbon steels and heat treatment identified in some cases, also edge-carburizing up to eutectoid values. A large object was a mill-axle from Zugmantel (86,5 cm Iong) made of ferritic iron heavily penetrated with slag.

CPSA

M C Manea-Krichten, N Heidebrecht and G E Miller. Instrumental neutron activation analyses of metal residues excavated at Tel Dan, Israel. In *Archaeological chemistry IV*, Advances in chemistry series, no. 220, R O Allen, 1989, 199–211.

Instrumental neutron activation analysis was used to determine concentrations of several major and trace elements in samples of heavily corroded residues found in crucible fragments excavated at Tel Dan, Israel. The residues were mostly hard, metallic phases admixed with nonmetallic inclusions that appeared to be ceramic material from the loose porous interior of the crucible itself. The objective was to identify the metals that had been melted in these crucibles. A method is described that attempts to separate nonmetallic and metallic phase data. In comparison to previous reports on analyses of source materials thought to have been used at Dan in this period (Late Bronze II Age-Early Iron I Age: 1400–1000 BC), high gold concentrations were found. These appear to be correlated to arsenic and antimony concentrations. This finding is discussed in relation to possible changes in the source of tin at this period.

AATA

M Mangin, S Corsini-Laurent, H Laurent and B Raissouni: La sidérurgie ancienne en Franche-Comté, Prospections et études archéometriques. Second rapport intermédiaire 1991. Institute d'Archéologie, Univeristé de Franche-Comté (Besançon) 1991, 36 pp.

Report by the group Metalla and Mines et Métallurgie dans la France de l'Est. Slag sites, ingots, tuyeres, Roman as well as undated, as reported by field reconnaissances and old published comments.

CPSA

M Mangin, J Scherrer and A Faivre: Haut et Bas-Auxois (Côte d'Or): Carte Archéologique générale et sidérurgique: Second rapport intermédiare, Soc. Metalla et Société des Sciences de Sémur et Auxois 1991, 39 pp.

Excavations in the smithy of Blessey found Gallo-Roman stone-founded buildings, hammerscale and 3 working levels.

CPSA

J-R Maréchal: Nouvelles considérations sur la préhistoire et histoire des Européens du Nord. [New considerations on the prehistory and history of the North Europeans]. *Mémoires de l'Académie des sciences, arts et belles-lettres de Caen* 1989, **27**, 25–55.

The question of the origin of the wootz steel is discussed: potential connections of the ancient ferrum Sericum and Parthicum, early production of white cast iron in China and East Asia including the metallurgical activity of Turks and Indoeuropean Tokharias and Scythians are considered.

CPSA

L' Mihok, M Soláriková, A Hollý and Z. Čilinksá Archeometalurgický výskum sečných zbraní z pohrebiska v Želovciach. [Archeometallurgical Research of Cutting Weapons from the cemetery of Želovce]. In: *K problematike osídlenia stredodunajskej oblasti vo včasnom stredoveku*, Nitra 1991, 67–85.

Eight iron weapons from the Avar period (7th century AD) cemetery at Želovce, SW Slovakia were investigated: 4 sabres, 1 blade, described as a paloš 1 Carolingian type sword a "langsax" blade and a one-edged war knife, (dagger). They are claimed to represent two successive settlement units. The technology consisted, in most cases, of welding together two bars of more or less carburized metal. The authors claim that there were two technologies, an Eastern one for the sabres and dagger, and a Western one for the sword and sax; from this they draw historical conclusions about the local community. However, the arguments are not supported by any analogies for the eastern blacksmith's technique; it seems premature to distinguish Eastern and Western techniques on the basis of the Želovce material which is, apart from the sword and sabre from grave 818, of rather inferior quality. Only the so-called dagger was made of steel exhibiting marquenching of its cutting-edge, which was presumably butt-welded.

CPSA

A Melucco, M A Vaccaro, A Mura Sommella and G C Argan, Marco Aurelio: storia di un monumento e del suo restauro. [Marcus Aurelius: history of a monument and of its restoration] Silvana Editoriale, Milan, 1989 277 pp.

Traces the history of one of the best-known monuments in the world, the bronze statue of Marcus Aurelius astride his horse in the Piazza del Campidoglio, Rome, Italy. The restoration of the badly corroded work is also discussed. Attempts at placing the statue in its historical context are retraced. Restoration of the work included cleaning, resurfacing of the gilding, re-touching work, removing dirt layers and deposits, applying surface protectors to inhibit further open-air corrosion, treating holes and lacunae. Notes on the gilding techniques used on the statue are also provided.

AATA

K Mesterházy: Münzdatierter spätkaiserzeitlicher Gerätfund aus Tedej. [A late Roman period hoard of tools, dated by coins]. *Alba Regia* 1990, **24**, 53–66.

A Gepid hoard of 8 iron artefacts containing agricultural implements, axes and horse gear had been found at Tedej near Székésféhérvár, Hungary: coins date the find to the period of the Hun invasion, after AD 375.

CPSA

L Mihok, M Solári Ková and A Hollý. Výroba Železnýeh predmetov, V Slovanskej osade, v Blatnych Remetách. [Manufacture of iron objects in a Slavic settlement at Blatné Remety]. *Hutnické listy* 1991, **1**(2), 103–107.

Nine artefacts from the period of 8th-mid–10th centuries examined (knives, a sickle, a bar and some fittings). Steel, heat treated, some composite artefacts, low carbon iron, also in the case of knife blades.

CPSA

L' Mihok archeometalurgický výskum trosky z výroby železa z Nižnej Myšle — Alameneva-popis nálezov. [Archaeometallurgical analysis of iron slag from Nižná Myšl'a-Alamenevo]. *Východoslovenský pravek III*, Košice, 1991, 193–194.

A slag-cake (PCB) containing much wustitte and unreduced iron ore, from a settlement feature. Dating not given.

CPSA

L' Mihok. Metalografický výskum železných predmetov staršej doby rimskej z Kvakoviec, okr. Vranov nad Toplou. [Metallographic analyses of early Romano-Barbarian iron objects from Kvakovce, E Slovakia]. *Východoslovenský pravek III.* Košice, 1991, 145–156.

Attention is drawn to two pattern-welded swords (Nos 2 and 5) in the Kvakovce find; they are equipped with steel cutting-edges but not quenched. Late Romano-Barbarian period.

CPSA

E Miroššayová, F Javorský, L' Mihok and A Hollý. Metalurgická činnosť na lokalite pod Zelenou Horou v Hrabušiciach. [Metallurgical activity at the site of Zelená Hora near Hrabušice]. *Nové obzory* 1991, **32**, 71–96.

Analyses of low wustitic bloomery slags from the transition of Hallstatt and La Tène periods from the settlement at Hrabušice, eastern Slovakia. Examination of a large socketed axe, presumably carburized on the cutting-edge.

CPSA

A Modronero. The Ancient tin trade in Golicia and its Interpretation through Petrograglyphs. *Bulletin of the metals museum*, 1992, **18**, 44–87.

The origin of the discovery of tin is studied. Galician petroglyphs are interpreted as being involved in the earliest tin trade.

JL

B Niemeyer. Eine tauschierte und mit Email verzierte Dolchscheide aus Carnuntum. [An inlaid and enameled dagger sheath from Carnuntum]. *Carnuntum Jahrbuch*, 1990, 297–301.

X-radiography revealed the delicately inlaid front of the dagger sheath. In comparison with similar objects, one could presume that the dark areas on the x-radiograph without inlays would be decorated with enamel. The conservation treatment is described and the technical construction is shown including a cross section. After an accurate observation of the inlaid silver and brass wires, and of the edges of the enameled grooves, it was possible to reconstruct the construction of the decoration. First, the longest wires were inlaid followed by inlaying the small filling wires. After the inlay was finished, the grooves for the enamel were cut (sometimes destroying the inlay partially) and finally filled with the red enamel.

AATA

E Nosek, ed. From bloom to knife. International Symposium of the Comité pour la sidérurgie ancienne de l'UISPP Kielce-Ameliówka 18–22 September 1989 *Materialy Archeologiczne* 1991, **26**, (Kraków).

K. Bielenin: Frühgeschichtliches Eisenhüttenwesen in Heiligenkreuzgebirge, 7–13; The history of the research project and development of methodology in the investigation of the early iron smelting centre of the Holy-Cross-Mountains. P Crew and C R Salter: Comparative data from iron smelting and smithing experiments, 15–22; Survey of reheating and forging processes on experimental blooms, transformed to billets and bars. Enormous mass losses during reheating. G McDonnell: A model for the formation of smithing slags, 23–26; Mechanism of forming and composition of PCB-cakes from British sites (York-Coppergate, Wharram Percy, Beckford etc.). Reaction of iron oxides with added sand flux and with hearth lining play decisive role in the composition of smithing slag. M. Senn and W. Fasnacht: Experimental iron smelting and smithing documented by the Department of Prehistory, University of Zurich, Switzerland, 27–30; Smelting in an ideal low shaft furnace inspired by the needs of education. Erzberg ore used, low yields (presumably due to long blowing of air into the furnace after finishing the charges, R.P.). H Svane: Rhombic iron axes and axiform currency bars from Norway, 31–33; Axe-shaped iron bars from the Gudbrandsdal area, occuring in many hoards, were superficially forged from low-carbon material.L-E Englund: Early ironmaking in Kind, 35–39; Preliminary results of reconnaissance digs in Kind, east southern Sweden, where some slag sites are reported, two of them having been tested at Tranemo (a stone-walled twin-furnace, charcoal pits, bloomery slag, also carefully crushed around anvil stones, about 1000 AD). J Piaskowski: The technology of iron implements on the territory of Poland in the late La Tène and Roman period (2–1 cent. BC–5 cent, AD), 41–51; Using data from more than 900 analysed iron objects from 188 sites, and published in previous years, and 282 slag samples from 161 sites, the author applied a calculated statistical analysis to determine some eight production centres in Poland. C Rovira and J Ma Solias: Iron mining and metallurgy in the lower course of the river Llobregat (NE of the Spain) during Iberic and Roman Republican Period, 41–51; A recently recognized iron producing region in Catalunia with scarcely specified smelting and mining sites, wrecks with iron ore and ingot cargoes in the estuary of the Llobregat river. M Mangin: La sidérurgie ancienne dans l'est de la France: Recherches en cours (1981–1989), 59–66; Discussion on the recent state of studies into the ancient iron production in Franche-Comté and Lorraine, as seen from the systematic activity of several research teams. E Nosek: Forging of high phosphorous iron, 67–70; Phosphoric iron from original axe-shaped bars from the huge hoard found at Kraków was experimentally forged, welded and carburized which brought some difficulties but was possible with some skill. Ph Andrieux: Introduction à l'étude thermique des elements de construction des fourneaux métallurgiques et leur relation avec des productions expérimentales, 71–77; Experiments directed to behaviour of the furnace shaft lining at high temperatures (air supply, wall thickness, reactions between lining and charges). A Espelund: Towards a classification of bloomery practices, 79–86; In the author's view the classification of types of bloomery processes is very important. He distinguishes two of them: the temperature-controlled and the slag-controlled processes. The latter involve the Catalan and Evenstad smelting, the former the Norvegian Heglesvollen and medieval furnaces. The problem of criteria deserves discussion. A Anteins: Der Geschichte der Rennöfen in Lettland, 87–88; A survey of some older as well as recent finds of low shaft furnaces (early Middle ages). A huge votive deposit of iron objects at Kokmuiža (1869, 1929) mentioned. L Rozanova and N Terekhova: Modelirovanije drevnyich priyemov zhelezoobrabotki k problemu rekonstrukciyi drevnych technologicheskikh processov [Experiments in early ironmaking operations: problems of reconstruction of early ironworking processes], 89–92; A very instructive report of experimental smithing of original 14th century AD iron blooms from Novgorod and manufacture of three-layered, piled, and pattern-welded knives of this material. J Lang: A dirk from Cyprus, 93–96; A blade of the 11th century BC revealed a steel coating and a kind of heat treatment. V Fritz, R Maddin, J D Muhly and T Stech: The iron from Kinneret, 97–102; About 50% of iron objects from 10th–8th centuries layers have been manufactured, according to authors, by secondary carburization. C Domergue: Recents découvertes aux Martys (Aude, France): des fours de réduction du fer du ler siècle avant J-C, 107–114; A very important account on archaeological excavations of two shaft furnaces (1st century BC), the first ones discovered in the enormous iron producing region of the Montagne Noire. T Goslar and M F Pazdur: Wiek radiowęglowy kopalni hematytu w Rudkach woj. Kielce. [Radiocarbon age of the iron ore mine in Rudki, Kielce woiwodship], 115–118; New datings from museum-kept timber show earlier date (about 100 AD) instead of former datings (about 230 AD). All radiocarbon dates from the Holy-Cross-Mountains smelting area do not conform with archaeological chronology which causes much confusion. Ph Andrieux: Preparation et experimentation d'un fourneau Burguonde (Burgenland) avec le professeur Bielenin, 119–122; Log book of an experimental smelt in a domed furnace of the Burgenland type, taking place at the occasion of the Symposium (Nowa Slupia). The volume contains valuable contributions, but the poor English and German of some of them, and numerous printing errors, make them in some places difficult to understand.

CPSA

E Oakeshott and T Mansfield. Records of the medieval sword. Boydell & Brewer, 1991.

Based on a typology devised by the author in the 1950s for swords of the High Middle Ages (ca. 1050–1520). The introduction highlights the problems inherent in dating individual swords due to the potential variations in date between the blade, hilt, and pommel. It also describes findings, find-places, inscriptions, find contexts, conservation, manufacture, and suppl, and contains sketches of sword families A-M and pommel types A-Z. The main body is taken up with examples of sword types X-XXII.2. Plates of each find are accompanied by tables presenting information on type, find-place, collection, blade, length, pommel type, cross style, date, condition, and details of any previous publication. Miscellaneous, unclassified and complex-hilt swords are followed by four appendices, the first entitled "The Living Sword: Construction of Modern Replicas of the Knightly Blade."

BAA

S Orzechowski. Próba rekonstrukcji stanu zalesenia północno-wschódnych obrzezy Lysogór w okresie wpływów rzymskich — Przyczynek do poznania środowiskowych warunków rozwoju świętokrzyskiego okresu hutniczego. [Reconstruction of forests on the north-west slopes of the Lysogóry during the Romano-Barbarian period — contribution to the knowledge of the environment of the Holy-Cross-Mountains iron production area]. *Acta Archaeologica Carpathica* 1991, **30**, 167–186.

Discussion of the fuel consumption and vegetation in the period ca AD 150–250 in the Holy-Cross-Mountains. In the adjacent zone to 900 bloomeries, consisting of 100 furnaces (smelts) each, were operated. This indicates an annual consumption of 9 ha of forest. The author interprets the furnaces as working on induced draught, for which he postulates that they must have operated in areas that were cleared of trees.

CPSA

J Papp. A veszpremfajszi nyaklícegyüttes restaurálása és anyagvizsgálatának eredményei. [Restoration of the Veszprémfajsz necklace assemblage and results of its analysis.] *A Miskolci Herman Ottó Muzeum közleményei*, 1989, **25**, 83–86.

During excavations at the medieval cemetery in the vicinity of Veszprémfajsz, a child's grave was unearthed with rich grave goods, including an interesting composite necklace. The grave was dated by coins and bracteates. The necklace assemblage was lifted together with the soil and taken to the conservation laboratory. The elements of the necklace, glass beads, and thin foils of metal coins were taken out with utmost care. Analysis of the object reveals several reworkings as well as chemical composition. After conservation, the finds were included into the permanent exhibition of the county museum.

AATA

M Paquier and M Mangin. Bibliographie mines et metallurgie anciennes: Le fer (with co-operation by J Jockenhövel, F Lassus, R Pleiner, J L Remy and V Serneels). Besançon, 1992, 138 pp.

The definitive version of the bibliography of early iron, including items edited until May 1990. The work is provided with an index, sorting the items into two principal chronological periods: prehistory (Hallstatt and La Tène periods) and antiquity (Roman and Gallo-Roman period). The concentration is on classical antiquity despite the presence of some medieval items, and the Western and Central European World. A thesaurus of key words is added. Although the bibliography is not annotated, it represents a great help for any scholar interested in the history of iron.

CPSA

S Pazda. Osada hutnicza z późnego okresu rzymskiego w izbicku, woj. Opole. [A smelting site of the late Romano-Barbarian period at Izbicko], *Silesia Antiqua* 1990, **32**, 23–59.

In the 1970's part of a settlement was revealed by excavations an area which comprised nearly 40 sunken bottoms of charcoal burning piles and a place paved with stones and lumps or bloomery slag, including two large slag blocks from slag-pit furnaces. Smelting installations as such were not discovered. Late 4th century AD.

CPSA

P-L Pelet. L'emploi des fournax à fer assymétriques du pied du Jura vaudois: deux hypothèses à verifier. [On the use of assymetrical bloomery furnaces at the foot of the Jura Vaudois: two hypotheses to be resolved]. In: *L'âge du fer dans le Jura*, Actes du 15e Colloque de l'Association Française pour l'étude de l'Age du fer (Pontarlier, 9–12 mars 1991). Cahiers d'archéologie romande 57, 1992, 341–349.

Finds of assymetrical stone-walled low shaft furnaces in pairs of the 6th–7th centuries AD discussed in terms of the air-inlet systems in two levels (Bellaires I, III, Montcherand, Boécourt). In the author's opinion these furnaces were able to produce primarily steeled and simultaneously reheated blooms (as suggested for the Želechovice-type furnaces).

CPSA

A Perea. Estudio microscopico y microanalitico de las Soldaduras y otros procesos tecnicos en la orfebreria prehistorica del sur de la Peninsula Iberica. *Trab ajos de Prehistoria.* 1990, **47**, 103–160.

Gold working welding techniques appear for the first time in the Iberian peninsula during the Late Bronze Age. Welding was only applied to granulation and filigree work in the orientalising period. These techniques were studied in the SEM with an EDS micro analysis unit. Fabrication techniques were also studied for objects from the Archaeological museums of Seville, Cadiz and Madrid, covering the period from the early Chalcolithic to the Iberian period, but were mainly for the orientalizing and Iberian periods. Some identification of work shop styles was found possible.

Author

J Piaskowski. Technologia wczesnośredniowiecznych przedmiotów żelaznych ze wzgórza wa-welskeigo. [The technology of early medieval iron objects from the hill of Wawel in Kraków]. *Studia do Dziejów Wawelu* 1991, **5**, 55–92.

From 22 examined iron artifacts found at the Castle hill of Kraków (11th–13th centuries), the former capital of Poland, attention is drawn to 9 knives, two of which were constructed as threelayer sandwich blades and three as pattern-welded knives. Also comments on 18th century descriptions of the pattern-welding technique (Parret, Wöstström, Rinman, Karsten).

CPSA

J Piaskowski. Metallkundliche Untersuchungen antiker und frühmittelalterlicher Eisengegenstände. In: *Latrus-Krivina IV — Spätantike Befestigung und frühmittelalterliche Siedlung an der unteren Bonau.* [Metallographic investigations of ancient and early iron objects from the late Roman fortification of latrus, now Krivina in Bulgaria]. Akademie Verlag, Berlin, 1991, 241–260.

Metallographic investigations of iron objects from the layers of 4th–6th centuries AD (an axe, a sickle) and from a settlement of the 7th–10th centuries AD (14 objects, mostly knives and sickles). Considerable As-contents caused hard ferritic grains and, in combination with some phosphorus, banded structures. However, the author's interpretation of an unsophisticated technology does not correspond with some microphotographs which show clear welds and systematic construction of blades (knife 3). Although the work was edited in Berlin, the German technical terminology is unusual; the confusion of an adze (Dechsel) with systematically used Deckel (lid) is unfortunate.

CPSA

R Pleiner. Study of the early production of iron in Czechoslovakia 1985–1989. In: *Archaeology in Bohemia 1986–1990.* Inst. of Archaeology, Prague, 1991, 252–255.

The paper deals with archaeometallurgical activity in Czechoslovakia roughly during the period between the two World Congresses of Archaeology of the UISPP (1991 in Bratislava), mentioning the programmes of the three main centres of research on the field of the history of iron: Prague (Laboratory of the Archaeological Institute), Blansko (Regional Museum), and Košice (Technical University). Appendix: Bibliography related to the early history of iron in Czechoslovakia 1985–1989 (36 items).

CPSA

H Reim. Die Kelten in Baden-Württemberg K Bittel, W Kimmig and S Schiek eds, Theiss, Stuttgart, 1981.

Within the survey of Celtic archaeology of this part of Europe, in a chapter on Celtic crafts and technology, the metalworking is mentioned on pp 205–214. The Hillesheim bloomery furnace (out of the area, late Hallstatt) is reconstructed explicitly as a domed installation. The important hoard from Kappel-Bad Buchau is also mentioned (blacksmith's tools, axes, large fire-dog) as well as the bi-pointed iron ingot from Heuneburg, one of the earliest among 700 in central Europe.

CPSA

G Spies, Ed. Der Braunschweiger Löwe, [The Lion of Brunswick]. Städtisches Museum, Braunschweig, 1985, 453 pp.

The so-called Lion of Brunswick is a medieval bronze sculpture (1166), located in the town of Brunswick, Germany. During the years 1980–1983, it underwent a thorough restoration, which is described in detail. The chapters report on general aspects of bronze restoration; metal analysis of the Lion; extent of corrosion; examination of the patina; amount of lead; x-ray radiography; and casting technique. After restoration, the Lion was not relocated to its original place (open-air), but to a museum.

AATA

L. Szöke: Schlackenhalden und Schürfungen im Braunen Jura zwischen Reutlingen und Weilsheim an der Teck. [Slag heaps and open-cast works in the Brauner Jura between Reutlingen and Weilheim an der Teck], *Fundberichte aus Baden Württemberg* 1990, **15**, 353–82.

An early medieval bloom containing portions of cast iron is discussed in connection with other archaeometallurgical sources from the region which indicate an early indirect process (Metzingen etc.). The results of reconnaissance and mapping of slag heaps and mine pits in this region, produced lumps of clayish Dogger limonite and yielded 4 types of slag which include, among bloomery waste, a type with high silica, aluminium and lime and low iron content, which indicates the indirect process. The find site of the bloom is not given. The dating of features, on the basis of pottery (Frickenhausen) and C-14 dates, points to about AD 700.

CPSA

M Ju Treister. Trade in Metals in the Greek World From the Ardaic to the Helleustic Epoch. *Bulletin of the Metals Museum* 1992, **18**, 29–43.

Discussion of the transportation of ore and ingots in relation to finds from underwater archaeology. Literary and coin evidence are also considered.

JL

H Vandkilde. A late Neolithic hoard from Vigerslev, North Zealand: an archaeological and metal analytical classification. *Journal of Danish Archaeology,* 1990 **9**, 103–113.

Two late Neolithic bronze objects found at Vigerslev (North Zealand) in Denmark, a metal-hilted dagger and a low-flanged ax, were analyzed for 11 elements (tin, arsenic, lead, antimony, silver, nickel, bismuth, cobalt, gold, zinc, and iron) by electron probe microanalysis (EPM) in the Department of Metallurgy and Science of Materials at Oxford University, and by energy dispersive x-ray fluorescence (EDXRF) and inductively coupled plasma mass spectroscopy (ICP-MS) at the Riso National Laboratory in Denmark. The ax falls into Group A of the SAM (Studien zu den Anfängen der Metallurgie) compositional groups; the dagger into Group B2. Both are common metal types in the Neolithic of Denmark and Central Europe. The analytical methods are in fair agreement, except that the ICP-MS value for tin in the dagger is much too low.

AATA

H Vandkilde, Metal analyses of the Skeldal hoard and aspects of Early Danish metal use. *Journal of Danish Archaeology,* 1990, **9**, 114–132.

Analyses for tin, arsenic, lead, antimony, silver, nickel, bismuth, cobalt, gold, zinc, and iron in 11 copper and bronze and two gold objects from the Late Neolithic Skeldal hoard in central Jutland, Denmark, were performed by electron probe microanalyses (EPM) at Oxford University. Various statistical treatments of the data are discussed in terms of the compositional classification of the SAM (Studien zu den Anfängen der Metallurgie) program, which used optical emission spectroscopy (OES), and of their geographic origin and chronological position.

AATA

A Werner and R Barth. Schmelzverusche im Rennfeueröfen — Experimentelle Eisenverhüttung in rekonstruierten Rennfeueröfen vom Typ Scharmbeck. [Smelting experiments in bloomeries — Experimental smelting of iron in reconstructed furnaces of the Scharmbeck type]. *Das Rheinische Landesmuseum Bonn — Berichte aus der Arbeit des Museums* 1992, 3, 33–8.

Short account of two experimental smelts organized by the Rhein. Amt f. Bodendenkmalpflege. Slag-pit furnaces based on the Scharmbeck find (2nd century AD) were used. Limontic ore/fuel ratio 1:2,5 and 1:2, vacuum cleaner blowing, temperatures 1100–1200°C after 2 hours of smelting. Duration: 6 hours. Iron-and-slag conglomerates in slag-pits, untouched until now, so the yields are not yet available.

CPSA

H Wigestrand. Frå malm i myra til verktog og våpen. [From bog iron ore to implements and weapons]. In: *Hovden: Arkeology og historie*, Bykle community, Norway 1991, 1–16.

A popular account of local iron production around Hovden, Norway, as represented in the open-air museum at Hovden.

CPSA

A R Williams: Italian Armour and Cosimo di Medici. *Journal of the Arms and Armour Society* 1991, **13**(5), 293–315.

The quality of Italian armour declined after a floruit in the 15th century, in the subsequent period; armour ceased to be quenched after 1510, according to metallographic investigations. Discussion of some celebrated armour workshops in Northern Italy.

CPSA

A Zifferero. Miniera e metallurgia estrattiva in Etruria meridionale: per una lettura critica di alcuni dati archeologici e minerari. [Mining an metallurgy in southern Etruria]. *Studi Etruschi* 1991, **57**. (Seria III), 201–241.

Critical survey of literary items. Magnetitic ores on Tuscany shores near Magliano and Monte di Tolfa and traces of metallurgical activity at some sites; use of Elban iron south of Cerveteri and near Tolfa.

CPSA

ASIA

O P Agrawal, H Narain, and J Prakash, Metallographic studies of iron artifacts from Bharadwaj Ashram (300–500 A.D.), Uttar Pradesh. *Studies in museology*, 1991, **27**, 1–12.

Metallographic studies of iron artifacts from Bharadwaj Ashram (300–500) in Uttar Pradesh in India were conducted to understand their fabrication techniques and to know the development of iron metallurgy in ancient India. It was found that the artifacts were fabricated from wrought iron and low carbon steel with elevated phosphorus content. During this period, the skill of making low carbon steel from wrought iron was known. There is indication that the carburization of the wrought iron was started here even before the Gupta period.

AATA

O P Agrawal, H Narain and J Prakash. Metallographic studies of iron artifacts of domestic use, tools & weapons from Khairadih (100–400 A.D.), Uttar Pradesh. In *Role of chemistry in archaeology: 1st International Colloquium, 15–18 November 1991* M C Ganorkar, and N Rama Rao Eds 1992 103–111

Khairadih is in ancient Iron Age site located in the northeast of district Ballia, on the right bank of the river Saryu in Uttar Pradesh, India. The explorations showed that this area flourished between 1100 BC and 400 AD. The findings from this site include a series of furnaces used for iron smithing, slags, unfinished tools, axes, chisels, knives, rods, nails, lamps, rings, and sickles. Metallographic examination of artifacts, which were mostly in an advanced stage of corrosion, indicated that the smith learned to carburize wrought iron here around 100–400 AD. The technology was not well developed and the worker was not able to impart sharpness to the cuting edges of tools (knife) and weapons (dagger) by any heat treatment technique.

AATA

Abstracts of National Seminar on Indian Archaeometallurgy 2–4 Oct 1991, Varanasi, Edited by the Banaras Hindu University, Depts. of Archaeology and Metallurgical Engineering, 1991, 36 pp.

Includes: A K Biswas: The literary highlight on Materials and Metals in Ancient India; A review of minerals and metals from Rigveda to Rasaratnasamacchya is announced. D M Tripathi: Ayas in the Rigveda; The connotation is uncertain, sometimes definitely meaning copper. S J Mahmud: Glory of Indian iron and steel in archaeology: On the contrary, the author maintains that ayas in the Rigveda denotes iron. P Srivastava and V Tripathi: Iron in the early Buddhist texts; Terms for tools and types of iron, quenching, organization of work. B Prakash: Metallurgical study in ancient swords; Wootz steel and Damascus swords, attempts at imitation, experiments. D Liversage: Pre-industrial crucible steel in South Asia; Separate metallurgical background. K K Prasad and R Sail: Evolution and development of earlier ironmaking processes and their relevance in Indian context; Beginnings of metallurgy 11.000 BC (?). H Narayan, J Prakash, O P Agrawal and M V Nair: Metallographic studies on iron artifacts of domestic use, tools and weapons from Springaverpura (250 BC to 600 AD) Uttar Pradesh: Five metallographic analyses reported, carburization attested. A Dutta: Iron technology at the chalcolithic phase of Mengalkot; The use of meteoritic iron in small quantities is not out of the question. J P Upadhyay: Metal implements of Northern India (from 1000–500 BC). M D N Sahi: Metal industry of the proto-historic western U P with special references to the evidence of Jakhera; The beginnings of the use of iron (agriculture included) are connected with the Black-and-Red pottery horizon; The PG period saw the full development. R P Pandey and A K Singh: Iron technology and its role in the historical developments in Morar valley, M P; Four metallographic analyses of axes, knife and spear-head from the site of Sooron, V Tripathi and A Tripathi: Mineral resources; a possible archaeo-metallurgical correlation; Iron ores and archaeological sites, search for pre-industrial smelters. S B Deo: Metal technology of Vidarbha Megalithians; Clay-built furnace at Naikund. N R Srinivasan: Rural iron making in Orissa; A project for reviving earlier technologies which was stopped in 1962. R K Dubey and M Sharma: Tristul of Tanginath near Bishunpur; A similar project in the area of Asur tribe smelters. B P Singh: Is iron in eastern India a tribal legacy? An etnoarchaeological inquiry; Indigenous smelter tribes of Lohar, Asur etc. S P Gupta: Coming of iron in India: why did it lead to different cultural configuration; According to the author, iron was known in India from 1000 BC and the development of its general use is connected with urban life. V K Thakur: Iron technology & social change in pre-Mauryan India; The role of iron in state development. T L Lowe: An embarrassment of archaeometallurgical riches: research in the Indian cultural context; Development of the wootz-steel process, culminating in the 17th century. B B Lal: Archaeometallurgical studies in early Indian iron smelting and iron working, The appearance of iron is claimed to be from the 13th century BC, the application of the wootz-process from the 4th century BC (no evidence given in the abstract). N C Ghosh: Introduction of iron technology in Bengal; Autochtonous origins are treated as one possibility.

CPSA

P Jett. Technologische Studie zu den vergoldeten Guanyin-Figuren aus dem Dali-Konigreich. [A technical study of the gilt bronze Guanyin figures of the Dali Kingdom] *Der Goldschatz der drei Pagoden: buddhistische Kunst des Nanzhao- und Dali-Königreichs in Yunnan, China: Museum der Provinz Yunnan, Kumming, Museum des Autonomen Gebiets der Bai-Nationalität, Xiaguan, Museum der Stadt Dali, Amt für Kulturgüter der Provinz Yunnan,* Albert Lutz, Ed 1991 68–74.

Describes the study of 10 so-called guanyin bronze figures which date to the 12th century and come from an area which is now in Yunnan Province, China. The figures, whose composition was determined by atomic spectroscopy, are all composed of arsenical copper. Lead isotope ratio analysis was also performed. The method of construction of the figures, studied, in part, using x-radiography, is also discussed. The essay is one of a group which make up a catalog of an exhibition of the art of the Dali and Nanzhao Kingdoms of ancient Yunnan.

AATA

P Jett. An example of the use of brass in Chinese lacquerware. *Archives of Asian art.* 1990; **43**, 59–60.

A Chinese black lacquer tray, attributed to the 14th century because of its style, bears metal wire and shavings as part of its decoration. The metal was analyzed using x-ray fluorescence surface analysis and found to be a leaded brass containing approximately 29% zinc. If the date of attribution of the tray is correct, then the presence of brass is unusual given the results of recent studies which suggest that brass did not come into common use in China until the early 16th century. Further study of trays of this type, which often bear wire inlay, may prove useful to our understanding of the histories of Chinese metal technology and Chinese lacquer work.

AATA

Y Kuno, K Yamasaki, M Murozumi and M R R Abhakorn. Metallographic and lead isotope studies on metal objects unearthed in the Tak area, Thailand. *Journal of the Siam Society,* 1990, **78**(2), 51–60.

A wide variety of iron and bronze artifacts was found together with Chinese and Thai ceramic wares in the burial sites high in the mountains along the border of Thailand and Myanmar (Burma) in Tak province. The sites are thought to be dated to the 14th–16th centuries. A bracelet, a bell, and three other metal fragments unearthed in the above burial sites were examined metallographically and the lead isotope ratios were determined. The bracelet is made of brass, while the bell is of bronze. Of the three metal fragments, two are made of bronze, and one of brass. The lead isotope ratios of the bracelet agree with those of the galena ores of supposed Burmese origin, but the lead isotope ratios of the bell show isolated values.

AATA

M Vijayakumar, M C Ganorkar, V Rao, Pandit and P Gayathri. A study of Vishnukundin coins. *Bulletin of materials science,* 1987, **9**, 2, 137–147.

Three types of Vishnukundin coins (ca. 475–615) belonging to the region of Andra Pradesh were analyzed by emission spectrography, atomic absorption spectrometry, metallography of cross-sections, and electron probe microanalyzer (EPMA). The coins are high-tin bronze (tin 29%–24.5%) with high iron (up to 11.9%) and low lead (lead 0.11%–0.67%). Sulfide ores (bornite) and either stream tin or pure tin metal seem to have been used to make the coins, as shown from the trace elemental analysis and confirmed by inclusions seen with EPMA. The structure of one coin is as-cast, with a little working and annealing on the surface. Another may be heavily worked and annealed, but the microstructures are not clear. The exact methods of fabrication of this brittle alloy are still not perfectly understood.

AATA

THE AMERICAS

P Craddock: Analysis of the iron in two objects from the Ross expedition of 1818. In: *Aspects of Early North American Metallurgy* M L Wayman, J C H King and P Craddock, eds. British Museum Occasional Paper No 79, 1992, 83–94.

The author analyses two Eskimo implements from Ross's 1818 expedition to the Arctic. Knife 87562 was made of terrestrial iron; the other knife/harpoon shows 5 scales of the cutting-edge to be of meteoritic iron (7.5–0.5% Ni). Interesting data about the Inuit and other Eskimo groups exploiting the meteorites of Cape York, Greenland.

CPSA

D Hosler and G Stresser-Pean, The Huastec region: a second locus for the production of bronze alloys in ancient Mesoamerica. *Science* 1992, **257**, 1215–1220.

Presents a brief outline of Mesoamerican metallurgy, descriptions of the different metalworking traditions of the Southern Hemisphere, and the results of atomic absorption spectrometry or electron microbeam probe analyses of 51 metal artifacts (plus one ingot and two pieces of intermediate processed material) from two late post-Classic (15th-century) archaeological sites in the Huastec region of eastern Mesoamerica.

AATA

D A Scott. Spanish Colonial and indigenous platinum: a historical account of technology and fabrication. In *Conservation of the Iberian and Latin American Cultural Heritage: preprints of the contributions to the IIC Madrid Congress, 9–12 September 1992,* H W M Hodges; J S Mills and P Smith, Eds, 1992, 148–153.

The pre-Columbian Native Americans of Ecuador and Colombia were the first people to make use of indigenous platinum. The dating of this metallurgy is difficult but it probably goes back to the early centuries BC and continues at least until 800 AD. The native people made use of sintering in the production of their platinum and gold alloys, some of which are plated with platinum over gold by the process of diffusion bonding of small platinum grains to the gold surface. This pre-Hispanic platinum metallurgy has no parallel in the Old World, where platinum remained unknown and unused in any quantity until the scientists of the 17th and 18th centuries began to investigate its properties. The Spanish platinum industry and the attempts of French and Spanish scientists to make use of the metal are briefly discussed.

AATA

AFRICA

D Killick. A tin lerale from the Soutpansberg Northern Transvaal, South Africa. *South African Archaeological Bulletin* 1991, **46**, 137–141.

All previously published examples of the lerale (a distinctive type of ingot formerly produced in the Transvaal) are made of copper. The article notes the first instance of a lerale made of tin. The form microstructure and chemical composition of this artifact are described, while the technology of its production and its possible provenance are discussed.

Author

D Schorsch. An Egyptian ibis sarcophagus in the Virginia Museum of Fine Arts: a technical report. *Arts in Virginia*, 1988, **28**, 48–59.

An extensive technical examination was carried out on a Egyptian composite gilded wood and copper alloys ibis sarcophagus attributed to the Late period (Egyptian) or Ptolemaic period. Evidence from a radiographic examination, as well as surface appearance and elemental composition indicate that the metal components of the ibis are probably of modern origin. Examination of a cross section from the gilded and gessoed wooden body and carbon-14 dating of the wood itself suggest that although the body is ancient, the gilding is modern.

AATA

D Schorsch. Copper ewers of Early Dynastic and Old Kingdom Egypt: an investigation of the art of smithing in antiquity. *Mittleilungen des Deutschen Archaeologischen Instituts, Abteilung Kairo* 1992,. **48**, 145–159.

Copper ewers of the Old Kingdom in Egypt originally became a subject of study in the department of objects conservation of the Metropolitan Museum because of certain similarities between them and the three silver libation vessels from the so-called Three Princesses' Treasure, a large and varied group of objects dating to the Eighteenth Dynasty, which is presently undergoing stylistic and technical revaluation by the departments of Egyptian art and objects conservation. The study of the ewers was carried out primarily through visual examination, x-radiography, and replication experiments. These ewers, which had separate applied sprouts, were raised from copper sheet and evolved from an open form common in the Early Dynastic period, to an exceedingly closed late Old Kingdom form that placed increasing demands on the skill and ingenuity of the smiths who produced them. Most importantly, it would have been quite difficult, as it still is for contemporary smiths, to force the metal walls to compress sufficiently to terminate in the very small opening on the top of the ewer. Some ewers were raised in spite of these difficulties, leaving evidence of such in the form of cracking or overlapped metal on the rim. For a number of the most extreme examples, separate bottoms were inserted, and in the case of an archaicizing New Kingdom example, the bottom was cast in. Secondly, the problem of the manufacture and attachment of the spout prompted a number of solutions. The spouts themselves were either made from hammered sheets that were riveted or crimped together, and represent fairly early examples of hollow casting. The attachment is often clearly mechanical, involving the use of rivets. The other joins, where no mechanical means are visible, have been described in earlier literature as being soldered, but this is unlikely. Rather the spouts appear to have been cast with an extra flange that would facilitate attachment by crimping.

AATA

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