Abstracts

GENERAL

A C Cook, J R Southon and J Wadsworth. Using radiocarbon dating to establish the age of iron-based artefacts. *Journal of the Minerals, Metals and Materials Society (JOM), 2003, 55(5), 15–22.*

An overview of radiocarbon dating of iron-based materials. Recent advances include simplification in sample preparation and reduction in sample size for accelerator mass spectrometry measurements, and the potential use of rust as a viable source of material for radiocarbon dating. Additionally, a summary is presented of all 63 previously published results and 29 previously unpublished results for iron-based materials. These materials range from low-carbon wrought irons to medium to very high-carbon steels and cast irons. Artefact dates range from several hundred to several thousand years ago. Brief descriptions are given of some samples to illustrate issues and complexities that can arise in determining the age of iron-based carbon materials using radiocarbon dating. Authors (adapted)

G C Holywell. Magnesium: The first quarter millennium. *Journal of the Minerals, Metals and Materials Society (JOM)*, 2005, 57(7), 26–33.

From its discovery in the mid-1700s, through wars and geo-political changes to the present, magnesium has been studied extensively and processing techniques have evolved. This article provides an overview of the history of magnesium production worldwide. Author

P Webster. The brasses – properties and applications. Copper Development Association, 2005.

This is an updated version of a useful popular reference publication.

BRITAIN AND EUROPE

A Deraisme, L Beck, F Pilon and J-N Barrandon. A study of the silvering process of the Gallo-Roman coins forged during the third century AD. *Archaeometry*, 2006, 48(3), 469–480.

We have observed by fast neutron activation analysis (FNAA) that the global composition of the official silver coins of the Gallic emperor Postumus is not the same as those from the contemporary unofficial mints. In order to explain this phenomenon, we have carried out a metallographic study of the artefacts. The silvering process of unofficial coins was re-created in order to better understand the manufacturing process of silvering. The different steps of the replication process are explained. Authors

R M Ehrenreich, E Hamilton, and S K Nash. Far from barbaric: re-assessing the sophistication of Merovingian metalworking. *Journal of the Minerals, Metals and Materials Society (JOM)*, 2005, 57(8), 51–55.

The Merovingian dynasty lasted from the mid-5th to the mid-8th centuries AD and at its height controlled states that stretched across France, Belgium, Germany west of the Rhineland, and most of Switzerland. Archaeometallurgists used to believe that metalworking technology declined after the demise of the Roman Empire. To assess the level of sophistication of metal use during this period, 36 iron tools and weapons were compared with eleven Iron Age, three Roman and four medieval iron artifacts from the same region. The results are fairly typical in that they varied from good quality to poor. Authors (adapted)

E C Joel, J J Taylor and R D Vocke. Geological implications of the lead isotope data on ores from the Great Orme mine, North Wales, UK. in L van Zelst (ed), *Patterns and Process. A festschrift in honor of Dr Edward V Sayre.* Suitland MD, Smithsonian Center for Materials Research and Education, 2003, 291–309.

By using carefully contexted material from the Bronze Age period of extraction at the Great Orme, it was found that lead isotope analysis could reliably characterise the ores, provided a careful sampling strategy is employed to address the archaeological questions being asked. It is shown that broad-brush or random sampling can mislead the assessment of both the technique and its effective application to archaeology. Lead isotopes can be used to characterise the geological ores known to be of archaeological significance in a specific time or context, and sometimes define the geological zones from which the ores were extracted. This may make it possible to identify which ores or parts of the ore bodies were of interest to Bronze Age miners.
Authors (adapted)

A Karatzani and T Rehren. The use of thin metal threads and decorations in Byzantine-Greek orthodox ecclesiastical textiles. *Journal of the Minerals, Metals and Materials Society (JOM)*, 2006, 58(5), 34–5.

Samples of metallic threads, sequins and other metallic decorations were taken from textiles of the 13th–19th centuries and examined using optical microscopy, scanning electron microscopy with energy-dispersive X-ray spectrometry, and electron-probe microanalysis. The type of thread and its manufacture were

identified, and compositional analyses were carried out. JL

T L Kienlin, E Bischoff and H Opielka. Copper and bronze during the eneolithic and early Bronze Age: A metallographic examination of axes from the Northalpine region, *Archaeometry*, 2006, 48(3), 453–468.

The results of a metallographic examination of Eneolithic and Early Bronze Age axes from the north Alpine region of central Europe are presented. Different types of copper were in use: arsenical copper, fahlerz copper and tin bronze. The extent to which the different properties of the metals used were known to prehistoric metalworkers and actively manipulated in the production of the axes and the development of methods of casting and smithing are discussed. During the Early Bronze Age of the north Alpine region different traditions of early metallurgy can be identified, which differ in their use of fahlerz copper, their attitude towards tin alloying and the use made of tin bronze in the production of axes. These traditions can be best described by reference to both composition and knowledge of the production techniques provided by metallographic data. Authors (adapted)

F Nocete. The first specialised copper industry in the Iberian peninsula: Cabezo Juré (2900-2200 BC). *Antiquity*, 2005, 80, 646–657.

A new research project has revealed a fully specialised copper industry in SW Iberia at the beginning of the 3rd millennium BC. Ores, furnaces, crucibles, hammers and moulds have been found with slag and artifacts at various stages of manufacture. Lead isotope analysis suggests a source at nearby Tharsis. It is claimed that ore was heated to above 1200°C in an oxidising atmosphere. Crucibles, manipulated with stone tongs were used for refining. JL

G Renoux, F Dabosi and J-M Pailler. Les armes en fer d'Uxellodunum (Puy d'lssolud, Lot), dernière bataille de César en Gaule: Etude paléométallurgique de pointes de flèche et trait de catapult. *Revue d'Archéométrie*, 2004, 28, 141–152.

Excavations at Uxellodunum have produced an exceptional collection of iron weapons, with arrow heads and catapult arrows. The study characterises their metallurgical structures and determines the distribution, morphology and composition of phases and constituents. The data provides information about developments in production and thermo-mechanical treatment in the 1st century BC. X-radiography, analysis, macroscopy and microscopy (optical or SEM) were carried out to identify the structural features of each type of component (metal, oxides, carbides or residual slag inclusions). Vickers microhardness values allowed an evaluation of mechanical resistance. The distribution of impurities at the surface and concentration profiles were investigated with electron microprobe and secondary ion mass spectrometry (SIMS). Authors (adapted)

R Schwab, D Heger, B Höppner and E Pernicka. The provenance of iron artefacts from Manching: A multi-technique approach, *Archaeometry*, 2006, 48(3), 433–52.

Iron finds from the Celtic oppidum of Manching in southern Bavaria (Germany) are analysed in view of their possible provenance. The exceptional size and the location of Manching are usually attributed to the presence of abundant iron ores in its vicinity. After a review of previous approaches for source determination of iron artefacts, lead isotope analysis is introduced as a new approach. However, only by combining the trace element patterns of slag inclusions and iron metal with lead isotope ratios in the metal is it possible to distinguish various iron ore formations near Manching. As a result, it turns out that, indeed, the most obvious ones – namely, bog ores near the Danube – constituted the main resources for iron production at Manching. It was even possible to select one occurrence as the most likely ore source. Authors

J M Webb, D Frankel, Z A Stos and N Gale. Early Bronze Age metal trade in the eastern Mediterranean. New compositional and lead isotope evidence from Cyprus. *Oxford Journal of Archaeology*, 2006, 25(3), 261ff.

This paper presents the results of chemical and lead isotope analyses of 17 early and middle Bronze Age artefacts from Cyprus. These suggest that a number of objects are of non-Cypriot copper. This leads to the identification of several as imports, a new explanation for some artefact types as ingots, and a discussion of the nature of deposits at the key Cypriot site of Vasilia. This in turn allows a reconsideration of the role of Cyprus in Aegean/eastern Mediterranean metals trade in the early years of the second half of the 3rd millennium BC and of the development of metalworking on the island. Authors

J-M Welter. Understanding the copper of the Statue of Liberty. *Journal of the Minerals, Metals and Materials Society (JOM)*, 2006, 58(5), 30–33.

Pierre-Eugène Secrétan, a French copper industrialist, donated the copper sheets for the construction of the skin of the Statue of Liberty when it was built in 1875–76. It can be inferred from the history of Secrétan's activities that the sheets were rolled in his plant of Sérifontaine. The impurities found in two samples obtained from the US National Parks Service show that different qualities of copper were used. They indicate, by also taking into account the commercial relations of Secrétan, that the copper may possibly have come from Spanish or South/North American ore. Author

MIDDLE EAST

P R Meyer. Production of silver in antiquity: ore types identified based upon the elemental compositions of ancient silver artifacts. in L van Zelst (ed), *Patterns and Process. A festschrift in honor of Dr Edward V Sayre*. Suitland MD, Smithsonian Center for Materials Research and Education, 2003, 271–288.

Elemental analyses of silver artifacts have contributed greatly to the understanding of the production of silver in the ancient world. Systematic changes in average gold content of silver artifacts, as a function of date and geography, have allowed the outline of a general scheme of silver production technology in antiquity. Smelting residues and artifacts from Laurion, the Aegean, Anatolia, Iran and Afghanistan have been analysed and

the usefulness of lead and bismuth as indicators of ore types are discussed. JL

G Philip. Tell El-Dab^{c}A XV. Metalwork and metalworking evidence of Late Middle Kingdom and the Second Intermediate Period. *Österreichische Akademie der Wissenschaften. Denschriften der Gesamtakademie* 36, Vienna, 2006.

Discussion of the form and technology of the metallurgical remains from Tell El-Dab^{c}a – moulds, ingots, crucibles, tuyères and industrial waste – illuminates the nature of metal processing on the site, and provides evidence of the relationship between types of mould and specific products. Data on the chemical composition of a range of silver and copper-alloy artifacts demonstrates that the relationship between form and alloy is complex, and is not solely determined by mechanical concerns. The evidence highlights various characteristics of the metal industry in the Nile Delta, which render it distinctive from those of both the Levant and the Nile Valley. Author

AMERICAS

G A Camacho-Bragado, M Ortega-Aviles, M A Velasco and M José-Yacaman. A microstructural study of gold treasure from Monte Alban's tomb 7. *Journal of the Minerals, Metals and Materials Society* (*JOM*), 2005, 57(7), 19–24.

This article presents a microstructural study of a set of samples from the treasure of tomb 7 of Monte Alban, Oaxaca, in SE Mexico. The purpose was to elucidate the manufacturing methods used by the pre-Columbian artisans of the Oaxaca valley. An additional goal was to establish a point of comparison between Mesoamerican cultures and cultures in some other regions of the Americas. Ten gilt samples from the post-classic period (700-1300 A.D) were analysed. The microstructure and elemental composition of the samples were determined using optical, scanning- and transmission-electron microscopy and electron-energy-dispersive spectroscopy. The samples were classified by the method of manufacture. A predominant use of gold alloys was found, rather than the gilt copper commonly used by some cultures in South America. Authors

H Lechtman. Middle Horizon Bronze: centres and outliers. in L van Zelst (ed), *Patterns and Process. A festschrift in honor of Dr Edward V Sayre*. Suitland MD, Smithsonian Center for Materials Research and Education, 2003, 248–268.

A variety of bronze alloys began to be produced in the Andean area, based around the ancient cities of Wari (near Ayacucho, Peru), and Tiwanaku (on the southern shores of Lake Titicaca) in the Middle Horizon (600-1000AD). These included copper-arsenic, copper-tin and copper-arsenic-nickel. The uses, properties and fabrication regimes are discussed. The period is characterised by the far-flung exchange of ideas and technological experience across political, cultural, and topographic boundaries, stimulating the manufacture of a variety of bronzes in an uncommonly mineral-rich environment. Author (adapted)

M Noguez, R García, G Salas, T Robert, and J Ramírez. About the pre-Hispanic Au-Pt 'sintering' technique for making alloys. *Journal of the Minerals, Metals and Materials Society* (*JOM*), 2006, 58(5), 38–43.

The 'sintering' technique to produce Au-Pt alloys in pre-Hispanic times in the South American region of Tumaco-La Tolita (North Ecuador, South Colombia) is reviewed. Two Au-Pt alloys were made using small pieces of pure gold and platinum in an attempt to simulate some pre-Hispanic alloys. A 'sintering' process (950°C, cold and hot hammering) was carried out and the results were analysed with optical and scanning electron microscopy and compared to the available microstructures of some similar pre-Hispanic alloys. Authors (adapted)

ASIA

R Balasubramaniam, A Saxena, T R Anantharaman, S Reguer and P Dillmann. A marvel of medieval Indian metallurgy: Thajnavur's forge-welded iron cannon. *Journal of the Minerals, Metals and Materials Society* (*JOM*), 2004, 56(1), 17–23.

Metallurgical aspects of a 17th-century forge-welded iron cannon at Thanjavur are addressed, including an analysis of manufacturing method based on careful observation of its constructional details. Microstructural examination of iron from the cannon reveals that it was extracted from ore by the direct process. The cannon was fabricated by forge welding and not by casting. Electrochemical polarization studies indicate that the corrosion rate of the cannon iron can be compared to that of 0.05%C mild steel under complete immersion conditions. However, the atmospheric corrosion resistance of the cannon is far superior to that of modern steel and can be attributed to the formation of an adherent protective passive film. It is concluded that this cannon constitutes a marvel of medieval Indian metallurgical skill. Authors

A Feuerbach. Crucible Damascus steel: a fascination for almost 2,000 years. *Journal of the Minerals, Metals and Materials Society* (*JOM*), 2006, 58(5), 48–50.

Whether you call it Indian wootz, Central Asian Pulad, Bulat, or oriental Damascus, crucible steel has fascinated craftsmen, scientists, and laymen for almost 2000 years. This paper presents current research on the origins of crucible steel, its influence on the history of ferrous alloys, and the current interest in this decorative, yet functional, metal. Author

J D Verhoeven, A H Pendray, and W E Dauksch. The continuing study of Damascus steel: bars from the Alwar Armory. *Journal of the Minerals, Metals and Materials Society* (*JOM*), 2004, 56(9), 17–20.

The authors published a paper in this journal in 1998 entitled 'The key role of impurities in ancient Damascus steel blades'. Because of the continued popularity of the on-line version of this paper, additional experiments were conducted on some three-century old Damascus bars. The results of those experiments are reported. Authors

P L Benson and R S Gilmour. Ultrasonic non-destructive imaging of worn-off hallmarks on silver: preliminary results.

in I D MacLeod, J M Theile and D Christian (eds), *Metal 2001: proceedings of the international conference on metals conservation* site near Rehoboth in central Namibia have $^{207}Pb/^{206}Pb$ isotope ratios that match a particular deposit at Swartmodder, but are markedly different from other known occurrences in the Rehoboth-Windhoek areas. For this reason, precise lead isotope determination is not necessary to source the ore, and raw peak height ratios obtained by inductively coupled plasma mass spectrometry are sufficient. This characteristic signature is present in all samples of malachite ore, slag, and copper prills collected on the site. Significantly, it is absent from a sample of local native copper, as well as from seven copper beads found elsewhere in central Namibia. This not only identifies the probable source of malachite ore but also provides a powerful tool for provenancing copper artefacts made at the Drierivier site, distinguishing them from those made elsewhere in the Namibian highlands.

Authors

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