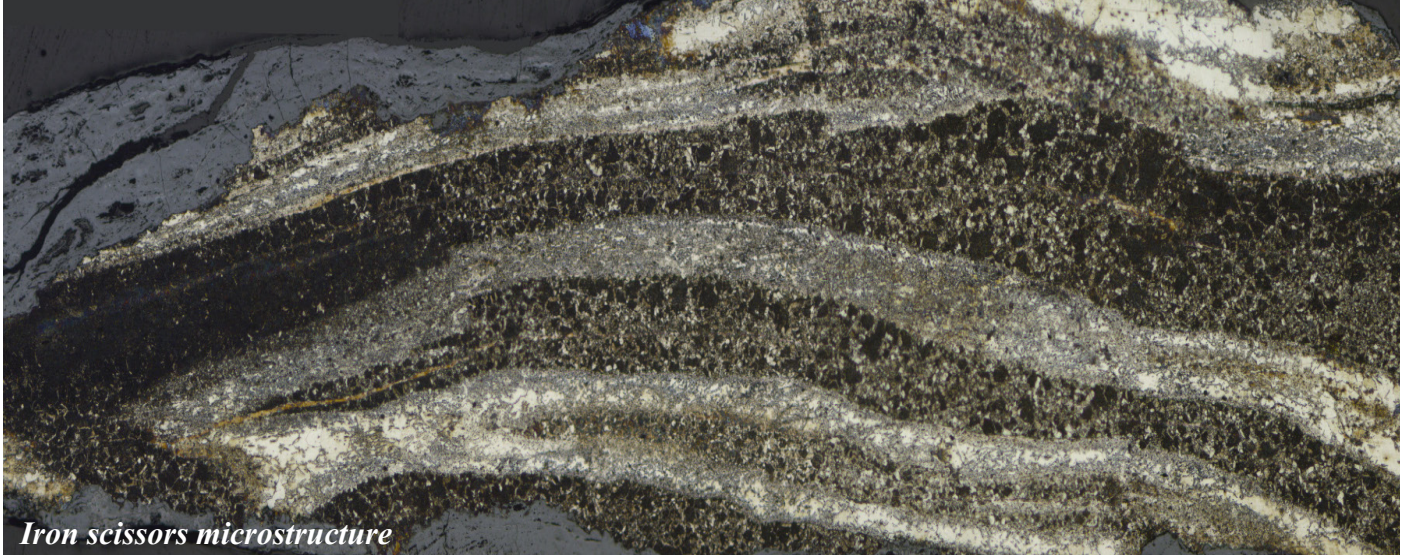


# THE CRUCIBLE

**Historical Metallurgy Society News**

**Issue 91**

**Spring 2016**



*Iron scissors microstructure*

**Editor**

*Marcos Martín-Torres*

**Assistant Editors**

*Loïc Boscher*

*Carlotta Gardner*

*Matt Phelps*

*María Teresa Plaza*

**Submissions**

*Submissions to **The Crucible** are welcome at any time, but deadlines for each issue are 1<sup>st</sup> March, 1<sup>st</sup> July and 1<sup>st</sup> November every year. Contributions can be sent in any format, but we prefer digital if possible.*

***The Crucible***

[thecrucible@hist-met.org](mailto:thecrucible@hist-met.org)

*c/o Marcos Martín-Torres*

*UCL Institute of Archaeology*

*31-34 Gordon Square*

*London WC1H 0PY*

*United Kingdom*

[www.hist-met.org](http://www.hist-met.org)

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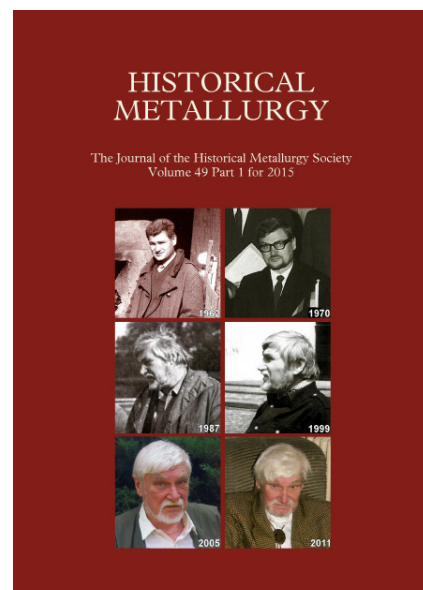
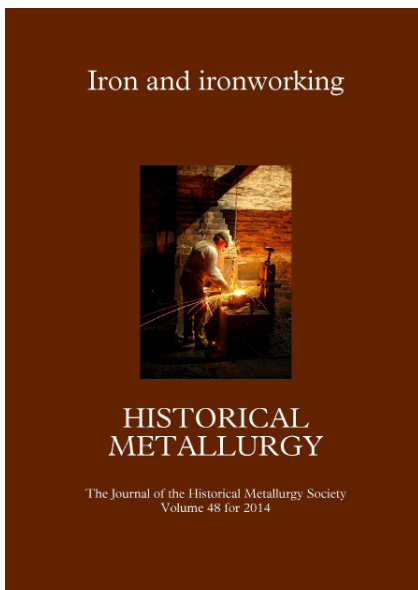
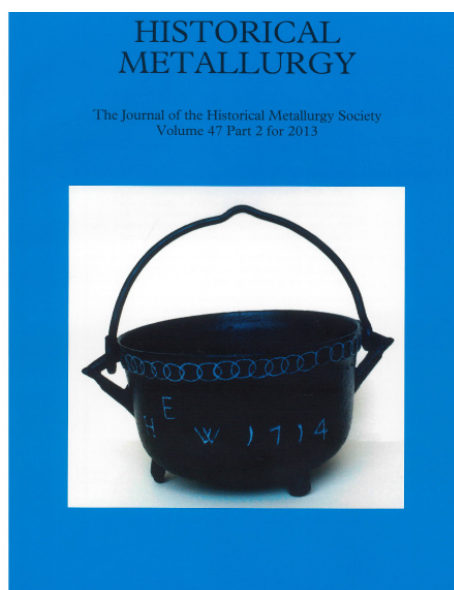


The **HISTORICAL  
METALLURGY**  
Society

# FROM THE CHAIRMAN

The last twelve months have been a busy period for HMS for several reasons. Firstly, and most importantly, it has been a period of negotiation over a new publishing arrangement to allow Historical Metallurgy to appear online (in addition to its print version). Unfortunately, although there has been good progress and there was much optimism during the year, those negotiations have not, so far, proved fruitful and despite our best efforts it is now unlikely to be available in a digital version before the beginning of 2018 at the earliest.

As a component of the changes necessary to achieve an agreement for digital publication, the 2016 AGM will be asked to approve new levels of subscription fees and a simplification of the membership classes; at present there are simply too many classes for efficient management. Full details of the proposals will be circulated with the AGM notice. Council hopes very much that members will understand, and be supportive of, these changes; subscriptions have not been raised since 2003, and, for institutional subscriptions in particular, the fees have not been at a sustainable level for some time. The new rates will be intended to provide the society with the financial stability it needs during the period of developing its digital platform. The AGM at which these changes will be presented, will be within the Summer Meeting at Merthyr Tydfil, on 18th June 2016. Details of the meeting, which will focus on industrial ironmaking in Merthyr and elsewhere, may be found elsewhere in this newsletter.



Another area of great activity for HMS over the last year, has been with the publication of Historical Metallurgy. The journal, as members will be aware, had slipped behind with publication. The aim is to be fully up-to-date with the journal by the end of 2016. Achieving this goal is a necessary pre-requisite for any future publishing arrangement. Members should have received v47 (part 2) and v48 (parts 1 and 2 as a single volume) at the end of last year. Volume 49 part 1 (for 2015) is now almost ready to go to the printers. Volume 49/2 (for 2015) and Volumes 50/1 and 50/2 (for 2016) will follow during the course of the year. The task of editing the journal will be enhanced through a new Editorial Board to support the Honorary Editors in their work – further details of which will appear in the next edition of **The Crucible**.

On the matter of journals, we apologise most sincerely to members who have not yet received v47/2 and v48. We are still working to determine precisely what happened, but it appears that issues for overseas members were not been sent out by the overseas mailing agents employed by our printers. Any member who has not already contacted me about non-receipt of journals should please email me as soon as possible ([Tim.Young@geoarch.co.uk](mailto:Tim.Young@geoarch.co.uk)). The missing volumes will be reprinted as distributed as quickly as possible.

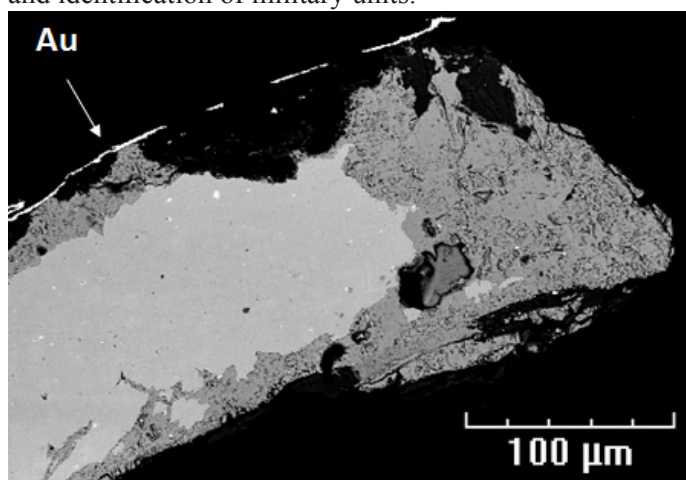
Another important area of recent HMS activity has been that of the curation of the collections held by the Society. The Archives and Collections Committee are working on the digitisation of these and they call for volunteers to assist with the transcription of Ronnie Tylecote's notebooks (see elsewhere in this newsletter), so that they may be linked with the physical specimens in the collections. This initiative will enable a virtual integration of much of the Tylecote archives and collections – and it is hoped this will become a valuable resource accessible via the internet to researchers everywhere.

I am looking forward to an equally busy year ahead, as the society's publications and collections become increasingly accessible for members and researchers, not just in Britain, but around the world.

*Tim Young*

## NEW ANALYSES OF ROMAN COPPER ALLOYS

Roman military equipment has traditionally been studied from a typological perspective based on a linear concept of change. Whilst Roman alloys have been analysed scientifically and general studies on them have been published, analysis of military equipment has been scarce and mostly secluded as part of excavation reports of individual sites. Scientific analysis though, can provide independent ways of studying military equipment. It can answer questions about production and distribution of the raw materials and finished objects and is capable of informing on reasons for technological choices (the intention of obtaining determinate colours, for example), and identification of military units.



*Electron microscope image of a copper horse harness ornament with layer of gilding.*

As part of a PhD project at the University of Liverpool, a total of 216 copper-alloy military objects from the British sites of South Cadbury Castle, Ham Hill, Usk, Carlisle, Chester and Kingsholm, and the German site of Kalkriese were selected for obtaining metallurgical characterisation: chemical analysis at major, minor and trace element levels and microstructural analysis to obtain fabrication history and to identify any plating. The analytical techniques employed were atomic absorption spectrometry (AAS), scanning electron microscopy with energy dispersive x-ray spectrometry (SEM-EDS), optical microscopy and multivariate statistics methods such as principal component analysis (PCA), discriminant analysis (DA) and multivariate analysis of variance (MANOVA). The aim of the project was to characterise the chemical and physical make-up of Roman military copper-alloy metalwork from the 1<sup>st</sup> century AD, with especial interest in the immediate post-conquest period.

The results of the analysis show a difference between the Roman military equipment from the British sites and the equipment from Kalkriese, based on trace element patterns. This difference can be explained by a large input of material into Britain that had been made in the years before AD43 in preparation for the conquest. Contrary

to recent scholarship, and based on compositional and microstructural evidence, some lorica segmentata brass fittings seem to have been centrally produced. Primary brass and specific gunmetal compositions seem to be associated with the military and probably chosen primarily for their appearance and resemblance to gold, rather than for their mechanical properties.

*Pablo Antonio Fernández Reyes*

## ARCHAEOMETALLURGY STUDENT BURSARIES

The Institute for Archaeo-Metallurgical Studies (IAMS) and the UCL Institute of Archaeology invite applications for two student bursaries for postgraduate studies in archaeometallurgy leading to an MSc degree.

The two available bursaries are: The IAMS Bursary in Archaeometallurgy (£5,000) and The Ronald F. Tylecote Bursary in Archaeometallurgy (£5,000)

Any candidates accepted for the MSc in the Technology and Analysis of Archaeological Materials are eligible for either bursary, provided that they express a commitment to write a dissertation on an archaeometallurgical topic. Students are welcome to suggest their own dissertation topics at the time of applying, but this is not a requisite. In the personal statement accompanying their application to the MSc, they should include a brief comment expressing their interest in being considered for the above bursaries.

Applications will be assessed based on the academic merit of the applicants and their statements.

Deadline: 1<sup>st</sup> July 2016. Enquiries: Marcos Martín-Torres [m.martinon-torres@ucl.ac.uk](mailto:m.martinon-torres@ucl.ac.uk)



## CALL FOR PAPERS AND POSTERS: ROMAN FINDS GROUP MEETING

9<sup>th</sup> - 10<sup>th</sup> September 2016  
University of Reading

Papers and posters concerning Southern Romano-British finds will be considered. We welcome short paper and poster submissions from Master's students and graduating undergraduates. Please send abstracts and/or questions to [RFGReading2016@gmail.com](mailto:RFGReading2016@gmail.com).



## A POSSIBLE EXPLANATION FOR THE PRESENCE OF CALCIUM AND PHOSPHORUS IN MELTING CRUCIBLES

This text focuses on the presence of calcium (Ca) and phosphorus (P) in connection with copper-alloy (Cu-alloy) residue on the inside of melting crucibles from south Sweden dated to the late Bronze Age (ca. 1100 - 500 BC). This connection was first noticed on this material in an earlier study (Eklöv Pettersson 2014). On the basis of similar observations earlier studies have shown that Ca and P in crucibles might derive from: i) the connection between cremation and metal working (Gansum 2004:121; Goldhahn 2007:207ff), ii) deposition of the crucibles in graves (Dungworth 2010:13f), iii) an extra inner layer of Ca-P rich materials (Hjärthner-Holdar et al. 2011:113;127; Stilborg 2006; González 2010:58; Plaza & Martín-Torres 2015), iv) the use of Ca and P-rich materials as temper for the clay (Söderberg 2010:10) and v) the ash from the fuel that was used (Crew 2000; 2007). These explanations cannot fully explain the observation made on the south Swedish material (Eklöv Pettersson 2014:5). An extra inner layer on the inside of the crucible is not a shared feature of the south Swedish material. The increase of Ca and P is not seen in general or overall but instead observed as a relative increase only on the inside. Therefore, the authors of this article wish to present another possible explanation through experimental and scientific archaeological methods.

This study is based on the experience of one of the authors, Lönnberg, who during a period of over 20 years has been working with historical reconstruction of bronze and other Cu-alloy castings. When melting Cu-alloy in a traditional open hearth it is vital to determine if the metal is properly melted and to check that the melt is free of charcoal and other debris before casting. Furthermore, when alloying metals stirring may be required to ensure homogeneity.

Testing if the metal is melted in addition to cleaning and homogenizing of the melted metal is mainly done by Lönnberg with a metal rod or wooden pole. Traditionally molten bronze is stirred with a fresh wooden pole, “poling” (Hurst 1996:217) in order to reduce dissolved gasses and homogenize the alloy. The wooden pole contains some water and therefore causes the metal to bubble (“boil”) which stirs the metal but also may cause metal loss when drops are spilt out of the open crucible into the hearth. Furthermore, the wooden pole has a low durability since it quickly catches fire. Iron or other metal rods do not cause “boiling” but instead have a strong cooling effect on the Cu-alloy. The melted metal also sticks to the metal rod when cooled leading to metal loss at each casting event. Since none of the two described materials are optimal a third possible material; animal bone, was tested.



*Experimental copper melting and refining using wood and bone rods.*

By shafting a longer splint of bone to a wooden stick, a tool for controlling the melting process was made and used in an open hearth for melting and alloying bronze (Cu-Sn) and brass (Cu-Zn-Pb). During the experiment, the bone point proved to be most useful. It did not cause the metal to “boil”, it was relatively sustainable and it did not cause any metal loss.

Another problem for the caster is that melted copper alloys will produce gasses such as oxygen and hydrogen. This can cause pores to development in the final cast object. Re-melting and use of scrap metal will also give a content of cuprous oxide in the alloy. Using bone in the melting process may help prevent this as bone is rich in phosphorus and calcium. The phosphorus will reduce dissolved oxygen, and the calcium will help form slag that binds impurities, which will set on the inside rim of the crucible.

After the experiment, the crucible was first cut and thoroughly rinsed. It was then analysed for traces of Ca and P in connection with Cu-alloy using a portable ED-XRF spectrometer. The analysis show clear similarities with the earlier study of the archaeological material with clearly higher levels of Cu-alloy as well as Ca and P on the inside of the crucible compared to the ceramic ware. Furthermore, the metal melted in the crucible contained no noticeable traces of P and an insignificant amount of Ca (using a pXRF). Is it possible that the Ca and P found in connection with Cu-alloy remains in crucibles from south Sweden derives from the use of animal bone for poling, as described above?

Another explanation is the possibility that Ca from ash deriving from the fuel may have made this trace (as have been proven in iron production residue by Crew (2000; 2007)). Therefore another experiment and subsequent analysis following the procedure as described above was conducted on another crucible. However, a wooden pole was used, instead of animal bone. The results of the element analysis show no specific increase of P or Ca on the inside of the crucible due to the use of the wooden tool

or charcoal fuel. This indicates that the increased levels of Ca and P observed on the archaeological material derive from some other source. Since these experiments were on only two crucibles, further repetition of the tests are needed before making any final conclusion.

Paul Eklöv Pettersson

Mats Lönnberg

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## PREHISTORIC METALLURGY AT BUTSER (EXPERIMENTAL ARCHAEOMETALLURGY) COURSE

13<sup>th</sup> -16<sup>th</sup> May 2016, Butser Ancient Farm, UK

This is a practical and theoretical short course on the use of experimental archaeology in examining the production of metals at the beginning of the Bronze Age. Through lectures on prehistoric archaeometallurgy and daily practical workshops, the course will provide valuable experience for anyone working in this field or interested in it (either at undergraduate or postgraduate level). During the practical sessions students will work in small groups to build, operate and record smelting hearths and then use these to produce metals (principally copper and tin). In addition, these groups will make much of the ancillary equipment such as the bellows, tuyeres, crucibles and moulds used in the production of metals from ores. Students will finish with the casting of small objects such as bronze or copper axes.

Contact: Simon Timberlake via email at [simon.timberlake@gmail.com](mailto:simon.timberlake@gmail.com) or Fergus Milton at [fergus@fingerbuster.com](mailto:fergus@fingerbuster.com).

Further details and online registration can be found on our website: <http://www.fingerbuster.com/>.



## THE “WHO CARES”? PROJECT

The National Slag Collection, which is owned by the Ironbridge Gorge Museum Trust, and managed in conjunction with the Historical Metallurgy Society, has recently been the focus of an Arts and Humanities Research Council (AHRC) funded project which sought to examine some of the less glamorous collections held by museums.

The “Who Cares? Interventions in ‘Unloved’ Museum Collections” project, which is a collaboration between the Ironbridge Gorge Museum Trust, The Science Museum, the Museum of English Rural Life (MERL), The University of Reading and the Ironbridge International Institute for Cultural Heritage at the University of Birmingham, has held a number of different workshops and events, including a session at Coalbrookdale involving the Ironbridge Young Archaeologists’ Club and the Historical Metallurgy Society’s Archives and Collections Committee, and a stand at a Science Museum late event which had over 5,000 visitors.

The project culminated with a conference at the Science Museum last November and it is hoped that a number of publications arising from the project, including one focusing on the National Slag Collection, will be produced in the near future. More details about the project can be found at <https://whocaresinterventions.wordpress.com/>. If you would like to learn more about the National Slag Collection and the work of the HMS Archives and Collections Committee please see the relevant sections of the HMS website <http://hist-met.org/>.

*Shane Kelleher  
Ironbridge Gorge Museum Trust*



## STORIES OF METAL FORMING: A REQUEST FOR HELP

I’m writing to the Historical Metallurgy Society with a request for your help in finding great stories about forming metal: shaping metal in solid state, after it’s been cast - metal-bashing. The background to my request is that in September 2017 I am hosting in Cambridge the world’s largest research conference on metal forming, the 12<sup>th</sup> International Conference on the Technology of Plasticity. This leading conference, held triennially, attracts around 600 delegates from all over the world, and this will be its first visit to the UK, so we’re trying to do a great job. For the opening of the conference, I have booked Cambridge’s largest public theatre - the Corn Exchange - and have invited 600 local school children to join us for what I hope will be the best public lecture on metal forming ever given! This is being produced by an experienced West End producer, will feature a range of performers (probably including a horse) and will be hosted by Sir Tony Robinson, famous for his role as Blackadder’s side-kick Baldrick, and more recently as the presenter of the archaeological series ‘Time Team’.

To create this lecture, I am assembling a book telling stories of how metal forming has evolved - the series of chances, accidental discoveries and the endless imagination of those involved in forming metal, wanting to make things even better. I’ve already picked up some great stories - of the secret technique for hammering cymbals, of how metal rolling began in South Korea at least a millenium before Leonardo da Vinci sketched a rolling mill, of how Brunel had to find ways to cope with the distorted magnetic field that inhibited navigation on his first iron ships. I’m working with the curators of several British museums, including the Royal Armouries, to find out more about this, and am also in touch with the national societies of contemporary metal forming research in several countries. But clearly, within the span of the Historical Metallurgy Society, you will collectively have detected many more contributions to this great, and so far untold narrative.

If you have, or have heard of, a great story about metal bashing, please could you get in touch with me, via email at [jma42@cam.ac.uk](mailto:jma42@cam.ac.uk).

*Julian Allwood*



## AN OPPORTUNITY TO HELP YOUR SOCIETY – VOLUNTEER NOW!

We want you to become involved in a new project to digitise the Tylecote Archive.

The Archive comprises three elements:

1. His papers which includes drafts, correspondence, photographs and notebooks.
2. The slags and other metallurgical debris which he collected during his long career.
3. The metallographic samples he prepared and analysed.

The HMS Archives and Collections Committee plays a leading role in conserving and promoting these various archives. The aim is to ensure that this resource is available for present and future researchers. We have transferred the metallographic specimens to Oxford University and they can be viewed via their online database ([http://www.arch.ox.ac.uk/Tylecote\\_collection/](http://www.arch.ox.ac.uk/Tylecote_collection/)). The slags and other metallurgical debris have recently been re-packaged, catalogued and a digital online database is being prepared for uploading to the HMS website.

The Archives and Collection Committee has successfully run a series of study days at Ironbridge where we have begun to catalogue the various Tylecote papers. One important element of this archive is the 111 notebooks in which Ronnie recorded observations in the field and laboratory. These notebooks are an invaluable resource for understanding both the metallographic collection and the slag collection. All of the notebooks have been scanned (as PDF files) but the contents need to be transcribed so that researchers can search the contents for specific samples, place names, people, etc.

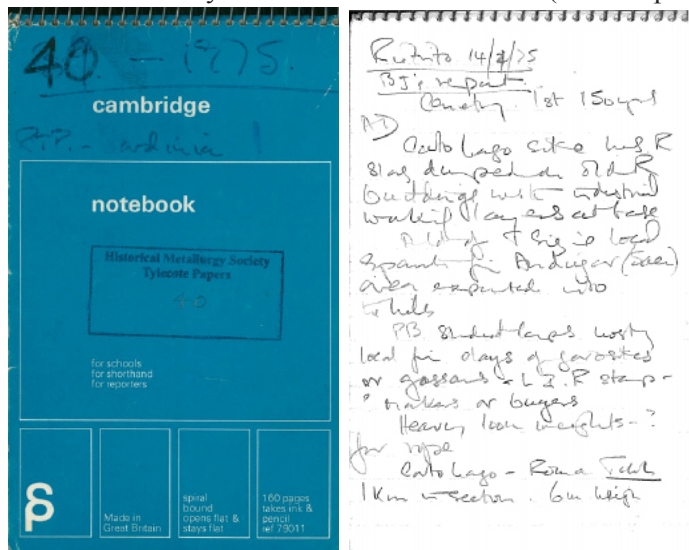
We want to recruit members of the Society to help in this transcription process (Citizen Science/Crowd Sourcing). The idea is that you will each be given the PDF of a single notebook which you will read and transcribe (as a simple



text or word processing file). This means you can get involved in the crucial work of the Society even if you can't get to a Study Day in Ironbridge. You can do the work in your own home at a time and pace of your own choosing.

Once the contents of the notebooks have been transcribed we will start a new project to search for links between the notebooks and the metallographic and slag collections. This will greatly enhance the value of these collections to current and future researchers.

If you would like to be a part of this exciting opportunity please contact Aurélie Cuénod ([aur@cuenod.net](mailto:aur@cuenod.net)) to register your interest.



## IAMS SUMMER SCHOOL IN ARCHAEOMETALLURGY

The Institute for Archaeo-Metallurgical Studies is finalising the arrangements for this year's two-week Summer School in Archaeometallurgy, which will take place in London the 20th of June - 1st July, and will focused on iron, silver and gold. As usual, we are hoping to combine some field experiments with lectures, handling sessions and laboratory demonstrations. Please check out [www.ucl.ac.uk/iams](http://www.ucl.ac.uk/iams) for the final programme in the next few days, and/or email Umberto Veronesi if you would like to be informed when the final programme is ready ([umberto.veronesi.13@ucl.ac.uk](mailto:umberto.veronesi.13@ucl.ac.uk)).



## SHARADA SRINIVASAN

**S**harada Srinivasan is Professor at the National Institute of Advanced Studies, Bangalore. She has made pioneering contributions to the study of archaeology and history of art from the perspective of exploring engineering applications in these disciplines, i.e. archaeometry, archaeometallurgy and archaeological sciences. Her landmark contributions have included archaeometric characterisation of bronzes of South India using lead isotope analysis, archaeometallurgical studies on ancient mining and metallurgy in southern India, studies on wootz steel, and documenting artisanal technologies such as mirror making and bronze casting at Swamimalai. She is also an acclaimed performer of Bharata Natyam and has given numerous lecture-demonstrations such as the artistic and scientific perspectives on the Nataraja bronze.

**THE CRUCIBLE:** Can you summarise your career in a couple of sentences?

**SHARADASRINIVASAN:** I guess the areas I have contributed to, can be clubbed under archaeometallurgy, archaeotechnology, technical art history and ethnometallurgy. I have been exploring the art and science of statuary bronzes from southern India, such as the famed Chola Nataraja bronze of the Hindu god Siva, to suggest that one can tell apart earlier from later medieval bronzes from their lead isotope ratios and trace element profiles. I have been engaged in exploring early evidence for mining and metallurgy such the legendary wootz steel from Golconda, said to be exported to the Islamic Arab and Persian world to make Damascus blades; and the study of rare metal crafts such as the

exotic Aranmula delta high-tin bronze mirror.

**THE CRUCIBLE:** What is your most memorable professional moment?

**SHARADA SRINIVASAN:** I may say that the conferment of the Dr Kalpana Chawla Women Scientist Award (2011) by the Government of the Indian State of Karnataka did move me somewhere deeply. Firstly for the recognition that it gave archaeological sciences within the mainstream scientific world: as a discipline with some scientific rigour, which can yield outcomes of scientific value. Secondly it is named after NASA's Dr Kalpana Chawla, who perished in the Columbia Shuttle in 2003 as the first Indian-born woman astronaut (actually as a young girl I really wanted to become an astronaut! However, after my undergraduate in engineering physics I realised I wasn't cut out for that and that the remote frontiers of earth outside the window of the scientist's lab would do fine for me). Moreover, the fields of archaeometallurgy and archaeology also involve a level of adventure, which especially apply to us as women exploring remote areas in developing countries... I still remember a spectacular cheetah that sprang out from an old lead mine that I visited in 1991, in the Guntur area in southern India.

**THE CRUCIBLE:** Who has been your most influential colleague, and why?

**SHARADA SRINIVASAN:** It is never easy to pinpoint any one person 'most influential' since so many people have contributed along the way to the journeys I have engaged in



whom I cannot fully list. But some researches or writings of colleagues have more closely influenced outcomes. The paper by Nigel Seeley and W. Rajpitak in *World Archaeology* (1972) on the enigmatic Thai high-tin bronzes of prehistory was one of such. That article mentioned the account in Strabo's *Geography* that 'Indians used vessels which shattered like pottery', which the author's point out fitted the description of high-tin beta bronze. That struck a bell, and when I went to India and asked my grandmother if she could tell me about her old pots and pans, she mentioned the 'ottupatram' which broke like pottery when dropped and which was said to be made near Trichur in Kerala. That led me to identify previously unknown craft survivals for making Indian high-tin beta bronze vessels. I would also like to mention that my colleague historian Dr. Jaikishan's work identifying numerous surface sites for iron and wootz steel production in the Telangana region and the intangible heritage of rituals of blacksmiths, which have been very valuable for us to build a deeper understanding of the social history and archaeometallurgy of that region.

**THE CRUCIBLE:** What is your main current project?

**SHARADA SRINIVASAN:** I am currently involved with the making of a series of documentary films on 'Vanishing heritage of Kammalar' or traditional metalworking clans in southern India with IGNC, whose legacy we see in many splendid Indian metal artefacts; from the incredibly finely forged megalithic high-tin bronze vessel of the Nilgiris, to the legendary high-carbon wootz steel. The sad irony is that, even I could not have envisioned when I started this endeavour, it really would be about capturing the fading story of the very last vestiges of a range of once vibrant artisanal technologies now down to few struggling individuals. For example, the high-tin beta bronze vessel making (23% tin) no longer survives in that form due to the lack of demand and the physical rigours of the metal craft. It's also sad that these are being re-cycled en masse in Kerala, to make high-tin beta bronze musical cymbals for which there is at least some demand; as fresh metal is too expensive for them to afford and as the old vessels are discarded by householders. Filming is a whole new field for me and that has been challenging and rewarding too. It imposes a different kind of discipline since you have to try to capture the most compelling nuances; and especially the human dimension which perhaps, as detached archaeometallurgists/scientists, we don't usually encounter, such as the poignance of the Kammalar or bronze-smith who has gone deaf from a lifetime of hitting at the anvil...

**THE CRUCIBLE:** What multi-million project would you like to develop?

**SHARADA SRINIVASAN:** Ha ha! You would like me to engage in wishful thinking? The sad fact is that a country like India really does need multi-millions at its disposal to serve the fields of archaeometallurgy and historical metallurgy, although there has been a general lack of awareness of the importance of fostering such fields. So many archaeometallurgical production sites and old workings dotted across the landscape need to

be studied and documented, even as they are being lost by cultivation, construction, indiscriminate modern mining and so on. I would like to explore the heritage of gold mining in southern India; and in relation to the surviving crafts and undocumented temple treasures, setting up a metal museum, better conserving temple bronzes corroding in vaults or reviving crafts traditions and promoting artisans, an endless wish list...

**THE CRUCIBLE:** Which publication should every HMS member read?

**SHARADA SRINIVASAN:** I am quite pleased with the way our volume on 'Metals and Civilizations' has turned out, as the proceedings of the first and only conference under the Beginning of Use of Metals and Alloys Series, founded by eminent archaeometallurgist Robert Maddin, to have been held in India at Bangalore. Through the diligent efforts of many of my colleagues in the editorial and BUMA committees, it features many landmark articles on a range of topics in Asian Archaeometallurgy by leading international scholars and also a sizable number of contributions from India. It includes our tribute to late Dr Balasubramaniam, who made seminal contributions on the Delhi Iron Pillar before his untimely death.

[Sharada Srinivasan, Srinivasa Ranganathan and Alessandra Guimlia-Mair eds, 2009, *Metals and Civilizations, The Proceedings of the Seventh International Conference on the Beginning of the Use of Metals and Alloys*; NIAS Special Publication No. SP7-2015; <http://eprints.nias.res.in/756/>].

**THE CRUCIBLE:** Have you got any advice for young students interested in archaeological and historical metallurgy?

**SHARADA SRINIVASAN:** I would like to say to young students that it does not require multi-millions to make significant contributions! It just takes grit and determination, sometimes probably just exploring in one's backyard (at least in countries like India or Africa which may still have continuing crafts, remnants of metal production sites, scientific heritage and so on), and of course some serendipity. Also, one doesn't have to be obsessed with looking for the 'earliest' or the 'first', the technological heritage of every age, including the recent past, and of every part of the world, and every cultural milieu is just as significant and important to document.

**THE CRUCIBLE:** I would like to tell every reader of *The Crucible* that...

**SHARADA SRINIVASAN:** What I like best about archaeometallurgy is the inter-disciplinarily and out of the box thinking it can draw out of us. In fact, the scientific investigations on the Nataraja bronze spurred me to get back to performing south Indian classical Bharata Natyam dance, to engage with the devotional poetry and to experiment with the expressive repertoire to elucidate some of the material aspects and crafts traditions related to cultural artefacts. The work with late Indian astrophysicist Nirupama Raghavan is such a cross-disciplinary exploration, where she and I speculated that the iconographic aspects of the Nataraja bronze may have been inspired by star positions in the Orion constellation.

# MEET YOUR COUNCIL

## MIKE COWELL

I have been a member of the Society since about 1986. I joined Council back in 1992 and have served continuously to date. Not the longest currently on Council though, as Justine Bailey will acknowledge. There have certainly been many changes over that period.

I originally hail from near Northallerton, North Yorkshire with good access to the dales, particularly Wensleydale and Swaledale, and roaming about there introduced me to the lead mining industry remains. In the early 60s the Cobscar smelt mill was more complete and the chimney quite prominent. I learned more from Clough's book on the smelt mills that had just been published. So an interest in, at least industrial, archaeology was kindled. Before that a chemistry set for birthday probably set me on the route to analytical chemistry. That was subsequently formalised through Chelsea College and Royal Society of Chemistry courses.

My first employment was as a quality control chemist with Unigate Dairies in Park Royal, London. This subsequently involved investigating complaints, usually 'foreign objects' found in dairy products and identifying their composition and origin. All this was by classical chemical analysis. Later in my time there I was asked to do some 'conservation' work on a set of tinned milk churns for an exhibition at Head Office. Whether my account of the methodology of this at interview was useful in securing a placement at the British Museum I do not know but I started at the (then) Research Laboratory in 1970, continuing to retirement in 2004. I initially worked with Paul Craddock and Michael Hughes on a Neolithic flint provenance project but over the years on most of the materials and artefact types in the BM collections. However, there was a definite focus on metalwork and, since I had an interest in and had collected coins, they became a particular speciality. I have examined most coin series, from the earliest, Lydian electrum, through to Victorian aluminium bronze patterns, the latter being the subject of my first members' contribution (remember those?) at an HMS conference.

Having joined HMS (encouraged by Janet Lang I recall), a few years later in 1992 I found myself on Council as Hon. Treasurer, taking over from Justine Bayley who was 'moving sideways' to be journal editor. Initially this seemed quite daunting but Justine and Ian Standing, former treasurer, had the accounts very well organised so continuity was not that difficult. Since then, and not just at my instigation, we have moved from a hand-written ledger to spreadsheet, established new grant-giving funds, revised our investments, introduced Paypal payments and changed the presentation of the accounts to conform to the 'public benefit' criteria recommended by the Charity Commission.

After just over 20 years in office I decided that it was time for change and Peter King agreed to take on the role



*Trying on a replica of the Great Torc from Snettisham at the Buried Treasure: Finding Our Past exhibition at the BM in 2004.*

in 2013. I have remained on Council for the time being initially as a backup to the Treasurer, although the transition has gone smoothly, and also to chair the grants committee. Formerly, the latter was the responsibility of the Treasurer but it was sensible to separate this, as at certain times the additional workload was rather onerous. The four members of the grants committee examine the applications twice a year and submit proposals to Council. Applications for the March meeting are the most numerous, particularly if there are conferences coming up. We have about £1500 per annum available from the three funds, based on the investment yields. However, as this is invariably distributed amongst several applicants the individual grants are relatively modest, just sufficient to provide a boost to a project or cover basic travel costs. With plans to move to e-publishing and revisions to subscriptions I hope that any increased income might supplement the available grants funding.

Mention of e-publishing is an indication that the Society is not standing still and I think we are going in the right direction. We have an upgraded website, an attractive and informative newsletter, a popular facebook page (so I am told) and the useful Research in Progress meetings, all supported by a diverse membership. However, membership levels still remain around the 500 level with libraries and institutions in some decline (almost halved since 2002). The expectation is that the plans for e-publishing will help to redress this issue, and also hopefully filter down to the personal membership numbers. So we enter a new phase for the Society but I still regard HMS as the 'friendly society', all are welcome specialist and non-specialist alike.

## METALS AT AWRANA 2015

### METALWORK USE-WEAR ANALYSIS:

#### THE LOSS OF INNOCENCE

27<sup>th</sup> - 30<sup>th</sup> May 2015, Leiden, Netherlands

**A**WRANA (Association of Archaeological Wear and Residue Analysts) is an international network of archaeologists who have interests in the study of how artefacts functioned and how they have been modified through use. While this report focuses on the metal artefacts, the organisation includes the study of ceramics, lithics, bone, antler, or any material that has been used and modified by humans. This year the meeting and conference was held at the University of Leiden in the Netherlands.

The metals session was chaired by Andrea Dolfini and Rachel Crellin. The theme of the Loss of Innocence was borrowed from Clarke's seminal work on archaeology, in that the session was meant to explore the state of current research and to envisage a map for the future of use-wear in archaeometallurgy. Andrea Dolfini gave the opening address beginning with the history of use-wear in archaeometallurgy. He went on to present major points that were necessary to organise a path forward in the field.

Many of the problems seen in use-wear analysis stem from a lack of training in microwear analysis and the lack of specialist experience in the study of wear. Wear is not often visible, or difficult to interpret by those not trained in microwear analysis. In the past metallurgical studies have had too close of a focus on typology and metallurgical analysis, instead Dr Dolfini recognised the need for an eclectic approach to research, including experimental archaeology. This includes the development of a more sophisticated methodology, and that replica testing and experimentation is essential. He pointed to Ben Robert and Barbara Ottaway's (2003) work with experimental use and quantification of wear on bronze axes that provided a standard for research in the area. He also stressed that that use wear represents the mid-life of a tool, a phase that is often overshadowed by manufacturing or the destruction of metal objects. He also emphasised the need for a systematic quantification of wear, that there must be consistent field testing, formalised protocols and terminology, and that it was essential to share research methods. All of these could contribute to a database of wear on experimental artefacts that could be used for better understanding how metal objects were used.

Much of the research presented in the session involved Bronze Age weapons. Dr. Dolfini pointed out the reluctance to consider the presence of violence in the past, and in keeping with his comments about the martial aspects of metal artefacts, the first paper presented was by Dr Christian Horn (Christian Albrecht's University, Germany) who spoke about the recognition of use-wear

seen on spears and swords, and the mechanics of different types of damage and wear are created.

The following paper (Elpidia Fregni) sought to establish criteria for interpreting wear on metalworking tools. This was not related to the martial use of metal, but could be connected to the theme in that one the hammers used as an example exhibited wear from hammering an axe to sharpen it. The experiment showed how repairing and sharpening an axe resulted in a smoother face on the hammer, but the task also deformed the hammer causing burring and distortion of the edges. The axe blade was recorded before and after sharpening, illustrating the deformation caused by the process.

Rachel Crellin (University of Leicester) continued the theme of Bronze Age weapons with an analysis of combat as seen in wear marks on weapons. Working as part of a team, her work seeks to examine damage to weapons in order to determine if wear-use can be used to interpret ephemeral actions such as body position and fighting styles. The project includes examination of weapons in museum collections and experimental work with replica swords and spears.

The session papers resulted in lively conversations and debate about the interpretation of use wear on metals. All agreed that it was an essential aspect of interpreting metal artefacts and that further research was needed in this field.

The session included posters that explored both wear on Bronze Age weapons, and also analysis, and the use of metal with other media.

Charles Acero (Universidad de Granada) presented a poster on metal tools from the Bronze Age Granada that emphasised the need for interdisciplinary studies that include examining trace elements using XRF and metallography along with experimental work to gain a more complete understanding of how the objects functioned.

Consuelo Huidobro of the Sorbonne presented a poster on iron nails used for knapping obsidian in post-contact Patagonia. Her work combines ethnographic research and experiments to examine how evidence of use would appear on the nails, and to compare these to artefacts recovered from archaeological sites.

Metals and metalworking were also represented in posters from other sessions, including Valerio Gentile's (Universiteit Leiden) research using replicas of Gündlingen swords. Identical replicas were made using Bronze Age techniques and alloys, and were used by experienced martial artists in controlled combat to record and quantify the damage sustained in both defensive and offensive acts. Gentile catalogued the angle of the strikes and the types of impact that caused the damage in order to compare the damage recorded on the experimental swords to that seen on the original artefacts.

Pedro Muñoz Moro of the Universidad Autónoma de Madrid presented a poster that combined analysis and experimental work which provided a new interpretation of Early Bronze Age wrist guards. Surface analysis and microscopic examination of stone wrist guards showed fine scratches and the presence of copper alloy residue. From this he determined that rather than just protecting the archer's arm, these wrist guards were used as whetstones for sharpening arrows.

AWRANA provides a much needed forum for all archaeologists working with material culture. There is a need to recognise the wear on all objects and to be able to read the marks and damage as series of events that occurred in the lifetime of the object. The scratches, nicks, and dents that cover an artefact play an important role in interpreting how the objects were used and how they were a part of the lives of people in the past.

More information about AWRANA is available at [awrana.com](http://awrana.com). The next meeting will be held in Nice, France in 2018.

*Giovanna Fregni*

## References

Roberts, B., and B.S. Ottaway, 2003. "The use and significance of socketed axes during the Late Bronze Age." *European Journal of Archaeology*. Vol. 6, no. 2, pp. 119-140.

## HMS RESEARCH IN PROGRESS 2015

**13<sup>th</sup> November 2015, Brunel University, Uxbridge**

The past Research in Progress 2015, organized by Lorna Aguilano and held at Brunel University, once again proved to be a fantastic event where attendants were able to witness firsthand the latest results and investigations regarding a large range of topics, from mining to metal production as well as novel techniques and proposals for metal preservation, experimental archaeology and historical research both from the UK and abroad.

One of the most interesting aspects of this conference was the presentation of various dissertations related to new methods and techniques for both archaeometallurgical research and metal preservation. Among these papers were those of Samantha Rowe (University of Huddersfield) who presented her first results on metal artifact decay in plough soils in the UK, assessing the important relation between soils and metal artifacts to understand the different conditions under which metals decay and therefore being able to present different strategies for the recovery and preservation of metallic objects.

William Hawkes (West Dean Collage) presented an outstanding dissertation on the qualities of Saponin for silver cleaning and preservation compared to the traditional use of acidified thiourea. By the comparative analysis, having used XRF for superficial chemical analysis, of sterling silvers before and after having been treated with both products, he was able to demonstrate how Saponin was much less corrosive to silver surfaces as well as being cheaper, less dangerous and less aggressive for preservation treatments. His presentation was awarded the HMS prize to best presentation and here we would like to congratulate him on his outstanding work.

Within this same line regarding application of new methods and techniques we must also highlight the dissertations of Alan Williams and David Edge (Wallace Collection Museum) who presented the use of neutron diffraction for the study of swords as a non-invasive technique rather than using the traditional method of metallography; as well as that of Michael Carlton (University Collage of London), who presented the latest results of the IRONWORKS projects, centering on the importance of data quality and processing data, and whose work has been fundamental for establishing a correct analytical protocol for slag analysis, stressing the importance of slag analysis for understanding metallurgical production processes.

One of my personal favorites was the dissertation presented by John Boothroyd (Oxford Archaeology) on the latest finds of Roman iron production in the UK, not only because of the impressive contexts they have been able to document at the Bexhill to Hastings road (large iron furnaces and slag heaps, evidence of large scale iron production), but because the presentation of results from urban archaeological excavations tend to be missing in many conferences and seminars, or are usually over-passed by long running research projects. This presentation demonstrates the importance urban archaeology has in order to advance in archaeological research and historical knowledge and proves how important it is for urban archaeology to have representation in these types of events since, in many occasions, it is the front-runner of archaeological research.

It is also very important to highlight the presence of many international researchers who presented us with some the latest research that is being carried abroad; in this case being specifically noted the presence of our Italian colleagues Elisa Grassi (Università Cattolica del Sacro Cuore) who spoke about metallurgical production in sacred contexts from the Capitolium of Brescia, and Vasco La Salvia (D'Annunzio University of Chieti-Pescara) in collaboration with Marco Valenti, Stefano Bertoldi, Vittorio Fronza, Manuele Putti and Lorna Aguilano, who presented novel information on metallurgical activities documented at some sites in Central and Southern Italy.

These are just some of the 15 outstanding presentations we were able to enjoy, such as those presented by Marta Matosz and Julio M. del Hoyo Melendez on the analysis of dinarii from Poland minted by the early Piasts; Eleanor Blakelock who presented the results of the analysis of the silver objects from the Staffordshire Hoard; Peter King with new results regarding the transition of puddling to the Bessemer and Open Hearth processes in the UK during the 19<sup>th</sup> century; David Cranstone, on finery steelmaking in the area around the Forest of Dean from the second half of the 16<sup>th</sup> century A.D and throughout the 17<sup>th</sup>; Yvette Marks, on the origin and latest ideas on the role of itinerant smiths for the transmission of metallurgy during the late Neolithic and the Bronze Age; Patrick Cropper, with a new approach on the study of the lack of prehistoric metallurgical remains in the UK from the field of experimental archaeology; David Sables, with novel information on the important role that mining played within the monastic life at the Cistercian Abby of Strata Florida; and Peter Claughton who presented the latest discoveries of lead and silver production at Combe Martin.

The conference ended with a visit to the Experimental Techniques Center at Brunel University where we were offered an outstanding tour of the facility with first hand explanations of the different techniques available at their center and their application to archaeology in general and archaeometallurgy in particular.

Finally, we would once again like to congratulate the organizers and Brunel University, as well as all the speakers for a fantastic day where attendees, students, new researchers and established scholars were able to discuss some of the latest research in worldwide archaeological and historical metallurgy. I would personally like to stress here the importance of these events held by the HMS which give an opportunity for both students and the scientific community to present the latest research that is being carried out worldwide regarding metallurgy and that leads us, step by step, to a better comprehension of the role of metals and metallurgy throughout human history. Once again congratulations to William Hawkes for winning the HMS prize with his outstanding presentation “Polishing our performance and wining silver” and to Lorna Aguilano and the HMS community for organising such a successful day.

*Charles Bashore Acero*

## HMS SUMMER MEETING AND AGM

17<sup>th</sup> - 19<sup>th</sup> June 2016, Merthyr Tydfil

Commemorating both the 250<sup>th</sup> anniversary of the construction of Cyfarthfa Ironworks (1765-7) and the 225<sup>th</sup> anniversary of the first successful implementation of the puddling process (1791). This meeting will address issues associated with the development, introduction and application of puddling during the late 18<sup>th</sup> and early 19<sup>th</sup> centuries, as well as associated subjects connected with Merthyr, its ironmasters and people.

The programme will include an excursion to an open-cast coal mine, to examine the resources on which Merthyr was founded, on the afternoon of Friday 17<sup>th</sup> (limited places, first-come, first-served; subject to the state of the mine on the day), followed by an evening reception in Cyfarthfa Castle (home of the Crawshays and now a museum), a day of presentations on Saturday 18<sup>th</sup> and a tour of some of the remains of Merthyr’s iron industry on Sunday 19<sup>th</sup>. The two trips (Friday and Sunday) will cover aspects of the operations of all five of the Merthyr ironworks, including the natural resources of the Dowlais and Penydarren Ironworks, the remains of the Cyfarthfa and Ynysfach Ironworks and the houses of the iron-masters of the Cyfarthfa and Plymouth ironworks from the heyday of puddled iron.

There is still some very limited time within which to offer papers (500 word abstract; oral or poster) across the range of subjects: the story of puddling (technology, economics, social history, engineering implications, international adoption), the wider story of iron conversion technology, the development of Cyfarthfa Ironworks and its people (Anthony Bacon, Charles Wood, the Homfrays, the Crawshays, their engineers and partners), and the broader development, social history and context of the iron industry in Merthyr Tydfil and South Wales from 1750 to 1950.

A booking form is enclosed with this edition of *The Crucible* and full details are available on the website (<http://hist-met.org/meetings/2016-agm-summer-meeting.html>). Delegates should make their own arrangements for accommodation, but the conference will be centred around the Premier Inn, at Pentrebach Merthyr Tydfil with the presentations and AGM in the adjacent Table Table restaurant, housed in Pentrebach House (built in 1850 by Anthony Hill, son of Richard Hill, who had originally leased the Plymouth furnace from Anthony Bacon’s estate in the 1780s). The conference booking deadline is 1<sup>st</sup> May 2016, but attendees are advised to book their hotel accommodation as soon as possible (see the website for details and advice). The HMS 2016 AGM will be incorporated within the programme on Saturday 18<sup>th</sup> June. All members are encouraged to attend (at no charge, unless you wish to book lunch – in which case please do so through the conference booking form).

**BASTIAN ASMUS** writes “Cast bronze church bells are used at least from the 8<sup>th</sup> century onwards or so. The earliest surviving cast bronze bell is from Canino, Italy dated to the 8/9<sup>th</sup> century AD. I carried out archaeological experiment at the Campus Galli museum in Germany to reconstruct the bell casting process following the treatise of Theophilus Presbyter. Despite Theophilus having lived in the 12<sup>th</sup> century he described a much older process, which is given evidence by the bells themselves. The casting process differs from the modern process inasmuch as it is a lost wax process. The archaeological reconstruction worked very well and in 2016 I will cast the next reconstructed bronze bell”.



*The first reconstructed Carolingian bell chimed only hours after its casting. Photo: Oliver Bonstein, 2015.*

**ANNABELLE COLLINET, DAVID BOURGARIT, VANA ORFANO, and ZIAD EL MORR** report “The ISLAMETAL project (2013-2017), jointly conducted by the Islamic Art Department (DAI), Musée du Louvre, and Centre de Recherche et de Restauration des Musées de France (C2RMF) and kindly co-funded by the Roshan Cultural Heritage Institute, deals with the detailed technological investigation of copper-based metal wares from the Indo-Iranian world (11<sup>th</sup>-18<sup>th</sup> centuries AD) kept at the Louvre collection. Investigation of mostly household and domestic objects incorporates elemental analysis (PIXE, ICP-AES) with X-radiography and microscopy. Emphasis is put on the relationship between and the development of alloy recipes, fabrication methods, and the specific decoration techniques, e.g. engraving, inlays, etc. Overall, the project builds on published data and aims to better define production centres of the broader region and the transmission of technological knowledge diachronically.”



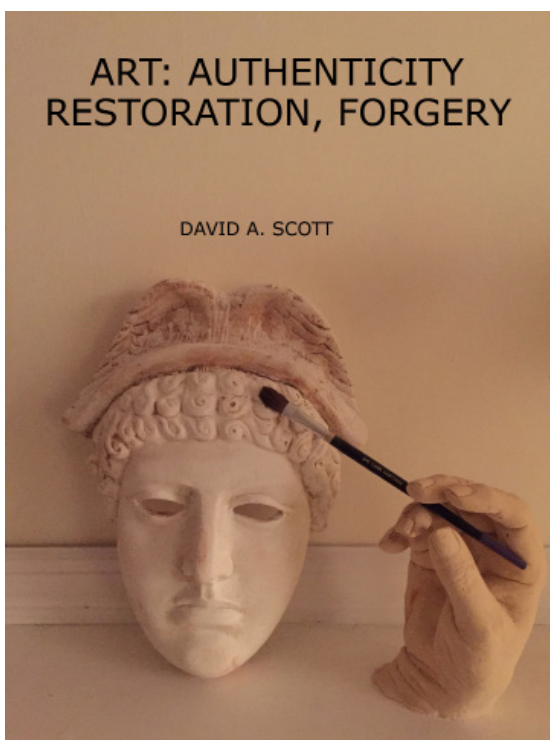
*Detail of lead-rich brass (red brass) inkwell from Ghazna, Afghanistan, early 13<sup>th</sup> century AD, decorated with inlaid silver and copper, engraving, chasing and champlévé. © Annabelle Collinet and Vana Orfanou, 2015.*

**CHLOE N. DUCKWORTH, DAVID J. GOVANTES EDWARDS, DEREK PITMAN and KATE WELHAM** write “We carried out a combined geophysical and geochemical survey of 10<sup>th</sup> century production zones at Madinat al-Zahra, near Cordoba, Spain. The survey (c. 5 ha), was carried out in summer 2015 and aimed at investigating possible high-temperature activities (using magnetometry) and industrial pollutants (using surface HH-pXRF) in this 10<sup>th</sup> century urban/palatial site near Cordoba (Spain). The results included the identification of magnetic anomalies which seem to indicate several areas of pyro-technological activity found in association with a large building complex, as well as other structural remains (specifically, what appears to be a large keyhole furnace) found in close connection with considerable surface concentrations of elements used in medieval industries (Pb, Mn and Cu). Plans for continued survey of this c. 100 ha medina are already underway.”

Contact: [cd227@le.ac.uk](mailto:cd227@le.ac.uk)



**DAVID A. SCOTT** writes “I have been completing a book that presents a detailed account of authenticity in the visual arts from the Palaeolithic to the Post-Modern. The restoration of works of art can alter the perception of authenticity and may result in the creation of fakes and forgeries. These interactions set the stage for the contents of this book which examines initially the conservation perspective, followed by a detailed discussion of notions of authenticity, and salient aspects of the philosophical background of authenticity. Authenticity is a disputed territory between those who view the present-day cult of authenticity as fundamentally flawed, to those who have analysed its impact upon different cultural mileau, operating across performative, contested and fragmented ground.”



**STEPHEN MERKEL** reports “After completing my PhD at the Deutsches Bergbau-Museum Bochum on the elemental and lead isotope analysis of silver finds from Viking Hedeby, I moved to the archaeometallurgy of medieval brass in West/North Germany. In addition, I have had an interest in silver production sites in the Islamic world (Al-Radrad in Yemen, Panjhir, and the Ilak of Uzbekistan). Currently, I am studying the non-ferrous metals, chiefly brass, of Elsfleth, a Roman Empire era recycling workshop in North Germany. I teach archaeometry at the Ruhr University Bochum and am now the managing editor of *Metalla*, which will be made into a peer-reviewed English-language journal on archaeometallurgy and mining archaeology. Call for papers will appear shortly.”

Contact: [StephenWilliam.Merkel@bergbaumuseum.de](mailto:StephenWilliam.Merkel@bergbaumuseum.de)

**TIM YOUNG** reports on some of the significant GeoArch sites of the last 12 months and of future projects.

The analysis and reporting on early medieval (late 9th-early 10th century AD) iron smelting at Churchills Farm, Hemyock, Devon, with the analysis of residues from the slightly earlier (8th – 9th century AD) neighbouring site at Culmstock Road, Hemyock, progressing towards publication. These projects are entailing a substantial revision of understanding of the development of the technology of iron smelting in early medieval southern Britain.

The analysis of an assemblage of late Bronze Age copper ingots from St Michaels Mount, Cornwall.

The preparation for publication of the analytical studies of medieval (13th century) smelting of tin contaminated with tungsten at Brownie Cross, Shaugh Prior, Devon (near the vast tungsten resource of Hemerdon Bal).

The preparation for publication of the analysis of refining residues from Ynysfach ironworks, Merthyr Tydfil and of a historical review of the origin and development of refining.

Smaller pieces of work have included the assessment of assemblages from a Late Iron Age smithing site, three Roman smithing sites, two Roman iron smelting sites, two early medieval iron smelting sites, two medieval smithing sites and one post-medieval tinplate works.

Current large projects, and those coming up in the first half of 2017, include several analytical projects on Iron Age iron smelting (two sites in Cornwall and two sites in Berkshire) and two projects involving the caching and processing of cassiterite in the early Bronze Age of Cornwall. Recent and on-going small projects thus far in 2017, include the assessment of two non-ferrous and four ferrous assemblages from Ireland, a Roman smithing assemblage from England and two early medieval iron smelting assemblages from Wales.

These and more are accessible from the GeoArch website: <http://www.geoarch.co.uk/>

## FUTURE INTERVIEWS

*Who would you like us to interview for the next issue of **The Crucible**?*

*Would you like any additional question added to our standard list?*

*Please let us know at [thecrucible@hist-met.org](mailto:thecrucible@hist-met.org).*

# FORTHCOMING EVENTS

Conference, Date and Location	Description	Website, Email and Prices
<b>23<sup>rd</sup> International Congress of Advanced Thermal Processing</b> 18 <sup>th</sup> - 22 <sup>nd</sup> April 2016 Savannah, Georgia, USA	The ASM Heat Treating Society and the International Federation of Heat Treatment and Surface Engineering have partnered to create an exciting event focused on Thermal Processing, Heat Treating and Surface Engineering.	<a href="http://www.asminternational.org/web/ifhtse">http://www.asminternational.org/web/ifhtse</a>
<b>Bushfire Forge 'Forge-In' demonstrations and lectures</b> 6 <sup>th</sup> - 8 <sup>th</sup> May 2016 East Wickham Farm, Kent, UK	Owen Bush is hosting three days of lectures and practical demonstrations this May. There will also be a smelt and chances to have a go at forging using the school facilities.	<a href="http://owenbush.co.uk/forge-in-may-6th-7th-8th-2016/">http://owenbush.co.uk/forge-in-may-6th-7th-8th-2016/</a>
<b>DTRG Conference</b> 6 <sup>th</sup> - 11 <sup>th</sup> May 2016 Tavistock, Devon, UK	An international conference entitled " <i>A Celebration of the Tinworking Landscape of Dartmoor in the European Context – Prehistory to the 20<sup>th</sup> Century</i> ".	<a href="http://www.dtrg.org.uk">www.dtrg.org.uk</a>
<b>Prehistoric Metallurgy (Experimental Archaeometallurgy) Course</b> 13 <sup>th</sup> - 16 <sup>th</sup> May Butser Farm, Hampshire, UK	This is a practical and theoretical short course on the use of experimental archaeology in examining the production of metals at the beginning of the Bronze Age. Through lectures on prehistoric archaeometallurgy and daily practical workshops, the course will provide valuable experience for anyone working in this field or interested in it.	<a href="http://www.fingerbuster.com/">http://www.fingerbuster.com/</a>
<b>41<sup>st</sup> International Symposium on Archaeometry</b> 15 <sup>th</sup> - 20 <sup>th</sup> May 2016 Kalamata, Greece	The International Symposium on Archaeometry (ISA), is a most welcome forum to present the latest data and updates of the Archaeometry research and archaeological science, covering the full spectrum of topics, materials, techniques, time span and global applications.	<a href="http://isa2016.uop.gr/index.html">http://isa2016.uop.gr/index.html</a>
<b>REHABEND</b> 24 <sup>th</sup> - 27 <sup>th</sup> May 2016 Burgos, Spain	This mayor international conference is oriented to construction and cultural heritage management. Some interesting topics are " <i>Conservation of industrial heritage</i> " and " <i>Restoration of artworks and archaeological materials</i> ".	<a href="http://www.rehabend.unican.es/">http://www.rehabend.unican.es/</a>
<b>HMS Summer meeting and AGM</b> 17 <sup>th</sup> - 19 <sup>th</sup> June 2016 Merthyr Tydfil, UK	Celebrating the 250 <sup>th</sup> anniversary of the Anniversary of Cyfarthfa Ironworks and the 225 <sup>th</sup> anniversary of the puddling process, this conference will discuss a range of related topics including the story of puddling, as well as the wider story of iron conversion technology and the broader development, social history and context of the iron industry in Merthyr Tydfil and South Wales from 1750 to 1950.	<a href="http://hist-met.org/meetings/2016-agm-summer-meeting.html">http://hist-met.org/meetings/2016-agm-summer-meeting.html</a>
<b>MeTools Conference</b> 24 <sup>th</sup> - 25 <sup>th</sup> June 2016 Belfast, UK	The conference entitled <i>The metalworker and his tool: Symbolism, functions and technology in the Bronze and Iron Ages</i> will focus on the different roles of metalworking tools – in metal, stone, fired clay or organic material – to comprehend their evolution from the beginning of metallurgy until the Iron Age, and to better understand the artisan's place within society.	<a href="http://metools2016.sciencesconf.org/">http://metools2016.sciencesconf.org/</a>
<b>IAMS Summer School in Archaeometallurgy</b> 20 <sup>th</sup> June - 1 <sup>st</sup> July 2016 UCL, London	As usual, we will combine some field experiments with lectures, handling sessions and laboratory demonstrations. Please check the website for the final programme in the next few days and/or email Umberto Veronesi if you would like to be informed when the final programme is ready.	<a href="http://www.ucl.ac.uk/iams">www.ucl.ac.uk/iams</a> <a href="mailto:umberto.veronesi.13@ucl.ac.uk">umberto.veronesi.13@ucl.ac.uk</a>
<b>Archaeometallurgy Course</b> 7 <sup>th</sup> - 12 <sup>th</sup> August 2016 Sedgeford, Norfolk, UK	This course is primarily a practical course. There will be a guided experimental project to construct an actual working furnace. Participants will be preparing ores, and fuel, assisting in building a furnace and will also be involved in running the furnace itself. It is an ideal opportunity to learn about the principals and techniques of archaeometallurgy and also participate in a live project.	<a href="http://www.sharp.org.uk/courses/Archaeometallurgy.html">http://www.sharp.org.uk/courses/Archaeometallurgy.html</a>
<b>22<sup>nd</sup> Annual Meeting of the EAA</b> 31 <sup>st</sup> August - 4 <sup>th</sup> September 2016 Vilnius, Lithuania	As always, the European Association of Archaeologists Conference is slated to include many topic relevant to our readers. Covering a much more diverse range than our typical conferences, sessions of interest include: " <i>Methods of metal detecting survey in archaeology</i> ", " <i>Iron making techniques and social change in the medieval and early modern Europe</i> ", " <i>Fueling crafts and industries in medieval and post-medieval Europe</i> ", and " <i>Tradition, Innovation and Networks – Metal Working Around the Baltic Sea from the Bronze Age to the Middle Ages</i> ".	<a href="http://eaavilnius2016.lt/">http://eaavilnius2016.lt/</a>
<b>International Early Engines Conference</b> 11 <sup>th</sup> - 13 <sup>th</sup> May 2017 Elsecar, South Yorkshire, UK	Including visits and presentations, the inaugural International Early Engines Conference will provide a forum for presentation and discussion of new research into heat engines prior to 1812.	<a href="https://www.earlyengines.org/">https://www.earlyengines.org/</a>
<b>Iron in Archaeology: Bloomery Smelters in Europe and Beyond</b> 30 <sup>th</sup> May - 2 <sup>nd</sup> June 2017 Prague, Czech Republic	International conference in honour of the late Radomír Pleiner and to commemorate the 50 <sup>th</sup> anniversary of the founding of the Comité Pour la Sidérurgie Ancienne (CPSA).	<a href="http://www.arup.cas.cz/ia2017/index.html">http://www.arup.cas.cz/ia2017/index.html</a>

