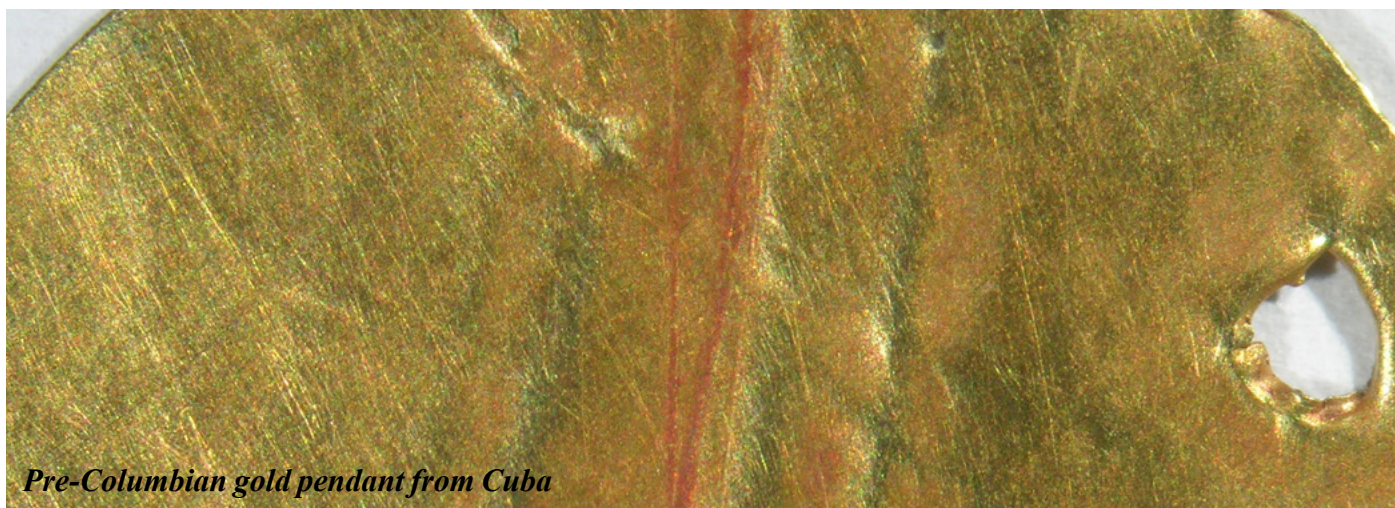


# THE CRUCIBLE

**Historical Metallurgy Society News**  
**Issue 84**

**Winter 2013**



*Pre-Columbian gold pendant from Cuba*

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*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.*

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The **HISTORICAL**  
**METALLURGY**  
Society

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This year marked the 100th anniversary of the official discovery of stainless steel, and HMS celebrated the occasion with its annual conference in Sheffield, “the Steel City”. It therefore seems fitting that much of this issue of **The Crucible** concentrates on ferrous metallurgy, not only with a review of the Sheffield conference but also with reports of conservation work in important ironworks and relevant publications. Even the Meet your Council section has a strong ferrous flavour through the words of Peter King, who diligently helps us keep the HMS accounts in order, while continuing his extremely thorough research on the history of post-medieval iron in Britain.

The conservation of industrial metallurgical heritage, primarily blast furnaces, was a core concern of the founding fathers of our Society 50 years ago, as reported in revealing historical notes by Tim Smith. While this concern has not been abandoned, as shown by the report from Gunns Mill, HMS has continued to expand its membership and scope of action. It is perhaps significant that the editorial team of this very newsletter includes representatives from five countries and three continents! We are therefore very pleased to see this diversity of interests and approaches increasingly reflected in the pages of **The Crucible**. It is hard to think of something more diverse than a ‘A letter from...’ signed from both Chile and France, outlining an inter-continental comparative approach with very interesting implications for our understanding of the different developmental trajectories of copper metallurgy in both regions. Also from France, and with interests ranging from experimental archaeometallurgy through to Gaston Bachelard, David Bourgarit displays his usual combination of wit and insight in the One Minute Interview.

The issue is completed with further reports and conference announcements, including one sent from China about the recent BUMA conference in Japan. And Japan will be the destination of one of the first two beneficiaries of the HMS Anniversary Fund, which keeps growing thanks to your very generous donations and, in turn, helping others with their training and research on matters of historical and archaeological metallurgy. We are very keen to keep promoting the internationalisation of **The Crucible**, as a true reflection of the HMS base – so please keep them coming! We want to read your news, views and reports from around the world.

If you are reading these lines on a hard copy, don’t forget that you can also download a full-colour version from the HMS website ([www.hist-met.org](http://www.hist-met.org)), where you will also find interesting features such as a growing number of Archaeometallurgy Datasheets and a brand new HMS Shop, as well as details of exciting HMS Conferences on the horizon. You can additionally join the HMS Facebook page ([www.facebook.com/groups/histmet](https://www.facebook.com/groups/histmet)), which has recently welcome its 600th member, and follow HMS on [Twitter \(@histmet\)](https://twitter.com/histmet). It has never been easier to stay involved and up to date!

*The Editorial Team*



*The impressive sight of copper smelting experiments in Serbia. Full article to follow in the next issue.*



## GUNNS MILL FURNACE, FOREST OF DEAN, GLOUCESTERSHIRE

**T**he Forest of Dean has a long history of iron making. In the Middle Ages it was the premier iron-making district in the realm. During the 17th century it had, for a time, the greatest number of charcoal fuelled blast furnaces and forges in the country. Gunns Mill was one of them.

The furnace is a rare and important survival. It is described as one of the most impressive sites of its kind in England. The timbered superstructure is unique.

### The Furnace

Gunns Mill Furnace is a surviving 17th century blast furnace. The raw materials used to produce cast iron were iron-ore, bloomery slag and charcoal. The cast iron was then refined in chafery and finery forges to become wrought iron, usually in bar form. Molten iron from the furnace will also have been cast into moulds for items such as fire backs.



*Gunns Mill Furnace, circa 2000. Photo reproduced by kind permission of Chris Morris.*

### The history of Gunns Mill

The furnace sits on a strong tributary of the Westbury Brook, in the Flaxley Valley. It occupies a site that was used by corn and fulling mills from at least 1435. The place-name derives from the clothier William Gunn, lessee of the mill in 1596. Around 1625, a blast furnace was built, almost certainly, by Sir John

Winter, ironmaster of Lydney. Sir John was a grandson of Drake's associate, Admiral Winter. He was also secretary to Queen Henrietta Maria.

Winter forfeited his estates during the Civil War and the furnace was seized in 1644 by John Brayne. Winter regained his lands and the furnace was in his hands by 1653. After 1680 the furnace was rebuilt by the iron masters Scudamore of Herefordshire, and Hall of Highmeadow near Coleford. The cast iron lintels carry the dates 1682 and 1683. Dendrology dating has revealed that the oak trees used for the beams of the superstructure were felled in 1681-82 and thus formed part of the rebuild. The survival of a 17th century furnace superstructure is unique in Britain.

In 1702, Gunn's Mill was purchased by Thomas Foley of Stoke Edith. Under the Foley Partnership cast iron was produced there until 1736. The output in 1705-06 was 779 tons. Iron making ended somewhere between 1736 and 1741.

Iron making with newer methods continued in Dean long after Gunns Mill was blown out. In the 19th century Dean metallurgists invented processes and materials of worldwide significance.

### Conversion to a paper mill

In 1741, Joseph Lloyd founded the paper works. This was continued by his descendants until 1840 and they also owned the paper mills at Postlip near Winchcombe. After 1842, paper making at Gunns Mill was continued by others with steam power added in 1851. Production ceased in 1879 and the buildings were afterwards used by farmers. The fine mill house was reduced from three storeys to two. The pond was infilled and many of the ancillary buildings were demolished or fell down. Increasing dilapidation continued despite a Building Preservation Order being made in 1968 following pressure for action from Dr Cyril Hart.

### The site today

In the 1980s the site and Gunns Mill House changed hands. A conversion of the furnace into a dwelling was proposed. In 1986 the site was scheduled by English Heritage. In 1994 William Parker purchased the furnace and the adjacent land to protect it from adverse development. By this time the structure was in poor condition and the scale of work needed for preservation was large. Subsequently, English Heritage, being unable to take it into Guardianship, inserted massive, scaffold shoring and weather proofed the structure. The dating of the oak timbers has increased the historic value of the site from important to unique. But for more than a decade Gunns Mill Furnace has remained shrouded in white plastic and it continues to deteriorate. It is high on the English Heritage Monuments at Risk Register.

In 2012 the site and buildings were gifted to the Forest of Dean Buildings Preservation Trust with a view to rescue, conservation and a new end use. The project ahead is large. The task has the approval of the District Council and English Heritage and the site has been seen by the director HLF South West Region.

Alyson McDermott, the historic wallpaper conservator, wishes to use the finished site as a workshop, training centre and archive store.



*Historic image of Gunns Mill. Photo reproduced by kind permission of Chris Morris.*

The site also has a key educational role to play in preserving and explaining the Forest's and County's contribution to the industrial growth of Britain.

### **The Forest of Dean Buildings Preservation Trust**

The Trust was established in March 2009 with the encouragement of the County and District Councils in order to preserve for the benefit of the nation, the historical, architectural and constructional heritage in and around the Forest of Dean. Website: [www.fodbpt.org](http://www.fodbpt.org).

### **The Team**

A strong team of trustees has been appointed with the wide-ranging skills necessary to meet the challenges. Links have been forged with other organisations that will support the Trust's endeavours.

The first two properties that have come into its ownership are both a part of the industrial heritage of the Dean. Both are scheduled monuments and priorities on the Heritage at Risk register. The Trust's concerns are not limited to industrial heritage and it is currently reviewing all the properties on the 'heritage at risk'

register. These range from individual buildings to local townscapes, from archaeological sites to industrial monuments. There will be no shortage of contenders.

### **The challenge**

The tasks facing a newly formed Buildings Preservation Trust are legion, ranging from the selection of the most urgent projects and the development of a sustainable end use, to the identification of potential funders, but perhaps the most difficult is that of raising the capital to fund the preparatory work necessary to launch an appeal.

The conservation of Gunns Mill was always destined to be high on the agenda of any organisation interested in the care of our local heritage. The challenge has been the cost of the work necessary and the identification of an end use. The latter has now been addressed, so there is, at last, the opportunity to undertake a task that was first identified nearly 50 years ago.

*Ian Standing*

## **WORK TO BEGIN AT BRYMBO IRONWORKS**

We are happy to announce that Brymbo Heritage group is the proud recipient of a Heritage Lottery Fund to create a visual and oral record of this important ironworks described a 'key piece of the Welsh industrial heritage'.

Brymbo Ironworks is the sole remaining complete physical monument to the notable industrialist John Wilkinson and houses three scheduled ancient monuments and a Grade II\* listed building on site. The site built in 1796 is a unique surviving example of a late 18th century ironworks and the project will help capture the memories of former workers which will then provide an opportunity for local residents and schools to learn about their heritage.

Over the last 10 years the Brymbo Heritage Group has undertaken extensive work to raise awareness of this significant site and to protect it from development but the physical remains of the historic ironworks continue to deteriorate as they have not been in use since the 1980s. This project aims to keep the memory of Brymbo Ironworks alive for future generations.

For more information, visit the announcement page at <http://www.hlf.org.uk/news/Pages/Brymbo.aspx>



## THE ORIGINS OF HMS

Of the 27 founder members of HMS, two are still members today. One of these, David Crossley – now retired from the Department of Archaeology, Sheffield University – presented a keynote paper on the origins of the society on the occasion of the 50th Anniversary Conference held in London in June. This was supported by a paper from Justine Bayley, co-editor with him of *Historical Metallurgy*, the HMS Journal. What follows is a few notes about the early years of the Society.

In the early 1960s, a small number of industrial metallurgists and engineers in UK companies and research centres along with academics from UK's technical and archaeological departments, realised the need to preserve at least some of the country's industrial heritage which was under threat either through neglect or destruction. Among these founder members was Ronald F Tylecote of King's College, Newcastle upon Tyne (before it became a separate University), George (Reg) Morton of Wolverhampton Polytechnic, Charles Blick of the British Steel Corporation, Henry Cleere, then working for the Iron and Steel Institute, and David Crossley, from Sheffield University. The latter two are still members today.

In 1961, Reg Morton wrote an article in the *Journal of the Iron and Steel Institute* calling for Duddon blast furnace, a charcoal fired furnace dating from 1736, in the Lake District to be preserved as a National Monument. A letter the following year in the same journal co-written by R C Benson, W I Pumphrey and R F Tylecote welcomed Morton's suggestion and his approach to recording old metallurgical sites and said "We obviously need for this purpose some sort of metallurgical preservation society." This led to the formation of the Historical Metallurgy Group with 27 founder members.

Its first *Bulletin* was published in April 1963. At the HMS 50th Anniversary Conference, when Justine Bayley projected a page from that issue onto the screen, Henry Cleere called out "I typed that". Issue No 1 of the *Bulletin* tabulates 23 blast furnaces dating from 17-18th century era onwards but declares most in too far a state of decay to warrant preserving. With the efforts of members of the group, unrecorded blast furnaces were added to the list along with their dimensions and state of decay. Not only blast furnaces, but also bloomery sites were excavated and recorded by members, with Henry, for example, locating many Roman bloomery sites in the Weald of southern England, the region where the blast furnace was first introduced to Britain in around 1496. A major breakthrough in preserving some of the extant blast furnaces was made when the UK Government's Inspector of Ancient Monuments, John Hurst, was persuaded to visit a site being excavated by David Crossley and thenceforth gave encouragement and support.

The survival of most of the early blast furnace sites that we can visit today in the UK is thanks to the efforts of the early HMS Members. In addition to Duddon, examples survive at Blackbarrow in Cumbria (1711); Low Mill and Rockley, near Barnsley, Yorks (c1700); Whitecliff (1798) and Gunn's Mill (1625) both in the Forest of Dean, Glos; Tintern on a tributary to the Wye Valley (c1629); Bonawe in Argyll, Scotland (1753) and in Coalbrookdale, within the Ironbridge Gorge Museum. Here a number of furnaces have been preserved including that used by Abraham Darby which was first reported to be using coke instead of charcoal in 1709.



*Rockley blast furnace c. 1700 during excavations in the 1980s by David Crossley (note casting pit in foreground). Rockley is located close to junct 36 M1 north of Sheffield.*

In 1965, two of the forerunner organisations which eventually became the Institute of Materials, Minerals and Mining (IoM3) – the Iron and Steel Institute and the Institute of Metals – agreed to provide secretarial and editorial services to the group and undertake the production and distribution of future issues of the *Bulletin*. Research papers by HMG Members were also published in the *Journal of the Iron and Steel Institute*. 1968 saw the evolution of the typed and stencilled pages of the

earlier *Bulletins* into a typeset bound volume publishing twice yearly. In 1974 the title was changed to '*Historical Metallurgy*', the present-day title, and HMG became HMS.

Even as early as 1965, ferrous metallurgy was not the sole focus. In Vol 1 No5, June 1965, for example, there is a report on early tin and copper smelting in Cornwall. Over the years there has been an increasingly broad range of industrial and archaeological papers published from prehistoric times to the 20th century from sites across the world.

The work of HMS continues, although with much greater emphasis on the archaeology of metallurgy, the technical analysis of material remains, and the recording of sites by excavation rather than by preservation. It also aims to encourage local groups to preserve sites such as the Whitecliff furnace in the Forest where the Forest of Dean Local Action group recently undertook a £16500 project to preserve the endangered structure and erect interpretation boards. This furnace was one of only two in the Forest fired with coke and had attracted David Mushet (the father of Robert who first developed alloy steels) to move from Scotland in a fruitless attempt to get it working properly.



*Nothing survives today of the Stanton ironworks demolished in the 1970s.*

But there have been failures too. In South Wales, Brecon blast furnace, dating from 1720, was destroyed in the 1960s for the value of its scrap iron, and, of more modern works, Stanton Ironworks in Derbyshire, was demolished in the 1970s. In the Lake District, Backbarrow, which was to have been incorporated into a residential development, is in a sad state of repair following the demise of the developers. Also, not a single open hearth steel furnace has survived in UK, despite the process surviving until 1979.

Thus there remains a need for volunteers to follow in the steps of those pioneers of 50 years ago to help preserve and expand the knowledge of archaeological and historical metallurgy up to the Industrial Revolution and beyond. HMS now counts around 500 members from around the world, including professional archaeologists, historians and materials scientists, but also amateurs with a passion and interest in metals. Their interests are much wider

than in the early days, now spanning from the earliest production of metal through all ferrous, non-ferrous and noble metals around the world. This allows for a multitude of new ideas and a plethora of talent across all related disciplines, as demonstrated last summer at the 50th Anniversary Conference.

*Tim Smith*

## HMS MEETING - IRISH IRON

**BLARNEY, IRELAND, 12<sup>TH</sup> -13<sup>TH</sup> APRIL 2014**

Next year's HMS Spring Meeting will be held in Ireland on the 12<sup>th</sup> and 13<sup>th</sup> of April. Base camp will be Blarney, just outside Cork City, with many accommodation options, lively pubs and, of course, the only place in the world dispensing 'the gift of the gab'.

On Saturday, a full day's visit is planned to east County Clare where an extensive charcoal blast furnace industry was established in the 17<sup>th</sup> century around several rich hematite mines. It is the location of the furnace owned by Foote and Beecx in the 1630s, before they went over to New England to establish the Saugus ironworks and, in the 1690s, it was the main hub for a project involving zinc-plated iron production. The main importance of the area, however, is the exceptional preservation of the furnaces and we will be visiting the remains of several of these dating to the 17<sup>th</sup> and early 18<sup>th</sup> centuries.

On Sunday morning, the site of the ironworks established by the East India Company near Bandon (Co. Cork) will be visited. This interesting and surprisingly little known site, dating to the 1610s, is located within a defensive enclosure and while the furnace itself is demolished, part of the finery is still visible.

In the early afternoon an exhibition will be presented at University College Cork, where a selection of characteristic, and a few exceptional, remains of early Irish iron working will be on display. This will include a preserved slag pit bloomery furnace and artefacts such as various types of Irish tuyeres and early blooms. A short talk will offer an overview of the current knowledge on early Irish iron technology, the history of which has recently undergone a complete revision.

More information about this meeting, including registration forms and the full program, can be found on our website at <http://hist-met.org/meetings/spring-meeting-irish-iron.html> or by contacting Paul Rondalez at [prondelez@yahoo.com](mailto:prondelez@yahoo.com).



## HMS CONFERENCE AND AGM CALL FOR PAPERS - METALS USED IN PERSONAL ADORNMENT

BIRMINGHAM, UK, 31<sup>ST</sup> MAY – 1<sup>ST</sup> JUNE 2014

For many centuries metal, especially precious metals, has been the dominant material used in the construction of jewellery and other items of personal adornment. The basic form of personal adornment varies over time, location and culture. This influences not only the style of the pieces but also impacts the method of manufacture.

This conference therefore provides an opportunity to examine the metals used and the metalworking techniques carried out to produce these pieces. Papers are welcome on topics covering all aspects of metal use and manufacture of items of personal adornment (or specifically jewellery) from any period, location or culture.

Abstracts for papers should be submitted by the 6th of January. They should be no more than 250 words and should be sent to [HMSagmconf@hist-met.org](mailto:HMSagmconf@hist-met.org). A single picture can also be provided for the abstract book. Please indicate the name and affiliation of all the authors and indicate the presenting author in bold letters.

As part of the conference there will be a tour of the Museum of the Jewellery Quarter, and a behind the scenes tour of the Birmingham Museum conservation department where they are working on the Staffordshire Hoard.

The booking form is available on our website, <http://hist-met.org/meetings.html> with online payment for the conference available soon. The programme will be announced in early February.

For more information please contact [HMSagmconf@hist-met.org](mailto:HMSagmconf@hist-met.org) or post to Eleanor Blakelock, Conservation and Scientific Research, British Museum, Great Russell Street, London WC1B 3DG, UK.

## HMS ANNIVERSARY FUND

Including generous donations from members and contributions from HMS itself, the Anniversary fund is now well past £10,000. If you have not contributed yet, please consider doing so, you will find details on the web site at <http://hist-met.org/about-hms/anniversary-fund.html>.

The first two grants have recently been made from the fund. These were contributions to a conservation training grant, and to a travel grant to allow study of Tatar steel experimental smelts in Japan with the last Tatar-master.

## HMS CONFERENCE AND CALL FOR PAPERS - METALLURGY IN WARFARE: A SPUR TO INNOVATION AND DEVELOPMENT

SALISBURY, UK, 3<sup>RD</sup> - 5<sup>TH</sup> OCTOBER 2014

The 2014 annual conference is timed to coincide with commemorations of the outbreak of the First World War – “The Great War” of its generation. Salisbury has been chosen as the venue because of its convenient location for many military museums, two of them associated with weapons inconceivable without metals, the Bovington Tank Museum, and the Museum of Army Flying at Middle Wallop. Sunday 5th October will be available for Museum visits. Salisbury City Hall is itself a Memorial Hall for the Second World War.

The scope of the conference is not limited to any particular period. Although any relevant contribution will be considered, the organisers are particularly hoping for papers on the following themes:

- Developments in metallurgy arising from particular military needs
- Developments in weapons or military organisation arising from metallurgical innovation
- Developments in the organisation and management of metal/metal artefact production required as a result of urgent military demands

Offers of papers or posters are welcome on any of these themes.

The conference language will be English.

There will be facilities available for posters and time will be allocated for a poster session. The maximum size for posters is A0 (841 x 1189mm – upright/portrait format).

Abstracts for papers and posters should be submitted by 28th February 2014. Abstracts should be sent by e-mail to [HMSannualconf@hist-met.org](mailto:HMSannualconf@hist-met.org) in Word format and should be no longer than 250 words. Please include the name and affiliation of all authors and indicate the presenting author in bold letters.

Alternatively you can send abstracts by mail to:

Eddie Birch, 1 Fields End, Oxspring, Sheffield, S36 8WH

For more information please contact [mejbirch@aol.com](mailto:mejbirch@aol.com).

Booking forms will be available online <http://hist-met.org/meetings/annual-conference-2014-metallurgy-in-warfare.html> from early 2014.

## EMERGENCE OF LARGE SCALE COPPER PRODUCTION DURING THE EARLY BRONZE AGE IN SAINT-VÉLAN (FRANCE) AND IN PREHISPANIC NORTHERN CHILE: A COMPARATIVE RESEARCH PROGRAM

Recent research on the organisation of copper production tends to show that metallurgy has rarely developed on a simple and linear manner but rather along quite tortuous paths. A team of Chilean and French archaeologists, archaeometallurgists, and geologists are currently comparing different social and technological contexts surrounding the emergence and/or development of various copper metallurgies including domestic and large-scale types of productions. The latter are explored in both France during the Early Bronze Age and Northern Chile during Pre-Inca and Inca periods through a combination of field work, archaeometric investigation and metallurgical experimental simulation. The on-going work focuses on two Chilean mining and metallurgical areas, Miño and Ujina-Collahuasi, and on the Saint-Véran district in the French Alps. The French and the Chilean historical contexts are culturally independent, allowing us to conduct our studies according to a comparative method. The expected result of such an approach is to better understand and explain the different trajectories of development of metallurgy in the two regions.

Whereas a single model of copper extractive metallurgy has long been assigned to the Early Bronze Age Saint-Véran district, namely large-scale reduction of bornite thanks to very efficient smelting processes (Bourgarit et al, 2010), current fieldwork and slag investigation are putting into light a much less mature metallurgy (Figures 1 and 2). This alternative technology has yet to be phased in order to determine its place in the metallurgical activity of the district.



Figure 1 Saint-Véran, Hautes-Alpes, France. View from the copper mine 'La Tranchée des Anciens'.

In the Upper Loa in Northern Chile, the intensive production system brought by the Inca largely relied on pre-existing widespread copper extractive metallurgies practiced at smaller scale (multipolar development of metallurgy, *sensu* Mille and Carozza 2009). Traditionally, it has been assumed that Inca conquest introduced important transformation in local metallurgical traditions, including new types of furnaces, emphasis on specific alloys and/or the manufacture of specific types of objects. Our ongoing research in the mining

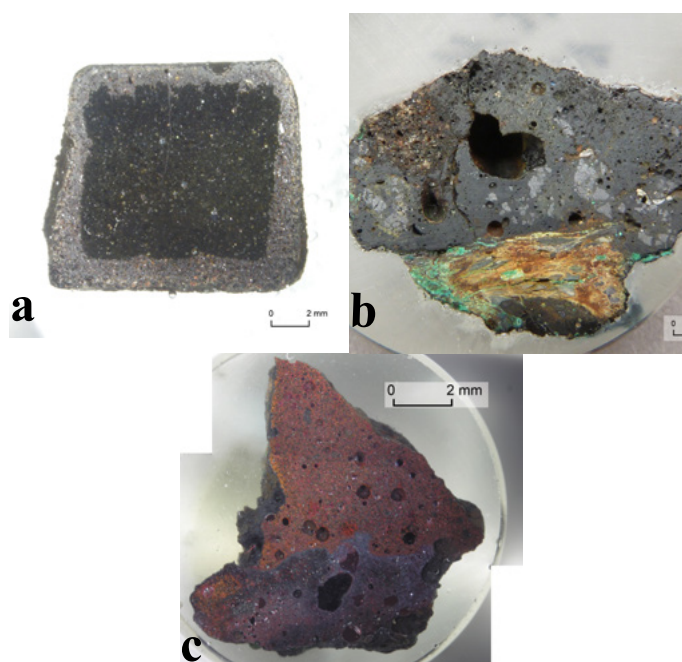


Figure 2 Comparison of EBA plate slags and undated conglomerate slags at Saint-Véran (a & b) with conglomerate slag at Miño (c); Dark-field optical Micrographs taken from polished sections.

and metallurgical districts of Miño and Ujina-Collahuasi seems to prove otherwise (figure 3). Even though there is an evident increase of production scale during the Inca period both in mining and metallurgical sites, this change appears to have been promoted more by a reorganisation of the activity — increase of human power, improvement of the mining settlements, development of transportation for both catering and production — rather than by any marked technological progress in smelting (Salazar et al, 2013a). Indeed, most local technological peculiarities are still to be seen during the Inca period, as exemplified by two aspects. First, conglomerate-like copper slags are produced in both Pre-Inca Miño and at Ujina-Collahuasi during the Inca period, thus pointing so far to few if any improvement of the copper smelting technology (figure 2). Second, at Ujina-Collahuasi, very peculiar large stone furnaces, which had not been reported previously in other metallurgical sites in the Andes, have been brought into light for both Pre-Inca and Inca periods (figure 4). These smelting reactors, always located on the top of small hills, are powered by wind, taking advantage of a strong airstream which has been proved by the local meteorological records to be very steady in both intensity and direction.

Although the research program is at its very beginning, several preliminary observations may already be pointed out. Interestingly, the Chilean case offers another nice example of multipolar emergence of metallurgy. This adds to the former proposition stated for Languedoc, France at the end of the 3rd mill. BC (Mille and Carozza 2009). Moreover, it enlightens how determinant efficient supplying system and mobilisation of manpower may be for the rise of a large-scale copper production in hostile environments. This may





Figure 3 View from the modern Rosario mine at Collahuasi, Chile.

offer new avenues of research at Saint-Véran where the working organisation underlying the Early Bronze Age copper massive production is not yet fully understood. Regarding technology, the exact role of the efficiency of the smelting process in the change of production scale has to be examined as well. In Northern Chile, the apparent absence of any clear technological improvement needs further investigation. At Saint-Véran a “Bronze-Age” technological revolution has clearly occurred, although the two types of metallurgies recognized so far, namely the non-slugging and the very efficient slugging process have still to be phased chronologically in relation to each other. Finally, the very question of the copper ore destination needs to be addressed. For example, in Prehispanic Northern Chile copper seems to have been traded more as an ore than as a metal. The huge disequilibrium between the mining production at the Tranchée des Anciens and the smelting activity obliges to reconsider this aspect at Saint-Véran as well.



Figure 4a Large stone wind-powered furnace at Ujina 8 (bench-shape type).

Despite the fact that considerably more fieldwork has been done in Europe, our understanding of ancient metallurgy in the Prehispanic Andes is more advanced than for the European Alpine Bronze Age. This is obviously related to both a better conservation of the Chilean sites and to the availability of ethnohistorical sources. Moreover social, political and economical contexts so far have been much more taken into consideration in South-America than in Europe in order to study the historical development of metal production. These may also be future prospects of research.



Figure 4b Reconstruction of an Ujina-Collahuasi bench-shape furnace for a smelting experiment; a 40 km/h<sup>-1</sup> wind was produced with an industrial fan.

At least, one parameter of paramount importance should be systematically recorded during fieldwork on prehistoric metallurgical workshops: the scale of production. And this variable should be addressed not only from the archaeometallurgical remains alone, but from the overall archaeological context where these are situated (Salazar et al., 2013b).

*Benoit Mille, Diego Salazar, David Bourgarit, Valentina Figueroa, Catherine Perlès, José Berenguer, Laurent Carozza, Paulina Corrales, Florian Balestro, Pierre Rostan, and Albane Burens-Carozza*

## Acknowledgments

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## References

- Bourgarit, D., P. Rostan, L. Carozza, B. Mille and G. Artioli. 2010. Vingt ans de recherches à Saint-Véran, Hautes Alpes: état des connaissances de l'activité de production de cuivre à l'âge du Bronze ancien. *Trabajos de Prehistoria*, 67(2), 269-285.
- Mille, B. and Carozza, L. 2009. Moving into the Metal Ages: The Social Importance of Metal at the End of the Neolithic period in France. in: Kienlin, T. L. & Roberts, B. W. (eds.), *Metals and Society, studies in honour of Barbara S. Ottaway*. Bonn: Habelt, 143-171.
- Salazar, D., Berenguer, J. & Vega, G. 2013a, Paisajes minero-metalúrgicos incaicos en Atacama y el Altiplano Sur de Tarapacá. *Chungara*, 45(1): 83-103.
- Salazar, D., Borie, C. & Oñate, C. 2013b, Mining, commensal politics and ritual under Inka rule in Atacama, northern Chile, in: K. Vaughn, K. & Tripevich, N. (eds.): *Mining and quarrying in the ancient Andes: sociopolitical, economic and symbolic dimension*. Springer, 253-274.



## DAVID BOURGARIT

Most regular members of the HMS will instantly recognise our french colleague David Bourgarit who has been an active participant to so many of the society's meetings. His interest in archaeometallurgy is one which he developed out of his studies in material sciences, a foundation which has allowed him to explore in depth the physical and chemical behaviour of metals. He has published extensively on topics such as brass cementation, experimental methodologies, and Chalcolithic copper smelting.

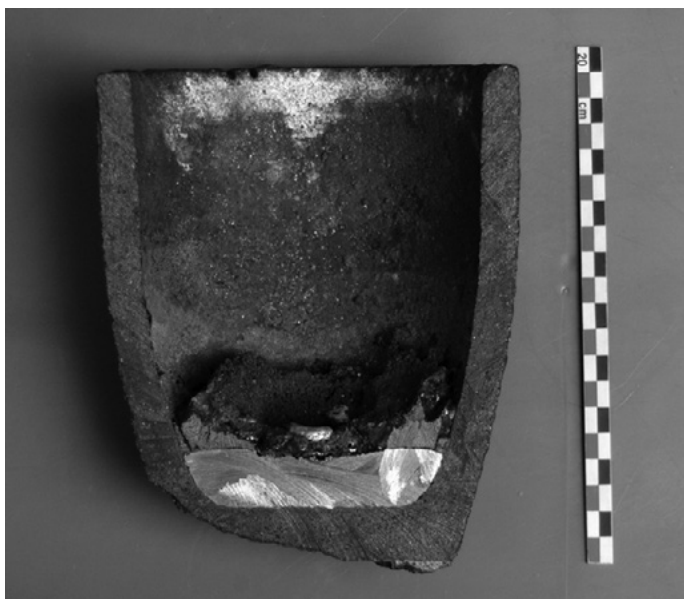
David's background is in physics and more specifically in materials science (Master Degree at the Ecole Nationale Supérieure de Physique de Grenoble, France and Master training at the Ecole Polytechnique de Montréal). He specialised in physical metallurgy during his PhD at the Université Paris XI and at the Commissariat à l'Energie Atomique of Saclay, studying the microstructure, texture and fracture toughness relationships at cryogenic temperatures for a titanium alloy incorporated into a turbo engine of the rocket Ariane 5. This rocket belongs now to history, as do most of the metallic objects he has been studying from then on as head of the Metal Group at the Centre de Recherche et de Restauration des Musées de France at Paris.

He joins our illustrious group of one-minute interviewees by adding a touch of his typical wit and aplomb.

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

**DAVID BOURGARIT:** My first contact with metallurgy was with a titanium alloy, studying the relationships between microstructure, texture and cryogenic fracture toughness (for the Ariane rocket, my PhD). My first job was at the metal group of the Centre de Recherche et de Restauration des Musées de France, in 1996... and I am still there. I have had the chance to work on quite a variety of metallurgical topics since then. Belonging to a public institution devoted to all the 1209 so-called French Museums, I have been examining artefacts from almost all periods and regions, including the sword of Napoleon and 19th c French aluminium jewellery. As far as research is concerned, I have always been studying copper metallurgy. I started with early copper extractive metallurgy, and I am still in it. I also turned to medieval European metallurgy and especially brass cementation process. More recently, I started studying the techniques of modern bronze statuary after an incursion some years ago into the field of Khmer bronzes. My passion is in metallurgical processes, and I particularly appreciate the experimental simulation route. One reason probably why we succeeded in setting up, in the very middle of the Louvre, a platform where several high temperatures furnaces are running, sometimes night and day: might have changed the smile of Mona Lisa...





*One of David's experimental brass cementation crucibles certainly is something to smile at.*

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

**DAVID BOURGARIT:** Chile, altiplano, 4500m altitude, tens of wind-powered furnaces with corresponding slags, in a perfect state of conservation, as if the craftsmen just left them for a couple of days (probably to attend the HMS annual meeting).

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

**DAVID BOURGARIT:** Benoit Mille, C2RMF, because he is simply the best.

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

**DAVID BOURGARIT:** I am actually involved in three main projects. The protohistoric copper extractive metallurgy project is continuing at Saint-Véran, French Alps, with strong connections with pre-hispanic Chile. Medieval European copper metallurgy including the Mosan Valley project with Nicolas Thomas and the SPW is extending towards the Islamic world. Finally, the manufacturing techniques of modern French bronzes statuary are keeping me quite busy these days. Moving from desert highlands to luxurious Palaces...

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

**DAVID BOURGARIT:** I would like a whole district of bronze foundries to be excavated in the very centre of Paris (not only in order to tease the Parisian car drivers and thus discover a handful of new poetic French expressions). According to the archives, the zone around rue Saint Denis seems quite promising, notably for the 16th century bronze production. With the remaining money (multi-billion project?), a nice experimental

platform would be set up at the premises of a friendly University devoted entirely to archaeometallurgy, and ancient gastronomy. There, the newly born French Historical Metallurgy Society would be hosted. I am afraid we would have to launch a competing newsletter then: "Le Chaudron".

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

**DAVID BOURGARIT:** Although not specifically devoted to archaeometallurgy, "La psychanalyse du feu" by Gaston Bachelard reminds you how subjectivity and dreams may control technological choices, and how subjectivity and dreams influence our perception of these choices. Ok, Gaston may sometimes exaggerate with sex, but I definitely adore his philosophy: "C'est dans la joie et non dans la peine que l'homme a trouvé son esprit". A nice book to read near a fire camp after a whole day spent in trying to get a few grams of copper out of several kilograms of chalcopyrite.

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

**DAVID BOURGARIT:** Three tips:

1) Stay young, that is, open-minded: information is often where you do not expect it to be, including modern technical treatises and engineering reports. In this respect I agree with what David Killick said in the spring issue regarding specialisation: archaeometallurgy requires quite a broad vision...but isn't it the case for any scientific field?

2) Stay young, that is, critical towards what the "ancients" have written so far on your subject (especially those who are interviewed in "**The Crucible**").

3) Stay young, that is, never accept to answer the so-called 60 second interview for **The Crucible**, it takes much more than 60 seconds!

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

**DAVID BOURGARIT:** Archaeometallurgy is great, but they already know that.

## 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).*

## PETER KING

I was appointed as Treasurer at the 2013 AGM last June. I have been a member of HMS for about 30 years and was in my second period as an ordinary member of Council. My first degree was in chemistry, after which I practised as a solicitor in Stourbridge for some years. The bookkeeping, included in my training as a solicitor, has proved valuable in enabling me to keep accounts for various organisations. My interest in the iron industry grew out of the study of local history and local field archaeology. My grounding in land law enabled me to use old title deeds to undertake a tenement reconstruction for two parishes near where he was living.

The series of forges and slitting mills along the Worcestershire Stour, which flowed past the garden of my parents' home in Kinver, led me into work on the iron industry. This in turn led to me studying the history of the blast furnaces that supplied those forges; and then to forges and other ironworks elsewhere; ultimately nationally. I thus assembled a series of histories (still largely unpublished) of every furnace, finery forge, and other ironworks in Britain, apart from the Weald where the subject has been covered by others. The research took me all over England and Wales. It is quicker to count the number of record offices that I did not visit while doing this research than those I did. This provided the data which I then used in my doctoral thesis. This contained a large scale interpolation exercise to produce an estimate of how much iron was made in Britain in the period 1500-1815, which has been the main period I have studied. By adding figures on the import and export of iron, I was then able to estimate the consumption of iron in England and Wales. This and work on the accounts for Coalbrookdale ironworks for 1718-38 to calculate the costs of this early coke ironworks formed major elements of the thesis, *The iron trade in England and Wales 1500-1815: the charcoal iron industry and its transition to coke* (deposited with Archaeological Data Service: search for "Peter Wickham King").

I have written nearly 40 substantial articles (published or forthcoming) at various academic levels, apart from a number of smaller articles and notes. About half are directly concerned with iron and steel and most of the rest with other industry or with transport, both usually in the period of his interest in the iron industry. This has included two in *Economic History Review*, one covering his production estimates and the other the production costs at Coalbrookdale. Articles in *Historical Metallurgy* have dealt with early to mid-18th century statistical lists; Dud Dudley; the north Worcestershire scythe industry; and recently 'Iron in 1790', dealing with another ironworks list and providing its context in a period of technological transition. I wrote about the management of the Foley ironworks business from the 1660s to the



1730s in *Accounting, Business, and Financial History* (now *Accounting History Review*), but I do not expect to return to accounting history. Several other articles deal with particular ironworks or groups of them, including the Vale Royal Company in Cheshire; Ashburnham Furnace in Sussex; Grange Furnace near Wolverhampton; the Tern Company in Shropshire; and Frizington in Cumberland (forthcoming).

More locally to where I live, I have written about the Black Country coal industry; Andrew Yarranton, who made the river Stour navigable (but only briefly); water mills on that river; Sir Clement Clerke, who was involved in the early use of coal in smelting lead, copper and iron; and early railways in the Severn Gorge; and two near Stourbridge (forthcoming). A few of my articles are concerned with various local history subjects, largely unrelated to metallurgy, deriving from his original interest in local history in the area where I live. I am currently working on an article on charcoal (using production data from my thesis) and on quantifying iron and steel production 1860-86. These were the subject of papers at the Society's two most recent meetings.

I have a wide range of other interests. I am less active in my local church than I once was. I am a vice-chairman of the Worcestershire Branch of the Campaign to Protect Rural England and a parish councillor. In both capacities, my main concern is with the planning system: objecting to planning applications and to the strategic plans against which they are judged. This can be quite time-consuming, particularly when it comes to opposing strategic plans or large planning applications. At times I find that this voluntary work takes me away from doing the history that is my main love. I am also treasurer of Birmingham and Warwickshire Archaeological Society and the Midland Mills Group, as well as involved in running two small evangelical charities.





## THE BEGINNING OF THE USE OF METALS AND ALLOYS VIII

NARA, JAPAN, 11<sup>TH</sup> - 15<sup>TH</sup> SEPTEMBER 2013

The 8th International Conference of the Beginning of the Use of Metals and Alloys (BUMA8) was held in Nara, a quiet, beautiful ancient capital city of Japan. BUMA was founded in 1981 by two eminent archaeometallurgists, Professor Tsun Ko from the University of Science and Technology of Beijing (USTB) and Professor Robert Maddin from the University of Philadelphia with focus on the metallurgy of Asia and the Pacific rim region. The previous BUMA conferences were held in Zhengzhou, China (1986), Sanmenxia, China (1992), Matsue, Japan (1998), Gyeongju, Korea (2002), Beijing, China (2006) and Bangalore, India. Nowadays, BUMA has become much more international and involves archaeometallurgical studies all over the world.

BUMA8 was a tremendous success with over 100 scientists, engineers, archaeologists and historians from Asian (Japan, China, India, Korea, Thailand) and non-Asian countries (UK, USA, Germany, France, Italy, Spain, Russia, Hungary, Serbia, Norway, Australia and Egypt). The theme of BUMA8 was “Cultural Interaction and the Use of Metals”.

The conference was opened by the welcome address of Kazuhiro Nagata and Srinivasa Ranganathan. During the three days of the conference, there were 12 sessions of about 60 oral presentations. The themes of these sessions included early metal interaction, ancient copper and bronze, iron production in various regions, iron sand smelting and refining, non-ferrous metals, silver and gold, alloys (including bronze) and speiss, iron artefacts, bronze technology and conservation, and new technology of archaeometallurgy. Between sessions, participants had time to enjoy 50 poster presentations

covering a wide range of topics. Every poster presenter also had three minutes to introduce their research on stage. Three poster awards were given to Marcos Martín-Torres, Miljana Radivojević (both from UCL Institute of Archaeology, UK), and Takahiro Ozaki from Bureau of Education, Niigata Prefecture, Japan.

One of the hottest issues at this conference was on the origins of copper smelting technology in Eurasia which followed by the development of manufacturing technology of early bronze artefacts and the cultural interaction between China and Central Asia demonstrated by these artefacts. Evgenij N. Chernykh from the Institute of Archaeology, Russian Academy of Sciences, summarised the five stages of Bronze Age metallurgy in Eurasia (based on his concept of Metallurgical Provinces) and put forward a series of topics worth further study. Three scholars, Kathryn M. Linduff from the University of Pittsburgh, Mei Jianjun from USTB and Chen Jianli from Peking University discussed the manufacturing and use of early metal artefacts in China and its adjacent regions. These artefacts made with various materials and decorated with complex symbolic patterns illustrate the links between China and its northern and northwestern neighbours. Early metallurgy in China is likely to have been influenced by the Western traditions; however, it had rapidly established its own hallmarks such as piece-mould bronze casting and cast iron production. The development process took a different path from Central Asia and West Asia. Meanwhile, evidence of technological transmission from the east to the west, i.e. the widespread occurrence of bronze cauldrons and

cast iron tools in east Eurasia should not be overlooked. These speakers all expressed hope to further investigate the nature of early interaction of China with the Eurasian Steppe, Central Asia as well as West Asia and Europe.



*An excursion at a local swordsmith.*

A number of papers were related to bronze production in various regions. Liu Yu from Institute of Archaeology, Chinese Academy of Social Sciences, looked into the smelting and casting techniques of early bronze artefacts from the sites of Taosi, Xinzhai and Erlitou in the central plains, China (2300~1500 BC). Thomas Oliver Pryce introduced the Southeast Asian Lead Isotope Project carried out from 2008 to 2013. This project combined typological, technological, isotopic and elemental analyses of regional metal production and consumption assemblages, in an attempt to inform upon interactions between Southeast Asian populations of different levels and relations with South and East Asian social groups. He proposed that the circulation of copper as commodity money might explain some of the geochemical patterning. This paper was echoed by TzeHuey Chiou-Peng from University of Illinois Urbana-Champaign who interpreted the emergence of metallurgy in prehistoric Southeast Asia in the light of current archaeological data. Other papers talked about the bronze technology of two Harappan sites in Gujarat, India and another site in the Korean peninsula (~3rd century BC); the copper alloys with polychrome decoration from Roman Egypt and Japan; the production sites of bronze bell and iron kettle in ancient and medieval Japan; bronze sculpture casting site at Royal Palace workshop in Angkor, Cambodia (12~14th centuries AD); the technology of inlaid Eastern Zhou bronzes in the British Museum, etc.

A large portion of presentations was dedicated to iron production in various regions, including iron and steel artefacts. Several Japanese scholars reported new finds of iron smelting sites in different regions. Yasuyuki Murakami introduced the excavation of the 1st century BC-2nd century AD iron smelting furnaces

in the Minusinsk basin, south Siberia; the furnaces were round, rectangular or oval, and arranged in a line at equal intervals. Tomotaka Sasada presented the discovery of the iron smelting furnaces of the Nomadic Empire “Xiongnu” at Khustyn Bulag (dated to ~2000 BC). Besides the rectangular furnaces, calciner or roaster of iron ore, slag disposal pits, and tuyères were all found similar to those in south Siberia or Central Asia, rather than to those in China. Kazuo Miyamoto reported the discovery of an iron smelting furnace (6-7th century AD) at Galazong, Sichuan. This furnace was located in a pit connected to a tunnel used for natural draught. This type of furnace design had been unknown in the Central Plain of China and might have been spread from South Asia. Gill Juleff from the University of Exeter introduced the field survey of iron and crucible steel production sites in northern Telangana, India, and found two different traditions of crucible steel making using small, thin-walled crucibles and large, conical-lidded crucibles.



*Traditional opening of the conference by the chairs at the Nara National Museum*

An entire session was devoted to the research on Tatar furnace, a traditional Japanese iron and steel making technology using iron sand. The late Edo (1830-1860 AD) picture scroll shown by Yoshikazu Senoo illustrates the process. Another 11 talks and posters were dedicated to technological issues of Tatar furnaces. Two of them clarified why two different types of iron sand (Masa and Akome) produced high-carbon steel (Kura) and pig iron (Zuku) respectively, using analyses of iron sands and reduction tests. A series of experimental Tatar operations was carried out by Japanese scholars to understand the influence of various operation factors on smelting and refining of iron sand.

Thilo Rehren from UCL Qatar and his colleagues reported new findings about mankind’s earliest iron beads from an Egyptian tomb dated to about 3,000 BC. By using neutron-based non-invasive methods,



they found that the iron beads were made of meteoritic iron, which was first hammered and then rolled into tube. Bharat Dixit from the Indian Institute of Science studied the microstructure of a wootz steel blade made by a modern blacksmith in northern Telangana. Scholars from India, UK and Japan presented their researches on the forge welding technology of iron cannons in medieval Deccan forts, the differences of Japanese and European armours from the same period, and welding technology of steel sheets used for Kusazuri Armature in the Edo period.

A few papers were on other metals, such as gold, silver and zinc. Paul Craddock from the British Museum talked about the excavations and studies of silver-lead mining and smelting sites at Dariba and Agucha in Rajasthan, India. This was followed by Siran Liu, a PhD candidate from UCL, who analysed slag from gold and silver smelting sites at Baojia and Mengshan in Jiangxi province, China. Several Japanese scholars introduced the field survey, excavations and analyses of the famous Iwami Ginzan silver mines and the Sado gold-silver mines. Quansheng Huang from Guangxi Radio and TV University investigated several zinc smelting sites in south China and found over ten rectangular furnaces, three bowl-shaped furnaces, and a large quantity of retorts and slags. Wenli Zhou reported her PhD project finished at UCL last year on zinc smelting sites of the Ming and Qing Dynasties in Chongqing, southwest China.

More and more new techniques have been employed in archaeometallurgy. Kazuhisa Yoshimura from Kyushu University used the change of sulphate and magnesium concentrations of speleothems to record the sulfide ore smelting activities at Naganobori copper mine site and their influences to the environment. Takashi Minami from Kinki University determined the sources of vermilion used in Japanese burial mounds by measuring sulphur isotopes. A number of scholars attempted to use non-destructive techniques such as neutron diffraction, neutron imaging, X-ray absorption spectroscopy, synchrotron X-ray radiography and X-ray fluorescence and CT in the studies of ancient metal artefacts. Other techniques including remotely controlled robots, 3D laser scanner and computer simulation were also reported to be used in various types of archaeometallurgical research..

Following the three-day conference, there were two-day excursions to swordsmiths and the Museum, Archaeological Institute of Kashihara. In summary, one of the prominent characteristics of this conference was that most of the papers were not limited to analyses or experiments, but rather had international perspectives and historical viewpoints. Case studies from different regions and different periods are constantly enhancing

our understanding about issues surrounding the ancient metals and alloys. BUMA is becoming a key international gathering point for scholars across the world interested in metal production and consumption in early human societies. .

*Wenli Zhou and Yu Liu*

## HISTORY OF IRON & STEEL - To COMMEMORATE 25 YEARS OF RUSSULA

Sponsored by the Spanish based automation and water treatment specialists, Russula, 'A History of Iron & Steel – To Commemorate 25 years of Russula' contains 68 articles on the history of iron and steel selected from those published in Steel Times International over the past 10 years.

The hard-back book commences with a time-line outlining the history of Russula followed by the steel history articles. These are grouped into 'Personalities'; 'Regions'; 'Technology'; 'Warfare'; 'Civil Engineering'; 'Commemorative' and Archive. The latter includes book reviews and a review of the British Film Institute archive of steel related films.

Commemorative has two articles on postage stamps with the theme of iron or steelmaking, while Civil Engineering looks at the use of wrought or cast iron or steel in construction. Warfare covers guns and armour.

Technology is the largest section and covers the greatest time span from bloomery ironmaking to exhibits at the Chicago Exhibition of 1893.

Personalities is the second largest section which looks at some of the pioneers of iron and steel production.

Articles relate to many regions of the world and a section on 'Regions' includes those pages that focus on regional developments such as the first ironworks in Canada, the Iron Trail in Austria, Peter the Great's establishment of the iron industry in Russia and the late 19 century steel industry of USA.

'A History of Iron & Steel – To Commemorate 25 years of Russula' Edited by T G Smith Published by Quartz Business Media 76 pages Hardcopy Price £25-00 + P&P. Available from Steel Times International, Quartz Business Media, 20 Clarendon Road, Redhill, Surrey, RH1 1QX, UK.

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*Tim Smith*



*The River Don Engine, built by Davy Brothers of Sheffield (1905). Kelham Island Museum, Sheffield.*

## HMS ANNUAL CONFERENCE 100TH ANNIVERSARY OF STAINLESS STEEL

**19TH-20TH OCTOBER 2013, CUTLERS' HALL, SHEFFIELD.**

The magnificent Cutlers' Hall in Sheffield was the setting for our HMS Annual Conference. I cannot think of a more fitting location to celebrate the 100th anniversary of Stainless Steel than in the city of its birth. The conference was a reflection of the history of HMS and the story of stainless steel, its conception, its development, through to modern day industrial practices and contemporary uses of this dynamic material.

The delegates included a diverse mix from the worlds of industry, academia and amateur. This made for a multi-faceted perspective which was highly informative and thought provoking. The day began with an overview of the history of the Historical Metallurgy Society, which was given by two of the journal's editors, Justine Bayley and David Crossley. This presentation included a diverse collection of images which provided a fascinating look at how the society has progressed over its fifty years. This presentation served as a fitting introduction to an exciting

programme of talks to follow.

The day continued with a presentation by David Dulieu, the author of 'Stay Bright: A History of Stainless Steels in Britain'. This presentation provided a thorough introduction to Brearley and his discovery of stainless steel in 1913. The presentation provided an excellent overview of the early development of the stainless steel industry in Sheffield, as well as discussing some controversial moments within its history. This was followed by John Beeley of Outokumpu Stainless, who discussed the stainless steel industry 100 years on. He explained through various company mergers half a million tons of the metal is still being melted per annum.

After lunch we were invited to the Muniments Room. This gave us the opportunity to view a selection of historic knives, in particular the multi-bladed Norfolk Knife by Joseph Rodgers and Sons' Norfolk Street Works. This display consists of a comprehensive collection of 72



knives constructed in a Swiss army like form for the Great Exhibition of 1851. In addition, copies of '100 Years of Stainless Steel' were made available for purchase.

Joan Unwin took us through the history of the knife drawer, including an overview of the progression of the domestic knife set and the changes that are evident in the design of blade and handle type. She discussed how the stamping out of cutlery rather than the traditional assembly method changed the industry in the 1960s. She highlighted the fact that the local industry changed irrevocably due to the importation of less expensive metal from developing countries. This was followed by an informative discussion by Peter King who gave an in-depth analysis of the statistics of the iron and steel industry 1860-1886.

really is a thrilling experience. The visit was topped off by viewing the River Don Engine fully operational, complete with reverse gear change at full speed (this is worth the journey alone).

On a final note, HMS would like to take this opportunity to thank all delegates for participating in what was a thoroughly enjoyable weekend. In particular the society owes a great debt of gratitude to Ellie Blakelock for producing yet another first class meeting. A special thanks should also be noted to Joan Unwin for her contribution throughout the day.

*Vanessa Castagnino*



*Bessemer Converter at the gates of Kelham Island Museum. In use until 1975 and one of only three now left in the world.*

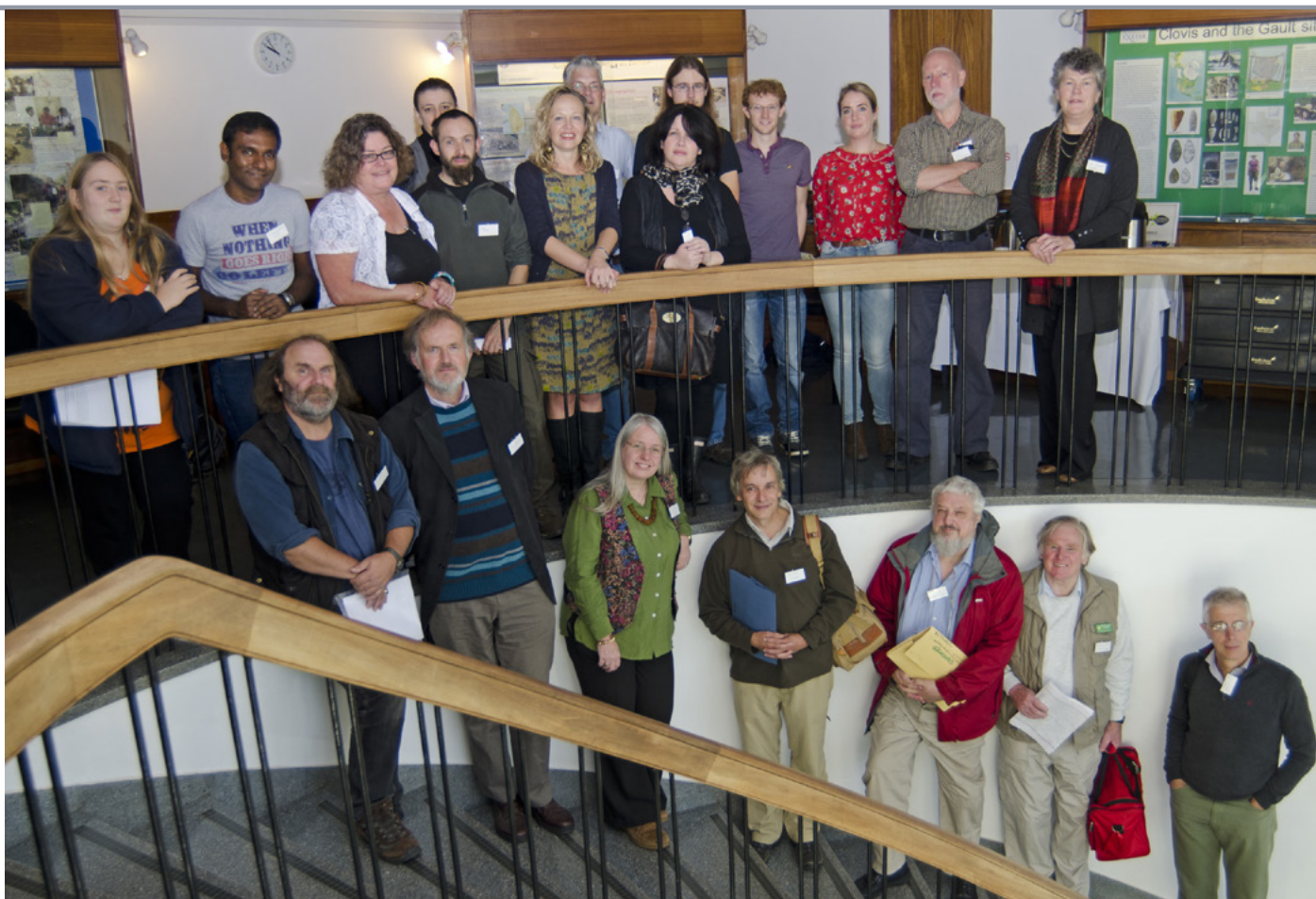
After refreshments the afternoon session began with a presentation by Mick Steeper and Jonathan Aylen on rolling mills and their development from the steam-powered (the Rive Don engine being a prime example), to electricity and finally to the modern computer mechanised. The paper ended with an overview of today's metal-forming industry and the effects on Sheffield.

The day ended with a stimulating paper from Robert Booth, a sculptor in stainless steel and an avid performance caster. The paper displayed his work (<http://www.robertbooth.co.uk>) and showed the aesthetic beauty of the material rather than focusing purely on its functional use.

An interesting and informative weekend culminated in a field trip to the Kelham Museum on the banks of the River Don on Sunday morning. For the first time visitor this

## BRIAN BASTOW

We are very sorry to report the death of Brian Bastow on the 7th November. Brian Bastow was a member of HMS for over 30 years and a regular and enthusiastic participant in the annual conference. A full obituary notice will be found in the next edition of **The Crucible**.



## HMS RESEARCH IN PROGRESS 2013

10<sup>TH</sup> OCTOBER 2013, EXETER, UK

After an early start I arrived at Exeter University for the research in progress meeting. These meetings provide an excellent platform for a range of speakers including academics, students and professionals as well as groups or individuals with an interest in historical metallurgy. As usual the talks offered a fantastic overview of various research projects currently taking place. The range of approaches taken was also particularly interesting, with presentations of experimental studies, instrumental analyses, historical economic based work and academic research in different combinations.

The meeting started with the student presentations, which as usual were excellent and made it very difficult for the HMS council members present to choose a winner for the student prize. This year Giovanna Fregni was awarded the prize for her presentation on the 'minimum tools required: a system for organising Bronze Age metal-smithing tools'. Through the creation of a detailed catalogue of Bronze Age tools she was able to understand the processes taking place, identify the potential activities being carried out by owners of hoards and even suggest tools that are missing or may have been misinterpreted.

Tathagata Neogi's presentation and research focuses on the people and society behind iron working in India, and this has revealed much about the nature of iron-working in the community and its relationship to those involved, the techniques used, trade

and religion. Brice Girbal, also working in India, is investigating Wootz steel production, he intends to not only visually assess the material collected but also to carry out scientific analysis to investigate the raw materials used and processes involved.

The presentation by Angela Wickenden provided a possible use for tin mine waste, new and old, in the production of ceramic vessels. Steffan Klemenec carried out a number of experiments to replicate the rivet holes found on the tangs of bronze swords. David Budd presented joint research with Kathryn Bonnet looking at the manufacture in the hope that this would reveal the possible use of the rather strange billhook's found in cemetery contexts. The results from this study, while shedding light on the construction methods, still have not revealed a use for the tool, which is still a mystery.

After the student presentations, Tom Greeves introduced us to the site of Upper Merrivale Tin Mill where a series of excavations have taken place 1991-1996. The slag has been analysed but there are a number of soil samples still waiting to be analysed to reveal more about the efficacy of the process and changes through time. If anyone is interested in taking this up as a potential topic please contact Tom ([tomgreeves@btconnect.com](mailto:tomgreeves@btconnect.com)). A presentation by Roger Hutchins questioned the use of long reaves on Dartmoor as early boundaries, and provided both map and photographic evidence to suggest that they connected



various mines and trading points, and could therefore have acted as track ways to transport ore from the mines, possibly using pack animals.

Steve Grudgings gave two interesting presentations on the iron and steel used to build the Newcomen engine, and also specifically on the manufacture of the early boilers. Chris McKay introduced us to the turret clock in the church of St Cuthberga, Wimborne Minster and the speculative amounts of iron, brass and wire required to manufacture it.



*Giovanna Fregni the best student presentation prize from Tim Young.*

The analysis of the archaeometallurgical residues from the Ynysfach ironworks was presented by Tim Young; this included research on the refining process slag which revealed that it had an important de-phosphorisation effect in addition to de-siliconisation, thus increasing our knowledge of the refining process. Neil Philips reported on the new research and excavations carried out at the early Angidy works. This has revealed another large building with a 6m wheel pit and the ghost of a battery frame, all of which are not on the 1763 map. Finally Peter King gave a detailed presentation on the charcoal consumption in the iron industry in England and Wales.

All in all, Tathagata Neogi and Brice Girbal organised and hosted an excellent Research in Progress meeting at the University of Exeter, under the watchful eye of Gill Juleff. I am looking forward to the next research in progress meeting to be held in Oxford.

*Eleanor Blakelock*

## SIR HENRY BESSEMER

To celebrate the year of the bi-centenary of the birth of Henry Bessemer the Herne Hill Society – the area of Southwark, London where Sir Henry lived when he moved to London – has reissued an updated version of a booklet by Patricia Jenkyns first published in 1984.

The 52 page A3 size publication, with additional illustrations, contains 46 photographs and drawings and paints a picture of Bessemer's life and achievements starting with his early childhood with his parents in the

village of Charlton, Hertfordshire, England where he spent time in his father's foundry, entering the business at the age of 15. At 17, he moved with his parents to Clerkenwell in London where his father re-established his foundry business.

Henry's first display of inventiveness was to make casts of natural objects such as flowers in white metal which he electroplated with copper. The book describes how at the age of 20 he invented an embossing process to prevent the fraudulent use of stamps on official documents, which was adopted by the government Stamp Office, who refused to pay for the invention which had not been patented. After that, Bessemer patented 117 inventions – with the exception of his greatest money spinner – the production of 'gold' paint from ground brass foil. Other inventions described are for the pressing of sugar cane, a process to cast sheet glass between rollers and the development of a more accurate projectile fired from cannon. It was this latter which led to his research into producing steel, more suitable for manufacturing cannon than the cast iron then used.

Of his 117 patents, 65 relate to iron and steel production. This is reflected in the fact that eight pages of the book are devoted to his development of pneumatic steelmaking and the problems associated with that.

Nine pages of the book are devoted to his estate in London, in Denmark Hill, where he moved to in 1863 from Baxter House – his previous London location and where he had his workshop. He eventually extended the Denmark Hill estate to 40 acres (16 hectares) and improved the existing house, renaming it 'Bessemer House', adding a pavilion and observatory, a model farm and landscaping the grounds. Sadly, none of these improvements survive, having been demolished in 1947 to make way for housing, the only evidence now remaining being a single oak tree in the grounds of Bessemer Grange Primary School.

The only criticism of the book is in the final paragraph which states that only one works in England was still operating a Bessemer converter in 1920, and that the process finished on the Continent in the 1950s. In fact, in England, the last Bessemer blow took place in July 1974 at Workington, Cumbria, and on the Continent, the basic (Thomas) Bessemer survived in west Germany until 1977 and to 1981 in East Germany as well as in South Africa, Brazil, Argentina and India.

'The Story of Henry Bessemer' by Patricia M Jenkyns 2nd Ed 2013 Published by The Herne Hill Society ISBN 978 1 873520 95 6.

Price £5.00 plus post & packaging £1.50 (UK), £3.50 (Europe); £4.50 (RoW).

*Tim Smith*

# FORTHCOMING EVENTS

Conference, Date and Location	Description	Website, Email and Prices
<b>8th Experimental Archaeology Conference</b> 10 <sup>th</sup> -11 <sup>th</sup> January 2014 Oxford, UK	While the conference broadly cover experimental archaeology in all its forms, it typically includes several several papers on metallurgy which may be of interest to many of our readers.	<a href="http://experimentalarchaeology.org.uk">http://experimentalarchaeology.org.uk</a> £35-55
<b>HMS Spring Meeting - Irish Iron</b> 12 <sup>th</sup> -13 <sup>th</sup> April 2014 Blarney, Ireland	The spring meeting of the Historical Metallurgy Society aims to offer a new experience its members by locating it in County Cork, Ireland. The meeting will entail a series of visits to several blast furnace sites, an exhibition of early Irish ironworking finds and as well as a series of talks on the subject.	<a href="http://hist-met.org/meetings/spring-meeting-irish-iron.html">http://hist-met.org/meetings/spring-meeting-irish-iron.html</a> <a href="mailto:prondelez@yahoo.com">prondelez@yahoo.com</a> £130
<b>Medieval copper, bronze and brass - 2014</b> 15 <sup>th</sup> -17 <sup>th</sup> May 2014 Dinant and Namur, Belgium	History, archaeology and archaeometry of the production of brass, bronze and other copper alloy objects in medieval Europe (12 <sup>th</sup> -16 <sup>th</sup> centuries). The aim of this conference is to present current knowledge of not only the medieval products, techniques, workshops and labour force, but also of the market and trade in these products. This symposium will present the research carried out in history and archaeology of materials and processes with, in some cases, the support of scientific studies.	<a href="http://www.laitonmosan.org/">http://www.laitonmosan.org/</a> <a href="mailto:laiton.mosan@gmail.com">laiton.mosan@gmail.com</a>
<b>International Symposium on Archaeometry (ISA)</b> 19 <sup>th</sup> -23 <sup>rd</sup> May 2014 Los Angeles, USA	The ISA will bring together internationally renowned archaeological scientists and archaeologists with museum professionals, conservation scientists, policy-makers, representatives from non-governmental organizations and industry, natural scientists and engineers to discuss new findings, innovations in technology and scientific research, and address current and global challenges in archaeology and cultural property ranging from the looting and illicit trafficking of antiquities to the archaeology of transitional periods.	<a href="http://www.archaeometry2014.com/">http://www.archaeometry2014.com/</a> Early Bird (before Feb 1st): \$320; Student: \$160.
<b>HMS conference and AGM - Metals used in personal adornment</b> 31 <sup>st</sup> May - 1 <sup>st</sup> June 2014 Birmingham, UK	This year's HMS conference will offer members an opportunity to exchange ideas and thoughts on the topic of jewelry and the role of metals and technology in its production through the ages. Topics will cover all time periods, locations, and cultures.	<a href="http://hist-met.org/meetings/personal-adornment.html">http://hist-met.org/meetings/personal-adornment.html</a> <a href="mailto:HMSagmconf@hist-met.org">HMSagmconf@hist-met.org</a>
<b>First International Conference on Early Mainline Railways</b> 19 <sup>th</sup> -22 <sup>nd</sup> June 2014 Caernarfon, UK	The Conference will cover the pioneering period of the public main line railway, up to the establishment of a regular network of routes with agreed or amalgamated running rights. (this period extends from the opening of the Liverpool & Manchester Railway in 1830 to the major consolidation of companies which had taken place by about 1870; start/end dates will differ for other countries). The emphasis of the event will be on the formation, cultural impact and effects (financial, social, technical, etc.) of the early main lines in all their aspects.	<a href="http://www.rchs.org.uk/early.main.line.railways@gmail.com">http://www.rchs.org.uk/early.main.line.railways@gmail.com</a>
<b>HMS Conference - Metallurgy in warfare: A spur to innovation and development</b> 3 <sup>rd</sup> -5 <sup>th</sup> October 2014 Salisbury, UK	The scope of the HMS autumn conference encompasses the various roles that metals have taken in warfare through the ages. Although papers on any topic is welcome, the main themes are: the development of metallurgy arising from military needs, the developments in military organising arising from metallurgical innovation, and the developments in metal and metal artefact production arising from the urgencies of war.	<a href="http://hist-met.org/meetings/annual-conference-2014-metallurgy-in-warfare.html">http://hist-met.org/meetings/annual-conference-2014-metallurgy-in-warfare.html</a> <a href="mailto:mejbirch@aol.com">mejbirch@aol.com</a>



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