THE CRUCIBLE

Historical Metallurgy Society News

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Copper/cuprite prill from 7000-year-old copper slag from Serbia

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

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Inside The Crucible

The HISTORICAL METALLURGY Society

Editorial

If everything has gone to plan, you should have received this copy of The Crucible in full colour. This is a positive change, not least to make up for the disappointing print quality of the last issue. The change is particularly timely, as it allows us to appreciate some of the colour, heat and flames (if not the beat of the drums) of the copper smelting experiments reported by Miljana Radivojevic in A Letter from Serbia. Her article reports a series of tests aimed at replicating the evidence for Europe's earliest metallurgy, which managed an excellent balance between scientific experimentation and public engagement.

The protagonist of our One Minute Interview is also firmly grounded on experimental archaeometallurgy. Peter Crew reminisces about his thirty years working nominally as the archaeologist at the Snowdonia National Park in Wales, effectively as an archaeometallurgist of iron that seamlessly combined field archaeology, experiments and scientific data obtained through a wide network of collaborators and friends. Peter's experience at smelting and smithing iron, gained over numerous experimental campaigns, has enlightened our understanding of the evolution of bloomery technology and provided plenty of reference material for subsequent studies. In addition, crucially, many of us had our first, unforgettable experience of a hot furnace because we had the opportunity of joining him for one of his famous 'XP'.

One of the many highlights of Peter's interview has to be his final message: "Iron rules, ok?". This is a message that Tim Smith is likely to agree with, even if he is interested in much more recent forms of ironmaking. Responding to an article published in the previous issue of The Crucible, Tim has meticulously compiled a list with as many as 23 extant Bessemer Converters around the world. Please let him – and us – know if we can make the list grow even further! Also on the industrial iron front, Paul Vigor outlines his admittedly 'unorthodox' approach to the Bedlam Furnace. As usual, we will be looking forward to reading any reactions.

The HMS Council member on the spotlight this week is also famously fond of iron, even though she has recently expanded her interests to cover noble metals too. Eleanor Blakelock shares with us some of her experiences as the youngest (and certainly one of the most energetic) members of the Council, and as the person who often makes our wishes come together, typically in the form of conferences. Once again, she invites all, young and old, to get more actively involved in the running of our HMS. We certainly echo her call.

As we keep growing internationally, we would also like to invite HMS members around the world to organise events in partnership with the Society. No matter where you are, this can be a way of obtaining some support for your event, while also helping share news about HMS. If this seems like something you might be interested in, please get in touch.

The Editorial Team

Copper smelting in Serbia using ceramic tipped blow pipes.

A COMPILATION OF KNOWN BESSEMER CONVERTERS

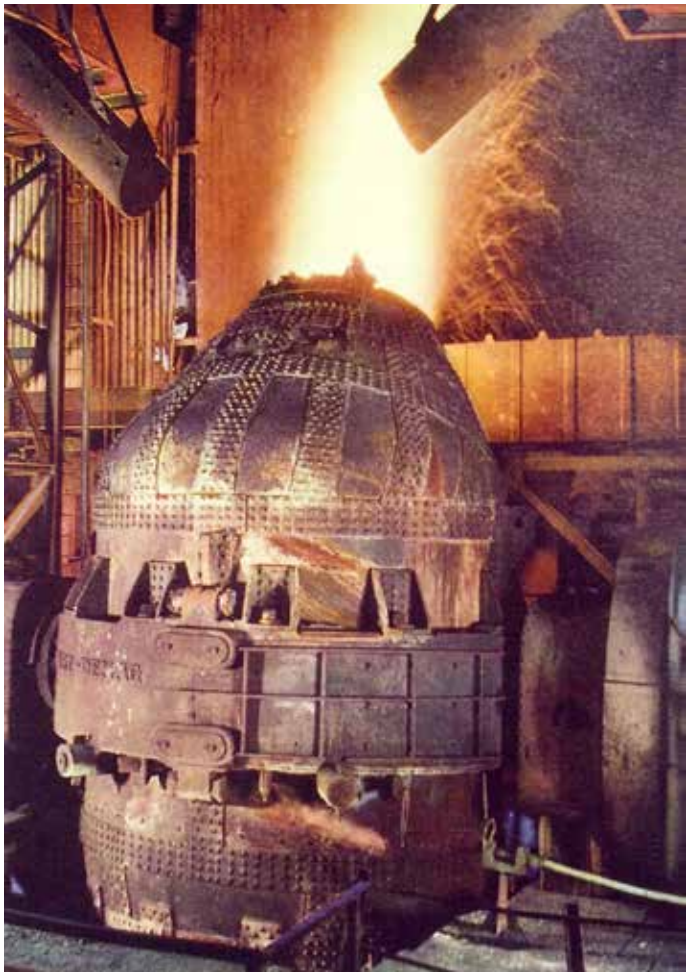
The caption on page 17 of the winter 2013 issue of The Crucible (No 84) sent a shudder through my heart when I read that the Bessemer converter illustrated was '[…] one of only three now left in the world'.

Fortunately this statement is far from correct and arose from an error on the Kelham Island Museum website (since corrected) which made this claim – and also had the date of the last blow of the converter illustrated incorrect – the correct date was July 1974, at Workington, Cumbria.

This prompted me, however, to draw up a list of preserved Bessemer (and Thomas or Basic Bessemer) converters around the world. The total so far comes to 23; ten in Sweden, seven in Germany, three in UK (including Bessemer's pilot converter and Gilchrist Thomas' experimental vessel), and one each in Austria, USA and Canada.

I include details of each below – and if you know of others, or further details of those below, please inform me by e-mail at tjsmith560@btinternet.com.

The Västanfors bruk Bessemer converter currently in Fagwersta, Sweden.



A Bessemer converter during the blow. Picture courtesy Kelham Island Museum.

Sadly, not all preserved converters have survived, a notable loss being the 25t unit at Iscor's Pretoria works in South Africa which had proudly adorned the entrance but was scrapped when the works closed in the 1990s.

The Bessemer process survived until 1981 in South Africa, Brazil, Argentina, India and DR Germany, but although a total of 12.8Mt of Bessemer steel was made that year it accounted for only 0.2% of world production.

Bessemer steel production peaked in UK as early as 1900 when 1.1Mt were produced. In Germany, peak production was reached much later in 1960 when 12Mt was produced; the final blow was in 1977. Here, the Basic Bessemer or Thomas process dominated due to the use of high phosphorus iron. In the USA the peak of production was in 1906 when over 12Mt of Bessemer steel was made representing 55% of total output; production ended in the early 1960s. In the USA, Carnegie bought up the patent to the Thomas process to prevent it competing with the Acid Bessemers that he was using.

The Siemens Martin Open Hearth furnace was the main competitor to the Bessemer until the early 1950s when the basic oxygen converter (BOF) process was introduced. Open Hearth steelmaking dominated world production until 1970 after which the BOF took the lead.

Today, a small amount of open hearth steel is still made, totalling 16.9Mt in 2012, but representing only 1.1% of world steel production. Most of this is made in Ukraine, Russia and India, but it is a modified form to the original Siemens Martin concept using twin hearths and oxygen lance blowing. In each of these countries it is being phased out.

I know of only one preserved Open Hearth furnace, a small 8 ton unit at Munkfors in Sweden. In the USA, at the site of Carnegie's Homestead works near Pittsburgh, an impressive row of OH chimneys has been preserved on the site of what is now a shopping mal.

If you know of others, please let me know.

Tim Smith

Bessemer located at the Henrichshütte Bessemer works in Hattingen, Germany. It belonged to the Eisenwerke Rödinghausen compary.

Present Location	Former Company	Ceased Operation	Nom Heat Size
Sweden: Information supplied by Yngve Axelsson of Jernkontoret			
Svartnäs	Stora Kopparbergs Bergslag	1875	?
Västanfors	Västanfors bruk	1897	2.5 ton
Tekniska museet, Stockholm	Västanfors bruk	1897	2.5 ton
Långshyttan	Långshyttan	1931	4 ton
Iggesund (2 converters)	Iggesund bruk	1944	?
Hagfors (2 converters)	Uddeholms AB	1946	?
Högbo bruk	Sandvikens Jernverk	1946	4-5 ton
Forsbacka	Forsbacka bruk	1949	3.5-4.5 ton
Germany: Information supplied by Olaf Schmidt LWL-Industriemuseum & Robert Laube			
LWL-Industriemuseum Hattingen (2 Converters)	Eisenwerke Rödinghausen, Menden	1915 1916	15 ton
Henrichshütte Bessemer works Hattingen	Eisenwerke Rödinghausen, Menden	1915/16	15 ton
Unterwellenborn	Maxhütte Unterwellenborn	?	?
Dortmund DASA exhibition	?	?	?
Dortmund Hoerde	Phoenix Ost steelworks	1964	?
Munich – German Museum	(sectioned converter)	?	?
UK: Information from Tim Smith			
Kelham Island Museum, Sheffield	BSC Workington	1974	25 ton
Science Museum, London	Bessemer's pilot plant	1865	?
Blaenavon (Thomas pilot)	Blaenavon Iron & Steel	1877	?
Austria: Information supplied by Robert Laube			
Hüttenberg, Carinthia, S Austria	?	?	?
North America: Information from Tim Smith			
Pittsburgh PENN Station Square	A M Byers Co	1960s	10 ton
Dofasco, Hamilton, ON, Canada	Dofasco	?	?

CONSERVATION OF ARCHITECTURAL IRONWORK

This was the title of a thoroughly informative course I attended in York last November, run by the National Heritage Ironwork Group (www.nhig.org.uk). As well as those with an interest in metals, participants included architects, conservation officers and planning advisors. I was able to attend following a generous grant from the R.H.Tylecote Memorial Fund, for which I would like to say a big 'thank you'.

Day one was led by Chris Topp, a smith with a lot of experience in restoring ironwork. He took us through the history of architectural iron, from the twelfth century ornate iron hinges in Stillingfleet Church (near Selby), through the golden age of the eighteenth century when Tijou created beautiful iron screens for Hampton Court, right up to the nineteenth century foundries making station buildings and bridges.

This was followed by a discussion of the metallurgy of iron and steel, highlighting the different qualities of the metals and different manufacturing techniques through the ages. The key focus was how to identify what materials and techniques had been used through visual assessment of historic ironwork. Clues comes from marks left on the surface during manufacture, how the piece was fixed together, and how an item has corroded or suffered damage with time. Wrought ironwork can be bent without breaking, unlike cast items.

The third session of the day looked at how ironwork might be repaired. Using lots of examples, we were taken through a summary of the key techniques and pitfalls to avoid. For example, forged spindles in a length of railing will all be slightly different in size/shape and will only go back in the order they came out so numbering them saves a lot of trial and error. To test our new observation skills we then we went for a walk around York assessing the ironwork we passed and discussing what repairs could be carried out.

Day two, led by another conservation practitioner, Geoff Wallis, began with a look at specifications and

standards for repairs. As with other forms of conservation, key features include minimal and reversible interventions that should aim to ensure long-term survival. Further to yesterday's session on repairs, we discussed protective coatings and paints that might be applied to the surface of ironwork. Comparisons were made with coatings used in the nineteenth century to prevent fresh castings from corroding. Interestingly, the restoration process reveals coatings were also used to disguise defects in the work. In one case, holes in the surface of an object had been filled with plaster and then painted over!

Geoff presented numerous and varied examples of contracts he has undertaken and described the work carried out. This led to an interesting discussion about how to decide what is worthy of preservation and, often very expensive, repairs. English Heritage, in their conservation guidelines, suggest that 'heritage value' is a measure of the evidential, historic, aesthetic and communal values that an item holds. However, judging these can be a very difficult task and we couldn't all agree on the examples we were given to debate.

The afternoon finished with a tour of York Minster, making a close inspection of the doors, screens, grills and railings within. Again Chris and Geoff challenged us to use our new knowledge, avoiding the red herrings.

We discovered that several older items of ironwork have been moved around in the church and re-fixed using modern screws!

In summary this was a brilliant course that has been of enormous benefit to someone with an interest in street ironwork, items that surround us everyday but are usually overlooked. HMS plans to hold a conference on Street Furniture in 2015. I hope we'll be able to tempt you to come along and find out more about this fascinating topic.

Rachel Cubitt

Figure1. Bedlam (Lower) Furnace: the conserved, officially interpreted SAM. Looking west towards the Upper Furnace at Lake Head. One may compare this view with William Pickett's aquatint: 'Iron work, colebrook dale'. Pickett's two chimneys, locating the Upper Furnace, stood centre-left – where Waterloo Street bends to the right.

Bedlam Furnaces, Ironbridge: Revisited, Revised

In July 2013, the Ironbridge Gorge Museum Trust (IGMT) and the University of Birmingham hosted the 'Rust, Regeneration and Romance' (RRR) conference at the Ironbridge Gorge Museum, Shropshire, UK. I attended this prestigious event as a graduate of the University of Birmingham (MSocSc in Industrial Archaeology, 1997), and as a researching member of the Historical Metallurgy Society since 1995. I took the opportunity to present a paper which revisited, reconsidered and revised my reportedly 'controversial' (Lawes, personal communication 1997) 1996 Masters dissertation: 'The Breaking of the Bedlam Enigma: A Case for the Identification of a Physical Icon of the Industrial Revolution'. What follows is a précis of my conference paper.

Bedlam by name, Bedlam by nature?

In February 1996, whilst an industrial archaeology student studying at the Ironbridge Institute (an academic collaboration between the IGMT and the University of Birmingham), I hypothesised that the Madeley Wood/ Bedlam Furnace Scheduled Ancient Monument (sited within the Ironbridge Gorge World Heritage Site, Shropshire, UK) had been misinterpreted. That, for more than seventy years, primary documentary, artistic and archaeological evidence relating to two physically separate blast furnace installations at the Madeley Wood/Bedlam site had been confused and combined habitually to explain one.

Between February and November 1996, I sought to test my unorthodox theory by undertaking a thorough, robust, evidence-based reinvestigation of the Bedlam Furnace site, its landscape and standing archaeology. Working single-handed and unsupported, I was guided by contemporary works of landscape art; historic cartography; and enigmatic documentary references to Upper and Lower Furnaces at the Bedlam site, as recorded in the 'Madeley Field and Madeley Wood Furnace Reckoning, 1790-97'.

In February/March 1996, whilst working to report their latest reassessment of the Bedlam Furnace monument to English Heritage, IGMT field archaeologists were confronted by these same troubling, historic references to upper and lower furnaces present at the Bedlam site. They struggled to explain them to their archaeological funders. Philosophically restricted, apparently, by the long-established, orthodox, Bedlam Furnace single-site paradigm, the archaeologists concluded: 'The furnace in blast was known as the Upper Furnace.' (IGMT Archaeology Unit 1996). Known to whom? A bluff, perhaps? No references were cited in support of this baffling declaration.

Into the field

Early in the initial field-work phase, my investigations revealed massive, above-ground industrial archaeology indicating that an unrecognised, early atmospheric steam

engine house had been adaptively incorporated into a cottage. This cottage stands at the Lake Head, Ironbridge – a group of three dwellings located approximately 100m west of the conserved and IGMT-interpreted Bedlam Furnace ruin.

According to long-established, orthodox historical and archaeological interpretations of the Bedlam Furnace landscape: an atmospheric steam engine house should not be present at this location – the Lake Head, Ironbridge. I combined close analyses of primary visual and documentary sources, with informed archaeological field observations, and interpreted the Lake Head cottages as adaptively converted, former industrial buildings. I hypothesised that these three dwellings comprised the remaining, surviving structures of Bedlam Upper Furnace, built c.1757-58; whilst the conserved, IGMT-interpreted furnace ruin represents Bedlam Lower Furnace, built c.1770-76; enlarged c.1801-02.

Bedlam Upper Furnace: smithy – 10, Waterloo Street

Close examination of a sketch depicting Bedlam Furnace c.1770, currently attributed to Edward Dayes (1763-1804), led me to inspect 10, Waterloo Street, Ironbridge. This cottage retains archaeological features suggesting initial usage as a smithy. Artistic and archaeological evidence relating to chimneys – especially the stump of a demolished chimney retained in the attic – indicates that this building should be interpreted as the Bedlam Upper Furnace smithy (c.1758).

This building retains an enigmatic, windowless, ground-floor room, featuring a brick-built, barrel-vaulted roof. Measuring 4.40m by 2.25m, this room suggests first phase of industrial usage.

Bedlam Upper Furnace: probable joiners' shop – 9, Waterloo Street, Ironbridge

According to P.J. de Loutherbourg's iconic oil painting, 'Coalbrookdale by Night', the Upper Furnace smithy had been extended westward to house a possible joiners' shop. This extension to the smithy [c.1770-76] is confirmed archaeologically by a visible butt-joint in the dentil course of brickwork (see Figure 2); and a variation in roof level, observable at the peak of the roof ridge and to the rear of the building.

The early abandonment and conversion of the proposed joiners' shop into the Lake Head Inn, c.1779-1780, may relate to the retrenchment of the Bedlam site following the completion of the campaign to cast components for the Iron Bridge in 1779 – probably at Bedlam Lower Furnace. It may be no coincidence that the Lake Head Inn's first liquor licence was granted in 1780.

Bedlam Upper Furnace: atmospheric steam engine house – located to the rear of, 11, Waterloo Street, Ironbridge

Having been schooled in the finer points of identifying, investigating and interpreting adaptively converted steam engine houses by the Ironbridge Institute; 11, Waterloo Street provided a unique opportunity to field-test my training.

Although access to 11, Waterloo Street was restricted, sufficient technical features were observed to postulate that an early atmospheric steam pumping engine house [built c.1757], measuring 6.50m by 4m, stood to the rear of this extended, enlarged dwelling.

The principal, ground-level door into the brick- and stone-built engine house, having been obscured by a later phase, hip-roofed extension, could be examined from within a basement room. The brick-blocked engine house door measured 1.75m high and 1.38m wide. The dimensions of early engine house doors are important. Engine house door dimensions provide a guide to the maximum size of cylinder that could be installed within. In this case, cylinders with diameters up to 48 inches (1.22m) could be admitted with ease. Based upon the size of the cylinder, one may estimate the size and power of the steam engine.

Atmospheric engine house investigators tend to overlook openings provided to admit steam pipes from replacement, external boilers. I was alert to their presence.

The stone-built wall to the right of the door had been pierced, circa-, or post-1780, to admit a steam-pipe. The resulting port, 1.50m above ground-level, measured 20cm square. This steam-pipe, probably heavily lagged, may have connected the steam engine to an external, replacement, Boulton & Watt-type wagon boiler [see: de Loutherbourg, pen and ink sketch, 'Fire Engine Coalbrookdale']. This steam-pipe port has since been employed to admit modern utility pipes. It has been filled with expanding foam.

The outer face of the northern, bob wall of the engine house has been rendered, disguising its archaeology. However, the inner face retains evidence of the gable-shaped opening for the engine beam. The opening has been partially blocked with brickwork, leaving a recess that has been fitted with bookshelves.

Independent confirmation that this building is, indeed, a converted atmospheric steam engine house built c.1757 [see below: 'Post-conference postscript'] invites interpretation of this structure as the earliest known – intact, roofed – atmospheric steam engine house in the British Isles.

Figure 2. Bedlam Upper Furnace: The Lake Head cottages, 9, 10, & 11, Waterloo Street, Ironbridge. These dwellings were adaptively converted from the Upper Furnace atmospheric steam engine house (built c.1757); the smithy (built c.1758); and the joiners' shop (built c.1770-76). Compare these buildings with the Bedlam Furnace buildings as depicted by P.J. de Loutherbourg in 'Coalbrookdale by Night'. Note: the hip-roofed building and lean-to, centre-right, are later additions.

Upper Furnace: steam engine house extended

De Loutherbourg's 'Coalbrookdale' painting recorded an intriguing technical feature: the Upper Furnace engine house had been extended to the north.

Archaeological evidence supporting de Loutherbourg's depiction was observed to the rear of the engine house. A brick-built extension 3.5m in length, had been constructed, and then partially dismantled. This extension may relate to the transition from air blast generated by pumped water and bellows; to air blast generated by an air cylinder driven directly by the steam engine.

I interpreted this extension as a new building constructed to enclose an engine-driven blowing cylinder and a water-type blast regulator.

Upper Furnace: charging ramp and bridge

Adjoining the engine house stands a massive masonry wall. This wall, the western elevation of the Upper Furnace charging ramp, is depicted by Paul Sandby Munn in his watercolour 'Bedlam Furnace, Madeley Dale' (1803). Furthermore, this charging ramp structure was recorded cartographically. It appears on a lease plan of the Bedlam Furnace site prepared between c.1826 – the apparent domestic conversion of the remaining Lake Head ironworks buildings; and 1839 – the demolition of Bedlam Hall, to make way for the Ironbridge Gas Works.

Field-observations indicate that the original, c.1757, water-driven bellows room may have been located within the charging bridge. It would have housed at least one waterwheel, and, presumably, two sets of bellows arranged to blow the two blast furnaces from the rear. This bellows room may remain sealed intact within the charging bridge structure.

Upper Furnace: two buried blast furnaces

In 1996, I proposed that the archaeology of Bedlam's first two blast furnaces lie buried in the garden of 11, Waterloo Street – alongside the former engine house.

A photograph of Lake Head Inn taken c.1860, records the apparent 'crenelated' top of a blast furnace tunnel head projecting above the roof of the converted engine house. A similar 'crenelated' tunnel head is depicted in 'Old Furnace, Broseley' (1821), a watercolour by J. Homes Smith.

Furthermore, whilst gardening (c.1995), the occupier of 11, Waterloo Street exposed, and photographed part of a large, rounded, soot-blackened, brick-built feature. He summoned archaeological assistance, and was informed verbally that his find was 'probably a brick kiln and a retaining wall.' However, close photographic and artistic analysis supports interpretation of this feature as a substantial portion of a brick-built, blast furnace tunnel head that had collapsed during demolition.

Post-conference postscript

On the afternoon of 13 July 2013 – the penultimate day of the RRR conference; delegates Dr Janice Baker (Deakin University, Australia), Dr Di Drummond (Leeds Trinity University College) and Robert Protheroe-Jones (Curator – Heavy Industry, National Waterfront Museum [National Museum of Wales], Swansea) accompanied me on a field trip to examine the Lake Head buildings. We were pleased to accept generous invitations to inspect the internal and external archaeology of 10, and 11, Waterloo Street.

Robert Protheroe-Jones is an authority on the archaeology of masonry blast furnaces, and their associated structures and technologies; an expert advisor to the Welsh Archaeological Trusts; and representative of the National Museum of Wales on the Royal Commission on Ancient and Historic Monuments of Wales (RCAHMW) Industrial Archaeology panel.

During our visit, Robert provided independent, informed verification that 11, Waterloo Street had been adaptively converted for residential occupancy from a pre-existing, substantial industrial building. Furthermore, he has since confirmed, in writing, that:

'… the artwork evidence that the conserved Bedlam furnace site is separate from an earlier furnace site at Lake Head … [is] … consistent and convincing.' …. 'Certain

Figure 3. Bedlam Upper Furnace: An atmospheric steam engine house (c.1757) standing intact to the rear of 11, Waterloo Street, Ironbridge.

of the walls at the eastern and north eastern end of the Lake Head site are of such a massive character to be very consistent with an industrial origin.' …. '… the east wall and spur-wall visible in the basement of the house [11, Waterloo Street, Ironbridge] is consistent with their having formerly comprised part of a blast furnace blowing engine house.' (Protheroe-Jones, personal email 2013).

In Conclusion

Having completed my research, I took steps to disseminate my summarised findings to respected individuals and heritage/museum institutions with known research interests in the history and archaeology of Bedlam Furnace and the Ironbridge Gorge. The replies I received remain in my project archive.

When interviewed for The Crucible, the respected archaeometallurgist David Bourgarit encouraged us to: 'stay young', be 'open-minded', and be '… critical to what the "ancients" have written so far on your subject.' (Bourgarit 2013).

My Bedlam Furnace investigations, February 1996 – ongoing, have raised almost as many questions as they have answered. Questions about the history and standing archaeology of this important early industrial site. Questions about how archaeological and heritage/museum professionals – the not so "ancients" – respond to new, original research that challenges [their own] orthodox thinking. Questions about how classically trained field-archaeologists 'do' unfamiliar industrial and metallurgical archaeology. And questions about how these archaeological professionals choose to interact with, and incorporate alternative findings generated by academics and professionals working in related fields and disciplines (Hayman et al. 1999).

Robert Protheroe-Jones' welcome, independent verification of significant, standing, industrial archaeology at the Lake Head, Ironbridge, supported and validated my 1996 investigation of the adapted industrial buildings at Lake Head and the wider Bedlam Furnace landscape. Robert's validation confirms that a detailed, informed investigation of the Lake Head site must be a precondition for any meaningful, historical and archaeological re-analysis of the phasic evolution and development of the Bedlam Furnace structures and landscape, c.1757-c.1843.

Paul H Vigor
paul.vigor@outlook.com

Lawes, G, Chief Executive, Ironbridge Gorge Museum Trust, personal communication, 13 February 1997.

'Madeley Field and Madeley Wood Furnace Reckoning, 1790-97', Shropshire Archives, 271/1.

Ironbridge Gorge Museum Trust Archaeology Unit, 'Bedlam Furnaces Ironbridge: Final Report for English Heritage', unpublished report. Ironbridge Gorge Museum, March 1996, 14.

Protheroe-Jones, R, personal email, 04/09/2013

Bourgarit, D, 'One Minute Interview', in The Crucible, HMS, 84, Winter 2013, 11.

Hayman, R., Horton, W., and White, S., Archaeology and Conservation in Ironbridge, CBA Research Report 123. York: Council for British Archaeology, 1999, 58-82.

LAUNCH OF NEW IRON TRAIL WITHIN THE IRONBRIDGE GORGE WORLD HERITAGE SITE

On Monday, March 3rd Severn Gorge Countryside Trust (SGCT) launched a new Iron Trail with a leaflet and video on a brand new website, which, along with several other new trails, aims to enhance Ironbridge Gorge's existing reputation as a major world tourism destination.

Following an interpretation strategy for the World Heritage Site by PLB consultants in 2008, SGCT have been working with a range of partners, including the Ironbridge Gorge Museum Trust and Telford & Wrekin Council, to improve the way the cultural landscape of the World Heritage Site is interpreted to both visitors and local people.

One of PLB's recommendations was that the beautiful yet complex landscape of the World Heritage Site together with the ten Museums could be better seen as one whole visitor experience through the creation of a series of high profile trails.

SGCT has spent the past two years researching the landscape history working closely with local people and experts, to produce a flagship Iron Trail, which is an enjoyable three and a half mile stroll starting from the Iron Bridge itself. It then winds its way through the Sabbath Walks within Dale Coppice, which were laid out by Quaker Iron Master Richard Reynolds in the early 1790s, and which we now believe was the first privately funded public park in the UK, some 160 years before National Parks.

The trail takes in breath taking views from the Rotunda on Lincoln Hill towards the Iron Bridge and then down a series of steps back into Ironbridge. For the hundreds of thousands of visitors who plan to come to Ironbridge each year, SGCT has developed a new website which includes two new videos where, from the comfort of your armchair, you can walk the Iron Trail and find out about our volunteering programmes or download a range of material.

Russell Rowley, Manager of SGCT said; "We will also launch a Lime Trail of Benthall Edge and a new Ironbridge to Blists Hill walking leaflet which takes in the remains of the historic Madeley Wood Hall and provides a safe and enjoyable stroll through Lloyds Coppice.

"We hope that the new website, videos and trails, will help local people and visitors alike to explore the wonderful landscape of the Ironbridge Gorge. We also hope that it will inspire visitors from all over the world to stay for a few nights in the excellent local hotels and B&Bs and spend that little bit more to help the many businesses that form a vital part of the local economy".

For copies of the new trails, send a self-addressed enveolope to the SGCT office at Darby Road, Coalbrookdale, TF8 7EP, UK, or they can be freely downloaded from website **www.severngorge.org.uk**; for more information email **staff@severngorge.org.uk** or Tel: 01952 433880.

WEALDEN IRON RESEARCH GROUP

A wide range of articles can be found in the 2013 volume of Wealden Iron, the Bulletin of the Wealden Iron Research Group, number 33 in the second series. Two bloomery sites have been discovered, one on the edge of Ashdown Forest, as yet undated, and the other on the now-land-locked Isle of Oxney, bordering Romney Marsh. This latter site included pottery and coin evidence of occupation probably in the late 2nd century AD. The search continues for new sites and one such foray in the Dudwell valley of East Sussex is described.

A small bloomery site in Hartfield, East Sussex, was excavated and the result is the subject of an article. Furnace remains were not located because the site was in woodland but pottery finds suggested a late-Iron Age date. Quantities of tap slag, and furnace lining from which an estimate of the furnace's internal diameter of 450mm could be derived, give some clues as to the process employed.

Theoretical considerations of aspects of iron making are to be found in three articles. In the first, the operating characteristics of waterwheels, bellows and tuyeres are examined in relation to the water available to a furnace in a catchment area. In the second, computer modelling has allowed the exploration of factors relating to cannon boring based on a wide range of information available in the correspondence of the Fuller family in the 18th century; these include boring times, costs and throughputs. Thirdly, and again using computer modelling, Themic Analysis has enabled factors less commonly considered subjects for statistical study – issues, emotions and achievements – to provide some insights into the attitudes the Fullers, father and son, experienced in their roles as businessmen and in their relationships with their agents.

St-Leonard's LIDAR analysis.

More down-to-earth, a recent LIDAR survey of St Leonard's Forest, an ancient area of woodland near Horsham in West Sussex, has revealed the distribution and extent of late 16th- and early 17th-century iron ore extraction pits. Undergrowth makes such surveys on the ground very difficult, so it is hoped that other areas known to have been exploited for this raw material of the post-medieval iron industry will be given the LIDAR treatment in the future.

An early 17th-century fireback is the subject of a short article which considers the possibility that it might be evidence for the continued use of Hendall Furnace in East Sussex. And finally, when it was reported in the WIRG Bulletin in 2012 that a hitherto unidentified water-powered forge site had been discovered, it might have reasonably been assumed that finding any more would be a remote possibility. But, like London buses, two turn up at once. Hothfield Forge, near Ashford in Kent, began to be operated in the 1650s, when forges elsewhere in the Weald were closing down as economic conditions changed. Predictably it did not last long, and the surface evidence is slender, but an inventory has survived as have records of ironworkers employed there.

Jeremy Hodgkinson

CHANGE TO OVERSEAS PAYMENTS

The Society has a considerable number of overseas members and in the past payment by cheque was a cost effective way of collecting membership payments. Sadly, due to rising bank costs, the Society has had to remove both foreign currency cheque payments and also the Credit Card payment system. Instead, we have set up a new system by which subscriptions and other sums can now be paid via PayPal. This is accessible via the Society's website. If an amount needs to be paid which the website does not make provision, please email the treasurer and a PayPal invoice will be issued manually.

Those unable to pay using the Society's website and PayPal should obtain from their bank a cheque or draft in £sterling, drawn on (or payable at) a bank in London. Alternatively, the Treasurer (on application) can provide bank account details to enable a payment to be made electronically.

Peter King
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EVIDENCE OF THE EARLIEST USE OF STEEL IN BRITAIN UNCOVERED IN SCOTLAND

Archaeologists have identified examples of the earliest use of steel in the British Isles from a site in East Lothian, Scotland. The site, an Iron Age hill fort known as Broxmouth, was excavated in the 1970s, however the discoveries are only now being published.

As part of the re-examination of the findings at Broxmouth, new analysis of some iron artefacts, dated to 490-375BC, found a possible knife blade made from high-carbon steel which had been deliberately heated and quenched in water. This is the earliest evidence of such sophisticated blacksmithing skills in Britain.The discovery is particularly significant for the insight it offers into not only the early development of such advanced manufacturing skills, but what it may tell us about social organisation at this time. Technical skills at this level would only be achievable by specialist metalworkers who devoted their lives to perfecting and developing their craft – a poignant start to the history of steel manufacture in Scotland, one of the great industries of the 20th century.

Dr Gerry McDonnell said:"The process of manufacturing steel requires extensive knowledge, skill and craftsmanship. It is far from straightforward, which is why such an early example of its production tells us so much about the people who once occupied this hill fort. It points to an advanced, organised community where complex skills were refined and passed on."

Details of the study can be found in An Inherited Place: Broxmouth Hillfort and the South-East Scottish Iron Age, by Ian Armit and Jo McKenzie (Society of Antiquaries of Scotland).

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 Tatara steel experimental smelts in Japan with the last Tatara-master.

Reconstructing the world's earliest metallurgy

Last September, the AHRC-funded "Rise of Metallurgy in Eurasia" project ran a series of copper smelting experiments at the site of Pločnik, in southern Serbia. The event gathered more than 50 people: local community, local museum workers, Serbian archaeologists and many archaeometallurgists from UK (mostly UCL), Germany, Canada, Thailand, Spain and China. The purpose of the experiment was to attempt to replicate the world's earliest metal-making recipe as reconstructed from the analysis of 7000 years old smelting debris from Vinča culture sites in Serbia (Radivojević et al., 2010).

What have been uncovered thus far are small pieces of individual slag samples (up to 2 cm in length), well contextualised and dated to c. 5000 BC from the site of Belovode. Alongside these slag droplets, the excavator of this site discovered ceramic sherds topped with metallurgical slag. The initial hypothesis of these being crucible fragments was rejected after close macroscopic and microscopic examination, and it appears that the slagged sherds were used as fragmented in the smelting process, as in lining a 'hole-in-the-ground', or similar (Radivojević, 2012). Another slagged sherd discovered in the site of Gornja Tuzla (c. 4400 BC) suggested a similar technological principle of early copper smelting in the Vinča culture, and a few more small slag pieces from the eponymous site of Vinča (c. 4700 BC) further confirmed this assumption. Thus, replication experiments of early copper smelting recipes could only be based upon small slag pieces and slagged sherds since they were the only archaeometallurgical materials to have survived the seven millennia.

Making blowpipes from local elderflower trees (above); Lining the smelting installation with fragmented sherds and clay (below).

The smelting 'playground' in the Neolithic site of Pločnik in south Serbia.

Significantly, provenance analysis pointed at local sources being exploited by the Vinča culture miners (Pernicka et al., 1993; 1997; Radivojević et al., 2010). The precise copper source exploited by the Belovode miners still remains unknown, although trace element analysis of copper metal embedded in slag from this site indicates that it matches the signature of 16 contemporaneous copper metal artefacts discovered across the Balkans. Our assumption is that either Belovode metal smiths were producing copper locally for ingots / artefact traded across the Balkans, or Balkan metal smiths were using the same single source somewhere in this region (Radivojević et al., 2010). As we were inclined towards the former theory, we decided to source ancient mines adjacent to the site of Belovode for copper ores that we intended to use for our experiments.

In total, we gathered c. 100 kg of copper carbonate-based minerals from the sites of Ždrelo, Rudna Glava and Prauria (Majdanpek), all within 5 – 50 km as the crow flies from the

The UCL team is mixing the local clay with river sand and organic matter for lining the installations.

site of Belovode. All minerals gathered were initially sorted into different grades, depending on the abundance of ore batches with copper carbonates. We noticed that the Ždrelo ores were of best quality and that they had black streaks impregnating the copper carbonate. This matched exactly the (colour) quality of copper minerals unearthed during the Belovode excavations, which were analytically shown to be rich in manganese. The substantial manganese concentration in the slag glass matrix in production evidence from the site of Belovode also suggested that the black and green copper

Charging the bellows-powered smelting installation with hornbeam charcoal.

minerals were the most likely copper ores used for metal extraction at this site (Radivojević et al., 2010). Therefore, we decided to make the black and green 'Ždrelo mix' our primary ore for replicating the 7000 years old copper smelting recipe.

The 'Ždrelo mix' was beneficiated and separated into ten bags of ores containing 375 gr for each of the ten planned experiments. For control material we selected pure copper carbonate without any black mineral inclusions, from Ždrelo and from the mine of Rudna Glava (for experiments No. 11 and 12), in order to compare and contrast changes in slag formation between the 'mixed' and the 'pure' ore charges.

The night smelting in the blow-pipe powered installation; drummer on the right is dictating the rhytm.

The twelve smelting installations were designed to replicate as accurately as possible the Vinča culture smelting installations, as hypothesised only from laboratory research. Thus, we decided to design 4 installations as holes in the ground lined with clay and fragmented Vinča culture pottery sherds, with variations in depth, use of either blowpipes or bellows, and including an option with pebbles lining as well. Two further installations were just holes lined with clay and powered with bellows; one of these contained a freshly-made crucible with a bed of sherds nearby set as the base for pouring out

the slag. Another two installations attempted to replicate the archaeological find from the site of Belovode during the 2013 campaign: a hole in the ground lined with a pot bottom. We also included a variation of this installation with a freshly-made crucible on top of a pot bottom.

The idea for the last two smelting installations came from Dr Simon Timberlake, who wanted to try copper smelting in a non-lined hole in the ground, which was, unlike others, charged with firewood only, and charcoal made in situ. Thus, out of 12 installations in total, 10 were run on highly-caloric hornbeam charcoal, made for this experiment by the locals in the village of Pločnik. While bellows were brought by the archaeometallurgists for this experiment, we made blowpipes from elderflower trees, which were growing next to the river of Toplica, which runs along the site of Pločnik. Elderflower tree is particularly suitable for blowpipes as it has a soft heart, which was possible to push and drill out using a copper wire.

Since we had a need for good refractory clay for our experiments, we talked to our ceramicist on the project, Silvia Amicone, about the clay sources used for making the Vinča culture pottery, and she indicated a location near the site of Pločnik as the most likely sourced for the Neolithic pottery making. For tempering, we used river sand (coarse and fine fraction) and dry grass growing on the site. After testing a few recipes with different combinations of tempers, the most durable clay briquettes proved to be those tempered with both fine and coarse sand, and organic temper. This combination was used to make all our nozzles (for blowpipes), tuyères (for bellows), crucibles, and clay lining in the installations.

Having set the 'playground' in the middle of the reconstructed Neolithic village of Pločnik and secured the immediate surrounding from potential fire hazard with heavy watering, we placed thermocouples in each of 12 smelting installations and pre-fired them before we started our experiments. A crew of c. 50 people was divided in three groups, each of which was running four experiments in total, and in parallel to each other.

The clay-lined installation after the smelting.

To make the atmosphere more entertaining, we invited Dimitrije Cvetković, a student from the Belgrade Music Academy to play drums for us throughout the day, to keep the spirits high and maintain the rhythm of the blowing / bellowing. We also kept going with the experiments throughout the night

Clay sherd with traces of slag and burning on the section (above); Slag with copper globules produced in one of the smelting installations (below).

in order to obtain photos of colours of the smelting event and thus record sensorial aspects alongside regular measurements conducted during each smelt. Incidentally, it quickly became apparent that the drumbeat was essential to maintaining a consistent airflow and rhythm between up to six different blowpipes.

We managed to produce copper as small globules embedded in slag in all 12 smelting installations, although of different quality and shape. The quality notion relates to the difficulty to extract the newly-produced metal globules (as in crushing), but also to the quantity of these in comparison to the copper oxide entrapped in the slag matrix.

Our primary goal, however, was not only to produce copper, but to replicate the smelting installations. The smelting design with fragmented copper sherds lining the hole in the ground only partially fulfilled our expectations, as there was little debris left on these sherds. Only a few samples carried the slagged mass on their top, and it was mostly those very close to the 'hottest' point in the installation, or near the bellows. The installations with pot bottom were the greatest surprise, as we succeeded to replicate the field feature from the Belovode 2013 season and leave no traces in the pot bottom despite the fact that we produced a substantial slag cake in it. Also, the local clay proved to be highly refractory, and withstood high temperatures without causing major breaks in the installations or pot bottoms / crucibles. In contrast, ceramic nozzles were constantly breaking, but mostly due to our lack of skills in making them, since the break lines were along the joining points with the elderflower blowpipes.

Therefore, the main conclusion from the experiments is that the traces left behind by smelting in our installations were minute, with most of the various components remaining intact

and generally looking unused in the smelting experiment in its aftermath. Further analytical work is currently concentrating on in-depth analysis of production debris, ores but also various installation parts and will be reported in the near future.

One of the most important outcomes of this event was the involvement of local community and media attention. We repeated several of the experiments the following day exclusively for the media and gained significant coverage with several national television networks, with leading newspapers reporting on the event. More significantly, the members of the local community are now trained to conduct experiments themselves, which is currently a leading touristic attraction for the visitors of the site of Pločnik. We plan to continue experimental work in the future and explore possibilities for making not only copper but also tin bronze, since the earliest known tin bronze artefact has also recently been recorded from the site of Pločnik (Radivojević et al., 2013).

Miljana Radivojević

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Pernicka, E., Begemann, F., Schmitt-Strecker, S., Todorova, H. & Kuleff, I. 1997. Prehistoric copper in Bulgaria. Its composition and provenance. *Eurasia Antiqua* 3, pp. 41-180.

Radivojević, M. 2012. *On the Origins of Metallurgy in Europe: Metal Production in the Vinča Culture*. PhD Thesis, UCL Institute of Archaeology.

Radivojević, M., Rehren, T., Kuzmanović-Cvetković, J., Jovanović, M. & Northover, J. P. 2013. Tainted ores and the rise of tin bronze metallurgy, c. 6500 years ago. *Antiquity*, 87, pp. 1030-1045.

Radivojević, M., Rehren, T., Pernicka, E., Šljivar, D., Brauns, M. & Borić, D. 2010. On the origins of extractive metallurgy: new evidence from Europe. *Journal of Archaeological Science*, 37, pp. 2775-2787.

IAMS Summer School 2014

The Institute for Archaeo-Metallurgical Studies will be hosting a one-week training course on the Archaeometallurgy of Copper and Iron. The course will cover the theoretical and scientific foundations, as well as archaeological materials, with examples from across the world. There will be specific sessions devoted to the handling of relevant production remains, metallography and pXRF analysis of archaeological metals. Speakers include Prof Thilo Rehren, Prof Marcos Martinón-Torres, Dr Michael Charlton and Dr Eleanor Blakelock.

The course will take place at the UCL Institute of Archaeology, London, 23rd-25th June 2014. Some limited funding available. See **http://www.ucl.ac.uk/iams** for more info.

SEDPGYM 15th International Conference on Geological and Mining Heritage

Call for Papers

Congress in memory of Vicente Sos Baynat and Craig Merideth. Logrosán, Cáceres, Spain. 25th-28th September 2014

The 2014 annual conference of the Spanish Society for the Protection of the Geological and Mining Heritage (Sociedad Española para la Defensa del Patrimonio Geológico y Minero -SEDPGYM-) will take place in the village of Logrosán (province of Cáceres, central Spain) from 25th to 28th September 2014.

The village of Logrosán is located within the Villuercas-Ibores-Jara Geopark and has a long mining tradition. Two important mining sites are located by the village: the Costanaza Mine, an open to the public underground phosphorite mine and the Cerro de San Cristobal (a Geosite) casiterite mines. Both of them will be visited during the congress.

Coinciding with new archaeological campaigns carried out in summer-2013 in the Cerro de San Cristóbal, this congress is dedicated to honor the memory of two men who promoted the research of the Cerro, the geologist Vicente Sos Baynat, and the archaeologist, Dr. Craig Merideth.

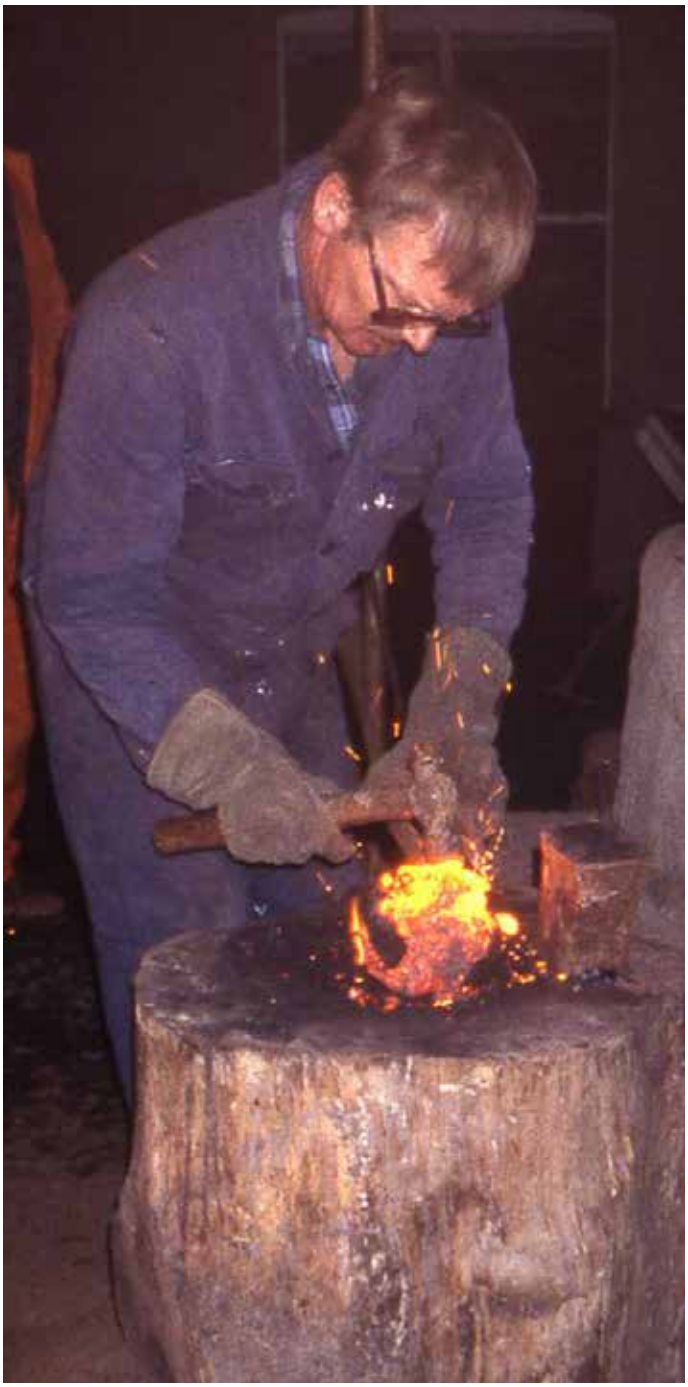
The scope of the conference is centered, with no geographical or chronological limitation, in aspects related with geological and mining-metallurgy heritage, archaeology and history of mining, and protection, public use and didactic values of the geological and mining heritage.

The conference languages will be Spanish, Portuguese and English.

Abstracts for papers and posters should be submitted by e-mail before 15th of August 2014, in Word format and with a A-4 maximum extension, to rocpetrus@gmail.com.

The booking form (general fee 150 €) is available on the web site **www.sedpgym.es** (please indicate if you will join the free pre and post congress excursions).

For more information or any inquiry you may have, please contact **mhunt@us.es**, or post to Dr. Mark A. Hunt-Ortiz, Jiménez Aranda, 6. Apartment 34. 41018-Seville.Spain.



Peter Crew bloom refining. XP 67, 1995.

Peter Crew

Peter was born in Elsecar, a small mining village in South Yorkshire, only a few yards from the local blast furnace, so slag was part of his life from an early age! After a science education, his early career was rather varied, with a spell at Tube Investments, an even briefer spell at Oxford reading mathematics, then several years earning a living from mountaineering. His father's refrain was 'when are you going to get a proper job'.This came as a computer programmer in the early 1960's, working on an early IBM mainframe with all of 650kb of memory. After other computing jobs with Spear and Jackson in Sheffield and at University College of North Wales, Bangor, he then went back there as a mature student to read Archaeology and Welsh History. His first and only job in archaeology was at Plas Tan y Bwlch, lasting for some 30 years. In partnership with his wife Susan, this led to a series of excavations on iron working sites, two conferences for HMS in 1985 and 1998 and two international conferences in 1997 and 2007. Now retired Peter and Susan continue to live and work in North Wales.

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

PETER CREW: For all of my archaeological career I worked for the Snowdonia National Park, first as a lecturer at Plas Tan y Bwlch, then as Archaeology Officer for the Park, but still based at Plas. This gave a remarkable degree of freedom, not being beholden to anyone. So, we were able to carry out thirty years of excavation of iron working sites - at two prehistoric sites, two medieval sites and two blast furnaces of 16th and 18th century date - all in the same small valley in the heart of Snowdonia. Linked with this we made nearly a hundred iron working experiments, over some 25 years. We were once accused of being 'too parochial', but this focus on the development of iron working in one small area has been very satisfying. It was all made possible due to the support of a remarkable group of people who excavated and experimented with us for many years.

THE CRUCIBLE: What is your most memorable professional moment?

PETER CREW: Most of our work was a long slow burn, so memorable 'moments' as such were rare. In terms of ideas, there were three: realising, after a long day in the field, visiting the excavation of Keith Challis at Stanley Grange, in Derbyshire, that his strange furnaces had to have been wind-blown, though it was Susan who got there first; realising that the raw data from gradiometer surveys could be re-processed to show the dipolar nature of the signal from a furnace, from which one might be able to recover the directions of magnetisation and hence an indication of the date; realising that the high CaO in some of our experimental slags must have been due to a large contribution from the fuel ash.

In terms of discoveries, there are few notable objects from the sites we have worked on, but the incredible collection of well-preserved medieval wood from the Llwyn Du bloomery, which included a cruck and a yoke, was really exciting, as was learning how to do dendrochronology and cross-matching the timbers. Another exciting occasion was at the Agorregi ironworks in the Basque Country. A visit from one of the divers on the Ria Oria shipwrecks, one of which produced the ore used in the experiments and one of which had a cargo of cut blooms and bars, led to a heated discussion amongst our Basque colleagues. It transpired that most of the cargo was actually stored

Peter and Susan at Agorregi, 1999 (Photo: Philippe Fluzin).

in the pond at Agorregi, so the pond was drained to reveal the timbers from the wrecks and a large pile of iron masked by a thick cover of marine concretion. A few pieces were removed and the concretion hammered off, revealing the spilt blooms and a 1.2m long 9kg bar forged to long tapering points, all in perfect condition.

If pressed, I would have to admit that the most memorable occasion was spending a good half-hour in the tapping bay of the Piombino blast furnace, transfixed by the rivers of iron and slag pouring out of the furnace.

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

PETER CREW: It is impossible to choose only one from the many people who have been important to me: Joan and Bert Shutt, for brilliant geography/geology field trips from grammar school and for introducing me to the mountains and climbing; Leslie Alcock, for introducing me to archaeology and encouraging me to go back to University; Frances Lynch and Keith Williams-Jones, for being inspirational teachers; Kazimierz Bielenin, despite our lack of a common language, who was a role model for someone prepared to spend his whole professional career quietly and determinedly studying the iron working in the Holy Cross Mountains; Susan, for nearly 30 years of support, continual discussion and argument.

THE CRUCIBLE: What is your main current project?

PETER CREW: Catching up on a backlog of excavation reports and a long list of papers waiting to be written. They won't all get finished, but as many as possible will be. As we get older and creakier, it becomes more and more apparent that what really matters in the long term, is what is in print and thus available to future generations. Much time over the past year has been spent in making a pdf archive of all our publications, which is now on the academia.edu website. This is a very useful forum for keeping abreast of new work and for making new contacts. This site could be very useful if more archaeometallurgists signed up and made their publications more widely available.

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

PETER CREW: Well, it is rather late for me to develop any projects! It would be nice, however, to have enough money to be able to set up an independent foundation to support long-term multi-disciplinary projects, on iron working of course, rather like the VW-Stiftung projects of the 1990's. One example of an area which would benefit from such a project is Cumbria, where there are hundreds of iron working sites crying out to be studied in detail. This foundation would also produce an open-source international journal for archaeometallurgy.

THE CRUCIBLE: Which publication should every HMS member read?

PETER CREW: Schubert's 1957 History of the British Iron and Steel Industry - not least for his wonderful dedication "To my wife Lottie ... in memory of many quiet years." Considering the date it was written, this was a remarkable piece of synthesis, anticipating many of the ideas and questions which are now the focus of current research. It is the most used volume in my library.

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

PETER CREW: I should like to introduce them to some of our family catch phrases:

"Yer but" (from Susan's father, Herbert) - question everything, even the most firmly-held ideas, especially your own, go back to basic principles, think the unthinkable and then more.

"I'll do it myself, said the Little Red Hen" - even if you can't actually do it, learn enough to ask pertinent questions and to be able to understand and question the results. No one will ever care about your projects as much as you do.

"Trust me, I'm an expert" - heavily ironic of course.

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

PETER CREW: Iron rules, OK?

FUTURE INTERVIEWS

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

Please let us know at thecrucible@hist-met.org.

ELEANOR BLAKELOCK

When deciding on an undergraduate archaeology degree I realised I was always more interested in the science side of archaeology than typologies or archaeological theory. My intention was to study all about geophysics and spend my career walking up and down fields all day trying to locate new sites, but considering the English weather I began to have second thoughts. So when Gerry McDonnell, during my degree, gave me a second option: 'why not study ancient metallurgy' I have to say I never looked back. I became fascinated by metallography and the microstructures of ancient metals. Following my degree at Bradford I went to the Institute of Archaeology at UCL and learnt even more about the analysis of a range of ancient materials including metallurgy. Finally I ended up back at Bradford University for my PhD to finish off the research on Anglo-Saxon and Viking iron knives started during my degree.

After spending much of my time studying Anglo-Saxon and Viking iron, I started work at the British Museum's science department. This involved a shift from iron to gold as I started working on the Staffordshire Hoard (a hoard of Anglo-Saxon gold and silver objects found in 2009). This privilege was only topped recently when I had the opportunity to analyse a number of Anglo-Saxon objects from the British Museum's collections, including the stunning Sutton Hoo shoulder clasps.

When I was first invited to sit on council I was just starting my PhD and was still a relatively new member of HMS. I am proud that I am one of the youngest members to have joined HMS council to date. My first council meeting was a bit daunting but the other members of council soon made me feel welcome. Now after six years on council I understand more about the inner workings of the society and realise the amount of work and effort that many HMS members (both on and off council) put into the society to keep it working.

Once I joined council I was quickly invited onto the Membership, Publicity and Programme (MPP) committee where I acted as secretary. In late 2009 after organising my second event for HMS I became the events officer and chair of the committee shortly after. MPP continues to develop new benefits for HMS members and ways of publicising the society to potential new members. The committee has recently been heavily involved in the re-branding of the society.

As the events officer I have organised numerous conferences for our members, and some of my best HMS moments have been at these conferences. I will never forget the discussion about iron manhole covers, street furniture and glass bottomed buses at Helmsley in Yorkshire, this has led to a Street Furniture themed event which will be held next year. I am always keen to hear from members about events

you would like to see happen. My role as events officer also involves assisting and advising other event organisers. So I am also happy to assist members who are interested in setting up their own Historical Metallurgy meetings or conferences but are unsure how to start.

If you think you may be able to assist HMS, MPP or any of the other committees in any way please get in touch as we are always looking for enthusiastic members to help.

BUTSER FARM EXPERIMENTAL ARCHAEOMETALLURGY COURSE

Tuesday 27th May – Friday 30th May 2014

at Butser Ancient Farm, near Petersfield, 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 (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 use of ancillary equipment such as 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.

10 – 12 places available; cost £350 (4 days teaching)

Food and accommodation costs not included – although reasonably priced Bed & Breakfast or hostel-type accommodation exists in Buriton and Petersfield within 3 miles of Butser Ancient Farm.

Contact: Simon Timberlake **simon.timberlake@gmail.com**

Fergus Milton **fergus@fingerbuster.com**

Noël Harold Gale

MA, DSc, PhD, BSc, ARCS, FSA
Emeritus Professor of the University of Oxford
Fellow of Nuffield College, Oxford.
24 December 1931 – 3 February 2014

It is with great sadness that we announce the death of Noël Gale, an academic who for many years in his research in Oxford strived to straddle the Two Cultures of Science and Humanities.

Noël was a star pupil of Brockenhurst Grammar School and graduated in Physics from Imperial College, London. He started his PhD degree in St. Bartholomew's Hospital, London, on application of nuclear physics to medicine, but then changed to a pure physics degree which he completed at the University of Manchester. Still as a nuclear physicist he worked for several years at the Harwell Laboratory of the Atomic Energy Research Establishment until the early 1960s when he was employed by the University of Oxford in the Department of Geology (later Department of Earth Sciences) to build one of the earliest mass spectrometers to be used in isotope geochronology.

His work in the Age Laboratory of this department led in 1975 to a meeting with Prof. Wolfgang Gentner of Heidelberg University who proposed that they collaborate on developing the use of lead isotope analysis in revealing the origin of ancient silver Greek coinage. Soon afterwards, Professor Colin Renfrew suggested to Noël that a really interesting project would be to investigate Bronze Age sources of lead and silver in the Aegean. Over the course of the next thirty years, at the University of Oxford, Noël Gale became a leading scientist in the field of application of lead isotope analyses in provenance studies of Bronze Age metals in the Mediterranean. Thanks to his total devotion to this subject and his uncompromising scientific integrity he raised this technique to a status amongst the archaeologists similar to that of Carbon-14 dating. Subsequent controversy over this method of provenancing ancient metals helped to refine the interpretation methodology and kept it on strong scientific grounds. His contribution to science based archaeology should not be underestimated.

Zofia Stos-Gale

Brian Bastow

Brian Bastow, whose death on 7 November 2013 was announced in the previous issue of the Crucible, was a member of HMS for over 30 years.

Brian regularly attended the annual conference, occasionally giving a paper, but always contributing to the discussion, both formal and informal. He was a keen walker and cyclist and for him the best part of any HMS gathering was the site visits.

Always modest, many will not have realised that Brian had a doctorate in metallurgy and published many papers. After post-doctoral work at Birmingham and Manchester Universities he spent his career working in corrosion science at BNFL in Cumbria. His experience as a practical metallurgist informed his interest in historical and archaeo-metallurgy; his insights were delivered with humour and patience.

Brian's range of interests was broad, ranging from Greek and Roman antiquities to the industrial heritage of Cumbria, and from prehistory to current technology. He generously left instructions that his collection of metallurgical books were to be made available to the HMS library.

We shall miss Brian sadly, not only as an HMS colleague, but also as a friend.

Eddie Birch

Forthcoming events

Conference, Date and Location	Description	Website, Email and Prices
HMS Spring Meeting - Irish Iron 12th-13th 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.	http://hist-met.org/meetings/spring-meeting-irish-iron.html prondelez@yahoo.com £130
Medieval copper, bronze and brass - 2014 15th-17th May 2014 Dinant and Namur, Belgium	History, archaeology and archaeometry of the production of brass, bronze and other copper alloy objects in medieval Europe (12th-16th 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.	http://www.laitonmosan.org/ laiton.mosan@gmail.com
International Symposium on Archaeometry (ISA) 19th-23rd 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.	http://www.archaeometry2014.com/ Early Bird (before Feb 1st): $320; Student: $160.
HMS conference and AGM - Metals used in personal adornment 31st May - 1st 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.	http://hist-met.org/meetings/personal-adornment.html HMSagmconf@hist-met.org
First International Conference on Early Mainline Railways 19th-22nd 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. 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.	http://www.rchs.org.uk early.main.line.railways@gmail.com
SEDPGYM 15th International Conference on Geological and Mining heritage 25th-28th September 2014 Logrosán, Cáceres, Spain	The 2014 annual conference of the Spanish Society for the Protection of the Geological and Mining Heritage (Sociedad Española para la Defensa del Patrimonio Geológico y Minero -SEDPGYM-), will center on aspects relating to geological and mining-metallurgy heritage, archaeology and history of mining, and protection, public use and didactic values of the geological and mining heritage. This conference is not limited in geographic or chronological scopes and welcomes contributions from all relevant topics. Note that the congress languages will be Spanish, Portuguese, and English.	http://www.sedgym.es/ rocpetrus@gmail.com mhunt@us.es
HMS Conference - Metallurgy in warfare: A spur to innovation and development 3rd-5th 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.	http://hist-met.org/meetings/annual-conference-2014-metallurgy-in-warfare.html mejbirch@aol.com