THE CRUCIBLE

Historical Metallurgy Society News

Issue 86 Summer 2014

Slag tapping during the experimental iron smelting in Dorset

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.

The Crucible
thecrucible@hist-met.org
c/o Marcos Martinón-Torres
UCL Institute of Archaeology
31-34 Gordon Square
London WC1H 0PY
United Kingdom

www.hist-met.org

Inside The Crucible

The HISTORICAL METALLURGY Society

From the Chairman's Desk

It is with some surprise that I find myself writing the 'From the Chairman' piece again. It is almost four years since I last did so (HMS News 76) and in many ways it feels a very short interval. When I look back over the last few issues of HMS News (now **The Crucible**) it reminds me, however, just how far HMS has come in that period under the chairmanship of Paul Belford. The transformation in the Society, including the active Facebook page, the wonderful new-look Crucible and the completely rejuvenated website (**http://hist-met.org/**) with its online shop, is remarkable. Paul's three years as Chair also saw a series of excellent meetings, culminating in the events of the anniversary year, but also more recently the field trip to Ireland in April (organised by Paul Rondelez, see p24 this issue) and the 'Metals in Personal Adornment' conference in Birmingham in May (organised by Eleanor Blakelock). It is very humbling to be elected as Chairman again and I look forward to the challenges of the years ahead – and challenges there most certainly are.

The Annual General Meeting in May was remarkable in many ways. The timetabling of the AGM within the Birmingham meeting meant that it must have been one of, if not the most well-attended AGMs, with 48 members of the Society present! It also saw the election of a 'new-look' Council. Five long-standing members of Council either retired or resigned (Louise Bacon, Paul Belford, Paul Cort, Gerry McDonnell and Colin Phillips); they will all be missed for their significant contributions over many years. Existing Council members Eleanor Blakelock and Vanessa Castagnino were elected into new posts as Events Officer and Communications Officer respectively, consolidating the crucial roles they play in the life of the Society. Rachel Cubitt, Peter Halkon, Gill Juleff, Andrew Naylor and Jonathan Prus were elected into the vacancies for ordinary members of Council. This all amounts to a significant change of personnel and I am looking forward enormously to working with the new team.

So what challenges face the Society in the near future? Perhaps the most immediate and pressing is the long-held ambition of establishing the journal's presence on the internet. A prerequisite for this is the elimination of the publications backlog and a strong 'roadmap' for that to be achieved by next winter is now established. The changes affecting academic publishing, including the concept of 'Open Access', have implications for the financial structure of the Society, so the decisions to be made in the very near future are more fundamental than those faced by the Society for many decades.

Intimately associated with the use of the internet as a medium for distribution of the Society's publications, is the need to place its relationship with current and potential members outside the UK on a more dynamic and ambitious footing. The journal already has a very high proportion of articles produced outside of Britain and overseas delegates are increasingly populating HMS conferences, but development of the Society's international relations are a key priority. Various mechanisms are under discussion, but Council would welcome ideas and suggestions as to how this might best be pursued.

The Society would also welcome the contribution of new members of its various committees. I realise that an encouragement to volunteer is a regular plea in these pages, but it is nonetheless important. The issue of 'internationalisation' is one not just for Council and for publishing, but is also present in all the other workings of the society, so it would be wonderful to be able to welcome members of the wider HMS 'family' into the team to drive forward the Society forward in the coming years! All offers gratefully received…

Tim Young

ABRAHAM DARBY II: A LIFE LESS ORDINARY

In 2011, the Ironbridge Gorge Museum Trust celebrated the 300th anniversary of Abraham Darby II's birth by creating the 'Abraham Darby II: Life, Work and Legacy' exhibition at the Museum of Iron, Coalbrookdale. In preparing this exhibition it became abundantly obvious that he was a man of great vision, drive, intellect and humanity. It also became clear that his achievements were perhaps not always appreciated given the blurring of these with those of his father, his son, and his nephew, to the point where the impression is given that Abraham Darby of Coalbrookdale '*combined the innovative versatility of Leonardo da Vinci with the longevity of Methuselah, and was making inventions at Coalbrookdale from the dawn of the 18th century until the Great Exhibition of 1851'* (Trinder 1974, 2). Therefore, on the occasion of the 250th anniversary of his death (31st March 1763), it was thought appropriate to produce a synthesis of our knowledge about Abraham Darby II and his custodianship of the Coalbrookdale Company. What follows is an abridged version of the paper arising out of this research, which is available at https://bham.academia.edu/ShaneKelleher or directly from the author.

Abraham's life

Abraham Darby II, the eldest son of the ironmaster Abraham Darby, was born at Madeley Court, Shropshire on May 12th 1711. He was described as '*small, slight of build, yet strong and active, with very bright black eyes'* (Hannah Rose). His father died when he was only six years old and when his mother Mary died a few months later he was brought up at Dale House, Coalbrookdale by his eldest sister Mary. Mary's husband Richard Ford, who along with Thomas Goldney had partnered Mary Darby in forming the Coalbrookdale Company, protected Abraham's interests until he completed his studies at the Quaker school run by Gilbert Thompson at Penketh, Lancashire.

In 1734 Abraham married Margaret Smith of Shifnal with whom he had three children. Tragedy struck in 1740 when his wife and sons died of illness. His sister Mary helped him raise Hannah until he married Abiah Sinclair (nee Maude) five years later. Abiah was the daughter of an important Quaker family in Sunderland, and together they had 7 children, 4 of whom survived to adulthood; Mary, Abraham, Sarah and Samuel. They lived at Dale House until 1750 when they moved to Sunniside House nearby. Abraham was prominent in the affairs of Quaker meetings at Coalbrookdale, Broseley and Shrewsbury, and was considered to be one of the most esteemed, active and trusted Friends in the area. Abiah became a Quaker minister in 1748.

Abraham assumes control

Richard Ford consolidated Abraham Darby's legacy during a vulnerable period and developed new ways for the company to expand its portfolio and capacity. He had seen an opportunity in the recent development of steam power, and in 1722 the company became the principal manufacturer of cast iron cylinders for Newcomen engines. In addition, in 1729, the Coalbrookdale Company cast the first ever iron railway wheels, and installed an innovative water recycling system using horse-drawn pumps, which extended the period in which the furnace could be sustained in blast.

In 1728, upon completion of his studies, Abraham Darby II was apprenticed to Ford and his interest in and understanding of the furnace and foundry side of the business meant that he soon assumed a major role in

The Coalbrookdale Quaker Burial Ground being recorded during a recent Festival of Archaeology event © Ironbridge Gorge Museum Trust

running the company and was ready to assume control when Ford died in 1745. One of his key improvements prior to this, in what is understood to be the '*first time that steam power was applied in the development of the iron industry'* (Thomas 2001, 30), was the construction of a Newcomen Engine in 1742 to replace the horse drawn pumps that had been installed by Ford (see Belford 2007, 136). This marked the beginning of a process which would see the end of the iron industry's reliance on a source of running/stored water, an innovation '*which for more than three decades provided one of the principal foundations for the development of the iron industry'* (Trinder 1974, 18). The Coalbrookdale Company was to greatly increase its profile and importance to the point where the impetus that Abraham's ingenuity *'generated in the iron industry was the spark that facilitated the take off of the Industrial Revolution in the country at large'* (Thomas 2001, 5).

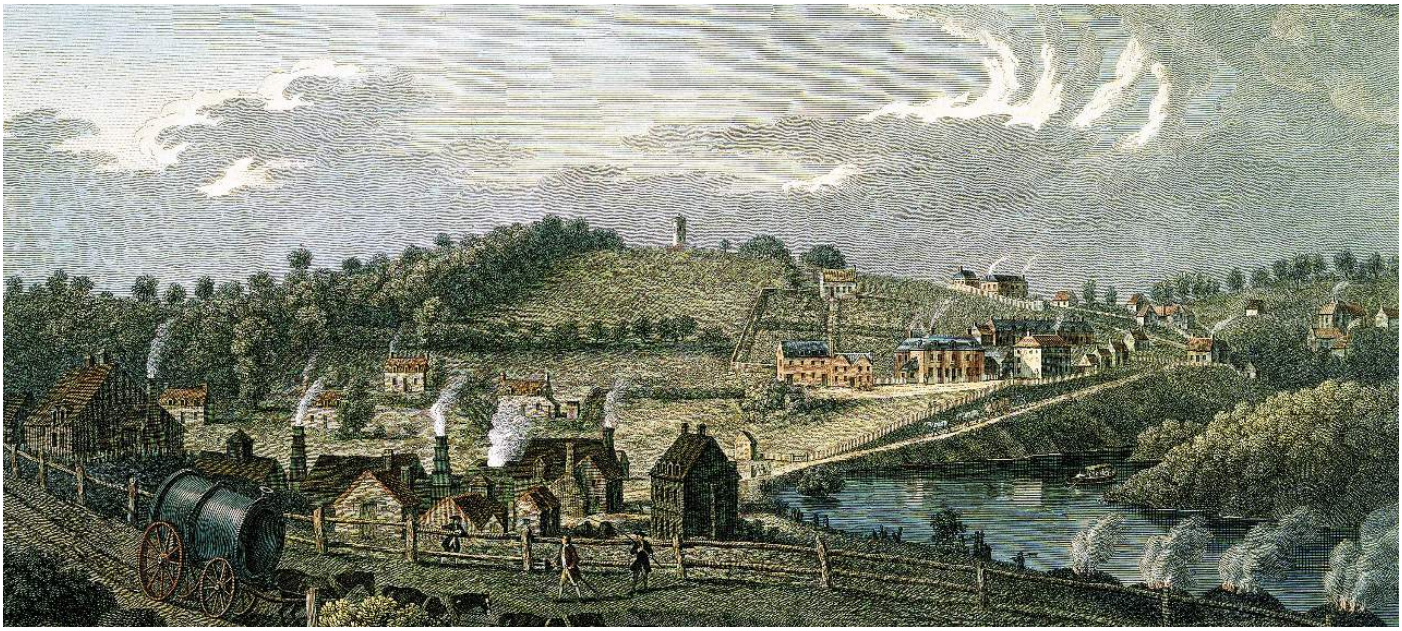
Abraham's breakthrough

Abraham's strategy was driven by an ambition to develop his father's legacy by producing coke-fired pig iron that could be used in forges for conversion to wrought iron and an awareness that reserves of iron ore and cinder in the Forest of Dean were near to exhaustion (Thomas 2001, 31). He set about examining the suitability of local ores and coals sensing that if he could '*supply a bar iron acceptable to the forge owners this would provide a major breakthrough in the business of the Company'* (Thomas 2001, 31) and move it into the mainstream of the iron trade.

Abraham's successful experiment c.1748 has been immortalised in a tale recalling how he spent 6 days and 6 nights at the furnace waiting for molten iron of an acceptable quality to run from the tapping hole when he collapsed and was carried home by his workmen. Trinder (1974, 19) observes that it is difficult to understand what was new in this process, however *'one of the secrets was certainly the careful selection of grades of iron ore with a low phosphorous content'*, although given the fact that there was *'virtually no knowledge at that time of the chemistry of iron and the significance of phosphorous'* Abraham's experiments would have been based upon his own extensive practical knowledge of iron production and the quality of local ores (Thomas 2001, 31). We are given a great insight into what happened next by Abiah- *'he sent some of our pig iron to be tried at the forges, and that no prejudice might arise against them, he did not discover from whence they came, or of what quality they were. And good account being given of their working he erected Blast Furnaces for pig iron for Forges'* (Labouchere 1988, 67).

Abraham's 'breakthrough'?

A recent examination of the Coalbrookdale Company's accounts shows that the above account is over simplistic (King 2011). He deduces that '*any technological difficulties in the use of coke pig iron in finery forges were overcome before 1728'* (King 2011, 132) but the depressed state of the British iron trade in the 1730/40s, due to Russian imports, *'discouraged the introduction to the market of coke-smelted forge pig iron, until the industry benefitted from an economic upturn in the 1750s'* (King 2011, 154). Nevertheless, King notes that there is *'no reason to doubt Abiah Darby's accounts of events'* (2011, 153), and actually provides fresh evidence to show that the Coalbrookdale Company was producing coke-fired pig iron for use at forges in the Stour Valley in 1754. Whilst Abraham may not have made the breakthrough of 'inventing' the process of, he certainly knew how to exploit it once it became economically viable. Furthermore, his importance to development of the iron industry was never reliant on



The Coalbrookdale of Abraham Darby II- 'View of the Upper Works at Coalbrookdale' 1758 by Francois Vivares. Note the cast iron steam engine cylinder in the foreground. © Ironbridge Gorge Museum Trust

this 'breakthrough'. His achievements were those of a *'coordinator rather than an inventor, a deviser of systems rather than processes'* (Trinder 1974, 23).

Abraham's 'Blast Furnaces for pig iron for Forges'

In 1754, Abraham raised capital to build the first purpose-built coke-fired blast furnace for producing iron suitable for forges at nearby Horsehay. Despite local derision, the whole operation, which as at Coalbrookdale *'ingeniously compensated for the inadequate water supply by using steam pumping engines to recycle water for the waterwheels'* (Hayman 2001, 39), was in blast by May 1755, and its success was '*spectacular and more or less immediate'* (Thomas 2001, 74) and was competitive with furnaces in which charcoal was used-previous to this the output of coke furnaces had been much lower in comparison (Trinder 1977, 4).

Abraham rejected calls to take out a patent for his new method saying that he *'would not deprive the public of such an acquisition'* (Thomas 2001, 74). Trinder sees this as possible proof that Abraham's experiments and 'breakthrough' encompassed *'something more than the choice of raw materials'* (1974, 19). Horsehay's output '*was as great as that of the largest charcoal-using furnaces, and it produced pig iron which could be forged into a good quality wrought iron'* (Trinder 1977, 4). Such was the success of this furnace, which was producing 22 tons of iron a week that soon Abraham built another furnace at Horsehay and 2 more at the Ketley. Abiah paints a colourful picture of celebrations to mark the opening of the second Horsehay furnace: *'we...dined upwards of 300 people so that our Family that day was large with poor folks besides. We killed a fat Cow, and fatted Calf: hams: and 10 large puddings full of fruit: and 2 hogs heads of drink. We carried it up in Railway Wagons and had 4 tables spread under covers'* (Labouchere 1988, 76). The success of Horsehay was soon imitated, and the company expanded into nearby Dawley, Lawley and Wombridge. In all, 9 blast furnaces were built within 6 kilometres of Coalbrookdale between 1755-8. For the rest of the 18th century the East Shropshire Coalfield was to remain the principal iron-making district in Britain.

Abraham's railway system

Abiah's reference to 'Railway Wagons' provides an insight into another important facet of Abraham's strategy. Despite a long-standing tradition of primitive wooden railways being used in the area, it wasn't until 1749 that a line was built to supply an ironworks. This proved to be the '*first of many lines that the partners were to build over the next hundred years'* (Trinder 1974, 19). Abiah records the shift to railway transport in a letter: *'...they used to carry all their mine and coal upon horses backs but he got roads made and laid them with sleepers and rails, as they have then in the North of England for carrying them to the Rivers, and bring them to the Furnaces in waggons... That of Iron Wheels and Axle trees for these waggons was I believe my husband's invention'* (Thomas 2001, 121-123).

Abraham's vertically integrated company

The railways helped control the supply of resources to the company's ironworks. Abraham soon developed upon this by securing an extension to the lease for the Coalbrookdale works, establishing a wharfage on the Severn, taking out leases for the mining rights to large coal and ironstone resources, and the purchase of lime-works and brickworks. The company also leased local farms in order to provide horses and fodder for their works. The final link in this network of operations, came with the construction of a railway from Coalbrookdale to the newly established wharfage. This meant that the company was in complete control of all of its operations. The strategy of vertical integration was imitated by other Shropshire ironmasters such as John Wilkinson, and prompted collieries to build their own blast furnaces, such as the Madeley Wood Company's at Bedlam Furnaces, and soon ironworks in Shropshire became *'some of the largest enterprises in Britain'* (Trinder 1974, 20).

Abraham's legal battles

The 1750s was a decade of unprecedented triumph for the company. However, Emyr Thomas has provided an insight into what was also a decade of *'turmoil and controversy'* which Abraham and his partners were at the centre of a '*bitter and ultimately ruthless struggle between the new and vigorous elements of industrial society and the old traditional power exercised through the historic ownership of land'* (2001, 5). Considerable opposition to almost all of the innovations that Abraham was trying to implement lead to a war of attrition which *'nearly brought the company to its knees, and at one stage even threatened the continued existence of the company in Coalbrookdale'* (Thomas 2001, 29).

The litigation records certainly provide context to a letter written by Abiah following Abraham's death: *'He had an extraordinary command over his own spirit, which with the assistance of the Divine Grace enabled him to bear up with fortitude above all opposition, for it may seem strange, so valuable a man should have antagonists, yet he had those called Gentlemen with an envious spirit, could not bear to see him prosper, and others covetous strove to make every advantage by raising rents of their Collieries and lands in which he wanted to make roads and endeavour to stop the works, but he surmounted all; and died in peace beloved and lamented by many'*. Thomas suggests that the sense of elation and pleasure that Abraham must have felt thanks

The Coalbrookdale of Abraham Darby II- 'View of the Upper Works at Coalbrookdale' 1758 by Francois Vivares. Note the cast iron steam engine cylinder in the foreground. © *Ironbridge Gorge Museum Trust*

to the unprecedented achievements of the company, were spoiled by the legal proceedings. These must have caused great stress and are likely to have exacerbated health issues, which led to his untimely death.

Abraham's legacy

Abraham died on the 31st of March 1763 aged 51. He was buried in a plot of land which thereafter became the Friends burial ground for Coalbrookdale. The company was entrusted to Richard Reynolds, husband of Abraham's daughter Hannah, until Abraham's eldest son Abraham Darby III was old enough to take control of the business. He was to make his own indelible mark on history.

In terms of the history and development of the iron industry, and consequently the Industrial Revolution, Abraham Darby II occupies a uniquely critical position. His skills as a coordinator and deviser of systems heralded what Richard Arkwright famously was to establish in the cotton industry some decades later. He was the first to apply the use of steam in the iron industry; he established the superiority of coke-fired iron; his railway system was a harbinger for the development of the modern railway to the point where it would soon run the first cast iron rails (1767) and probably carried the world's first railway locomotive (1802); he developed the first vertically integrated ironworks; and expanded and nurtured the Coalbrookdale Company to a point where, under his son Abraham's leadership, it was the largest iron-making concern in Britain which had the confidence, capital and imagination to build the world's first iron bridge.

Shane Kelleher
shane.kelleher@ironbridge.org.uk

Belford, P. 2007 'Sublime cascades: water and power in Coalbrookdale', *Industrial Archaeology Review*, 29, 2, pp. 133-45.

Hannah Rose. 'Some account of the Family of the Darbys; being what Hannah Rose has heard her Parents, John and Grace Thomas, concerning them'. *Lady Labouchere Collection*, IGMT.

Hayman, R. 2005, *Ironmaking: The history and archaeology of the British iron industry*. Stroud: The History Press

King, P.W. 2011 'The choice of fuel in the eighteenth-century iron industry: the Coalbrookdale accounts reconsidered', *Economic History Review* 64, 1, pp.132-156.

Labouchere, R. 1988, *Abiah Darby 1716-1793 of Coalbrookdale. Wife of Abraham Darby II. York:* William Sessions Limited

Thomas, E. 1999, *Coalbrookdale and the Darby Family. The story of the world's first industrial dynasty*. York : Sessions Book Trust.

Thomas, E. 2001, *Coalbrookdale in the 18th Century. Based on a study of litigation in which the Coalbrookdale Company were involved between 1749 and 1786*. Coalbrookdale.

Trinder, B. 1973 (rev. 2000), *The Industrial Revolution in Shropshire*. Chichester: Phillimore & Co Ltd.

Trinder, B. 1974 (rev. 1991), *The Darbys of Coalbrookdale* (Chichester: Phillimore & Co Ltd.

HMS ARCHIVES AND COLLECTIONS

The HMS Archives and Collections Committee (ACC) is organising a study/work day at the Long Warehouse, Ironbridge Gorge Museum Trust, Coalbrookdale on Saturday 27 September 2014. All HMS Members are welcome and invited to attend to gain an insight into the work of the ACC.

After a brief introduction, it is intended that workshop sessions on the management of the collections will be held. These will be "hands on" and as was evident from previous study days, will achieve useful progress in cataloguing and protecting the collections rather than just be set piece "exercises".

Please see Andrew Naylor's review in The Crucible No.83, Summer 2013.

Sessions will cover both the paper archives and the slag collections. We hope that participants will choose to split their time between the two, but if necessary it will be possible to select either one or the other.

Tea and coffee will be provided, and lunch at a cost of £4.00. Car parking at the Museum of Iron will be available free of charge.

Booking form is available on the HMS website www.hist-met.org

Group photo of all participants of the workshop next to Furnace 2.

EXPERIMENTAL IRON SMELTING IN DORSET: PRACTICE VS THEORY

For three days in late June 2014, and under the auspices of the Narnia International Training Network (www.narnia-itn.eu), a mix of international early career researchers led by Marcos Martinón-Torres from the UCL Institute of Archaeology explored the challenges and rewards of traditional iron smelting. The experiments took place at Down's Farm, located in the neighbouring parish of Six Penny Handley in Dorset. The proprietor of the farm, Martin Green, shared a passion for archaeology and the local history of his estate. The property is located upon a culturally and historically rich environment that included Neolithic, Bronze Age, Iron Age, Roman, Medieval, and Victorian sites. Most recently were the furnaces created by Jake Keen, which he has been constructing for decades on the farm's land. With the generosity of Martin and expertise of Jake, the metallurgical group from set the lofty goal of producing a viable iron bloom.

The project was set for three days with two smelting attempts using different ores and different furnaces. The first experiment was to use a smaller furnace 1.5m high (operated with a vacuum cleaner bellow) and ore from local English sources. The second using the newly built 4m high shaft (natural draft) furnace and employing a mixture of local and foreign ores. While the first furnace was tested and ready to go, the second furnace was still under construction. The group was split into multiple teams to tackle our first challenges: cutting wood, ore processing, breaking down an older furnace, and constructing the new furnace.

We had access to three different ores: hematite (from Sudan), siderite (from England), and limonite (from England). Processing the ores started with beneficiating the material by removing the unwanted mineral inclusions, mainly flint from the siderite and limonite. The hematite were pure enough that it did not require the same level of beneficiation. After which, the ores were roasted overnight to release any undesirable impurities, as well as create micro-cracks within the stone for easier crushing and gas penetration in the furnace.

A pre-existing furnace was broken apart for the reuse of its clay in the construction of the new natural draft furnace. This involved crushing the furnace wall into powder, sifting large inclusions out, and processing the powder with water, hay, and white clay into new material for the furnace. The furnace was built in layers, with a resting

Ore crushing and beneficiation.

The smaller furnace 1 operated with vacuum cleaner bellow

period and heating period every half a metre or so to insure stability of the furnace walls. This took the better part of two days, with Jake working on the furnace even when the group was not at the farm.

After a night of roasting, the ores were sorted and crushed. Each ore type was then weighed with a total weight of 12kg of hematite, 12kg siderite, and 27kg limonite. The

A trickle of slag during the tapping of smaller furnace 1.

ores were placed to the side so we could conduct our first experiment using a local hematite (pre roasted and beneficiated by Jake) in the smaller furnace.

The first experiment was under the pretence of using only one type of ore (approx. 25kg) and a ratio of 1:1 with charcoal. By using one type of ore for this experiment, we wished to measure the efficacy of the ore at hand. The furnace was lit at 10am with the first charge going in an hour later. Charges, containing a mixture of ore and charcoal, were dropped into furnace from the top of the shaft every 10-15 minutes. To keep a continuous and even airflow a vacuum cleaner was rigged to the tuyere. However, about 90 minutes into the experiment the airflow was increased. This, we suspect, was the reason why the bloom formed a layer of steel around the iron core. Likewise, and as predicted, the bloom formed on the side of the tuyere directly under the airflow.

The experiment lasted roughly 4 hours, during which time we witnessed both flowing tap slag and more solid furnace slag. The slags were removed throughout the smelting process to avoid blocking the furnace. They were placed near the side of the furnace in chronological order. The

A bloom just been extracted from the smelting furnace consolidated by hammering.

Cross-section of the bloom produced from Furnace 1.

bloom was located below the tuyere and behind a large piece of furnace slag. Once taken out of the furnace it was consolidated by Jake using a small hammer on a wooden stump. The final weight of the bloom was 2.4kg from the 25kg of ore; the size which was predicted from our calculations. The slag was then placed in chronological sequence, classified by surface features, weighed and selected pieces sampled for further study.

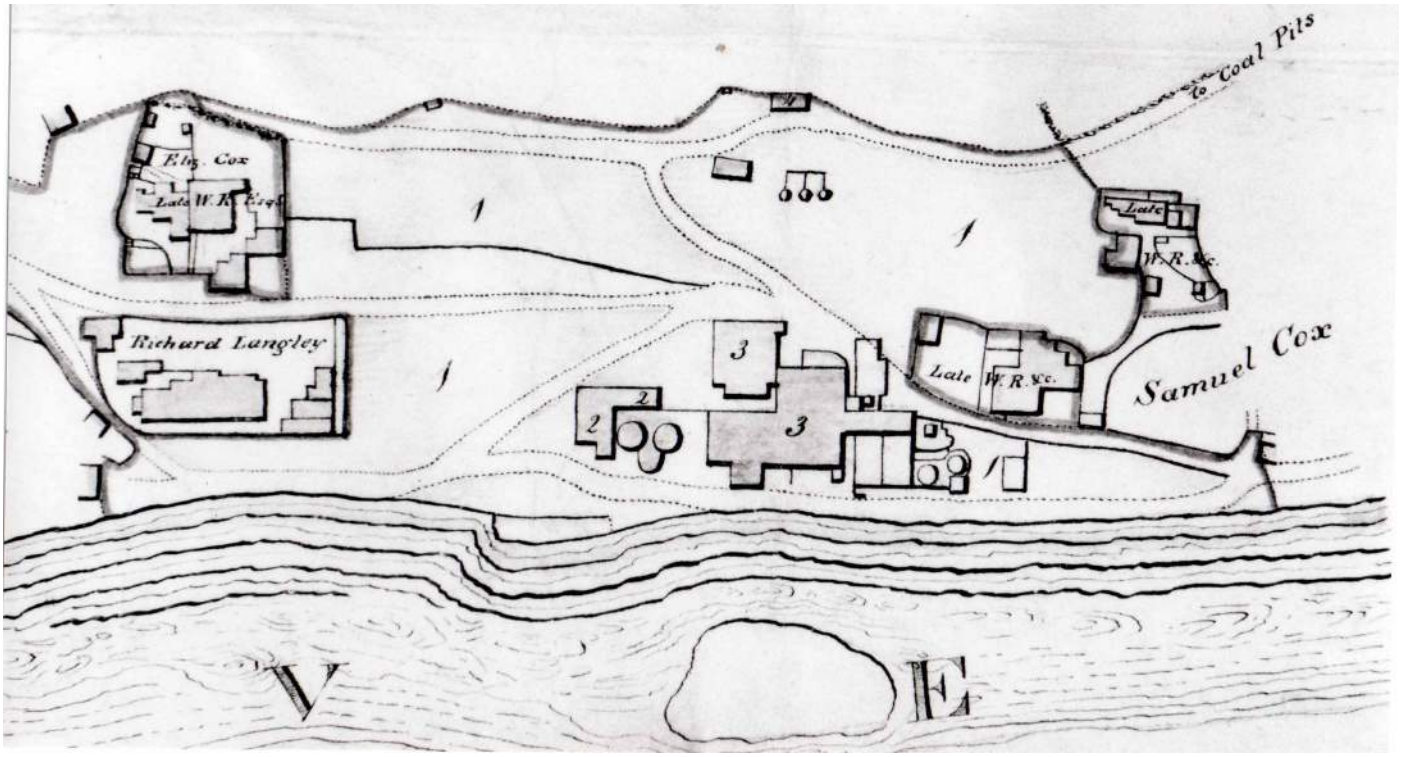
The experiment was hailed as a success! We had produced a bloom and learned a considerable amount about iron smelting.

Our next goal was considerably more ambitious, using twice as much ore and charcoal (50kg each) while smelting in a furnace 3 times as high. It was evident through the first smelt that the majority of the work was spent processing the ores and constructing the furnace. The only major process we did not undertake was making our own charcoal. Thus, once we had the large furnace built, the ore ready, and the fire started, it was merely a matter of adding charges (a mixture of 4kg of charcoal, 1kg of hematite, 1kg of siderite, and 2kg of limonite) to the top of the shaft down into the furnace. This process, however, took considerable more time. The furnace was lit in the morning and the first charge was added before noon. Charges of 5kg of mix ore and charcoal were added to the furnace every 15 minutes (roughly 20kg of charcoal/ore mix per hour). This lasted until the mid-afternoon when the charge was allowed to burn down. Around 4pm the bottom of the furnace was tapped, leading to successful liquid slag. However, as we learned first-hand, even with liquid slag, 50kg of ore, and a 4m tall furnace, a bloom was not guaranteed. While we did produce a small metallic feature, it was not what one would call a successful bloom. Some of the problem identified included hematite sintering together rather than melting, a lack of airflow, and possibly just not enough ore and charcoal for the furnace we were using. It is also possible that the smelting process was interrupted, by opening the bottom for tapping the slag, before the ore had the time to smelt and form the bloom.

The larger furnace 2 with chimney.

Overall, we gained significant perspective on just how complex and challenging it is to smelt iron. From logistical factors such as acquiring ore, charcoal, and clay to methodological factors such as temperature, airflow, and running-time of the furnace, smelting a single bloom of iron was an honest feat. A large part of this experiment revolved around the notions of taught vs learned skills. Here, a collective group of 20 highly educated students (and one professor) still could not match the knowledge of a single gentleman (Jake) whom without knowing what type of ore he was using, was still correctly identifying iron-rich materials and had the ability to control his furnace without laboratory equipment. Here Jake, which he so effortlessly demonstrated, was the master behind the scenes. He was the working notion that we try to unravel in the labs and off the bookshelves. Jake did not need a temperature guage for the fire; he just looked at the flames. Where we needed textbooks to determine the contents of the ores, Jake needed only his hands. We came to Down's Farm in an attempt to smelt iron; something which we succeeded in doing. We also succeeded in understanding the triumphs and tribulations that early iron smelters had to go though in order to produce iron, which today seems so common place. Away from London we were able to engage in practice over theory, to take our knowledge into the field, and to see first-hand the rigors and rewards of iron smelting.

Ben Turkel
Carlotta Farci



Detail of a lease plan showing Bedlam and its surroundings, undated but probably surveyed in the early nineteenth century and labelled with numerical references. North is at the top of the picture and the River Severn is on the south side. (1) represents coke yards on the hillside to the north and west of the works. (2) is the smithy and the engine house with its round boilers clearly visible. (3) represents the blast furnaces, charging houses and foundry. Just south east of the furnaces the plan depicts two round coke ovens, with square stacks. North east of the works are cottages let to the late William Reynolds & Co. On the left (west) of the picture is the Jacobean house known as Bedlam Hall, which by the early 19th century was tenements let to William Reynolds and Elizabeth Cox. Immediately below it are the two cottages on Waterloo Street, let to Richard Langley. Courtesy of Ironbridge Gorge Museum Trust.

THERE IS NO BEDLAM ENIGMA

Paul Vigor's article about Bedlam furnaces, published in issue 85 of The Crucible, makes misrepresentations, false claims and offensive remarks that must not go unchallenged. His subject is the Madeley Wood, or Bedlam, ironworks near Ironbridge, in operation from about 1757 to 1843. Mr Vigor claims that the present furnace site, owned by the Ironbridge Gorge Museum Trust, is not the original site, and that he has found evidence of an earlier site incorporated within houses on the adjoining Waterloo Street.

Mr Vigor directs plenty of criticism at an archaeological study of Bedlam undertaken in 1994-95 by the museum's archaeology team, which is the most detailed study of the site to date. I was the person who led the recording of the site, interpreted it in an unpublished report for English Heritage (IGMT 1996), and wrote the Bedlam chapter for the subsequent monograph published by the CBA (Hayman, Horton & White 1999). I was employed at Ironbridge from 1994-99, although of course now speak only for myself.

I visited the buildings on Waterloo Street in 1995, at the invitation of the owner, who thought he had found a remnant of an old blast furnace in his garden. I did not agree with him, but when Paul Vigor's dissertation appeared the following year the subject was not new. Contrary to the impression he gives, his dissertation was not regarded by the Ironbridge Gorge Museum Trust as controversial. His work was discussed by me with many colleagues, both in the archaeology and curatorial teams, and with the chief executive. The unanimous conclusion was that it was just wrong.

Whether his methods are orthodox or unorthodox is beside the point. His hypothesis is simply unconvincing. He claims to have made a *'thorough, robust, evidence-based'* study, but his dissertation, and the material in his recent article, is light on fieldwork and heavy on speculation. His article presents none of the evidence he says he has found – no photos or drawings of bob walls and tunnel heads. His piece ends with verification of *'significant, standing industrial archaeology'*, which is hardly an impressive return after so many years of study. Paul Vigor's analysis of pictorial and cartographic evidence is self-serving. For example, he cites a watercolour drawing of Bedlam, attributed to Edward Dayes (1763-1804), but dates it c1770

solely because his hypothesis unravels if the drawing is later. It is the classic error of tailoring the evidence to fit the conclusion.

Paul Vigor also misinterprets a lease plan of Madeley Wood which was included in a bundle of leases dated 1840, but was clearly surveyed much earlier. Annotations refer to the Late William Reynolds & Co (he died in 1803) and were clearly copied from an earlier plan. This was not unusual. Lease plans quite often copied earlier plans, whatever inaccuracies they introduced, a problem also encountered in Coalbrookdale in the early nineteenth century. Another example is a Madeley Wood lease of 1858 that shows the Bedlam furnace buildings long after they were demolished (this is discussed in more detail in Hayman, Horton & White, 1999, 63-64). The plan probably dates to the first decade of the nineteenth century, and shows the ironworks before a third furnace was built there c1806-10. The buildings studied by Mr Vigor are also on the plan, as houses let to Richard Langley and not as an ironworks let to William Reynolds. They stand directly below Bedlam Hall, the house made famous in de Loutherbourg's painting Coalbrookdale by Night. If these buildings really were part of a blast furnace complex, residents of Bedlam Hall would almost have been able to open their windows and charge the furnaces themselves. But he has produced no evidence of furnaces here. Mr Vigor has used de Loutherbourg's painting, and a similar view by Paul Sandby Munn, to support his own theory, but both artists placed Bedlam Hall in the foreground, with the furnaces in the background, just like the lease plan.

A more serious matter concerns how public discourse should be conducted. Mr Vigor makes several objectionable comments about the archaeology team that worked on Bedlam in the 1990s. Comments like the charge that we were *'philosophically restricted'* by our *'orthodox'* minds are gratuitous and add nothing to his own case. The 'in conclusion' section of his article is obnoxious. A typically snide remark is his claim to have contacted *'respected individuals'* with an interest in Bedlam. Needless to say, he excludes me from that category – a petty slight if ever there was one. He questions whether the archaeology team were up to the task of studying Bedlam because they were classically trained field archaeologists, a charge that would be the undoing of many leading industrial archaeologists. When he remarks condescendingly that I was working on '*unfamiliar industrial and metallurgical archaeology'* he shows how badly informed he is. He should admit his ignorance and withdraw the smear.

He is wrong to say that we failed to deal with *'new, original research that challenges … orthodox thinking'*. We considered the challenge and rejected it, and disagree that our thinking was orthodox, a word he uses as code for intellectual inferiority. He wrongly accuses us of failing to interact with other disciplines – in fact English Heritage appointed an expert referee for the project stages who is not a field archaeologist, and it worked well. He accuses us of failing to incorporate his alternative findings in our peer-reviewed monograph. If he had produced some decent evidence, we would have used it. During his study of the buildings in Waterloo Street he never interacted with the museum's archaeology team, or sought to tap our Bedlam expertise. It was his choice to work '*single-handed and unsupported'* – a damning indictment of his dissertation supervisor! His professed desire for a spirit of collaboration between disciplines is strange, given that his dissertation was presented in such a tendentious manner, betrayed by its self-glorifying title, 'The Breaking of the Bedlam Enigma'. There is no Bedlam enigma.

Your readers should be aware that the archaeological study of Bedlam in the 1990s provided a radical new understanding of the site. We did not struggle to explain it to our archaeological funders, as Mr Vigor sneers. Among other things, it was the first study to identify the survival of the cone-shaped brick stack of a blast furnace, which was previously interpreted as a brick kiln.

Bedlam furnaces are an important site of the coke era and the remains are fragile and vulnerable. Our primary function as archaeologists was to explain Bedlam to the public (see Hayman & Horton 1999; Hayman 2005) and to provide an informed basis for conservation. I can assure members of the Historical Metallurgy Society that all of the archaeology team at Ironbridge did and do take their responsibilities very seriously, even eighteen years after we finished our work there.

Dr Richard Hayman

Hayman, R, 2005, *Ironmaking: the history and archaeology of the iron industry.* Stroud: Tempus.

Hayman R, and Horton, W, 1999, I*ronbridge: History & Guide*. Stroud: Tempus.

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

IGMT, 1996, *Bedlam Furnaces.* Unpublished report for English Heritage.

Response to Dr. Richard Hayman.

I am very sorry that Dr Richard Hayman thought my research was based on misrepresentations and false claims, and I'm sorry he found some of my remarks offensive – they were not meant to be. My intention was not to smear anyone's reputation, I was attempting to challenge ideas, not individuals.

I was in no way suggesting that the Ironbridge archaeological team didn't take their responsibilities seriously, I sought to challenge their findings, and provide an alternative interpretation of the available evidence, in the spirit of academe.

I was drawn initially to research the Madeley Wood/ Bedlam Furnace landscape by enigmatic, and apparently unexplained, primary sources that referred to upper and lower furnaces, and tempting allusions to the possibility of a second fire [steam] engine at the Bedlam Furnace site; references to which I discovered in the archaeologist's 1996 report. Apparently, these challenging, contemporary references to upper and lower furnaces at Bedlam remain an unexplained historical and archaeological enigma.

To clarify: when I said that I worked *'single-handed'* – I was not a staff member of an archaeology unit or museum; and *'unsupported'* – I was a self-funded student. My dissertation supervisor was brilliant. He, and my friends and colleagues on the 1995-96 Ironbridge Institute IA course, encouraged my Bedlam Furnace research, as did one member of the IGMT Archaeology Unit.

The buildings I investigated were all occupied as private homes by private people. I was well aware that a grant of archaeological access is a great privilege, and not a right. Whilst the measuring of major features was just about possible; prolonged access for meaningful flash photography, and to produce proper archaeological drawings in dark, congested spaces, presented problems. I was aware of my responsibilities as an invited guest in people's houses, and had no wish to impinge on their generous hospitality.

Beyond Ironbridge, my 1996 Bedlam Furnace research has received informed support, endorsements and awards. For example: I have received kind, supportive and encouraging words from historical and archaeological friends and colleagues; a wonderful, informed project endorsement from the late Stuart B Smith; and the Association for Industrial Archaeology's Initiative and Student Awards for Fieldwork, 1997.

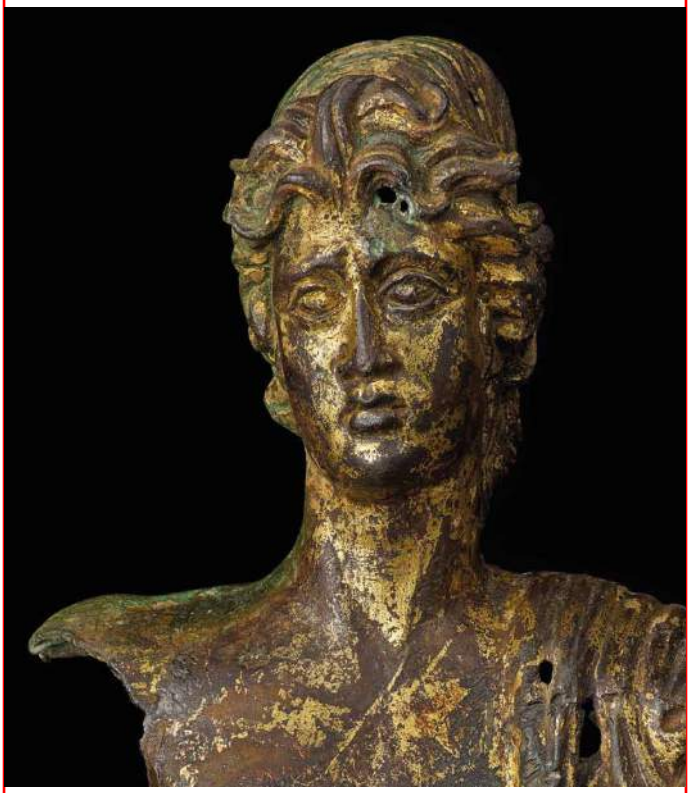
I have presented my 1996 Bedlam Furnace findings for critical discussion at subject-specialist conferences: AIA, Newcastle-upon-Tyne, 2007; 'Industrial Archaeology in Shropshire', poster display and Bedlam Furnace fieldtrip, 26-27 June 2004; and the Ironbridge Gorge Museum/ University of Birmingham's excellent 'Rust, Regeneration and Romance' event in July 2013, where my Bedlam paper was well received by impartial, subject-specialist, home and international delegates.

I offer my apologies to Dr Richard Hayman, and his colleagues at the Ironbridge Gorge Museum Trust as I did not wish to hurt anyone's feelings, I was simply attempting to offer an alternative interpretation of the facts. I was acting in the spirit of Peter Crew's wise advice to archaeological and historical metallurgical students: *'question everything, even the most firmly-held ideas, especially your own, go back to basic principles, think the unthinkable and then more.'*

Paul Vigor

BROKEN SPLENDOUR: LARGE ROMAN BRONZES FROM THE UNESCO WORLD HERITAGE LIMES

A major exhibition on large Roman statuary from along the German limes is currently on show in Bonn (until 20 July 2014), and is then due at the Limesmuseum in Aalen, southern Germany (16 August 2014 to 22 February 2015) and at the Museum Het Valkhof Nijmegen, Netherlands (21 March to 21 June 2015). This is one of the outputs of a major research project, funded by the VolkswagenStiftung as part of their programme to make collections and museums more accessible to current research, which has brought together historians, art historians, and scientists to document and study the wealth of bronze statuary that formed part of the limes and its immediate hinterland and infrastructure.



The exhibition is accompanied by a substantial hard-cover book (in German) offering in-depth background chapters to the topic, and many brief sections on individual items and assemblages on show. Several of these are of particular interest to more technologically-minded readers, but all of them are informative, well-written and well-illustrated.

For more information visit: **http://www.landesmuseum-bonn.lvr.de/de/ausstellungen/gebrochener_glanz_2/gebrochener_glanz_3.html**

Justine Bayley

MORE PRESERVED BESSEMER CONVERTERS

In the Spring 2014 issue of 'The Crucible' page 3 'A compilation of known Bessemer Converters' I incorrectly said that the Bessemer convertor at the Pretoria works in South Africa had been destroyed when hot metal making at the works ceased. I had been told this by a former manager of the site but have been contacted by a local resident, Chris Pistorius who has kindly corrected me on this matter. The converter survives today and can be viewed on Google Street View by clicking **here**.

Pretoria Bessemer Converter. Alive and kicking

Also, I listed a vessel at the Blaenavon works in South Wales as the Thomas pilot plant. It is in fact a cupola furnace. Thanks to Robert Protheroe Jones, of the Museum of Wales for correcting me on this.

Jorge Madias has also informed me that the shell of a Thomas converter has been preserved at Aceros Zapla, Palpala, Jujuy, Argentina, so the total count now has reached 24.

Tim Smith

Tin Extraction Routes on Dartmoor

Dartmoor was the most productive source of alluvial tin ore in Europe. Cassiterite, the black oxide of tin, was to be found in many of the stream and river beds. Initially there was no need for deep mining. The precious ore was found on or near the surface. Cornwall and especially Bodmin Moor also had large quantities of tin, but much of it was deeper than Dartmoor tin.

Although there is little hard evidence that the Dartmoor tin was exploited in the Bronze Age, it is improbable that, the Bronze Age prospectors would have overlooked such a lucrative resource, given that the demand for 'tin bronze' was so great.

The granite upland of Dartmoor is the source of many rivers, and even if conditions were less wet in the Bronze Age, extraction and transport of the ore would have been difficult. Up to recent times Dartmoor farmers and peat cutters used horse drawn sledges or drag poles to move material over the wetter parts. Two ancient sledges can still be seen at Bovey Tracey, in the National Park headquarters. If you zoom in on Ryders Hill on Southern Dartmoor with Google Maps, it is still possible to see evidence of double tracks leading from tin sources to the top of the hill, in situations where no wheeled transport could have had access. These ancient tracks should perhaps be properly mapped.

The long reaves, which should not be confused with the boundaries of the co-axial field systems, are low banks made of stone and turf that run for miles across the open moor. They were originally interpreted as *"Trackways"*, as labelled in old maps. The reave that runs across Hurston Ridge was called *"The Great Central Trackway"*, and the suggestion was that it was perhaps a continuation of the Fosse Way, running East to West across Dartmoor. This was clearly not the case, and the idea was eventually rejected. Andrew Fleming, in his prize winning book 'The Dartmoor Reaves' says on page 14 *" The great central trackway is a dead concept now"*.

More recently, the long reaves have been interpreted as boundaries and all modern maps label them as boundaries. Having killed off the concept of the great central trackway, any lingering doubt that the long reaves could have been simply local trackways for the transport of tin ore and to supply the tin workers with food etc. has been dismissed.

The long reaves were described as boundaries about twenty five years ago, in spite of the fact that they made little sense as boundaries. This interpretation has now been universally accepted by Ordnance Survey, the general public, and academic archaeologists.

As a Dartmoor Guide, I used this interpretation for twenty years even though it made little sense to me and did not solve the problem of the long reaves.

A great deal of time was spent walking the reaves and checking them out on maps and Google. I could not think of an alternative interpretation until I discovered that raised tracks or causies were found on the Pennines and North Yorkshire moors to accommodate pack animals over the boggiest parts

There is an organisation called "The South Pennine Packhorse Trails Trust", and a book entitled 'Seen On The Pack Horse Tracks' by Titus Thornber. In this book he emphasises the need to create a causeway to cross peatland. Sue Hogg, the Research and projects coordinator of the Pennine packhorse Trail Trust, replied to my email *"The oldest routes in this area can be dated to late Bronze Age, and are similar to those described by Hoskins in 'Making of the English Landscape'. Defoe attributes causeways to the Romans but they are much older than that, and causeways were clearly used in medieval times"*.

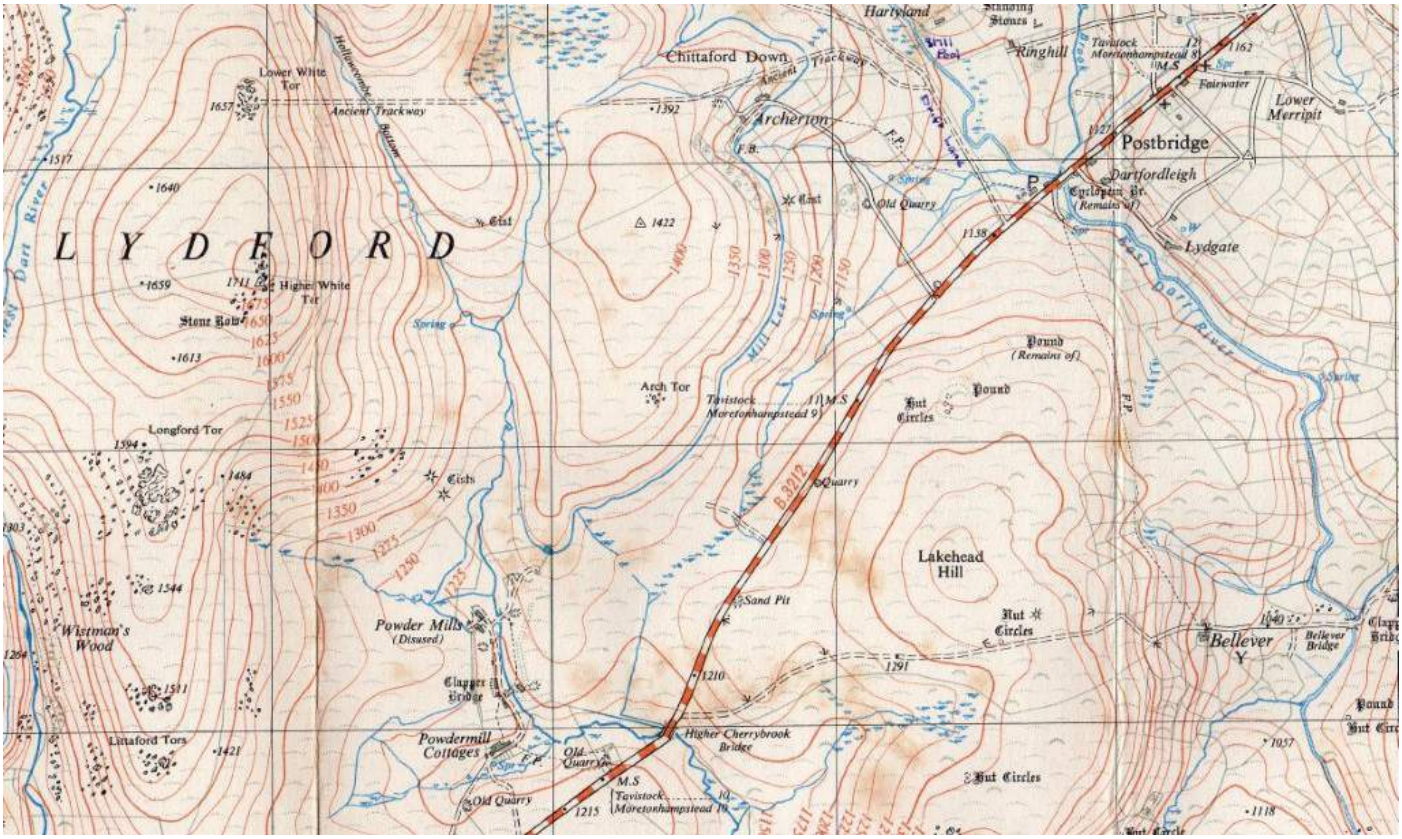
The bog roads of Ireland and the Sweet Track of Sedgemoor are examples of early engineered tracks across wet land. The use of wood or stone depended on availability with stone used on Dartmoor and wood at Sedgemoor.

Massive quantities of tin and tin ore have been taken off Dartmoor up to recent times, and people have been making their homes there since the Bronze Age. The problems of transport would have been the same for Dartmoor as it was for The Pennines and North Yorkshire moors. It is reasonable to expect that causeways of some description would have been constructed, but where are they? The reaves, when in their original state, were perfectly adequate to take a pack horse or some other form of pack animal. Sheep, goats, horses, oxen, camels, elephants, mules, donkeys and slaves have been and still are being used in some places for carrying heavy loads.

A donkey or mule train on Dartmoor would rapidly become up to the belly in mire so some kind of raised track would be essential. Any resource without access is of little use and in the past man has gone to great lengths to create access to valuable resources. Beautiful bridges were built in Cyprus to accommodate camel trains employed to get copper ore to the port at Paphos. Rail tracks were laid to get peat and granite off Dartmoor. Canals were dug all over England to move all kinds of materials from their source to the towns and cities.

The cost of access, extraction and delivery of a resource has to be weighed against the value of that resource. Tin at the height of the Bronze Age was a rare and valuable material. It would not be beyond the capabilities of the tin merchants to improve access by building raised tracks.

It is probable that the wealthy tin merchants used slave



Old map with reave labelled as 'ancient trackway'

workers to dig out the tin ore, and they would have needed food, shelter and infrastructure in place, requiring further movement of goods and materials.

A glance at the Dartmoor map will confirm that the long reaves were linking settlement to settlement, settlement to tinworks and tinworks to hard tracks such as ridge ways. The linking function is more obvious than a dividing or boundary function. Closer scrutiny will show that where the going is hard, on the tops of tors or on stony ground, then the reave will discontinue, only to be continued again when the going gets soft. Another clue to the function of the long reave is that they will change direction to take advantage of an easy crossing place of a stream or river. Side spurs off the main reave can be shown to go to tinworks or settlements. There is a situation where a reave passes through a field system, and space has been deliberately left between hedges for a passage. It requires a huge stretch of the imagination to see the long reaves as boundaries.

Roads and tracks were often used as boundaries. There are two reaves that were known as *"Le Rowe Rewe"*. At least one of these was to become a parish boundary. Is it possible that Le Rowe Rewe was the Norman French way of saying *"The Rough Road"*? The fact that it was used as a boundary does not mean that this was the original purpose.

Thousands of parish boundaries were marked out with standing stones. It is not easy to understand the thinking behind an almost continuous bank for a boundary that did not enclose land, but started and ended on open moorland. There is never enough material in a reave bank to create a stock proof boundary.

I was told by an old soldier that they were taught to create raised tracks in muddy situations to make it easier to get from place to place. The Romans obviously recognised this as they created miles of raised tracks for their armies.

There are also references in the Bible to *"a way cast up"*, or *"an embanked way"*, which suggest that embanking a road was common practice. Where flooding occured in the great estuaries of the fertile triangle it was essential to raise the roads above the flood level. On Dartmoor, during dry periods, there was no need to keep to the raised track, and sometimes well used tracks run parallel to the reaves.

The fact that the reaves linked settlements that are considered to be Bronze Age, and that the reaves themselves are considered to be Bronze Age would suggest that the tinworks were also exploited in the Bronze Age. The reaves could have still been used through to the coming of the hard cobbled roads and tracks and wheeled transport or even the railways.

I suggest that there is sufficient evidence for a revival of the trackway interpretation of the Dartmoor long reaves, and that their relationship to the tinworks and settlements would suggest that they were first constructed to improve access for the movement of Dartmoor tin in wet conditions.

Roger Hutchins

DAVID CRANSTONE

I studied Archaeology (and Anthropology, though not for long) at Cambridge, concentrating on prehistory, but I'd started working on digs well before going to university, and spent my holidays working around on the digging circuit, always with a spell at Fengate on the prehistoric gravel-terrace site for Francis Pryor in the summers. After university that settled into a pattern – the summers at Fengate, and the rest of the year supervising for an old friend, Pete Brown, on what would now be called the English Heritage National Heritage Collection – mainly abbeys and castles, and that was where I learnt how to excavate and record the archaeology of sites with stone buildings and upstanding structures, very different from the feature-into-gravel archaeology of Fengate. In my last winter with that team, we were diverted (probably more to keep the core team together than for any other reason) into cleaning up a 17th century blast furnace at Astley in Worcestershire, and I loved it – the opportunity to use proper excavation skills on an industrial site (very unusual then), and a very different and to me even more interesting type of site to understand.

Then I moved into steadier if still fixed-contract employment in what I thought would be my career path in prehistory, first at Fengate and then at Beckford in Worcestershire. After five years, the work dried up and when I mentioned to Pete Brown that unemployment was looming, he remembered my enthusiasm for Astley Furnace and invited me to take over what had become his portfolio of 'industrial' excavations at Duddon Furnace and Killhope Lead Mine since he was quitting full-time archaeology.

That marked the end of my misspent youth as a prehistorian, and I suddenly found mysef directing my first excavation, as a freelance with very little support, at Killhope – and that noone had previously excavated a lead mine washing floor, and that the vast areas of rotting timberwork that we were uncovering bore no resemblance to the mechanised dressing mills that the few books I could lay my hand on told me I should be finding! After that, the already fairly well-known archaeology of the charcoal blast furnace semed easy – David Crossley's pioneeing excavations were already published, and I was following in Pete's very capable footsteps at Duddon. The next project, the 1806 blast furnace at Moira in Leicestershire, was a return to slightly edgier ground and working with a 1980s Manpower Services Commision team was 'interesting'. That was when I realised the need for archaeogical science to understand the slags etc that I was finding, and hopefully explain why the furnace had been spectacularly unsuccessful – the final campaign had managed to melt the good-quality firebrick chimney of the furnace at over 1000 °C, while the charge in the boshes congealed. I was put in touch with Charles Blick at HMS, who arranged for Chris Salter, Keith Gale and Ian Standing to advise me, and of course I learnt huge amounts from those experts who were so helpful to someone who in many ways was still woefully ignorant of the lore and science of the blast furnace.

Chris soon invited me to join the newly-formed Archaeology Committee, which started a long and happy active involvement with the Historical Metallurgy Society. I was on the Archaeology Committee for probably longer

than anyone should be without a break, on Council in the early 1990s, Chairman in the late 1990s (when a single two-year term was still the rule), then after a bit of a break from active involvement as President from 2004 to 2008, and as Secretary since then.

Academically, blast furnaces are still very much within my interests – in fact Peter King and I seem to have spent much of the last week or so discussing two 16th century furnaces on the North York Moors. Pre-19th century steelmaking is also a major interest – having excavated and recorded the Derwentcote cementation furnace in the 1980s, I'm now working on the evidence for a decarburisation (finery process) steel industry around (as opposed to 'in') the Forest of Dean. I've also done a fair bit of work on the archaeology of the later 18th-19th century forge sector, though that isn't active just at the moment. My non-ferrous interests seem to be on the back-burner at the moment despite work in the 1990s on various lead smeltmills and on the Monuments Protection Programme for the non-ferrous metals and (with David Crossley) on the iron industry. Outside of metallurgy, my main active interest is coastal saltmaking – in fact there is an important overlap, since the coal-fuelled panhouse process which has dominated in Britain since the 15th century relied on massive iron pans with their demands for large quantities of plate iron and the ability to rivet them into waterproof vessels. These days, a lot of my work is technically historical as much as archaeological – as well as my own research, I work as a consultant offering specialist advice and site assessments within my various fields of interest. That change of direction is largely by choice and happenstance, though partial disability due to a spinal problem has pushed me further into desk-based rather than field research than I might have chosen.

As Secretary of the Society, a large part of the role is servicing Council – agendas, meeting papers and minutes for Council meetings and AGMs, making sure that we adhere to our Articles and that the Articles still reflect our needs in a changing world, and playing an active part in the general governance of the Society. I also act as first point of contact for queries both from our members and from (at least when they first contact us) non-members. That can be one of the most stimulating parts of the job – I never know what the email may bring, and while some queries are passed to those better equipped than me to answer them, others develop into lively discussions in which I often learn a lot about topics I'd never previously thought about.

Note on 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.

The bank charges involved in collecting foreign currency cheques for modest sums are considerable. Accordingly, the Society is reluctant to accept such. 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.

Archaeometallurgy in Europe Call for Papers

We cordially invite the submission of abstracts for oral or poster presentations to the International Conference ARCHAEOMETALLURGY IN EUROPE IV. MADRID 2015, from 3rd to 6th June.

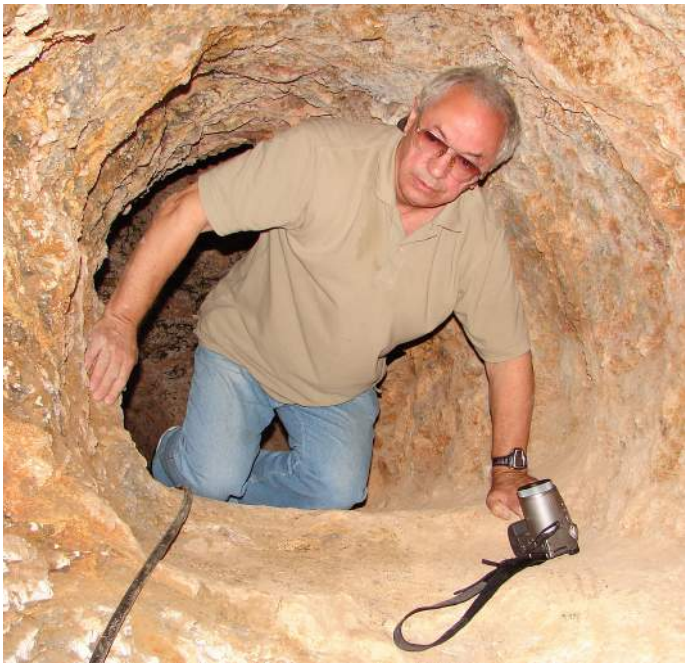
There will be 6 sessions covering the following main themes under which fall a wide range of possible topics:

- Early metallurgy: technological innovation and social negotiation
- Developments: new materials, alloys and processes
- Technological transmission, change and persistence
- Mines, mining and the miner
- Archaeometallurgy versus Archaeometry: you first
- Comparative studies

Due to space and administrative restrictions we are limited to a maximun of 90 oral papers and 60 posters. Proposals will be selected by the Scientific Committee.

Form information can be found at: **http://www.congresos.cchs.csic.es/aie4/**

EVGENIJ CHERNYKH



Chernykh in the mining shaft of Gava, a variscite deposit in eastern Spain, dated between 6th – 5th mill BC

Professor Evgenij Chernykh is an outstanding archaeometallurgist in his field. His scientific contrabutions thus far spans 5000 years of metal production across Eurasia, from southeast Europe to China, and beyond. The scope of his work includes chemical analyses of hundreds of thousands of metal objects. His ideas on the dynamics of metallurgical provinces influenced generations of scholars, many of whom are continuing his work in these regions.

Professor Chernykh was born was born on December 11, 1935 in Moscow, and spent all his life living in this city. The exceptions were the three years when, in early World War II in November 1941, Chernykh was taken out together with the plant, where his parents worked to the city of Samara (then Kuibyshev) on the Volga. There he began to study at school, but three years later returned to Moscow. In Moscow, he finished high school and enrolled at the Faculty of History, the Department of Archaeology at the University of Moscow. In 1958 he graduated and was admitted to the Institute of Archaeology as a research assistant. But the next year he went to study at the Institute of Metals, where in addition to theoretical courses mastered the methods of spectral analysis of metals. Since then and until today he has been working at the Institute of Archaeology of the Russian Academy of Sciences.

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

EVGENIJ CHERNYKH: I managed to organize a laboratory for spectral analysis and until 1979 I conducted more than 40,000 analyzes from many regions across Eurasia. Another avenue of my professional activity was about exploring and examining ancient copper and polymetallic mines scattered across Eurasia, from the Balkans to the Urals, the Caucasus, Central Asia and Mongolia.

THE CRUCIBLE: What is your most memorable professional moment?

Copper smelting experiment at the site of Kargaly

Chernykh (middle row, second from the right) with collaborators during the excavations in Kargaly. Note Salvador Rovira (bottom row, second from the right) and Sergey Kuzminykh (top row, first from the right), Chernykh's closest friends and colleagues.

EVGENIJ CHERNYKH: Firstly, the successful launch of the laboratory for spectral analysis at the Institute of Archaeology, which was bordering impossible for the recent humanities researcher. Secondly, the discovery of the ancient copper mine of Ai Bunar in Bulgaria in 1970-71, and also, thirdly, in 1989-90, the discovery of and conducting further 12 years of multidisciplinary research in Kargaly, the gigantic mining and smelting centre in the southern Urals.

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

EVGENIJ CHERNYKH: I have the closest and fruitful relationships with the staff of the laboratory that I lead "Natural sciences in archaeology": these are Sergey Kuzminykh and Ljuba Orlovskaya (in the last 40 years), Elena Lebedeva and Ekaterina Antipina (in the last 30 and 25 years). Furthermore, in the past 20 years I have built a strong friendship with Spanish colleagues: Salvador Rovira Llorens, Ma Isabel Martines Navarrete, and Juan Manuel Vincent Garcia.

THE CRUCIBLE: What is your main current project?

EVGENIJ CHERNYKH: Metallurgical provinces in the Early Metal Age in Eurasia, from 5000 – 1000 BC.

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

EVGENIJ CHERNYKH: Radiocarbon chronology of metallurgical cultures of western Eurasia, from 9/8th to I millennium BC; systematic treatment of more than five thousand years of development of many archaeological cultures.

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

EVGENIJ CHERNYKH: Focus not only on technical issues of metallurgical production, but on broad picture of spatial and chronological interrelations.

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

EVGENIJ CHERNYKH: I wish you to take interest in the broad picture of the development of metallurgy in our world.

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.

IAMS/NARNIA SUMMER SCHOOL IN ARCHAEOMETALLURGY

I am an Indonesian student in the first year masters in Quaternary and Prehistory at the Museum National d'Histoire Naturelle (MNHN) in Paris. I attended the Summer School in Archaeometallurgy at the Institute of Archaeo-Metallurgical Studies (IAMS) based at the UCL Institute of Archaeology, which this year was organised jointly with the NARNIA International Training Network, and focused on copper and iron. My aim was to further my knowledge in this field of archaeology, as I had not been involved with any study of metal artifacts before. With funding from the department of prehistory in MNHN, I decided to apply for the said summer course.

Following the positive response from the IAMS committee I was able to attend the summer courses on the 23rd to 27th of June in London, UK. I was very enthusiastic about gaining experience in these very interesting courses; moreover, it was my first time visiting London. The course lectures were truly excellent, very engaging, and facilitated questions from students. The professors, being experts in their fields, were able to answer all the questions perfectly. The first day lectures were presented by Prof. Thilo Rehren from UCL Qatar with the topic: Technical foundations: Mining and smelting copper and iron. He explained the basics of metallurgy as well as why people have been interested in metals and how they mine and process such. He explained the social transformations derived from the emergence of metals in different cultures, and brought real samples of copper and iron from his own work.

In the second day, Dr. Michael Charlton from the UCL Institute of Archaeology covere the topic: The analysis of bloomery iron smelting slag – Chemical analyses and multivariate statistics. He explained the principles of smelting iron and the varieties of furnaces used and iron slag produced with emphasis on how to use statistical tools to analyse chemical data from archaeological iron slag. In the third day, Dr. Eleanor Blakelock from the British Museum introduced Metallography and microstructure of archaeological metal objects. She explained how to infer the chemical composition of alloys of iron and copper using microstructures. After which, we had small group discussions about different photomicrographs of steel and bronze. She brought us to the optical microscopy room to observe directly iron-carbon microstructures of Anglo-Saxon knives. I was able to ask several questions about metallography which she diligently answered. This was my favorite topic because it is related to my current internship work.

The night of the third day session, we were able to attend

Group photo after the handling session

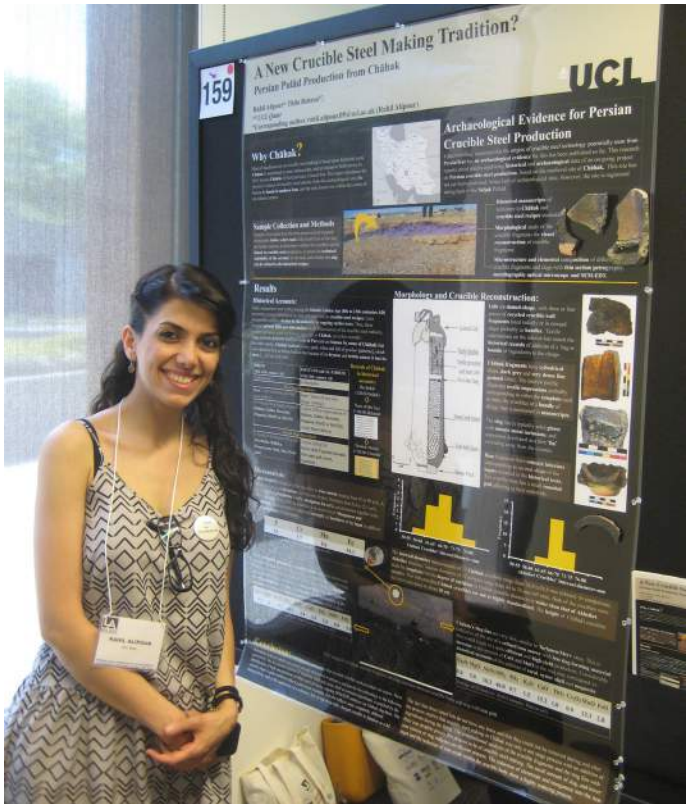
a public lecture to honour Prof. Beno Rothenberg, the founding father of IAMS. The said lecture was about Copper in the Bronze Age World and presented by Prof. Vasiliki Kassianidou of the University of Cyprus. She had worked with Prof. Rothenberg during her doctorate years in UCL in the 90s. Her lecture was a comprehensive and insightful review that encompassed the old mining processes and metal trades through the Bronze Age and into the Iron Age. I gained a much better overview of the history of copper mining and metallurgy in the Mediterranean.

Prof. Marcos Martinón-Torres from the UCL Institute of Archaeology supervised the last two days of courses, including Theory and practice of pXRF in archaeometallurgy and a Handling session of archaeometallurgical artifacts. Students were able to use a real portable x-ray fluorescence (pXRF) machine to explore assemblages of metal artefacts from the Institute's collections. Prof. Martinón-Torres emphasized that the said machine has advantages and disadvantages which must be taken into consideration every time. As a memorable example, we analyzed several two-pence copper coins and the resulting analyses using pXRF showed around 90 % by weight copper in all cases. However, when the coins were cut in half, it was shown that some were made of steel just plated with copper metal. During the last day session, we were able to handle old furnace pieces, metallurgical ores, archaeological slags and ingots of copper and iron from a wide range of sites across the world. We had a big group discussion about the artifacts he presented – including how to analyze them scientifically, and how to extract archaeological information.

Harry Octavianus Sofian

Metals and Metallurgical Ceramics at the 40th International Symposium of Archaeometry

The week-long 40th International Symposium on Archaeometry was held in May this year, and was split between two impressive Los Angeles venues: The Getty Villa and UCLA. The interdisciplinary conference hosted sessions on a wide range of applications of the physical sciences to archaeology and cultural heritage, and was highly international, with significant contributions of work from Asia, the Americas and Europe, and to a lesser extent Africa, Australia and the Pacific. As usual there were no parallel sessions, enabling participants to attend presentations that they might not normally have prioritised. Two hours were dedicated to each of the three poster sessions, providing ample opportunity to meet researchers and discuss their work on a one-to-one basis. An intense and demanding schedule, this year's ISA presented a diverse collection of some of the finest archaeometric research generated by established scholars and promising students over the past two years.



One of the student poster prizes winner Rahil Alipour

Two of the most dynamic oral sessions were those on Metals and Metallurgical Ceramics organised by Professors Dave Killick and David Scott, which were both well attended by engaged and often vocal audiences. There were also around 50 metal-related posters on this theme, demonstrating the broad chronological and geographical range of metallurgical studies, as well as the impressive array of analytical and statistical techniques that have been tailored to address archaeometallurgical questions. Posters included experimental research on the formation of free silica in slag (Liu, Larreina Garcia and Venunan), new second millennium BC dates for early copper smelting in China (Li, Li and Dai), and methodological advances in the use of ICP-OES for slag analysis (Eekelers, Vassilieva, Muchez and Degryse). It is worth noting that two of the three student poster prizes were awarded to posters in the Metals session: Rahil Alipour from UCL Qatar and María Teresa Plaza from UCL, demonstrating the high quality of current metals-based research.

The two Metals oral sessions were organised to reflect the early origins and later spread of metal production around the world, and so the six papers of the first Metals oral session dealt predominantly with the analysis of early copper and copper alloy objects from the Old World. Themes common to these papers included discussions of alloying preferences and raw material selection, with an emphasis on the recycling of metals and the movement of knowledge, metals and/or ores. Among these papers, Kristina Franke presented research examining the relative status of arsenical copper and tin bronzes during the Early Bronze Age of Jezirah, identifying the use of different copper ores for these two alloy groups, and providing an early date – 2800 BC – for tin bronze production in the region. Relating to a similar time period in central Europe, Florence Cattin and team used lead isotope analysis and trace element analysis to explore the provenance of nickel- and antimony-rich 'Singen' copper objects, suggesting that they derived from chemically similar ores over a broad geographical distribution rather than a single source. Moving slightly later in time, the work of Yannis Bassiakos and colleagues demonstrated that cassiterite (and later, tin ingots) were traded into the Aegean in the 2nd millennium BC in order to produce tin-bronzes using recycled arsenical-copper. Other papers considered the movement of metals and people across the Alps in relation to topography and recycling (Laura Perucchetti et al.), and changes in ore exploitation through time as seen in copper-alloy hoards in western France (Cécile Le Carlier et al.). The exception to this session's focus on object-analysis was a presentation of some experimental copper smelting. This work, by Miljana Radivojević and team, hopes to reconstruct the technology of what is currently the earliest evidence for copper production, and was featured in the previous edition of The Crucible (Issue 85).

The second oral session, consisting of seven papers, had a more global emphasis, alluding to the later expansion and dispersal of metal technologies. Copper-based alloys were again represented in Tom Fenn and colleagues' discussion of objects excavated from royal burials in Nigeria, in which they demonstrated material connections between

The Getty Villia, the conference venue for the first three days of the conference

medieval Nigeria and the Islamic world through elemental and isotopic analyses. We were also provided a tantalizing glimpse into first millennium AD copper production at the soon-to-be-destroyed mining site of Mas Aynak, Afghanistan. With only a handful of samples to work with, Loïc Boscher *et al.* are piecing together the details of a vast copper industry and have identified a shift in furnace design – though not ore charge – as production intensified at the site. The final copper-based paper, presented by Aaron Sugar, included an appeal for a future PhD student to take on the task of examining the earliest evidence for copper smelting in Central America at a well-preserved site in Honduras.

Poster session in the conference

Iron, silver and gold were also represented in this session. Stephanie Leroy presented research that combined slag inclusion analysis and direct radiocarbon dating of steel to highlight changes in the supply of iron used for construction at Angkor. Arne Jouttijärvi presented his chemical analyses of medieval iron working debris, including hammerscale, from Copenhagen. Siran Liu *et al.* discussed the development of different silver production technologies in China in terms of variation in local fuel availability. Finally, the session was brought to a close with a paper by Marcos Martinón-Torres (and María Alicia Uribe), who presented an inspiring and theoretically-driven analysis of the value of Muisca gold-alloy objects, and suggested that the act of production and deposition might have been more important than the finished items themselves.

Metallic subject matter also popped up in other sessions, notably the special session The Transition from the Bronze Age to the Iron Age, in which Vasiliki Kassianidou provided a thought-provoking discussion of the continuing use, role and value of copper-based alloys throughout the Iron Age of the Mediterranean. In the poster section of the same session, Oli Pryce presented his recent research on the rapid adoption of new metallurgical technologies in Southeast Asia, echoing the paper that he gave at the HMS 50th Anniversary Conference last year.

Together, the papers on metallurgy – whether in the metals sessions or not – brilliantly demonstrated the diversity and breadth of current metals-related research. With so much fascinating research of such a high standard, it was just a shame that there was not more time for spoken presentations. Other than a move to parallel sessions – a prospect raised in one of the (unsuccessful) institutional bids to host the 2016 ISA – the only option to continue to accommodate a broad level of participation is to maintain the strong emphasis on dedicated poster sessions. And with the next ISA meeting due to be held at the University of Peloponnese in Kalamata, Greece, the presentation slots will undoubtedly once again be in high demand. See you there in 2016.

Louise Iles

HMS Spring Meeting Blarney, Co. Cork Ireland 12th-13th April 2014

This year's Spring Meeting, which took place in Blarney, was planned and organised by Paul Rondelez of Cork University on the theme of "Irish Iron." Field trips with support talks were included in the programme combined with an exhibition at University College Cork. The meeting was based at Blarney Woollen Mills Hotel, Blarney, famous for the Blarney Stone Castle, on the outskirts of Cork.

The programme included field trips to east County Clare to view the remains of the 17th and 18th century charcoal blast furnace industry established around the areas rich in haematite mines.

Day 1 Friday 11th April 2014

The early arrival took the opportunity to visit the Blarney Castle and gardens. The present castle is the third to be built on the site with the first tenth century wooden building replaced by a stone built structure built for Cormac MacCarthy around 1210 AD. Some HMS Members climbed the tower, slowly, to admire the view and to comment on its archaeological significance within the local topography. We resisted the impulse to kiss the Blarney Stone and repaired to the Bar for an introduction to the local dark brown nectar and to meet and greet our fellow members.

Paul introduced the theme of the Spring Meeting at the informal evening session and outlined the structure and format for the next two days. Members were reminded of the need for suitable footwear as a number of the sites were located in marshy areas.

Day 2 Saturday 12th April 2014

The field trip visited three blast furnace sites in East Co. Clare Ballyvannan, Whitegate, and Derryoober. Our guide for the day was Dermot Moran a local historian from Lowghrea Co. West Galway with an extensive knowledge of local iron working and local historian Ger Madden from Scarriff.

Ballyvannan

There were upstanding remains of the 1610 AD (date is possible) furnace regarded as something of a mystery as the written sources held no reference to iron working on this site. The tower was some 10m high with evidence of a low level semi-circular tunnel around the base. It was suggested that the hearth would be approximately one meter below the present surface. Members queried the logistics of the location as no water supply was evident in the locality and the transportation logistics looked difficult for this 1610. It was possible to identify a probable waterwheel leat arriving at mid-point from the left; however, determining the size and location of the casting floor and tail-race was problematic.

Mark Wilson Blacksmith at Mountshannon Forge

We returned to the farm for a welcome al-fresco meal of soup and sandwiches kindly provided by the landowner Colm O'Brien. As previously noted the site was located in a heavily waterlogged area, the removal of muddy waterproof footwear added a certain agricultural terpsichorean challenge to the luncheon setting.

Mountshannon Forge

On our way to Whitegate, we visited the forge at Mountshannon operated by blacksmith Mark Wilson. Mark is renowned for his production of long-staff pikes. The possession of long-staffs even those without their metal tips was banned in Ireland, probably as a consequence of the 1798 uprising where there is evidence of a mass "piking" of some 70 prisoners at Wexford. The forge works on a charcoal charge with the charcoal reduced to small one centimetre pieces, Mark suggests that at this size there is more room for freedom of air movement and a more even temperature, which was demonstrated by the production of small iron fittings. To view Mark at work search see: www.viduba.com/video:QZlRXV1a5cUTyIFRjdEeWRWbSllVR1TP

Whitegate

This large,8m. dia. 18th century blast-furnace is located in the garden of a detached bungalow. The design is unusual

Whitegate Blast-Furnace Tunnel Exit

in that two angular walls on its left front complete the mainly square structure. In addition, there is a 2m high by 1.5m wide "L" shaped tunnel that enters low down on the right, just above hearth level, and, after some 8m, turns through a right angle at the left rear to exit at the front of the furnace. A small "inspection" window is present to view the main length. Notwithstanding a meaningful discussion on site and a plethora of site hypothesis, the purpose of this tunnel remains undiagnosed.

Derryoober

Our last visit of the day was to the site of the small, probable, 18th century blast furnace at Derryoober. This is the most intact of the furnaces visited today. The main body of the furnace was approximately 4m square internally with a height of some 6m set into the hillside. There was evidence of a charging ramp installed on the hill slope at the elevated rear of the chamber. As noted above there are questions regarding the completion of this furnace as there is no supporting documentary evidence.

Derryoober Blast-Furnace. One of the two lower level 1.5m square exit ports with rear wall just visible at the back

Evening

After a busy day, we were pleased to partake of an excellent meal at Christy's Bar and to take the opportunity to reacquaint ourselves with the local brew. As usual, in a gathering of old and new members, the conversation flew and the local customs of "pub craic" was well and truly embraced. Finally, we took ourselves to the Muskerry Arms to enjoy an evening of Irish Folk Music. It was surprising how word perfect and tuneful our members are, must be the result of misspent Student years.

Day 3 Sunday 13th April

Fully refreshed after an enjoyable evening and replenished by the "full Irish" breakfast we continued our field trip with a visit to the iron-smelting plant of the East India Company at Inishannon, Co. Cork.

Inishannon

Our guide for the day was Paddy O'Sullivan a retired Marine Diver, author, and Local Historian (His book on the sinking of the Lusitanian 1915 is being re-launched for the 100yr anniversary). Paddy gave us a detailed description of this East India Company's iron-smelting plant at Inishannon and in particular, how the need to provide an alternative source of boat building skills and oak wood supplies were required to meet their expansion plans. The Company's decision to relocate their ship building activities arose as a response to the increasing costs of proposed by the English Shipbuilders. In addition to the available oak timber, there were riverside moorings and working areas just downstream at St. Patrick's Quay with to the River Shannon. East India Company built two large 500 ton ships at this site and a further 300 ton. The "castle" adjacent to the site provided quarters for a "militia" defence force. The local availability of iron ore, water, and charcoal from the timber working made this an ideal site. The site was defined by major deposits of slag along the river banks and quarrying activity above the adjacent flood plain and was enclosed by a series of interconnecting stone walls which where interpreted as the remains of a dam constructed to drive power to the blast furnace. There is little evidence of the iron works remaining, however, it is still possible to visualise how the iron-smelting plant would fit into the topography. Again we enjoyed a Paul's al-fresco lunch this time favoured with a late spring sunshine.

Inishannon East India Company. Members engaged in their traditional slag gathering.

Cork University

The day was completed by a visit to Cork University Archaeological Department for talks by Tim Young and Paul Rondelez. Tim presented a talk on "Iron Production and use in Iron Age and Early Medieval Ireland" to describe the ubiquitous slag-pit furnace and note the low visibility for ironworking in the Irish Roman period. Tim also reviewed the production of hand-bells in Early Medieval Ireland. Paul, in his talk on "Iron Production after the Anglo/Norman Invasion," reflected on the results of his PhD research on Late Medieval Irish ironworking. Paul also provided a chronological overview of blast furnace development.

Following the presentations, we had access to the collection of important slag, plugs, and tuyère finds assembled from the collection of University College Cork including those from Paul's PhD investigations and research work by others.

The members would like to thank Paul for organising such an excellent Spring Meeting, with a range of visits to 17th and 18th century iron-working sites.

Denis B Waudby

The international symposium on medieval copper, bronze and brass

The international symposium on medieval copper, bronze and brass was held from the 15th to the 17th of May. Hosted in the historical towns of Dinant and Namur, the symposium focused on the "history, archaeology and archaeometry of the production of brass, bronze and other copper alloy objects in medieval Europe (12th -16th centuries)". The conference was organised through a cooperation of the Public Service of Wallonia (SPW, celebrating 25 years of regional archaeology), the French National Institute for Preventive Archaeology (INRAP) and the hosts at Dinant: the Mosan Medieval Heritage Centre (MPMM) and the Regional Cultural Centre at Dinant (CCRD).

Day 1:

The first morning's presentations were dedicated exclusively to raw materials and supplies. Bastian Asmus discussed the trade of metallic products from the Harz Mountains, focusing on the town of Goslar, Professor Emeritus Arne Espelund presented recent studies on copper extraction and smelting technology in Norway, and Bernard Lechelon reviewed the copper production in Languedoc during the 12th and 13th centuries. The session was closed by Professor Emeritus Paul Benoit who discussed the importance of 15th-16th century innovations in silver extraction technology from argentiferous copper.

The craftsmen and workshops session was opened by a thorough study on jewellery production in Novgorod from 10th to 15th century, mostly focused on chronological and spatial distributions of non-ferrous metal debris (Natasha Eniosova), followed by a talk on written and iconographic sources coming from Barcelona archives and museum, giving an overview on Catalan copper-based manufacture and its links with other European contexts (Lluïsa Amenós). Michael Depreter concluded the session with a study on the work organisation of the 15th century Bourgogne cannon founders.

The last session of the day concentrated on 'techniques' and started with a presentation on a study of brass vessels found in Gotlandic Viking Age tombs with a suggested Mosan origin (Gustav Trotzig). Next, Pete Dandrige presented a study on copper casting based on a technical investigation of the 13th century Hildesheim Cathedral baptismal font. The closing talk by Nicholas Thomas focused on brass cementation experiments, providing valuable information regarding the process in terms of cost, quality and quantity of the final products, workshop organization, and required skills.

The first day was concluded with a visit to the exhibition 'L'or de dinandiers' at the Maison du Patrimoine médiévale mosan (MPMM).

Day 2:

The second day opened with another session dedicated to craftsmen and workshops. Karoly Belenyesy presented his work on a 15th-16th century cannon foundry in Buda, Hungary, showing his excellent reconstructions of the technology and structures of the site. A further two foundries in Luca, Italy (dating to the mid 16th to early 17th century) were presented by Marco Milanese, found during structural surveys and restoration work on buildings within the historic town. The two talks complemented each other well, covering the casting methods of cannon through to the structural layouts of the foundries. Interestingly all three foundries – as well as the foundry, presented in day three, discovered in Dubrovnik - were discovered within the fortifications of the towns.

After a coffee break we commenced with the second session of the day, which focused on the theme 'products and trade'. The first presentation was a discussion by Joanna Olchawa on the Mosan aquamanilia from an art- and socio-historical perspective. Next, Susan La Niece gave an overview on copper alloys in the medieval Islamic world and Florence Fabijanec discussed evidence for the trade and use of copper (alloys) in Croatia between the 15th and 16th centuries. Adrian Andrei Rusu gave the last paper of the session on the reuse of bronze and copper artefacts in western Romania, demonstrating how and discussing why objects, particularly three legged cauldrons, were repaired.

'Techniques' were again the focus of the last session of the day. Elisabetta Neri discussed bell production workshops in Italy and their technical specifications, while Paul Dooley presented the intricate technicalities of brass or bronze selection to produce medieval harp strings, and Hannes Vereecke spoke about 16th century sheet brass for musical instruments. The last two talks, on the use of bronze, brass and copper in the production of musical instruments and their strings, were particularly interesting as they integrated the different approaches to reconstructing alloy use (i.e. scientific, experimental, and art-historical), and provided a musical note to the conference.

The first and second days were enhanced by two extensive poster sessions: the first was focused on the themes 'raw materials and supplies', and 'craftsmen and workshops',

Gorgeous weather to welcome the conference participants

the second on 'techniques' and 'production and trade'.

After an excellent day of presentations, the council of Dinant invited us to the town hall where we were welcomed by the mayor with delicious beer and a traditional Flamiche dinantaise.

Day 3:

The session on 'products and trade' continued on Saturday morning, starting off with a talk by Catherine Richarte comparing the influences between metallic and terracotta vessel production throughout Europe. Next was a discussion of copper alloy use in the manufacture of medieval keys and locks, showing the changing technology through the Middle Ages (Mathieu Linlaud) and lastly, a presentation by Sophie Oosterwijk on medieval European copper tomb decorations and their importance as statements of wealth and power.

After the coffee break, the session on 'craftsmen and workshops' was resumed. Carlotta Gardner presented the analysis of metallurgical debris from a late- to post-medieval foundry in Dubrovnik, illustrating the complexity and variability of production waste and giving insights into Ragusa's international commercial activity. Next, Francesco Carrera presented the extensive and complex remains of a Pisan workshop, providing rich illustrations and reconstructions of the entire chaîne opératoire to be expected in such glass and metal production contexts. Closing this session, Emmanuel Lamouche discussed activities of the Roman metal artisans in service of the papacy.

After the lunch break, presentations on 'techniques' continued, with Jean-Marie Welter giving a chronological overview of alloy use for Italian statue casting, illustrating choices made by different workshops and changes through time in both fashion and technology. This was followed by an overview of alloy compositions produced in sixteenth century northern Italy by the Severo da Ravenna workshop, where Dylan Smith drew on extensive analyses made in the National Gallery of Art, Washington. Next, Lisa Wiersma argued for a re-evaluation of the prevalence of metal sculpture displayed throughout the Low Countries during the Middle Ages, and the unique nature of Netherlandish brass sculpture tradition. Finally, Manon Castelle presented some new insights into the medieval origins of the lasagna technique, assessing the influence of contemporary Italian and German techniques on the French method.

The final session focused on medieval brass eagle-lecterns. Monique de Ruette presented the results of her extensive research into the techniques used to make these lecterns and combined them with archival information. Christopher Green took a different approach analysing the mineralogy of the residual mould material from a number of these lecterns. The results showed that the material was from the same source and could have originated from either southern England or western Belgium. Both presentations added to the ongoing debate about where the eagle-lecterns were produced.

Overall, the symposium was a great success and was summarised splendidly by Justine Bayley, who briefly discussed the huge array of techniques and approaches that were presented over the three days and how they all complement each other. Justine also highlighted how we have managed to come closer to answering some important questions within this broad subject area and how continued work is needed to develop our understanding. Both venues were very comfortable and we were fortunate to have two excellent translators who worked hard to keep up with some technical discussions. The catering throughout the conference was superb and everyone was made to feel very welcome. Many thanks to the organisers for this fruitful meeting!

Carlotta Gardner
Frederik Rademakers
Mainardo Gaudenzi

Reconstruction of a medieval brassmaking furnace at the Dinant Museum

Forthcoming events

Conference, Date and Location	Description	Website, Email and Prices
Sliabh Aughty Furnace Festival 20th-21st September 2014 Mountshannon, Co. Clare	A weekend of fun and learning in Mountshannon, Co. Clare. On Saturday, you can play 17th century games, watch blacksmiths and charcoal makers, get lost in a maze or get your thrills at the sword fight. At the same time, academic and local researchers will be talking about various aspects of the project. On Sunday, you can join us on a guided tour of the furnaces themselves.	http://www.furnaceproject.org/
Archives and Slag Collections, Study & Work Day 27th September 2014 Ironbridge Museum	The Archives and Collections Committee (ACC) is holding another Study/work day on Saturday 27 September 2014. This is another opportunity to gain an insight into the work of the ACC and the breadth of the Tylecote archive.	http://hist-met.org/meetings/hms-acc-s-w.html
Metallurgy in Warfare: A Spur to Innovation and Development 3rd-5th October 2014 Salisbury	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.	http://hist-met.org/meetings/annual-conference-2014-metallurgy-in-warfare.html
HMS Research in Progress Meeting 14th November 2014 Oxford	This year's RIP meeting is aimed at a wide variety of contributors, from historical and archaeological metallurgists to excavators, historians and economists. It aims at bringing together contract and public sector archaeologists with academic researchers, and in fostering links between the different disciplines studying metallurgy and related activities.	http://hist-met.org/meetings/hms-research-in-progress-2014.html
Archaeometallurgy in Europe IV 3rd-6th June 2015 Madrid	Archaeometallurgy in Europe is the most important forum for scientific discussion on early metalworking in Europe and far abroad. Next year's conference in Madrid atms at putting together all the interdisciplinary knowledge and regional studies we have been accumulating and negotiate a historical picture that will permit us to face future challenges.	http://www.congresos.cchs.csic.es/aie4/conference
Exhibition on large Roman statuary Now to 21 June 2015 Germany, Netherland	A major exhibition on large Roman statuary from along the German limes is currently on show in Bonn (until 20 July 2014), and is then due at the Limesmuseum in Aalen, southern Germany (16 August 2014 to 22 February 2015) and at the Museum Het Valkhof Nijmegen, Netherlands (21 March to 21 June 2015).	http://www.landesmuseum-bonn.lvr.de/de/ausstellungen/gebrochener_glanz_2/gebrochener_glanz_3.html