THE CRUCIBLE

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Copper casting at UCL's 'PrimTech.' Image by Charlotte Frearson

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

QUESTION EVERYTHING – A TRANSLATION FROM SWEDENBORG'S DE FERRO

Paul Vigor's measured response in The Crucible (issue 86, p11) to Dr Richard Haymen's criticism of Paul's reinterpretation of the Bedlam Furnace at Ironbridge (Crucible Issue 85 p6) has prompted me to challenge the long held belief that a description of the operation of a blast furnace found amongst the Fuller papers refers to an 18th century English Wealden blast furnace.

'Fuller's' original manuscript was transcribed by Richard Saville and published in JHMS 14/2 1980 p65-73 under the title 'The operation of Charcoal Blast Furnaces in Sussex in the early Eighteenth Century'.

However, there have always been certain oddities in the text that did not seem to fit the evidence on the Weald. For instance, 'Fuller' refers to the breaking of ore with a water powered hammer: *'The mine being first Burnt is broken partly in pieces partly into dust, by a Hammer which goeth with a waterwheel…'*. But excavations of blast furnace sites on the Weald have never shown evidence of water driven hammers to crush ore and the predominant siderite ore on the Weald is relatively soft and easy to break – certainly after roasting.

On the opening page of the manuscript 'Fuller' refers to a 'Last' as a measure of charcoal '*…a modern furnace holds about holds* [repeated in manuscript] *from 12 to 8* (18 in de Ferro) *Lasts of Coales'*. In the margin he notes: *'A Last of Coales about 12 Bushels'* (Fig 1). The läst is a Swedish measure of weight.

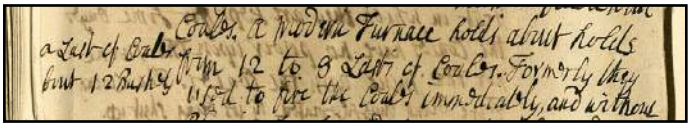


Figure 1 Margin insert in 'Fullers' manuscript defining the Swedish läst as 12 bushels.

Also, 'Fuller' refers to the colour of the slag, with green, indicating a good smelt: *'…If the colour of the drop be Green, and the fluidity everywhere equall, tis a sign the quantity of coal and mine is as it should be.'* but the blast furnace slags on the Weald are nearly always dark in colour, often close to black or brown.

Further indication of a Swedish connection is that in Sweden, water driven hammers were used to break the much harder magnetite ores often used there and also the country is renowned for its colourful slags – green and blue.

My suspicions were confirmed when I sent a copy of the JHMS paper to Bo Sundelin who is operating the replica 14th century blast furnace at Nya Lapphyattan. He has a Swedish translation of de Ferro and came back to say that large sections of the text are identical to what Emanuel Swedenborg wrote in Latin in 'Regnum subterraneum, sive minerale de Ferro', published in 1734. What is more, Bo says Swedenborg first published this description in a paper in 1717.

This prompted me to look at the original manuscript of the 'Fuller' account held in the East Sussex Record Office (ESRO number: ACC 2449/5/1), and to compare this with a facsimile of Swedenborg's book – referred to as 'de Ferro' for brevity in this article. The book has been scanned by Google and can be downloaded from the internet.

The 'Fuller' manuscript is undated and the writer unnamed. The curators of the Record Office have dated it at about 1740 in view of its context with the other documents associated with it, and likewise attribute it to a John Fuller because of this context.

John Fuller (1652-1722) built Heathfield furnace, in Sussex in 1693 (Cleere and Crossley 1995) but there were three later owners of the furnace all named 'John Fuller'(WIRG online database):

> John Fuller born 1680 – died 1745
> Owned Heathfield Furnace 1722-45
>
> John Fuller born 1706 – died 1755
> Owned Heathfield Furnace 1745-55
>
> John Fuller born 1757 – died 1834
> Owned Heathfield Furnace 1777-93.

All three of these could have had access to a copy of de Ferro should they care to translate it. Even John Fuller (1652-1722) could have access to Swedenborg's earlier paper of 1717.

'Fuller's' account makes no reference to a Wealden blast furnace. It is titled:

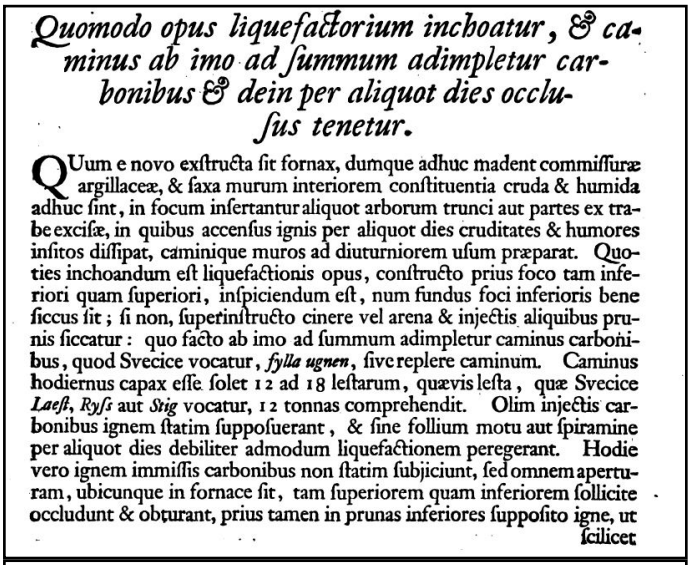
'*How the melting work is begun and how the furnace is filled with coals from the bottom to the top and for some days shut up close*'.

A similar sub head occurs on page 30 of de Ferro (Fig 2) *'Quomodo opus liquefactorium inchoatur, & caminus ab imo ad summum adimpletur carbonibus & dein per aliquot dies occlusus tenetur'* which translates (according to a scholar of Latin) as:

'*How the work of melting is begun, and the furnace from the bottom to the top is filled with charcoal and then is kept closed up for some days*'.

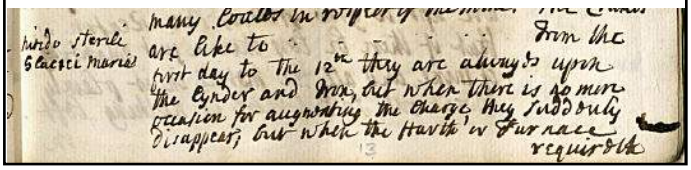
There are many other indications that the 'Fuller' account is a translation of de Ferro. On page 13 of the manuscript a section of the English text is missing and indicated by dashes: '*The Crumbs are like to --- --- --- --- From the first day to the 12th…*' and in the margin is the latin which appears to read: '*nibido sterili Glacici marias*' (Fig 3). In De Ferro (p40) this line is: '*nitido sterili seu glaciei Mariae*' (Fig 4) which translates as: '*The said grains are similar to bright or pure 'glass of Mary*'. ('*Glacies Mariae*' is possibly selenite or mica).

Commencing on page 40 of de Ferro is a list of 11 factors to look for when deciding if more ore or more charcoal is required in the charge. 'Fuller' lists and numbers all 11 faithfully.



Quomodo opus liquefactorium inchoatur, & caminus ab imo ad ſummum adimpletur carbonibus & dein per aliquot dies occluſus tenetur.

QUum e novo exſtructa ſit fornax, dumque adhuc madent commiſſuræ argillaceæ, & ſaxa murum interiorem conſtituentia cruda & humida adhuc ſint, in focum inſertantur aliquot arborum trunci aut partes ex trabe excifæ, in quibus accenſus ignis per aliquot dies cruditates & humores inſitos diſſipat, caminique muros ad diuturniorem uſum præparat. Quoties inchoandum eſt liquefactionis opus, conſtructo prius foco tam inferiori quam ſuperiori, inſpiciendum eſt, num fundus foci inferioris bene ſiccus ſit; ſi non, ſuperinſtructo cinere vel arena & injectis aliquibus prunis ſiccatur: quo facto ab imo ad ſummum adimpletur caminus carbonibus, quod Svecice vocatur, *fylla ugnen*, ſive replere caminum. Caminus hodiernus capax eſſe ſolet 12 ad 18 leſtarum, quævis leſta, quæ Svecice *Laeſt*, *Ryſs* aut *Stig* vocatur, 12 tonnas comprehendit. Olim injectis carbonibus ignem ſtatim ſuppoſuerant, & ſine follium motu aut ſpiramine per aliquot dies debiliter admodum liquefactionem peregerant. Hodie vero ignem immiſſis carbonibus non ſtatim ſubjiciunt, ſed omnem aperturam, ubicunque in fornace ſit, tam ſuperiorem quam inferiorem ſollicite occludunt & obturant, prius tamen in prunas inferiores ſuppoſito igne, ut ſcilicet



copiam carbonum in ratione ad venam eſſe. Micæ dictæ ſimiles ſunt nitido ſterili ſeu glaciei Mariæ, ut vocatur; primis diebus usque ad 12mum jugiter ſcorius & ferro inſident: at vero cum nulla augmentatio amplius ne-

Figure 2 (above, top). Title of 'Fullers' account on page 30 of de Ferro. Note line 11 of body text where 'Fuller' copies 18 as 8 (viz second line Fig 1).
Figure 3 (above, middle). Latin insert in margin indication untranslated text in the line showing gaps.
Figure 4 (above, bottom). The Latin phase in De Ferro untranslated by 'Fuller' (my underlining).

Finally, 'Fuller's' account ends abruptly with the metal still in the furnace with no account of tapping slag or metal. De Ferro, however, continues the description for a further 12 pages.

Thus the question seems to be, did Swedenborg copy 'Fuller' or 'Fuller' simply translate a section of de Ferro relevant to his interest in operating Heathfield Furnace? Swedenborg was known to have visited England (and Germany and the Netherlands) to study iron production between the dates 1710 – 1715. Indeed, he visited the Weald and other ironmaking regions of England and his observations are included elsewhere in de Ferro – the part relating to blast furnaces and the casting of iron cannon having been translated and published in the WIRG Bulletin of 1999 (Hodgkinson & Dalton).

Only Fuller (1652-1722) predates the publication of de Ferro in 1734 and even so could have had access to Swedenborg's paper of 1717.

The evidence is so strong that what we have is an incomplete translation of the Latin script of a section of de Ferro that we can no longer accept 'Fuller's' account as being that of a Sussex blast furnace.

Paul Vigor concluded his reply to Richard Hayman with a quote from Peter Crew *'question everything, even the most firmly held ideas, especially your own, go back to basic principles, think the unthinkable and then more'.*

I would like to add to this Sir Isaac Newton's words: *"If I have seen further it is by standing on the shoulders of Giants."* Had Richard Saville not located the account amongst the Fuller papers and undertaken the onerous task of transcribing it to print – we would have far less knowledge of the operation of a charcoal blast furnace – whether it be Swedish or British.

Tim Smith

References

Cleere, H. & Crossley, D. 1995. *The iron Industry of the Weald*. Cardiff: Merton Priory Press.

Wealdon Iron Research Group online database,accessed 2014. **http://www.wirgdata.org/searchpro2.cgi**

Hodgkinson, J. & Dalton, A. 1999. Swedenborg's description of English iron-making. *Bulletin of the Wealden Iron Research Group*, Second Series, No. 19, p47-63. Available as a download from **www.wealdeniron.org.uk/bull2.htm**

Acknowledgements

With gratitude to Bo Sundelin for bringing the similarities of text to my attention, to Jeremy Hodgkinson (WIRG) for directing me to the translation of part of de Ferro in the WIRG Bulletin and the facsimile of de Ferro, to David Crossley for his confirmation that he found no evidence of the breaking of ore by water driven hammers during his extensive excavations on the Weald, to Anne Drewery for her translation from the Latin and Don Wagner on comments relating to the Swedish translation of de Ferro.

BRICKMAKING AT BEDLAM FURNACE, IRONBRIDGE

In 1979, the late Stuart B Smith – formerly Deputy Director of the Ironbridge Gorge Museum and a published Bedlam Furnace researcher – reported a local Ironbridge anecdote that one of the redundant blast furnaces at the Madeley Wood/Bedlam Furnace had been adaptively reused as a brick kiln (Smith 1979, 23). The bottle kiln-like appearance of "Furnace II" at the conserved Bedlam Furnace ruin added some credence to the story. Consequently, although Smith had provided no reference to support his brick kiln hypothesis, the 'Bedlam brick kiln' anecdote became a popular narrative component of the site's history (Trinder 1984).

In 1994-95, archaeologists working on the Madeley Wood/ Bedlam Furnace site investigated Smith's 'Bedlam brick kiln' story (Hayman et al. 1999, 66-67). They examined the period c.1843 (when iron smelting ceased at Bedlam Furnace) to c.1908 (local historian, John Randall's description of the Bedlam site), but could find no physical or documentary evidence to support the 'Bedlam brick kiln' hypothesis. The only possible explanation concerned an enigmatic, furnace/kiln-like feature recorded on the 1883 6" Ordnance Survey map; a feature located on the eastern side of the former blast furnace site.

Having discounted the possibility of a brick kiln constructed in such an awkward position, an alternative proposition argued that the mapped feature might represent Bedlam's missing '*third* [blast] *furnace*' (Hayman et al. 1999, 67-68).

Bedlam "Furnace II" – right. The standing remains of the cone-like furnace structure.

Examination of the 1902 edition of the 6" Ordnance Survey map of the Bedlam site appears to clarify the situation. The enigmatic furnace/kiln-like feature is again depicted; however, the original symbol is joined by another map symbol: an italicised upper case "W". According to the Ordnance Survey in Southampton, an italicised, upper case "W" signified (in 1902) a well.

A working reconstruction of a small Victorian beehive-type brick kiln, photographed at the Acton Scott Museum, Shropshire. A kiln of this type and size may have fitted quite comfortably within the redundant cone/hovel of Bedlam's "Furnace II".

In 2005, the present author began a series of conversations with Mr Melvin Molyneux, a long-time resident of Coalbrookdale. Mr Molyneux was able to shed some new light on the 'Bedlam brick kiln' mystery. According to Mr Molyneux:

Edward Molyneux, a native of Broseley in Shropshire, worked as a stoker at the Ironbridge Gas Works. To supplement his income, he built and operated a small squatter brick kiln within the redundant cone of "Furnace II" at Bedlam Furnace, Ironbridge, between c.1926 and 1929. During his unofficial occupation of "Furnace II", Molyneux manufactured fire bricks and saggars from local clay, and fired them in his kiln. He transported his wares to customers in The Black Country using a Model T Ford lorry. In 1929 the kiln suffered a serious explosion, in which a young woman was injured. Following the explosion, Molyneux moved his family from Broseley to Horam in East Sussex. Having settled his family in Horam, Molyneux continued to work as a brickmaker. In 1939, the Molyneux family moved back to Broseley.

According to the conventional history of Bedlam Furnace, by 1929 the condition of the erstwhile blast furnaces had deteriorated to such an extent that demolition work commenced, using explosives (Trinder 1984). During the demolition process, an unfortunate trespasser was apparently killed by a fall of masonry. It is possible that the reported 1929 brick kiln explosion may have further

weakened the already fragile brickwork comprising the cone of "Furnace II". It seems likely that any surviving physical evidence relating to Molyneux's short-lived brick kiln may have been destroyed during the 1929 demolition, or the 1970s excavation and reconstruction work. Presumably, fragmentary debris from an exploded brick kiln may be difficult to distinguish from debris from a deliberately blown-up blast furnace.

Information provided by Melvin Molyneux has filled a gap in our knowledge about a lesser-known period in the productive life of the Madeley Wood/Bedlam Furnace. It appears to confirm that, although the bottle kiln-like structure of Bedlam's "Furnace II" hadn't been purpose-built for brickmaking, it had – for a short time – been adaptively reused as a hovel over a rudimentary brick kiln.

Paul Vigor

Refereces

Smith, S.B. 1979. New light on the Bedlam Furnaces, Ironbridge, Telford. *Historical Metallurgy*, 13(1), 23.

Trinder, B. 1984. *Bedlam: Museum Guide No. 3.02.* Ironbridge, Ironbridge Gorge Museum Trust, 10.

Hayman, Horton, & White. 1999. Archaeology and Conservation in Ironbridge, *CBA Research Report 123*. York. Council for British Archaeology, 59, 66-7, 82.

Hayman, Horton & White, 1999, Archaeology and Conservation in Ironbridge, *CBA Research Report 123.* York: Council for British Archaeology, 67-8.

Trinder, B., 1984, Bedlam: Museum Guide No. 3.02. Ironbridge: Ironbridge Gorge Museum Trust, 4.

MISSING: VHS TAPES!

We are very anxious to locate the VHS Tapes of a number of films, including those made unofficially by Dr Lewis Reeve at Scunthorpe. These were originally 35mm movie films shot within the steelworks at Scunthorpe where he was Director of Research from the mid 30's to 1960. They were mainly shot to use up film after holidays, not usually anything specific, more things he saw as part of his working routine.

These films, the property HMS, were transferred to tape, together with films from other sources around 1987 to 1990.

They are believed to have sent for showing at an HMS Conference or Study Day some years ago. If anyone is aware of their location, could they please let Eddie Birch know at **mejbirch@aol.com**.

WEALDEN IRON RESEARCH GROUP

The 72 pages of this year's Bulletin of the Group (2nd series, vol. 34) make it the fullest in its 45-year history. Once again, the subject matter is wide-ranging. Woodland surveys are becoming increasingly common and the overview of two woods in Hadlow Down, East Sussex, reveal the many uses for which evidence survives. This includes two bloomery smelting sites, as well as quarries where iron ore may have been extracted and platforms for charcoal making. The value of LiDAR has been demonstrated in many areas, and the Weald, with its dense tree cover, has yielded some of its secrets under the penetrating beam of this exciting technology. Such is the case with Forewood, Crowhurst, in East Sussex, where a spread of iron ore minepits have been revealed, in addition to known bloomery sites. The pits probably relate to the local 16th-17th century furnace.

Theoretical discussions have begun to taken their place in the pages of the Bulletin over the past few years and three are included in this volume: a consideration of experimental smelting practices and their underpinning theories; the potential of various ores available in the Weald to produce blooms; and the historical effectiveness of roasting Wealden ores.

An undated iron graveslab in the redundant church of St Michael in East Peckham, Kent, which possibly replaced an earlier memorial brass, is the first of several short historically-based articles. Its plain cross design and largely illegible brass inscription plate suggests that it was in memory of a 15th century cleric. Litigation in the 16th century around the disputed tenancy of the furnace and two forges in St Leonard's Forest, near Horsham, West Sussex, produced depositions by several local people, in some cases identified as ironworkers, colliers and related trades. An article listing their names adds to the growing database of personnel associated with the iron industry.

While the list of ironworks in the Weald drawn up for the Privy Council in 1574 covers the three Wealden counties of Sussex, Kent and Surrey, the lists drawn up in 1588-90 have only survived for Kent. Details of the two furnaces at Cowden include some anomalies, and a short article proposes Thomas Burgh, Lord Burgh of Gainsborough, as one of those named as having an interest in one of the works. Finally, the site of the forge and furnace at Biddenden Hammer Mill, in Kent, in operation from 1570, in the case of the forge, to about 1670, is the subject of a ground survey which identifies the working areas of the two operations.

Further information about the Wealden Iron Research Group can be viewed on the group's website: **www.wealdeniron.org.uk**.

Jeremy Hodgkinson

'STEEL' – A REMARKABLE ARCHIVE FILM NOW AVAILABLE

In The Crucible No 82 Spring 2013 p 17, I reviewed the release of a DVD by the British Film Institute of archive film recording the British iron and steel industry. Of the 21 films on the DVD twin set I declared the best to be a rare colour record made in 1945 called 'Steel' which was filmed by Oscar-winning Jack Cardiff.

This 34 minute film is now available free to view or download from the British Council archive of film at **http://film.britishcouncil.org/steel**.

The film was recorded at over 10 steelworks in UK and includes rare footage of crucible steelmaking. Bulk steelmaking is illustrated by both the Bessemer process and the Siemens Martin (open hearth). An electric arc furnace is also shown.

Steel filmed in 1945 includes a remarkable record of Crucible steelmaking

Ironmaking is followed from excavating the ore, through coke making to charging and tapping the blast furnace.

Made before the common use of continuous casting the teeming of ingots with steel is spectacular and the stripping of the moulds to reveal the red hot ingots.

The rolling of reheated ingots to long and flat products (strip) is recorded as well as the production of tube.

In addition, if you search on 'steel' at **http://film.britishcouncil.org** you will find other steel related programmes including 'Steel Goes to Sea' which follows the building of a ship (15min b/w 1941); 'Teeth of Steel' showing excavators at work including a walking drag line and the roasting of iron ore in open piles (10min colour 1942); 'How a Bicycle is Made' (10min b/w 1945); and 'Power to Order' on the building of a locomotive at Doncaster (10min b/w 1941). The commentary on each of these reflects wartime Britain.

The British Council film archive contains a host of other interesting films but for a record of steelmaking between 1901 to 1987 you cannot beat the compilation of 20 films ('Steel' for example, has been digitally enhanced) with a total running time of 348 minutes available from the BFI **www.bfi.org.uk/shop**.

Tim Smith

INVESTIGATING NON-FERROUS METALWORKING IN BRONZE AND IRON AGE NORTHWEST EUROPE

A major new three-year project, based at the University of Bristol and funded by the Leverhulme Trust, aims to reassess the organisation and social context of non-ferrous metalworking across northwest Europe during the Bronze Age and pre-Roman Iron Age. The focus will be on bronzeworking, which dominates the evidence for non-ferrous metallurgy, though the crafting of other metals such as gold, silver, tin and lead will also be considered. Our geographical remit covers Britain, Ireland, northern France and the Low Countries.

A key element of the research will be to systematically examine the find context of metalworking remains from excavated sites. The analysis will identify places where different kinds of metalworking occurred, and explore what the treatment and deposition of metalworking remains can tell us about the significance of this craft.

While there is no scope for any new archaeometallurgical analysis within our project, we do plan to synthesise the results of existing scientific analyses of excavated metalworking remains, such as slag, casting waste, crucibles, moulds and smithing tools. This will help us to characterise the nature of the metalworking activity occurring at individual sites.

We would be interested in discussions and collaborations with other researchers working on similar issues. In particular, we would be very grateful to learn of any unpublished finds or scientific analyses of non-ferrous metalworking remains from excavated prehistoric sites. We are of course happy to share information in return, and will fully acknowledge any assistance. Please contact **leo.webley@bristol.ac.uk**.

Leo Webley
Joanna Brück
Sophia Adams

PROFESSOR ELIZABETH SLATER

As we go to press it has come to our notice that Emeritus Professor Elizabeth Slater, who was a member of HMS Council in the 1980s, has sadly died. A fuller appreciation of her contributions to archaeometallurgy will be included in the next issue of The Crucible.

VANESSA CASTAGNINO

My path to the Historical Metallurgy Society has been slightly different from the traditional. Although I had worked on archaeological sites around Britain, I didn't come to archaeology in the academic sense until my thirties and archaeological science until I turned forty. It was at that time I had the good fortune to have Gerry McDonnell as my guide to archaeometallurgy. My all-consuming passion for ironwork developed out of my fascination with early medieval weaponry and out of that the discovery of the process of composite forge welding. The making of things has always intrigued me: how objects are constructed, the methods used and the materials chosen.

A visit to Howden Minster in the East Riding of Yorkshire. The North Aisle Door is decorated with 'restored' ironwork from the 14th century.

I built my first bloomery furnace for the BBC's MasterCrafts series with Gerry and ran his furnace at HMS's experimental conference at West Dean in 2010. Several furnace constructions on and I have learned to source my own ore, roast and smelt it. I have had instruction in traditional blacksmithing from Master Blacksmith, Bob Oakes in Lincolnshire. As a result I invested in a portable forge and anvil, and now have more hammers than I care to admit.

However, it is during my work at the English Heritage Archaeology Store in Helmsley, North Yorkshire, over the past five years, that I have learned most about metal artefacts. Apart from their care and conservation, I have produced user-friendly archives from the wealth of artefacts in their charge, from Roman sites such as Hardnott in Cumbria and Housesteads in Northumberland, to later great medieval religious houses such as Fountains and Furness. It is also through this work that I have been fortunate to access monastic metalwork and production waste under EH guardianship. These materials will form the basis of my current doctoral research, which is being undertaken at the University of York. I am only too keen to promote the abundance of metalwork sitting in storage facilities around the British Isles in desperate need of research. At a time when museums are starting to review how they deal with archives, and with increasing requirements for open access and online archiving, such collections should be earning their keep and we, in turn, should be gaining from that opportunity to research them.

A placement at the English Heritage laboratories at Fort Cumberland in Portsmouth consolidated my skills. Though my eyes were opened, and diverted, to the dark arts of heritage glass and the glories of ferrovitreous architecture (do love a greenhouse!), the placement enabled me to hone my scientific skills and allowed me to gain considerable knowledge and experience of the wider heritage profession. Today I juggle my position within the society with doctoral research, independent specialist contracts and my continuing commitment to both community and public archaeology.

I have been a member of HMS since 2006, acting as a committee member, committee chair and elected to Council in 2012. I took a prominent role in the rebranding of the society, most notably developing the website and the online bookshop for its 50th Anniversary. In March I was elected Communications Officer, which involves me overseeing internal communications, maintaining the website, bookshop and managing our social media presence.

As Communications Officer, my hope is to see the strengthening of our international ties and the growth and expansion of our membership, especially outside the realm of academia. Hopefully this will be encouraged by our social media presence and by the society's journal Historical Metallurgy soon being accessible online. Yes, there's still a lot more to do. If you feel you could contribute to the challenge, contact us and come join us!

HMS ARCHIVES STUDY DAY

A study/work day at the Long Warehouse, IGMT, Coalbrookdale on Saturday 11 April 2015 is organised by the HMS Archives and Collections Committee (ACC).

Workshop sessions on the management of the collections will be held. These will be "hands on" and will achieve useful progress in cataloguing and protecting the collections. Sessions will cover both the paper archives and the slag collections. 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.uk**

No bellows needed!

In the year 1982 a large bloomery site, which by means of ^{14}C-dating was found to stem from the Roman Iron Age, was found at Heglesvollen in the county North Trøndelag, Norway. A limited number of small, mainly research excavations in the years to follow, led by archaeologists from the University Museum in Trondheim, has disclosed a large production during the period 300 BC-600 AD, with a peak around 200 AD. Until now, some 400 sites of a very uniform character have been registered at altitudes from 300 – 600 m.a.s.l., from the inner part of the Trondheimsfjord to Jämtland in Sweden. Sites which have been studied by us are shown on the map in fig. 1.

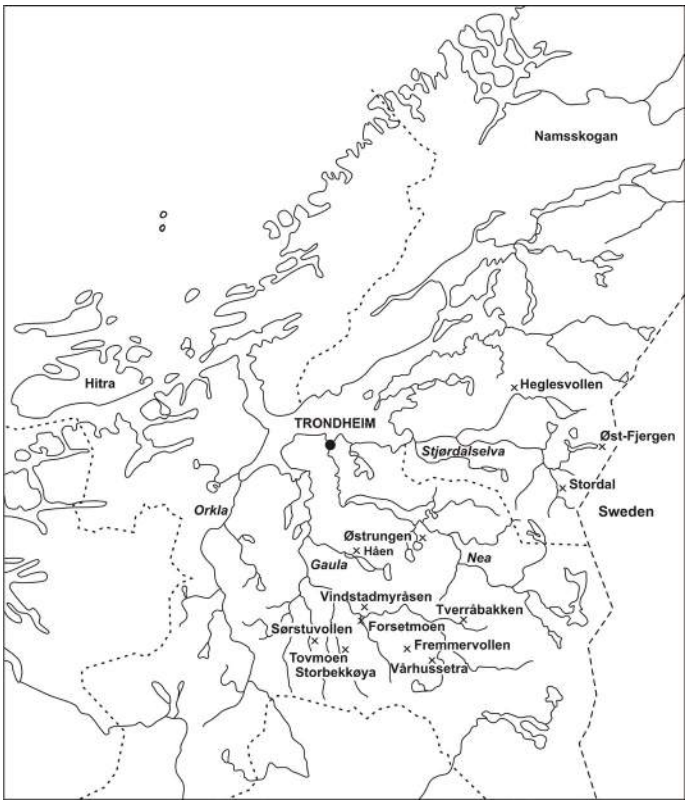


Figure 1. Bloomery sites studied by archaeologists in the Trøndelag region. The sites named Heglesvollen, Øst-Fjergen, Stordal, Tverråbakken, Tovmoen, Østrungen, Fremmervollen,Vårhussetra are all from the Early Iron Age while Forsetmoen at 180 m.a.s.l. represents a number of smithing hearths from the same period.

The standard site comprises a set of 3 – 4 furnaces 6 m apart, lying on a brink facing a river, a creek or a lake. No clear function of this water has been disclosed. Every "furnace" is a stone-lined pit in an excellent state of preservation, due to slag in amounts up to 150 kg left in situ from the last smelting, evidently in order to prevent damage by frost. The pits have a permanent opening like a slot about 40 cm wide, facing a slope, which was useful as a slag dump. The first excavated furnace is shown in fig. 2.

At first this construction was regarded as the furnace proper, which led to some unrealistic ideas about the position and the operation of bellows, retrieval of the blooms etc. However, finds of broken pieces of red-burnt clay represented remains of a shaft above ground.

Figure 2. The slag pit No. C2a at Heglesvollen after it was emptied. Photo by AE.

Sampling and weighing of slag led to 96 tons for the group of four furnaces, divided equally between them. The slag was found in large pieces weighing up to and over 50 kg. They had characteristic imprints and cavities showing the grain of wood. This implies that the stone-lined pit with an inner diameter of 80 cm acted as a holding tank, receiving liquid slag from above. Wood was imbedded in this slag, which prior to each run evidently was put across the pit, in order to create a platform for the charge of roasted ore and charcoal, being transformed into solid iron and liquid slag in the shaft. Remains of this wood have later decayed.

There are several indications that the necessary fuel was wood and not charcoal: a) no charcoal pits in the vicinity b) no spilling of charcoal around the slag pits (Norwegian archaeologists claim that charcoal burning in pits took place in the period 700 to 1500 AD).

The ^{14}C-dating of pieces of charcoal from slag dumps and from stored roasted ore revealed that pine was used exclusively as fuel, while birch was also available. This indicates that pine had a specific function: Pine is known to have a core of kernel wood, rich in resin and tar. Slow-growing pine will contain a large part of this type of wood, expressed on a cross section as a dark inner part. When heated, this kernel wood will deliver inflammable gases and leave charcoal. It can be said that pine burns twice.

Figure 3. A broken piece of the shaft with the half of an air inlet, measuring 8 cm in cross section. From the slag dump at Vårhussetra. Photograph by AE.

A single find of an air inlet seems to give an answer. In fig 3 is shown a piece of the shaft with apparently the half of an air opening, measuring 8 cm in cross section.

The opening for a nozzle of bellows would never exceed some 3 cm. It is therefore concluded that the furnaces were operated with the direct use of wood, and that the required high temperature for the draining of the slag and possibly the consolidation of fragments of iron were achieved by using the chimney effect.

Liquid slag solidifying in the pit, facing the "cold" stone wall shows ripples, implying that the slag came in discreet amounts of some 10 kg. Each slag episode must have taken place when wood was added on top. A piece of slag with such ripples is shown in fig. 4.

Figure 4 (left).Ripples on a piece of slag, which had solidified against the cold wall of the slag pit. Each ripple may represent decantation of some 10 kg of slag. From Vårhussetra. Figure 5 (right). Typical primary bloom, obviously taken hot out of the furnace and immediately split with an axe. Weight 17 kg, slag free, low in phosphorus and with 0.26 % carbon. Density about 6, due to large cavities. In the possession of the museum in Trondheim. Photographs by AE.

The annual production around year 200 AD was around 40 tons of iron. The authors have suggested that an export to the European continent took place. This lasted until a crisis and a loss of this market occurred on the continent, in the wake of the Migration period.

The iron produced was of a high quality. A museum piece weighing 17 kg is shown in fig. 5.

It is clear that the carbon content was controlled with a FeO-rich slag. How was an over-reduction of iron oxide avoided? One of the authors (AE) has suggested that a moderately oxidizing slag was maintained by a supply of half reduced ore from "reservoirs", as expressed in fig. 6.

Based upon finds and also metallurgical reasoning one of the authors (AE) has proposed a sequence of operations, as expressed in fig. 7.

The very successful method was used over a period of more than 800 years. The method was very specific and could be reproduced. It is claimed (AE) that the method was brought to Norway-Sweden from the Black Sea area. The method was not altered during this long period. Smelting took place at summer time by specialists. It appears that it was

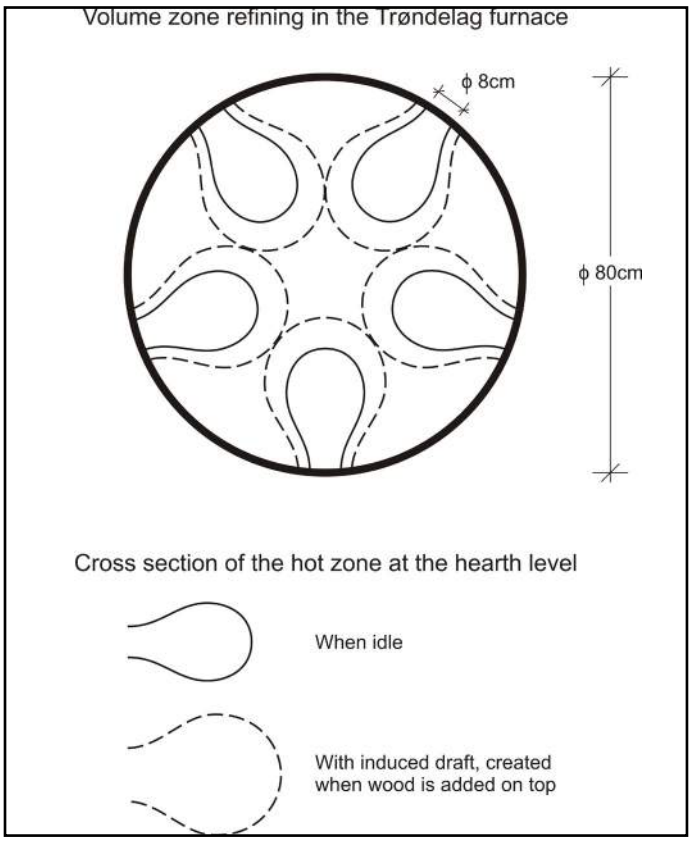


Figure 6 (above). Suggested cross section of the furnace at the level of the air inlets. Between these inlets the ore was reduced to FeO only. Whenever wood was added and the supply of air increased, oxide was added to the slag from these "reservoirs" Figure 7 (below). Proposed cyclical iron production process. Diagrams by AE.

carried out by a group of serfs, led by a chieftain, being a member of a guild. The size and the organization of this early iron production indicate a developed infrastructure, not hitherto revealed. There is an ongoing discussion of the shape and the dimensions of the shaft, based upon the finds and functional criteria.

Arne Espelund
Larse Stenvik

Thilo Rehren

On this occasion, the editorial team behind The Crucible might be accused of a bias for devoting the One Minute Interview to someone at their own institution. However, few could deny that Thilo Rehren is a major drive reshaping archaeometallurgy internationally, not least by training and enabling a large cohort of students that is progressively becoming the next generation of specialists. Currently Director of UCL Qatar as well as Editor of the Journal of Archaeological Science and Director of the Institute for Archaeo-Metallurgical Studies, Thilo is renowned because of the remarkable breadth of his knowledge and research interests, his love of phase diagrams, and his ability to spot double spaces.

He was born in 1959 in Celle, a gentle town in northern Germany. The youngest of four children, he stayed there until he finished school in 1977. After completing his national service he studied mineralogy at Freiburg (SW Germany) and Clausthal (north Germany) before doing his PhD in Freiburg, studying a nice Greek volcanic island in the Dodecanese (can't beat the fieldwork!). After that, he worked as a research scientist at the Deutsches Bergbau-Museum in Bochum and then as a Professor of Archaeological Materials and Technologies at UCL in London. Recently, he moved to the Doha to lead UCL's outpost there.

The CRuCible : Can you summarise your career in a couple of sentences?

Thilo RehRen: I had a basis in economic geology of base metals, followed by a PhD in volcanology. It was kind of logical for me to combine the two – metaphorically putting copper ore into a (little) volcano, aka furnace, and see what happens – not experimentally, but by reverse engineering, as I had done during my PhD when I reconstructed the magma development and 'production' output of that volcano. This sustained me through nearly ten years as a research scientist at the Deutsches Bergbau-Museum in Bochum: the best possible job for me. However, in 1999 I was offered the Chair in Archaeological Materials and Technologies at the UCL Institute of Archaeology. This added teaching to my duties and gave me the opportunity to develop a real research group within an exciting academic environment, making this the best possible job for me. More recently, I was involved in developing and then establishing UCL Qatar as an academic department of UCL – building up a whole department from scratch. Turned out to be the best possible job for me :) !

The CRuCible: What is your most memorable professional moment?

Thilo RehRen: Swinging in a hammock near a beach in Tuscany. This was where I had the eureka moment that laid the foundation for my work on Late Bronze Age glass making.

The CRuCible : Who has been your most influential colleague, and why?

Thilo RehRen: There are several colleagues whom I owe all I know and am, at different stages of my career. For archaeometallurgy, this is surely Hans-Gerd Bachmann. He inspired me to use mineralogy and geochemistry across the range of artificial materials, and with a focus on the archaeological processes that matter, rather than what I would call 'stamp collecting' – doing mineralogy on slags for the sake of it. Archaeometallurgy is first and foremost archaeology, not mineralogy or materials science.

The CRuCible : What is your main current project?

Thilo RehRen: Keeping UCL Qatar on the straight and narrow, towards a glorious future (once I'm retired). Apart from that – understanding urban metallurgy of all periods, and Roman glass, I suppose.

The CRuCible : What multi-million project would you like to develop?

Thilo RehRen: I'm doing one right now :). Beyond that? A research centre with PhD students and postdocs, embedded in a good university. This would focus on historical materials (younger than 1000 years), combining archaeological, historical and materials research methods to study the production of ceramics, metals, glass and pigments. These materials were closely related in the past, share raw materials, skills and methods for their production as well as their analysis, and therefore are best studied together. The recent millennium is woefully under-studied compared to the prehistoric periods, while being much more interesting in their cultural and material diversity and complexity.

The CRuCible : Which publication should every HMS member read?

Thilo RehRen: Uncle Tungsten by Oliver Sacks.

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

Thilo RehRen: Keep your eyes open – we know only a small fraction of what's knowable. Once you've learned the skills don't just repeat research by doing 'more of the same', but take the challenge to find new things. Study things you don't know what they are going to tell you – that's called research.

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

Thilo RehRen: I would like to tell every reader of the Crucible that they should question what they find in the literature, and to follow their own instinct and curiosity. We're a generation or so away from a proper comprehensive textbook for archaeometallurgy – until then, we need many more case studies, of unusual and 'weird and wonderful' sites and materials, and in regions and periods off the beaten track.

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**.

Interdisciplinary Studies of Ancient Materials from the Mediterranean

Nicosia, Cyprus, 17th-19th September 2014

Between 17th and 19th September 2014 the international conference on Interdisciplinary Studies of Ancient Materials from the Mediterranean was organised by the Archaeological Research Unit of the University of Cyprus. This conference was the concluding act of the multi-partner and interdisciplinary research network entitled New Archaeological Research Network of Integrating Approaches to ancient material studies (NARNIA) (for more information, please visit: **http://narnia-itn.eu/**). Alongside the presentations of 20 NARNIA-fellows, the conference was open for anybody interested in the study of ancient materials within the Mediterranean. Within 3 days 54 papers and 22 posters were presented for an audience of over 100 people by both early-stage and experienced researchers based at numerous universities and research institutes in Europe, USA and Near East.

Apart from sessions on ceramics, glass, dating techniques and palaeo-environment, building materials and pXRF, three sessions were dedicated to "Copper metallurgy across the Mediterranean". The 13 oral presentations covered the production of copper within several areas and countries of the Mediterranean by which primary smelting debris, metallurgical ceramics and/or final objects from different periods were studied by various techniques such as optical microscopy, portable and desktop XRF, SEM-EDS, EPMA, lead isotope analysis, archaeomagnetic analysis etc.

The second day of the conference was opened by a first session on metallurgy, chaired by Dr George Papasavvas. Lente Van Brempt presented the primary results of the analyses done on the metallurgical remains from Late Bronze Age Kalavasos-Ayios Dhimitrios, Cyprus, with the aim to reconstruct the technological process of copper smelting and to assess the role copper may have played within south-central Cyprus. Demetrios Ioannides gave us a detailed introduction to a promising research project on the technical ceramics coming from Kition, a much-discussed Late Bronze Age site in Cyprus, while Andreas Charalambous gave a talk about his completed study of copper alloys for which he analysed numerous artefacts from various Late Bronze and Iron Age sites in Cyprus by means of pXRF. Moving away from Cyprus, Frederik Rademakers evaluated the technological variability in ancient metallurgical crucible assemblages through different case studies from the Mediterranean, i.e. 13th century BC Qantir/Pi-Ramesses and the Late Roman Balkans. Ilana Peters closed this morning session with a presentation on the dating of major slag deposits in the central Timna valley by means of an archaeomagnetic study.

The third day of the conference was closed by two following sessions on metallurgy. Nerantzis Nerantzis opened the first session, chaired by Prof. Marcos Martinón-Torres, with presenting evidence for Thassian copper metallurgy during the Early Bronze Age through the analysis of raw materials, metallurgical residues and finished artefacts from several settlements in Thassos, North Aegean. Next Lena Hakulin gave a talk in which she enlightened a new approach for investigating the role of metals in Late Bronze Age Societies on Crete based on the quantification of the metal finds by weight. Damir Rumenjak gave a wide overview of the different types of furnaces used or possibly used in antiquity, a discussion of which could be one of the methodological tools in the clarification of issues regarding the production of copper. Naama Yahalom-Mack presented a paper on Egyptian bronze working practices in Late Bronze Age Canaan within which she examined the presence of canals at some sites in Canaan in comparison with those at contemporary Qantir/Pi-Ramesses identified as installations within which crucibles for copper alloying and bronze re-melting were placed. This session was closed by the presentation of Adi Eliyahu-Behar on a hoard recovered from Early Iron Age Megiddo that included both bronze and iron objects as well as bi-metallic knives, the study of which lead to the conclusion that both bronze and iron were produced by a local smith on the site.

The last session, chaired by Prof. Vasiliki Kassianidou, started with a presentation by Aurelia Masson-Berghoff on votive bronzes in Late Period Egypt within which she addressed the possible sources of the raw materials used and hence the use of local mines and import of metal in Egypt. Aurélie Cuénod extended the Mediterranean area by giving a talk on the Garamantian metal, the copper used in the pre-Islamic Sahara, and it's provenance, which may have been of Roman origin. As a closure to this session and the conference, Mainardo Gaudenzi Asinelli presented his research on the consumption of copper alloys in Tyrrhenian medieval towns by a technological and compositional study of copper alloy artefacts from Leopoli-Cencelle.

A small number of posters concentrated on archaeometallurgy by discussing the tin bronzes from the EBA settlement of Kastro-Palai, Volos, Greece (E. Asderaki-Tzoumerkioti and E. Skafida), the basalt anvils used in the final stages of the metal production found at the EBA-MBA settlement of Pyrgos Mavroraki, Cyprus, (M. Belgiorno), and the provenance of the silver used to mint Greek coinage in the Greek colonies of the 5th-3rd centuries BC (T. Edward Birch et al.). Metals were also addressed in the session on "pXRF application in Archaeology". Two papers presented the use of pXRF in the analyses of silver alloys, on the objects from the EMI-MMIIA cemetery of Petras, Crete (A. Giumlia-Mair et al.) and on the Iron Age hoards from southern Phoenicia (T. Eshel et al.).

We were fortunate to visit the copper mining area of Mitsero as part of the excursion organised on the day after the conference.

Apart of the splendid organisation and the presence of an attentive and interactive audience, the absolute strength of this conference was the attendance and sincere interest of an extensive Scientific Committee of renowned researchers and professors from 6 academic institutions, one research centre and two private enterprises from UK, Cyprus, France, Belgium, Greece and Jordan that take part in the NARNIA-network. Fruitful discussions did not only take place within the conference hall, but experience, knowledge and advise was also exchanged between all generations of researchers during the coffee-breaks, lunches and dinners, creating new networks for the future.

Therefore, congratulations to the organising committee, Prof. Vasiliki Kassianidou (NARNIA project coordinator) and Dr Maria Dikomitou-Eliadou (NARNIA project manager).

Lente Van Brempt

HMS Annual Conference

Salisbury, UK, October 3rd - 5th 2014

This year's Annual Conference was held in the historic city of Salisbury. The theme was Metallurgy in Warfare, a fascinating topic but with an additional poignancy on this, the centenary year of the World War I. Metallurgy has always been at the vanguard of advances in warfare and this was aptly demonstrated by the extremely diverse topics on offer.

Friday evening started with a session on Ancient warfare and hand-to-hand combat. Andrea Dolfini's "Bronze Age combat: An experimental approach," possibly one of the most interesting sounding research topics out there, compared use-marks and damage recorded during simulated combat using traditionally made Bronze Age weapons, to archaeological examples. They matched bent swords from flat of the blade parrying to ancient weapons, and noted the surprising efficacy of beaten bronze shields. Following the Bronze Age theme, Barry Molloy's "Avant garde? A techno-social perspective on the birth of the sword in the Bronze Age" (read by Tom Birch) dealt with the development of sword technology highlighting the need for very highly skilled casting; single pours, and the need to reduce casting errors, particularly at the junction between blade and handle to stop breakage. Off topic, but brilliant none-the-less, "Två 1800-talsbruk," a 1920's film of a 19th century charcoal blast and refinery furnace in Sweden recording the process from ore to finished bar iron, loaned by the Swedish Archive Centre and commentary by Tim Smith. This film was a remarkable historical record encapsulating not only the metallurgical process but a long lost way of life. Of interested was the use of horse drawn sledges for charcoal alongside trains for the ore; hand charging the blast furnace; operation of a Lancashire hearth; water driven tilt hammers for billet and bar production; protective clothing of no more than a leather apron and wooden clogs. The final paper of the day, David Edge's 'Damascus' watered steel: pretty lethal... or just pretty?' discussed modern methods in the identification of damascus steels, detailed study of objects from the Wallace Collection showed that Damascus steel was used only for

bits of the object that could be seen with little attempt to make use of its superior material properties.

Saturday morning began with a session on Firearms and Artillery, Chris McKay explained the process of gun casting in 18th century Woolwich, identifying little known techniques, as illustrated in "The Art of Gunfounding" by Carel de Beer. This was followed by Jean-Marie Welter "The Keller brothers; gun casters to Louis XIV" who commented on the many difficulties of producing cannons with reproducible compositions and microstructures despite the technological advancement in casting, this explained the relatively high failure rates in cannons. Kay Smith's paper "Breaking the mould" discussed the drivers of cannon innovation; the change from casting breach up to muzzle up around the late 16th century in an aim to reduce casting defects and stop failure in the breach area during use; and how changes to gun powder production and cannonballs affected cannon design.

The second session, Technology, Organisation and Production began with a very interesting talk by Janice Li on "Metallurgy and China's First Empire: Bronze weapons for the Qin Terracotta Army." This paper used a combination of SEM for compositional and visual analysis, as well as metric analysis, to understand the production of the thousands of bronze objects used for the warriors, concluding that completed objects were made at individual workshops using standardised components and not by assembly line methods. Also recognised were hand and rotary polishing marks. A great example of how scientific methods can inform on past technologies and organisational choices. The second paper, "Persian crucible steel production: Chāhak tradition," Rahil Alipour combined medieval manuscripts and compositional analysis of crucibles to investigate the processes of crucible steel production in medieval period Persia, sharing new insights into this important industry. This session ended with Tom Birch "Supplying the Havor lance: towards standardised war gear in Iron Age Scandinavia". The research centred around the astounding survival of thousands of iron weapons from lake depositions in southern Scandinavia, using metric and morphometric analysis of over 120 lances coupled with compositional analysis, a picture was presented of a highly standardised lance design with centrally controlled production that used iron from across Scandinavia.

Modern Warfare was the topic of the final session, beginning with Margaret Birch's presentation of the WWI war work of Major General William Huskisson as the Assistant Inspector of Steel, Bombs and Mines division, giving an insight into the organisation of war production. The day ended with an enjoyable presentation by Eddie Birch, "Liberty Ships: winning the logistics war," the design was based on the British designed Empire Ships; simple, versatile, modular and of a completely welded construction. While slow, they were quick to build, reliable and with 2700 built in 5 years, they made a significant contribution to the war effort, many of which continued to have long post-war lives owing to their versatility.

The conference ended with an enjoyable conference dinner at the Red Lion, and on the Sunday trips were organised to two local museums; the first was to The Museum of Army Flying which preserves a unique collection of military aviation history including historic fixed wing and rotary wing aircrafts. The second to the The Tank Museum at Bovington, the birth place of the tank in World War One, 6 halls exhibited an impressive collection of 300 vehicles which covered all major wars of the 20th century, including the first tank ever made, a feared German Tiger, and the modern Challenger 2.

Overall this was an informative and much enjoyed conference, with possibly one of the widest ranges of topics seen at a HMS conference, from Bronze Age swords and Iron Age lances, to cannons and WWII ships. This conference showed how archaeo-metallurgical techniques coupled with historical and archaeological approaches continue to enlighten us on past metallurgy, and how innovation in metal usage and production shaped the world we live in.

Matt Phelps
Rahil Alipour

HMS student prizes at Archaeometallurgy in Europe Conference

On the occasion of the Archaeometallurgy in Europe Conference, HMS is pleased to offer a HMS Prize for the Best Student Oral Presentation, and a HMS Prize for the Best Student Poster. The prizes will consist of a diploma, a free one-year subscription to HMS and a financial reward.

All posters and oral presentations with a student as lead author/presenter will be automatically considered for these awards, unless the authors express their wish to be excluded. The judging panel, made up of members of the HMS Council and the Archaeometallurgy in Europe International Scientific Committee, will base their decision on the combined merits of the originality, rigour and significance of the research presented, as well as the design and delivery of the poster or presentation.

The Society is also willing to consider applications for a small number of grants to assist with the costs of attending this conference. Further information on the HMS grants, and an application form, can be found on the HMS website **http://hist-met.org/about-hms/hms-grants.html**.

Historical Metallurgy in the Association for Industrial Archaeology

The Association for Industrial Archaeology Spring Meetings usually include something of interest to the Historic Metallurgists among their members. 2013 saw a coach sized group visit the Ruhr area of Germany. Apart from coal mines, coke works and transport sites, the group visited the Henrichshütte Iron and Steel Works, (now a Museum) where they were able to climb a blast furnace and look at the associated processes. Later the group saw the excavated remains of the much earlier St. Antony Hütte furnaces and also the former Thyssen works which is now an Open Air Museum (Landschaftspark Duisburg-Nord). Unfortunately the blast furnace stack there was closed to visitors because work was being carried out on the structure although the heavy rain may have made the climb hazardous and the view from the top would have been rather poor anyway.

Blast furnace at Henrichshütte.

The 2014 Spring Meeting was held in the Czech Republic and once again there was much to interest the Metallurgist. Now open from April to October as part of the Brno Technical Museum, the 18th Century Charcoal fuelled Blast Furnace at Adamov was keenly debated by participants. Being such a large group and the custodian having very limited English made life interesting for our long suffering translator but with the aid of the English Language leaflet provided for us we were able to reach the conclusion that the stack had been rebuilt a number of times and converted to water cooling and hot blast operation. Slightly worrying to this author were the obvious remains of the water wheel leat running directly under the furnace, but there does not appear to have been a problem. Later lime works on the site used the exhaust gases for their firing but the site was never altered to use coke and production ceased in the 1870s. Around the grounds of the furnace, several experimental early smelting furnaces have been reconstructed by the Museum although there was no explanation of their results on site (in English anyway).

Excavated remains of St Antony Hütte.

Later in the tour the group transferred to Ostrava. No visit to this town would be complete without a visit to the Vitkovice Iron and Steelworks where several Blast Furnaces remain. Arcelormittal still produce steel in the town but the old site is in the process of being converted to an attraction. The former Gas Holder has already been converted to a concert auditorium, and the charging hoist of one of the furnaces now houses a lift taking guests part way up the stack. Many steps complete the climb but the views from the top make it worthwhile as there is a clear view of the coal mine and coke works alongside the iron works, as well as over the town. The Mine and Coke Works still await restoration and access to them is not yet possible. Interpretation is still ‘work in progress’ and the guides are really not geared up to specialists, but the site is a useful comparison tool to match Völklingen, Duisburg, Henrichshütte and the other preserved late blast furnaces in Europe.

At the time of writing it is not known what Historical Metallurgical delights await participants on the 2015 AIA Spring Meeting in the Rhone Valley, (apart from the wine) but there will undoubtedly be some.

Mike Constable.

Forthcoming events

Conference, Date and location	Description	Website, email and Prices
9th experimental Archaeology Conference 16th-17th January 2015 Dublin	The 9th Experimental Archaeology conference will be held at the UCD's Moore Auditorium and the UCD Centre for Experimental Archaeology and Ancient Technologies at University College Dublin. The oral papers, posters and demonstations/live experiments will run Friday and Saturday, while Sunday there will be a field-trip to the Irish National Heritage Park, Ferrycarrig, Co Wexford, where a range of experiments will be displayed and Ireland's most visited prehistoric and historic building reconstructions will be explored.	http://www.ucd.ie/archaeology/eac9/ http://experimentalarchaeology.org.uk/ €40
Archives and Slag Collections, Study & Work Day 11th April 2015 Ironbridge Museum	The HMS Archives and Collections Committee (ACC) is organising a study/work day at the Long Warehouse, IGMT, Coalbrookdale. There will be hands on sessions dealing with the cataloging and protection of the photographic and slag collection. All are welcome and invited to attend to gain an insight into the work of the ACC.	http://hist-met.org/
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 aims 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
MSh Annual Conference 2015 - Celebrating Street Furniture 12-14th June Stratford-upon-Avon	Street furniture are a rich but much overlooked resource. The conference themes will include manufacturers, methods and technology, but will go beyond metallurgy to discuss design choices, trade patterns and the social and economic considerations. We also discuss the needs for recording and preservation of these slowly diminishing objects. Two days of presentations will be followed by a tour of Stratford-upon-Avon which boasts a unique display of lamp posts from the UK and beyond. Registration and paper submission is now open.	http://hist-met.org/meetings/hms-annual-conference-and-agm.html
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