THE CRUCIBLE

Historical Metallurgy Society News
Issue 105 Winter 2020

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Inside The Crucible

The HISTORICAL METALLURGY Society

From the Chair

Dear members,

It is with great relief that I can address you with light at the end of this most unusual of tunnels. It is also my sincere hope that your family, friends and colleagues have remained safe from this virus. Depending on where you live, we can start looking forward to once again interacting with our loved ones in a normal way, returning to our labs and institutions and, living our lives without having to consider this darkest of clouds.

While we are all looking forward to life returning to normal, your Council has been working hard to make changes to the society and the ways in which material is published. The world of publishing has been moving from printed text and digital subscriptions to fully open access. The costs of this open access are to be shouldered by so-called APC (Author Processing Costs) paid for by the author and ultimately by grant bodies. Open access, then, would be the condition for accreditation and future grants. This seemed to suggest two paths for our Society:

• We would remain non-open access, which would lead to a severe loss in grant-aided authors publishing with us and, likely, an unsustainable decrease in membership

• The Society goes open access, which would likely lead to the loss of non-academic contributions to the Journal and even membership becoming optional

However, the Historical Metallurgy Society has been, from its inception until now, a beautiful blend of the best Journal in its field with a wide diversity of members. As both of these paths would deeply disturb this balance, a third path was conceived.

The current vision of the Council, unanimously approved, is based on three pillars:

• We publish the Journal freely on the website to Gold Open Access standards and we do not charge APCs

• The costs for publication and running of the Society are carried by the membership, who continue to receive physical copies of Journals and ***The Crucible***

• The Society becomes more member-focussed with more frequent meetings and activities for the members and greater involvement by the members in its organisation

Full details of this Council proposal will be sent out to the members in the New Year and its approval will be sought at next year's AGM. I would like to sincerely thank every member of the Council for their contributions to this new vision and hope that you, our members, will join us on this new and exciting path for our Society.

If the above future of the Society is agreed, it is important that the Journal has synchronised publication and subscription years.

The publications team is working hard to achieve this and would be very much helped by receiving papers. So, if you have an article ready or almost ready, this would be the perfect time to submit it for consideration.

All the best

Paul Rondelez

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. Images should be sent as high resolution jpeg or tiff files.

For consistency, we tend to use contributor's names without affiliations and email contacts. Anyone wishing to contact a contributor not known to them is welcome to forward a message in the first instance to the editors who will facilitate the contact.

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HMS Events

Well the year 2020 has been a bit of a right off in terms of events ...

The next HMS event is the 2021 AGM Accidental and Experimental Archaeometallurgy 2.1 Conference to take place in June.

We will continuously be assessing the situation, there are many factors and conditions that ideally have to be met before we can go ahead with events. The AGM being both mostly outside and held during what is typically a warmer month means that it's not ideal conditions for the virus. However much rests on the production and distribution of a vaccine (i.e. if it's been given to those potentially at risk before the event), as well as a reduction in the current social distancing and travel restrictions. Any decision made will be based on a formal assessment of any risk to the health and wellbeing of those attending. We hope to be able to provide more information in the spring, when we may know more about the vaccine distribution progress.

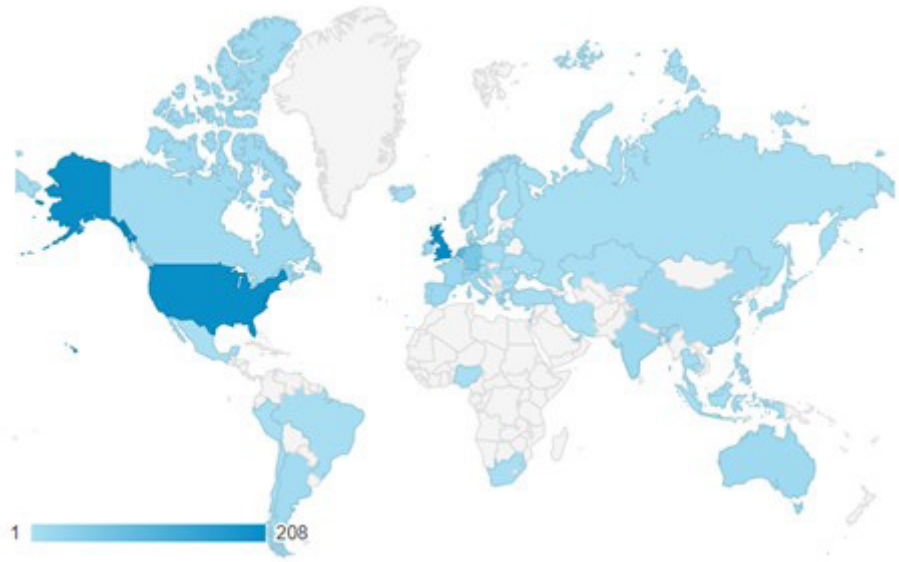
Eleanor Blakelock

HMS Website

The new HMS website continues to be developed, and the production of new content is being worked on by committees and individuals. A few more new members' pages have been added, as well as a new page describing the research on Mycenaeans and their precious metal vessels by Stephanie Aulsebrook and Christina Clarke. If any HMS member is doing research they would like to share please consider writing a piece for the website, or indeed the crucible, or both.

I thought I would take the opportunity to explain a few of the features of the new website. There is a handy search facility in the top right of the site (look for a magnifying glass), clicking this will open a search box. Next to this is a log in option, this will take you to a new page with a log in box, if you have paid your subscription via the new website by entering your details here you are taken to the members area, at the moment there is not much to see on this page but you can change your address or other details here. The final feature of the new site I would like to highlight is the 'past HMS events' section on the events page. Here there is a timeline of HMS events, going back to the year 2002. Some of these events include book abstracts, programmes, photo galleries and reviews. If you are able to contribute photos or documents for any past HMS event please send them to the **webteam@historicalmetallurgy.org** as we are hoping to add to this digital archive.

Finally I thought I would give you an idea of how the new website is doing. Since August we have been visited over 1200 times, by over 850 different computers. Over 40% of visitors to the site are coming from internet searches, whereas about 20% are coming direct from another site, i.e. via social media links. The majority of visits are from the UK or USA, however we also get regular hits from elsewhere in the world. The vast majority of visits to the site are via computers or laptops. However 8% of visits are by phone and another 2% come from tablets and the new website has been designed to support these devices.



If you haven't had chance to visit the new site please do take a look. And please provide feedback via **webteam@historicalmetallurgy.org** if you have any problems using the site or find any errors.

Eleanor Blakelock

IMPORTANT–EmailAddresses

HMS Council is currently investigating possibilities for enhanced member benefits, such as encouraging interest clusters with small discussion groups catering to niche interests, and for full participation by overseas members who wish to join.

There are several benefits to having a complete and up to date email list, both for HMS and for individual members. As well as routine interactions, improved inclusivity depends on reliable communications.

A small working group (Jonathan Prus, Vanessa Cheel, and Eddie Birch) has been set up to ensure that our email address list is as complete as possible as this will be our primary means of notification. It is not our intention to inundate members with electronic communications: general information will be posted on the HMS website.

Please send us an email to **secretary@historicalmetallurgy.org** from your preferred email address. If you have any doubt whether we have your up-to-date postal address or phone number, would you please also send these.

Your personal data will be handled in accordance with Data Protection Regulations. It will only be used for the administration of HMS and will not be shared further than is necessary to this end, even within the Society.

We appreciate you taking the time to do this,

Jonathan Prus

Call for Papers

A Metallurgical Miscellany

Because of the continuing uncertainty caused by the Covid-19 pandemic, the HMS Council have decided to organise an online conference. This will be held as well as the physical meetings we are planning, which we hope will be able to go ahead. The online conference will be free of charge to all, and participants will be able to drop in and out to listen to as many or as few of the papers as they wish. The date of the meeting has still to be confirmed but is likely to be in the first half of 2021. Further information will be posted on the HMS website as it becomes available, so look there for details.

I am now seeking offers of papers for this Metallurgical Miscellany. Each paper will be up 25 minutes long, and can either be delivered live or can be pre-recorded. If you are interested in speaking, please email Justine Bayley (**Editor@HistoricalMetallurgy.org**) with your name, affiliation (if any) and email address, the title of your paper, a brief abstract (of up to 200 words) and an indication of how long you would like to speak for. Please reply as soon as possible, and by the end of January 2021 at the latest.

Justine Bayley

From the Editors … *two new sections*

In this issue we have introduced 'from the back of the filling cabinet' to give readers the opportunity to present short pieces of work that were completed some time ago but not published. We have also introduced 'enquiries and debates' as a space to pose questions and generate debate. Contributions can be any length and we can post responses to questions in ***the Crucible*** or pass them directly to the author of the question. We hope these two sections will increase the ways in which readers can engage with ***the Crucible*** – as ever, we depend on your contributions!

We would like to apologise for missing the co-author of the piece on Styrian Steel in the summer issue of ***the Crucible***. The Styrian Steel piece was authored by Alan Williams and Helen Jones (German Historical Institute). *The editors*

FUTURE COVER IMAGES

Do you have any interesting pictures that you like to share with the community on the front of ***The Crucible****?*

Please send them to us at **thecrucible@hist-met.org**

FUTURE NEWS/MYSTERY OBJECTS

Are you working on an intriguing, amazing, or just downright confusing metal object that you would like to share with the HMS community?

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

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**

GERALD HARWOOD BANNISTER (1933-2020)

Gerry Bannister joined HMS in the 1980's but he was such a quiet and reticent man that he will not be well known to many members. By profession he was a Nuclear Scientist. He worked at Harwell in the 1960's, in the Metallurgy Division of the Atomic Energy Research Establishment, then for the Atomic Energy Commission Research Establishment in Sutherland, Australia, and finally for the Central Electricity Generating Board at Berkeley Nuclear Laboratories in Gloucestershire. During the 1960's to 1980's he co-authored a number of important papers on the metallurgy of the radioactive metals and alloys, some of which are still cited today.

Gerry lived at Dursley in Gloucestershire, where he was a well-liked member of the community. He was a very active and committed Scout Leader, attending Jamborees and events as far away as Australia. Under his leadership the troop raised money and purchased a Land Rover and trailer, which were used for expeditions to Turkey and a remarkable 4,500 mile tour of Scandinavia, from Oslo to North Cape, returning via Lapland, Helsinki and Stockholm. Gerry was affectionately known as Boss or Kim. One of the scouts remembering this trip, on the Dursley Facebook page, said that Gerry was the only guy he knew who could work out logarithms in his head.

The Dursley Scout group about to set off on their tour of Scandinavia. Troop leader Gerry Bannister on the right.

In the 1980's he excavated with a group from the Gloucestershire Society for Industrial Archaeology at Flaxley Abbey, near Mitcheldean, investigating the site of the charcoal blast furnace there. He also joined the team at Plas Tan y Bwlch, in Snowdonia, on the 1984-86 excavations at the late-16th century blast furnace at Dol y Clochydd, and the following year he came to the HMS annual conference at Plas Tan y Bwlch. From 1987 to 1989 he took part in the experimental ironworking project at Plas, teaming up with John Flanagan from Dublin (also an HMS member), spending most of their time learning how to refine the early and rather poor-quality blooms which had been made. One memorable occasion in 1989 was Gerry and John trying to forge what seemed to be a good quality rectangular billet which had been refined from the XP21 3.5kg bloom.

Much to their embarrassment the billet was left in the hearth a little too long and disintegrated, revealing prills of white cast iron with low-melting point phosphide eutectics (examined in detail by Gerry himself). They were so annoyed that they spent another one and a half days welding the pieces back together to make a small bar of 266g, using some 30kg of charcoal in the process!

John and Gerry (in white overalls) near the end of welding the pieces of the XP21 billet.

After his retirement Gerry continued his frequent travels all over the world. In 1991 on a trip to Dakar in Senegal, the group he was with were high-jacked by a band of thieves who took all their valuables, before leaving them stranded in the middle of nowhere. Luckily one phone had been well hidden, so they were able to summon help.

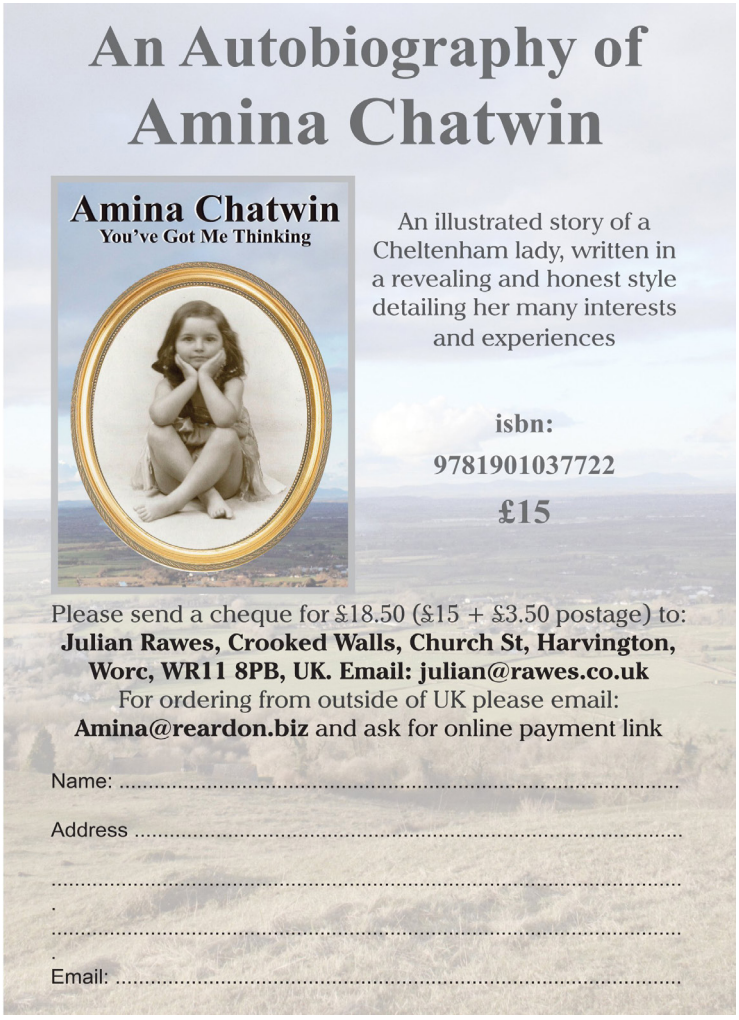
He kept a land Rover until a couple of years ago, when he finally had to give up driving due to failing eyesight. Gerry would walk miles every day without fail, but eventually ill-health prevented this and he had to go into The Hollies Care Centre in Dursley. He was well looked after by the staff there, continuing his wanderings to the very end, and he died peacefully in July 2020.

He had only one surviving relative and one of his final gestures was to leave a substantial bequest to the Historical Metallurgy Society, for which we are most grateful. Gerry will be remembered by the people who knew him as a very nice man who quietly achieved a great deal during his varied life.

Peter Crew

Front cover: Gerry and John near the end of refining the XP21 bloom using 'authentic' wooden tongs, which Gerry likened to holding a slab of butter

Amina Chatwin (1927-2016)



Amina was born in 1927 in Cheltenham, where she was brought up and lived for much of her life. She died earlier this year and at her memorial service her many enthusiasms and wide range of interests were remembered by a large group of her friends.

In her youth she was a champion ballroom dancer, made and performed with large marionette puppets, attended art school and travelled widely throughout Europe. From the 1960s she owned and ran a dress shop in Cheltenham but also developed the interests that were to bring her to HMS. She joined the Bristol and Gloucestershire Archaeological Society, and the Gloucestershire Society for Industrial Archaeology, eventually becoming its President in 1994.

By 1969 she had joined HMS and was first elected to its Council in 1979. She was HMS Chair from 1981-2 and edited HMS News, the predecessor of ***The Crucible***, for 18 years from 1985-2002, during which time it developed from an occasional news sheet to a more substantial regularly-produced newsletter.

She was a regular attender at HMS conferences, often driving herself to them in an MG Midget which she bought new for £800 in the 1960s and continued to use until about 10 years before her death – when she reputedly sold it for £7000!

Outside HMS Amina had other metallurgical interests. She was a great champion of historic architectural ironwork which was the subject of her first book, Cheltenham's Ornamental Ironwork: A Guide and History, which she published in 1975. She was also a keen supporter of modern blacksmiths and worked with both the British and American Artist Blacksmiths Associations; in 2002 she was the first woman to be elected a Companion of the Worshipful Company of Blacksmiths. Her second book, Into the New Iron Age: Modern British Blacksmiths, which she wrote, designed and self-published in 1995, is now regarded as a seminal work.

Justine Bayley

Handle with Care:

Measuring the breakage of charcoal on transportation

In smelting we know that size matters, and there must be many experimental smelters who have experienced that sinking feeling when they tip out a new sack of charcoal and great clouds of it blow away as dust or settles at their feet as fine particles. Similarly, many of us who have studied the locations of smelting sites in the landscape and considered the supply of vital resources, including proximity to sources of charcoal fuel, know instinctively that the further the charcoal has to be transported the more likely it is to abrade and fracture (*see front cover*). The quality and size range of material leaving the charcoal production site may not be the same as that arriving at the smelting site. Despite this critical consideration, there is little empirical data we can turn to that helps us quantify or assess the impact of transportation. Cleere and Crossley (1985, 135) state that the 'distance over which charcoal could be carried was normally limited by its friability to 5-6km' but do not tell us how this figure is arrived at. Hammersley (1973, 606) suggests a slightly higher range of 3-5 miles (4.8-8km) as normally acceptable for the transportation of charcoal based on data deriving from the iron industries of Britain and Sweden. But there appears to be no hard and fast measure as Cleere and Crossley also note the prosecution, in 1600, of Thomas May for carrying charcoal over a distance of 9 miles (14.5km), although it's not clear if the misdemeanour relates to the assumed wastage of charcoal or some other encroachment.

The data here was generated by experiments carried out in 2005 for an undergraduate dissertation at the University of Exeter. The work resurfaced only recently during a covid decluttering exercise and we present below a summary of the aims, methods and results of the work. The project arose out of contemporary fieldwork on Exmoor at a number of Romano-British, Medieval and Post Medieval sites relating to iron production, including charcoal-making locations as well as mining and smelting sites. The aim of the project was to measure the degree of breakage and wastage when charcoal was transported over distances up to 10km. As background, the project considered archaeological, ethnographic and documentary accounts of charcoal production methods, species selection, modes of transportation as well as possible economic and technically acceptable and unacceptable levels of breakage and wastage.

Front cover: Charcoal loaded into sacks and awaiting road transportation after being hauled through forest for over 1km (Sri Lanka 1994)

Fig. 1 Experiment 1 and 2 in progress

Experiments

The approach adopted, in the absence of any existing data, was to devise an uncomplicated experimental procedure from which robust baseline data could be gathered as a foundation for future, more complex and nuanced experimentation. The variables addressed in the experiment design were location and terrain; method of transport; distance; quantity of charcoal; type of charcoal; measurements taken. Three experiments were carried out.

Experiment 1: charcoal carried over a distance of 10km with measurements taken every 2km

Experiment 2: repeat of experiment 1 for data verification/ variability

Experiment 3: the same quantity of charcoal carried over the same distance but with measurements taken only at start and finish to avoid breakage and wastage caused by the measurement procedure every 2 km

The experiments were conducted in dry conditions on a farm in Devon. A gently sloping field of easily navigable low grass was selected, with 12 lengths of the field equating to 2km. Human portage was used, with the charcoal carried in close-woven fibre sacks with a secure rope tie and carrying sling. Experiments 1 and 2 were run simultaneously with two people walking side by side, each with a sack of charcoal (Fig. 1). The sacks were filled to capacity, giving a starting total in each sack of 5.55kg. The charcoal was locally-produced using the kiln method and comprised a mixture of oak and ash, with oak predominating. The walkers progressed at a steady pace, shifting the sacks from shoulder to shoulder as needed and taking rests every 600m. At the end of each allotted distance (2km, 10km in experiment 3) the sacks were taken to an adjacent barn for measurement and recording.

Fig. 2 Removing charcoal from sacks for sorting and weighing

Measurements

At the outset the charcoal was sorted into size categories. An arbitrary size categorisation was adopted.

Large = 8cm and above

Medium = 3-8cm

Small = below 3cm

Fragments at the boundaries of small/medium and medium/large were placed upwards into the larger category. Each sack was then filled with a mixture of 0.55kg small, 2.2kg medium and 2.8kg large fragments. To ensure good mixing the bags were filled by alternating large handfuls of each size category.

After each 2km stage in experiments 1 and 2 the sacks of charcoal had to be re-sorted and recorded. This was done with great care to reduce additional breakage. The charcoal was taken out of the sacks by hand and placed directly into the appropriate size bucket, i.e. not tipped out (Figs 2 and 3). After the first 2km there were noticeable size changes within the small category and new sub-divisions were created.

Usable small = 2-3cm

Unusable = below 2cm

Dust = unmeasurable fine material

The amount of material lost from the starting total was also recorded at each measurement stage. Overall, the method followed was time consuming and if further larger-scale experiments were conducted an alternative handling procedure would be needed. It was also noticed that the charcoal contained a number of 'brands' (pieces of wood not fully carbonised in the charcoal kiln). These generally fell in the large category and did not break down in the same way as the fully carbonised charcoal.

Fig. 3 Size category buckets used for sorting charcoal

Data collected

The results of the experiments are best presented graphically. The weights of each sorted category for all the experiments are given in table 1 and the same data for experiments 1 and 2 is shown as bar charts (Fig. 4).

The changes in each category over the 10km distance are plotted as graphs (Fig. 5). Table 2 presents the data from the additional sorting of material in the small category after the first 2km, and the discrepancy between the starting total of 5.55kg and the total at each stage is added here in the column 'lost from total'. The data in table 2 is illustrated in figure 6.

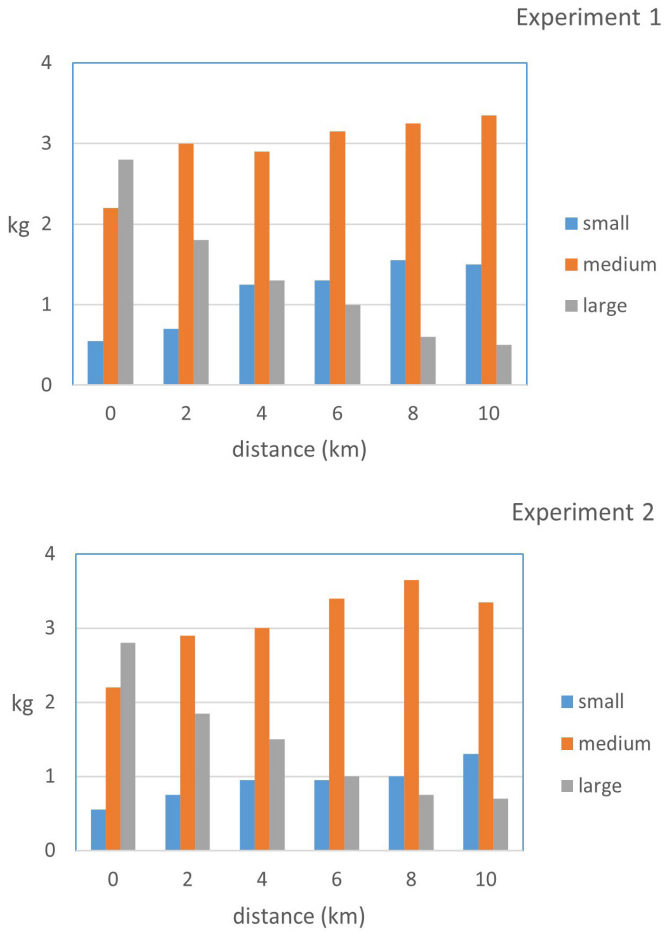


Fig. 4 Measurements of all three categories through experiments 1 and 2

Discussion of results

There is good coherency in the data across the three experiments, suggesting the methodology adopted was effective. The patterns of change charted in experiments 1 and 2 follow similar trajectories (Figs 4 and 5) and, while the two data points from experiment 3 can't be plotted, the overall change seen in experiment 3 (table 1) is consistent with experiments 1 and 2.

The most noticeable and significant observation is the dramatic reduction in the large category, falling from 50% of the total material at the start to 9-13% at the end of 10km of portage.

This drop is most pronounced in the first 2km and begins to level towards the end of the experiments. This may indicate that initially the large charcoal fragments are susceptible to fracture and breakage but that this lessens as the fragments generally reduce in size. There is a corresponding gain over distance in the small and medium categories. Both small and medium categories gain approximately a kilogram of additional material but percentage-wise the gain is greater in the small category, with a three-fold increase on the starting weight (table 1). It is not possible to determine confidently from this data what the mechanism of size reduction is. Do the large charcoal pieces fracture to give medium fragments and in turn medium fragments break to produce small fragments? Or are small fragments broken off from the large pieces? Presumably both these mechanisms occur along with general abrasion of the surfaces of all fragments leading to the unusable small and dust categories.

The further division of the small category after the first 2km into material below 2cm grading into dust and deemed unusable, along with the reduction in the overall total as material is lost, gives another indication of the impact of transportation. There is a gradual increase in the unusable and lost categories across all the experiments and by the end of 10km it accounts for a significant loss (table 2). The combined weight of material that is unusable and lost ranges from 0.7kg to 1.05kg which, in percentage terms, represents between 12.6% and 19% of the total. As the usable component of the small category increases over distance it is likely that the unusable material derives from the breakage and abrasion of medium and large fragments.

Experiment 3 was used as a control to assess the effect of the multiple sorting and weighing procedures of experiments 1 and 2. The data in table 1 shows that while handling did cause some increase in the changes across the categories these are slight and the patterns of change across all three experiments are the same. Overall there is less total loss of material in experiment 3 by just 0.10kg. The minor differences between experiments 1 and 2 can probably be accounted for by differences in the carrying techniques of the volunteers.

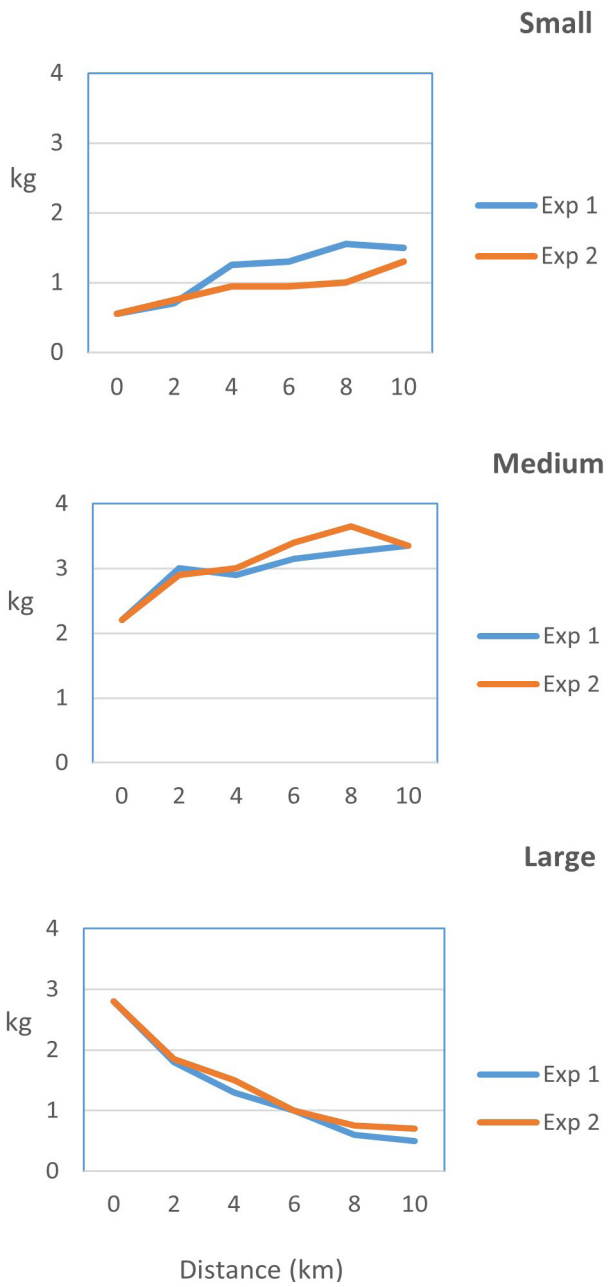


Fig. 5 Changes in categories over distance in experiments 1 and 2

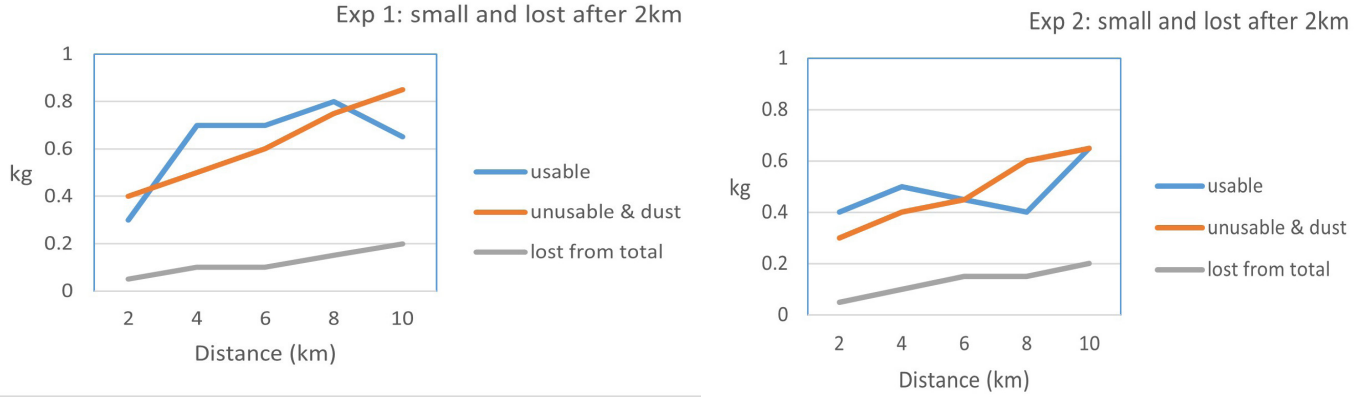


Fig. 6 Sub-sorting of the small category in experiments 1 and 2 as recorded in table 2

Experiment 1								
	km	Small (kg)	%	Med (kg)	%	Large (kg)	%	Total
start	0	0.55	*10*	2.20	*40*	2.80	*50*	5.55
1a	2	0.70	*13*	3.00	*55*	1.80	*33*	5.50
1b	4	1.25	*23*	2.90	*53*	1.30	*24*	5.45
1c	6	1.30	*24*	3.15	*58*	1.00	*18*	5.45
1d	8	1.55	*29*	3.25	*60*	0.60	*11*	5.40
end	10	1.50	*28*	3.35	*63*	0.50	*9*	5.35
Experiment 2								
	km	**Small (kg)**	**%**	**Med (kg)**	**%**	**Large (kg)**	**%**	**Total**
start	0	0.55	*10*	2.20	*40*	2.80	*50*	5.55
2a	2	0.75	*14*	2.90	*53*	1.85	*34*	5.50
2b	4	0.95	*17*	3.00	*55*	1.50	*28*	5.45
2c	6	0.95	*18*	3.40	*63*	1.00	*19*	5.40
2d	8	1.00	*19*	3.65	*68*	0.75	*14*	5.40
end	10	1.30	*24*	3.35	*63*	0.70	*13*	5.35
Experiment 3								
	km	**Small (kg)**	**%**	**Med (kg)**	**%**	**Large (kg)**	**%**	**Total**
start	0	0.55	*10*	2.20	*40*	2.80	*50*	5.55
end	10	1.50	*28*	3.30	*61*	0.70	*13*	5.45

Table 1: all collected data

Exp 1				
	km	usable (kg)	unusable & dust	lost from total
start	0	0.55		
1a	2	0.30	0.40	0.05
1b	4	0.70	0.50	0.10
1c	6	0.70	0.60	0.10
1d	8	0.80	0.75	0.15
end	10	0.65	0.85	0.20
Exp 2: small category after 2km				
	km	**usable (kg)**	**unusable & dust**	**lost from total**
start	0	0.55		
2a	2	0.40	0.30	0.05
2b	4	0.50	0.40	0.10
2c	6	0.45	0.45	0.15
2d	8	0.40	0.60	0.15
end	10	0.65	0.65	0.20
Exp 3: small category after 10km				
	km	**usable (kg)**	**unusable & dust**	**lost from total**
start	0	0.55		
end	10	0.90	0.60	0.10

Table 2: data from additional sorting of the small category

Conclusion

These experiments and the data generated substantiate and confirm the common assumption that it is unwise and uneconomical to transport charcoal fuel over any significant distance. Here we have demonstrated that human portage over a few kilometres radically alters the size range of charcoal reaching its destination and increases wastage. It would be interesting to know if further work using larger loads carried by pack animals produces a similar pattern of breakage and wastage.

James A.C. Cooper and Gill Juleff

References:

Cleere, H. and Crossley, D. (1985) *The iron industry of the Weald*. Leicester University Press

Hammersley, G. (1973) The Charcoal Iron Industry and its Fuel, *The Economic History Review*, vol. 26 (4), 593-613

Intentionally Chilled Iron Castings? – A Query

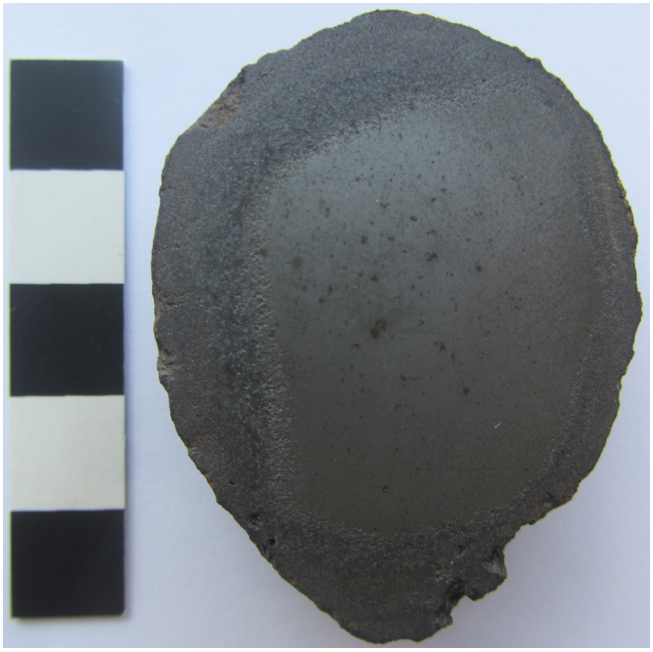


Fig. 1 Sectioned rail, 50mm scale

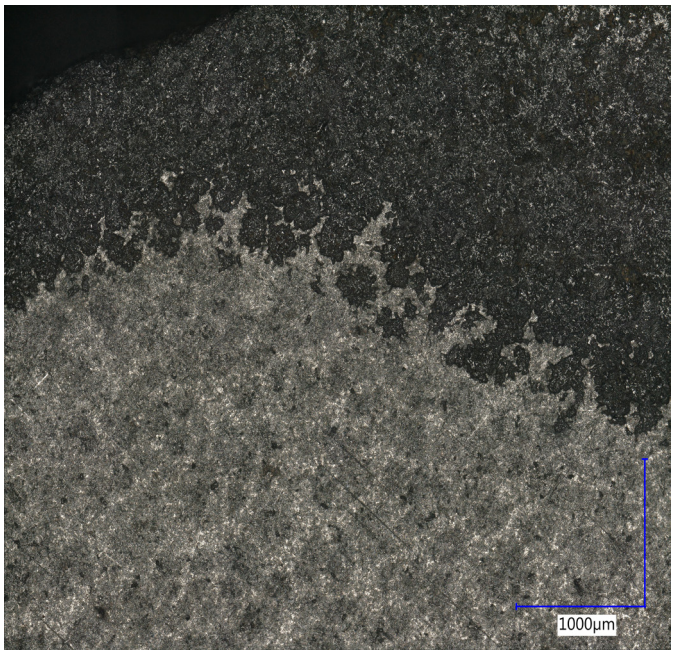


Fig. 2 Optical micrograph, 200x

From the late 1780s until the early 1820s the rails used in the construction of early iron railways were generally made of cast iron. At the turn of the 19th century the length of each rail was typically three or four feet. One such railway was the Congleton Railway, a colliery line traversing the Staffordshire/Cheshire border which opened in 1805. Fieldwork on this route in 2018 led to the discovery of many of the original rails and associated track components, and an interpretation of these artefacts formed the subject of a recent article (Patel 2020).

The original rails of 1805 were four feet long and of fish-bellied profile, reaching a maximum depth at mid-span. The rails were of an oval cross-section – John Farey, a contemporary observer – described them as 'oval or egg-shaped' (Farey 1817, 331). It is believed that these rails were probably cast by the Manchester iron founders Peel, Williams & Company. Many of the rails discovered in the field exhibit casting marks along the parting line, showing the rails to have been cast in two-part sand mounds. Some castings also show defects on the underside of the rail, where they contain small holes and occasional slag inclusions.

One fragment of rail recovered from the route was just 100mm long. A 10mm slice was cut from this fragment and polished on either side (Fig. 1). On sectioning the rail, it became apparent that the casting was chilled, for a central area of grey iron is entirely surrounded by an outer "skin" of white iron (Figs 1 and 2). These rails are 1.5in/38mm wide and at the deepest point on the fish-belly are 2in/51mm deep. Such an insubstantial section cannot have helped the castings to cool slowly, therefore they would have been susceptible to suffering from chill.

However, in light of the chilled casting, a number of questions present themselves:

• Firstly, since these rail castings were ready to use as-cast, with no machining necessary, would the chilled casting have been superior to a non-chilled casting? Since the wheels of loaded wagons ran upon these rails, they were subject to considerable wear. Could the hardness of a white iron exterior have been advantageous?

• Secondly, if the chilled casting could indeed have been superior to a non-chilled casting for its intended purpose, then might the chilling of the iron be intentional?

Any insights that members of the Historical Metallurgy Society can offer on these points would be gratefully received. Presumably the differing properties of white and grey iron would have been known long before there was any scientific understanding of these materials. It would be interesting to know when white iron was first formed deliberately because its properties were deemed desirable for some specific application.

Rowan Patel

Farey, J. (1817) *General View of the Agriculture of Derbyshire*, 3. London: Sherwood, Neely and Jones

Patel, R. (2020) The Permanent Way of the 1805 Congleton Railway: New Evidence from Fieldwork, *Industrial Archaeology Review*, 42 (1), 62-78

ELISABETTA GLIOZZO

Elisabetta Gliozzo is an eclectic archaeometrist whose research interests range from metals to ceramics, pigments, glasses, stones, all types of raw materials and, more recently, gems.

When her university course began, courses in Archaeological sciences did not yet exist in Italy. Therefore, she was forced to undertake two completely different paths, which led her first to the archaeological excavations and then to the mineralogical and petrographic laboratories.

In 1996, Elisabetta got an MSc degree in Archaeology, with a thesis on the epigraphy of the instrumentum domesticum (!). She describes those years as her golden period. Months of field works and frenzied study on both books and materials, that also marked the beginning of her interest in a new (at that time) discipline, called "archaeometry". To follow this ever-growing interest, she took courses of mineralogy and petrography and, in 2000, she won a 4-years PhD in 'Georesources and mineralogical and petrographic applications for the Environment and the Cultural Heritage'. Later on, she also enrolled in Geology and, in 2013, Elisabetta earned a Bachelor's Degree in Mineralogy, with a thesis on Acid mine drainage due to metalworking. After working for several Italian Universities and Soprintendenze, Elisabetta has been working as a freelancer since 2015. Currently, she participates in several research projects with a network of international collaboration.

She serves as editor-in-chief for Archaeological and Anthropological Sciences, and as Associate Editor for Journal of Archaeological Science: Reports.

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

Not an easy task! Let me tell you an episode. The morning I went to enrol at the university, my parents asked me if I had finally chosen and I replied: "I am still not sure: either Archeology or some of the Sciences". In hindsight, today I can say that maybe I was less confused than I thought. In the years that followed, I have never ruled out any new "passions" (to call them research interest seems reductive to me). Still, I fall into that category of scholars who find more interest in what they don't know than in what they can consider themselves experts.

THE CRUCIBLE: What is your most memorable professional moment?

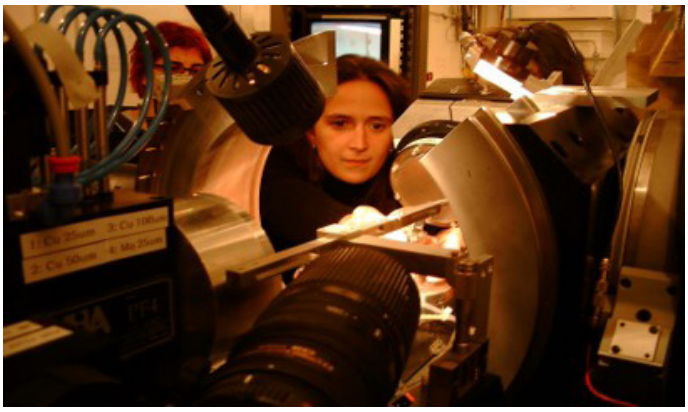
Professionally, the day I received the National Scientific License for Full Professor. Not for vainglory but for the recognition it implied. Since 1996, I have seen the value of an interdisciplinary competence grow in all countries except in Italy. For all those years, my multidisciplinarity was described with ambiguous or derisive terms ("hybrid" is perhaps one of the kinder adjectives) and used against me. That day I felt my professionalism was finally recognized.

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

Fortunately for me, I have had more than one. Moreno Lifodi, my Professor of Latin and Greek from high school, has been the first one. He taught me how to read critically and instilled in me an inexhaustible passion for the classics. During the University course, Daniele Manacorda, my professor of 'Methodology of archaeological research', was undoubtedly the most influential one. He taught me the importance of methodological rigour and intellectual honesty, as well as showed me the most accurate scientific method that I have ever seen at work. With the beginning of my professional career, two other colleagues played a key role. Giulio Volpe, who is a continuous inspiration with his strength and dynamism and an infinite passion for our work and Mariuccia Turchiano, with whom I shared many personal and professional moments and which never made me lack encouragement, support and trustworthy judgments.

THE CRUCIBLE: What is your main current project?

Which of the many? I believe it is now clear I am not a single-project or single-theme person. At this moment, I collaborate with the Universities of Bari, Verona, Trento and Venice on a very large project regarding 9th-10th century AD trade exchanges in the Adriatic area. An extensive but chronologically well-constrained project including the study of metal objects, sarcophagi, glass vessels and amphorae found along the Adriatic coasts.



I also collaborate with the University of Calabria to a project on the ancient material culture of Georgia and I'm thrilled about this because the Georgian territory has not yet received an archaeometric attention as it deserves. Other large projects in progress regard the lithic, ceramic, vitreous and metal finds of late ancient and medieval Puglia, in collaboration with the Universities of Foggia, Ferrara and McGill; the production plants and relative productions of southern Tuscany, in collaboration with the Siena and Babeş-Bolyai universities; and the study of several collections of chalcedonies in collaboration with the University of Bari, Cluj-Napoca and Barcelona.

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

I would create a research tool. I would use that money to organize, catalogue and integrate several data collection available today. Some classes of materials - including metals - rely on old typologies that would undoubtedly need a systematic revision. Also, the extreme dispersion of the archaeometric materials in a countless series of different Journals and publications makes it necessary to organize data in a structured repository and facilitate complicate queries. For many years, I have gained considerable experience in the creation and management of databases and I would use this experience to run the project. The fund would support a multidisciplinary team, capable of updating typologies, organizing data, integrating the information available for the various classes of materials and provide a wide-ranging reconstructive picture, as well as outline priorities and methods for the development of our discipline.

However, I am practical but not political; therefore, I do not expect to receive the multimillion fund. Conversely, I am interested that my low-budget projects comply with long term objectives so that one day they will still be able to converge towards results of higher value and wider interpretative breath. And I think this is the right perspective to work with today in a small community like ours.

THE CRUCIBLE: Which publication should every HMS member read?

I launch a little provocation: The two cultures by C.P. Snow. I suggest this reading in the hope that it will leave the same impression of superficiality and groundlessness that has left me. It is a book from an era that no longer exists and it is good to realize how much has now been overcome before mentioning it.

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

I think I have three useful tips for young students:

1) Indispensable: to acquire excellent preparation when you have the time to concentrate only on your studies. The disciplines advance rapidly and once the student period is over, the time for reading decreases. So read on. Read a lot and never stop doing it. In an academic world that pushes publication at all costs and admits evaluation criteria that seem to be more convenient for Publishers rather than the quality of research, take your time and prepare yourself to be a quality bearer.

2) A corollary to point 1: be patient and open-minded. Although my education has been a long period of training, I now recognize that the institutional shortcoming (the lack of academic course devoted to Archaeological Sciences) was my luck for the preparation it provided me. Hence, based on my personal experience, I suggest not to rush.

While to limit yourself to a single topic of study can be detrimental for your preparation, there will be plenty of time to specialize in the following years. Moreover, a researcher involved in Cultural Heritage studies should never forget that a picture is never fully understood if only a portion of it is analyzed.

3) Very practical: Keep both personal curiosity and professional flexibility high. Compared to other sectors, the field offers fewer employment opportunities and therefore, a high dose of determination and adaptability can turn necessary. When things don't go exactly as you would like, distract yourself with an exciting hobby and keep studying. From 1996, I have become a master-chef (Gordon Ramsay? Pfui!), a jewellery maker, a tap dancer, a writer... and I'm still sane and full-time active in archaeometry! It works!

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

They should not be disappointed that I have not focused on metals in particular in this interview. I wanted the message to be different. An encouragement to expand and integrate rather than reduce or isolate. May you reach the highest peak of success and best luck!

AN EARLY COALBROOKDALE CAST IRON POT - PART 2

The discovery and preliminary examination of this pot was described in ***The Crucible***, 103, p. 12.

The most important aspect of these thin-walled pots is the type of cast iron from which they were made. Grey iron has the minimum shrinkage and is the ideal composition. White iron shrinks much more, so a pot made with it would result in a failed casting.

Earlier pots made from charcoal iron had to be cast in loam moulds which were preheated to a high temperature to try to ensure that the metal solidified as grey iron, so the process was slow and expensive.

The innovation by Darby used coke-smelted iron, which resulted in more silicon being introduced into the metal. Both Si and P enhance the carbon equivalent (CE% = C% + 1/3P% + 1/3Si%) and thin castings such as these pots would require a value of around 5%. This meant that the pots could be cast in cold green-sand moulds and remain as grey iron, so they could be cast more cheaply, making them much more widely available (see Williams 2013, 'A question of grey or white: why Abraham Darby I chose to smelt iron with coke', Historical Metallurgy 47.2, 127-137).

Until now no coke-smelted pots of this kind have been examined and the break in this pot provided a convenient and easy way to take three samples for metallography (Fig. 1). The metal proved to be mottled cast iron, rather than grey iron, so it would have contracted rather more on cooling thus producing internal stresses. This is most probably what resulted in the eventual break (Fig. 2).

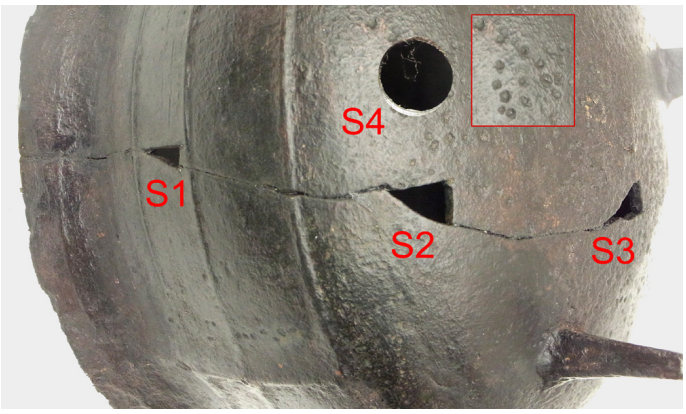


Fig. 1 The Coalbookdale pot, marked C-B-DALE 1 GALL, after cleaning and repair. Sideways view showing the vertical parting line (bottom), the four ridges and the slight swelling of the sprue. S1, S2 and S3 are the sample locations cut from the break. S4 was sampled subsequently for μXRF analysis, by drilling a 15mm diameter core using a high quality Starrett bi-metal coring bit. The inset shows the area before removal of the sample, which has a group of distinctive sub-circular pits.

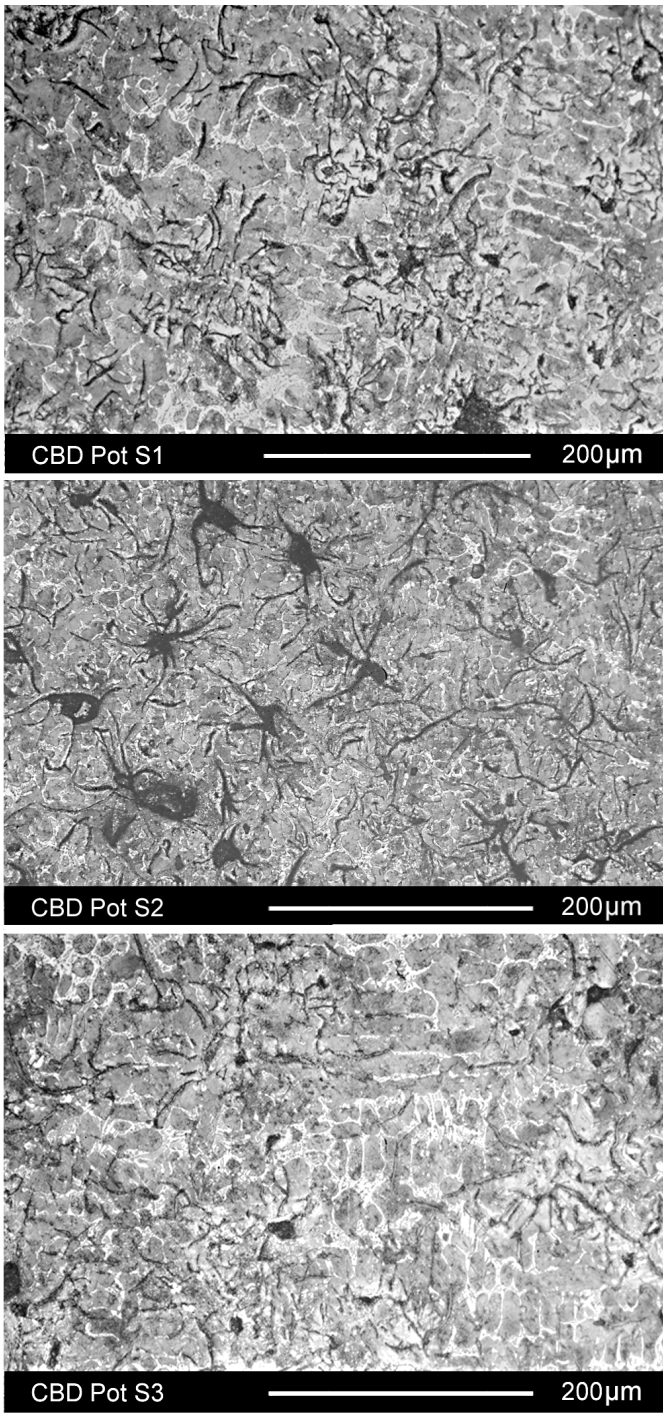


Fig. 2 Photomicrographs showing variations of the hypo-eutectic mottled cast iron, etched 2% nital. S1 and S2 both have graphite flakes and rosettes in a pearlite and cementite matrix, with pale zones of the ternary iron phosphide eutectic. S3 is rather similar but this image shows an area which has a whiter iron structure.

The S4 sample was cut into two halves, one of which was mounted on edge, so that the polished surface would give a section through two of the pits. This was to see if it could be determined whether they were an original cooling or shrinkage feature or a result of subsequent corrosion. It was examined by Tom Birch at Moesgaard Museum (Denmark), using a Bruker Tornado micro-XRF analyser.

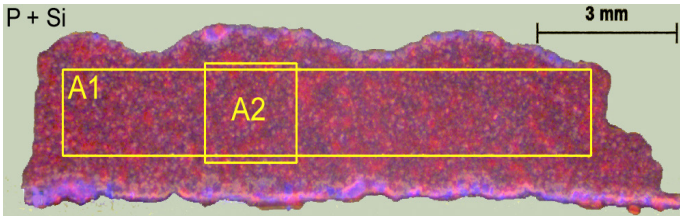


Fig. 3 Sample S4, µXRF map. This shows the two pits in the upper/outer surface and the combined map of phosphorus (red) and silicon (blue), the latter enhanced in the thin corrosion zones. The analysed areas A1 and A2 are in yellow. Scale 3mm. The full map of 15 x 4.3mm has over 162,000 pixels, each of 20 µm, needing a measurement time for a single pass of 35 minutes.

The technique produces a map of a relatively large area quite quickly, at a resolution of 20µm, and then analyses of areas of any size or shape can be extracted from the data (Fig. 3). A1 is the bulk analysis for an area of 11mm x 2mm. A2 is 2mm square and was re-measured with three passes in only 6 minutes. Additional passes improve both the quality of the map and the counting errors/statistics. The table below shows that there is no significant difference in the two sets of data.

	Fe	*P*	*Si*	*Mn*	*V*	*S*	*Area*
A1	96.1	0.88	1.78	0.51	0.18	0.12	22
A2	96.1	0.89	1.79	0.50	0.18	0.12	4

µXRF normalised wt% analyses of areas A1 and A2 for the main elements. The areas are in square mm. With say 3% C, the P and Si content would increase the CE% to about 3.9%. Around 5% would be needed for this thin casting to remain as grey iron, requiring more P and Si.

Maps can also be produced for individual elements or combinations of elements, which can be revealing. Fe, Mn and Si all have an even distribution across the sample, whereas the P map shows more variation reflecting the late formation of the ternary eutectic in the inter-dendritic areas. The maps for Si, S, V, Cr, As and Ti all show enrichment in the corrosion zones (Fig. 4). The S is also enriched in the surface pits, suggesting that these are indeed a corrosion feature. The isolated patch of V outside of the corrosion zone, which shows even more strongly on the Ti map, is due to a white Tippex dot used to mark the lower surface!

This µXRF technique clearly has great potential for the analysis of a relatively homogenous material like cast iron, at a lower cost than other techniques, giving both an acceptable bulk analysis and, if required, more detailed analyses of smaller selected areas.

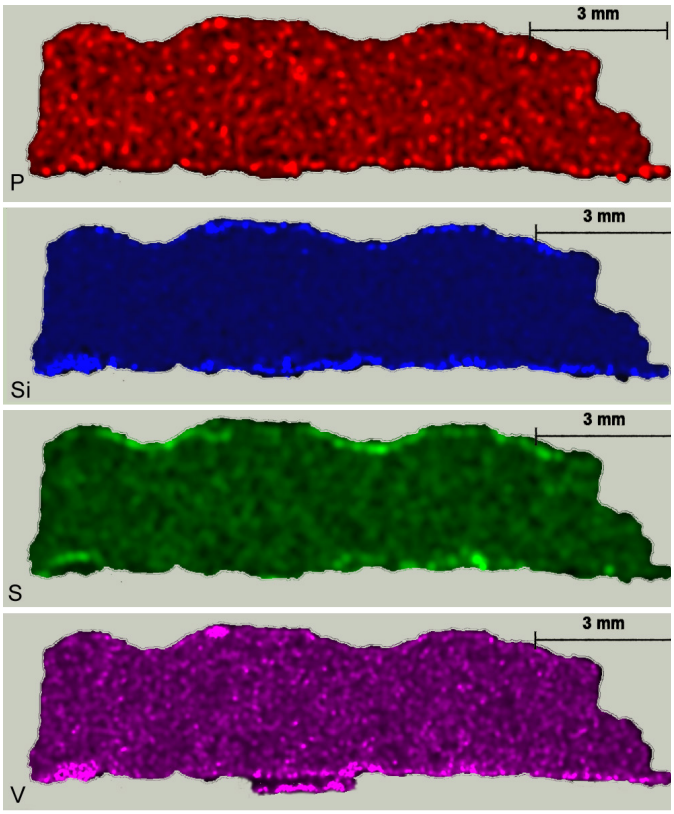


Fig 4 Selected maps for P, Si, S and V. Scales 3mm

For the past 6 months or so we have been gathering information about these early pots from a wide variety of sources. Surprisingly pots with names are rare, especially considering the increasingly large number of manufacturers who made them from the mid-18th century onwards. What we are trying to do is to establish a typology of these pots and eventually a chronology. Examples from dated North American shipwrecks will be especially useful in this respect. From our own collections we have several pots from other manufacturers, as illustrated on the cover of ***the Crucible*** with their marks, which show subtle variations in their shape, the ridge patterns and the forms of the ears and feet. These all have been sampled for metallography and analysis, which will be reported in due course.

Peter Crew, Richard Williams,
Brian Gilmour and Tom Birch

Front cover, from left to right: Dale Co 5 (Wine galls) 320mmØ, Cannon 4 Gal 282mm, Swain 8 (Imperial) Gall 400mmØ

MEDIEVAL WHETSTONES AND IRONWORKING IN THE WEALD

As part of my research project investigating the Medieval Iron Industry of the Weald, a fieldwalking survey was carried out over the summer (outside of lockdown) to investigate an ironworking site located near Horsham in West Sussex. Considerable evidence of the site's ironworking past was identified, including slag, iron ore and medieval pottery. Three whetstones, or honestones, (Figs 1 and 2) were also found in areas associated with high concentrations of slag, some of which may be associated with smithing but is awaiting further analysis. Whetstones, used for the sharpening of blades, are often hard to date with any precision and changed little in their design over time. However, in the case of these examples, their association with broadly 14th and 15th century pottery would indicate that they too are contemporary with the medieval occupation of the site.

Whetstone 1 is made of a fine grained sandstone. It is conical in shape, 35mm long and tapering in width from 30mm to 26mm. In a recent study, Reniere argued that there is a widespread distribution of sandstone whetstones originating from the Weald, found throughout Roman Britain and on the continent. Petrological analysis found that sandstones occurring in the Lower Cretaceous Weald Clay formations were the likely source for whetstones found in Silchester and Wroxeter, while the highest proportion of Wealden whetstone examples on the continent have been found on Roman military sites, with others occurring in towns and urban centres (Reniere et al 2018, 314-329). A comparison with other whetstone examples indicates that Whetstone 1 is also made of a Wealden sandstone, potentially sourced locally to the site from one of the sandstone outcrops near Horsham. Its discovery would suggest that the Wealden whetstone industry continued after the Roman period and was still in existence by the 14th and 15th centuries, operating at the very least at a local scale. Evison (1975) however, in her discussion of whetstones in Anglo Saxon contexts explains how at the sites of West Stow, Suffolk and Sutton Courtenay, Berkshire several examples of whetstones may be made of Kentish Rag stone. Allen (2014) (referenced in Reniere et al 2018) has argued that some of the Roman whetstones previously identified as Kentish Rag, may instead be sandstones from the Weald, and this may be the case for the Anglo Saxon examples referenced by Evison. Either way, it would suggest that there was trade in Wealden whetstones during the early medieval period. It is also worth noting that two whetstones of possible Kentish Rag (or Wealden Sandstone) were found along with a fragment of a crucible within a house at Sutton Courtenay, which dated to the 5th or 6th century (Evison 1975, 72). This evidence supports the idea that whetstones were still being manufactured and traded from the Weald into the medieval period and that they may have an association with metalworking.

Fig. 1 Three whetstones recovered during a fieldwalking survey at an iron working site in West Sussex. Whetstone 1 is made of a sandstone, most likely sourced locally within the Weald, while 2 and 3 are made from schist and may originate from Scandinavia.

Fig. 2 Cross section of the whetstones, demonstrating wear to the outer faces

Whetstones 2 and 3 are trapezoidal in shape and made from schist stone, possibly Norwegian Ragstone. Whetstone 2 is 96mm long, 44mm wide and 40mm at its narrowest point, where prolonged use has worn the stone along its vertical edge. Its thickness is 11mm and has a slightly curved profile. Whetstone 3 has a length of 56mm and a width of 43mm. Its varying thickness ranges from 25mm to 19mm, which again indicates use wear. Norwegian Ragstone became the most widely used stone source during the medieval period for whetstone manufacture, first appearing in Anglo Saxon contexts, and continuing in use after the Norman Conquest (Moore 1978, 70-72). It would suggest that the site at Horsham had connections with Scandinavia, more likely via secondary trade with places such as London.

The Portable Antiquities Scheme online database (**finds.org.uk**) has many examples of whetstones ranging in date from the Bronze Age to post medieval periods.

Many are found incomplete and out of archaeological contexts, suggesting they were potentially fairly disposable commodities. Some examples of medieval whetstones are however found with perforated holes, enabling a cord to be attached for carrying and safe storage, while other Roman and Viking examples are incised with Latin or Runic inscriptions, indicating that they were considered more personal possessions beyond simply utilitarian items. Examples of whetstones recovered from Anglo Saxon graves supports this. At Great Chesterford in Essex for example, a whetstone was found as part of a set of equipment contained within a pouch, within a grave, while at Sutton Hoo an elaborately carved whetstone was discovered within the famous ship burial (Evison 1975, 75-83).

It has been suggested that whetstones were not commonly used in the finishing stages of newly forged blades, with more efficient grindstones instead being employed by smiths (Andrews-Sanchez 2017). However, the discovery of these three whetstones in association with an ironworking site suggests they too formed part of the medieval ironworkers' toolkit. While they may not necessarily have been deployed in the finishing of products, they would have been used to maintain the everyday tools used within a forge.

Further work is needed to assess how frequently whetstones appear in the archaeological contexts of ironworking. The examples from Horsham do however hint at an association, and suggest that whetstones are not a tool that should be interpreted solely as domestic. The three whetstones here are indicative of the wider connections Wealden ironworkers had in order to obtain goods from greater distances, either by direct contact or more likely through down-the-line exchange. The sandstone whetstone indicates local resources were also utilised and that the production of Wealden whetstones continued long after the Roman period.

Jack Cranfield

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A Component of Cliché Type Coin Forgery Manufacture?

Fig. 1 Lead based sheet used in the manufacture of medieval coin forgeries

Fig. 2 Sheet metal marked with impressions of a medieval cut halfpenny

The item discussed and illustrated here is a small sheet metal fragment, assumed to be lead based and marked with several apparent coin impressions, overlapping and incuse, on one face (Figs 1 and 2). It was recently acquired by the author from a well-known auction site. It is said to have been found near Pontefract.

The sheet measures about 27x29 mm with a thickness of about 1-2 mm. There is extensive white corrosion mostly on the unmarked side and around the edges of the marked side. It is likely that the marked side has been slightly cleaned to expose the coin marks. The seller had taken an impression (in relief) from the marks, which would have dislodged any surface corrosion. The form and extent of the corrosion and the appearance of the sheet indicates that it is of some antiquity.

An examination of the marked side shows that there are several impressions, perhaps 4 or 5 at least. It is clear though, from the sharper top-most impression, and some underlying, that the coin involved was not a conventional circular disc but a half-circle. Furthermore, the detail and size of the impressions indicates that they are probably from the reverse of a medieval coin, specifically a cut-halfpenny. During this period round pennies were cut across in half or even quarters for small change. From a measurement of the cut side, the diameter of the original round coin would have been about 16 mm and the detail of the design indicates a medieval 13th century voided-cross penny, possibly short-cross. All the impressions seem to be from the reverse of the same coin. There are no identifiable obverse impressions.

The features of this object strongly suggest that it is a component used in the manufacture of cliché coin forgeries. This is a type of forgery that uses a genuine coin in the manufacturing process, without the need for false dies, and is particularly suitable for thin coins although it has been reported for those with thicker flans in the Roman period (Cowell et al, 2012). A detailed review of their occurrence and manufacture in the Medieval period is given by Oddy and Archibald (1980).

For silver forgeries, the process involves sandwiching a genuine coin between folded silver foil and placing this between two lead sheets or, more likely, one sheet folded over. The 'stack' is then hit with a hammer. This transfers an impression of both sides of the coin onto the foil. The foil is then removed and usually soldered together with a lead-tin alloy and the 'coin' trimmed to size. The forgery produced is difficult to distinguish from a true coin as it exactly mimics a genuine example. There is a ridge on one side of the lead sheet that appears to be a fracture line and suggests that originally it was folded over the coin-foil combination during manufacture, but has subsequently broken.

I am not aware of a report on a cut halfpenny being copied in this way. There are some benefits to this specific method of forgery however. The silver foil was probably folded over the genuine coin to maintain register of the two sides and while for a penny this would require a square of foil, leading to some loss as the foil was trimmed, for a cut halfpenny a circle of foil could simply be folded over the cut side with little loss. In addition, although perhaps less prevalent in hoards, cut halfpennies constituted a significant component of money in circulation (Allen, 2012, especially pp. 347-8) and could more easily have passed unnoticed with other small change.

Michael Cowell

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How the elements were named

Peter Wothers, P. Antimony Gold and Jupiter's Wolf: How the elements were named, 2019, Oxford University Press. xii + 273 pp. £ 20 or $25.99

If you have ever wondered why graphite (the lead in your pencil) is called plumbago, why copperas contains no copper and why magnesium is not magnetic, then this is the book for you. As the title states the structure of this book is how the elements were isolated, identified and named in chronological order. As such it forms an excellent basis for a study of our changing perception of matter. Wothers is a chemist with a very strong interest and deep knowledge of the history of his subject. He is also an excellent author, clear, authoritative, and entertaining but never trivial or irrelevant.

We start with early perceptions and the equation of the seven metals of antiquity with the seven known heavenly bodies, their properties and alchemic symbols. This system survived well into the post medieval period in Europe, but began to break down as the separate identity of metals such as antimony and bismuth was recognised and new metals such as zinc were described. Parallel with these discoveries was the gradual development of the concept of elements as we understand them today rather than the four elements of Empedocles, with all metals ultimately striving to become gold.

However old confusions from Classical antiquity continued. The minerals galena, graphite and molybdenite are superficially at least similar, dark and shiny. Galena is by far the most common so it is not too surprising that the others were confused with it. Ancient Greek and Roman names associated with lead included molybdos, galena (although Roman galena almost certainly was lead oxide, not our term for the lead sulphide mineral) and plumbago. It was recognised that there were differences, Agricola for example mentions a form of 'sterile galena' which did not yield lead, and almost certainly he was referring to graphite. It took the detailed scientific analysis of Scheele in the late-18th century to recognise their true nature, and to name the soft form of carbon graphite after its most common use, but molybdenum remains, at least in name, forever linked to lead.

The ancients were interested in the waters that flowed from old mine workings, especially iron and copper sulphates. The Greeks named the hydrated ferrous sulphate 'shoemaker's black' because it was used to stain leather used in footware. Hydrated copper sulphate was named 'flower of copper'. As both solutions ran from the same mines and both could be green, red or even blue they were confused and the ancients such as Pliny had no clear idea of their separate identity. This confusion continued and gradually the aqua cuprosa in Latin became copperas in English.

Things were no better in Germany, where Agricola in the original Latin version of De re Metallica gives ferrous sulphate the original Roman name atramento sutorio, shoe maker's black.

The very next year after Agricola's death the work was translated into German and the mineral is called Kupfferwasser, 'copper water'. With the rise of empirical science more discoveries of elements were made by chemists, such as Carl Wilhelm Scheele in Sweden and Martin Klaproth in Germany, using ever more sophisticated smelting and separation techniques. But there was a limit to what could be achieved by heat and the next stage was the isolation of metals from their minerals by electrolysis, in which Humphrey Davy made a major contribution, isolating the alkaline metals, sodium and potassium, and the alkaline earths calcium, barium and magnesium.

The naming of magnesium is a story of complete confusion stretching over two thousand years. Pliny lists five types of stone that were ferromagnetic, and a sixth that was light and white, and somewhat inexplicably, non-magnetic, all called magnesia. Pliny deepens the confusion still further by stating that magnesia was to be added to glass possibly to lighten or decolour it. His magnesia, the mineral magnetite, Fe_3O_4, is of course the last thing that should be added to glass to decolour it. Indeed it was already known that pyrolusite, manganese dioxide, was a decolourant, so perhaps this was the mysterious mineral (and this is why manganese dioxide was regularly referred to as magnesia in antiquity, although at this stage there was no association with magnesium carbonate). The trouble with this interpretation was that pyrolusite was dark and the mysterious magnesia was white, and so the special form of manganese salt, probably the carbonate, was called magnesia album. This in turn began to be confused with another white mineral which inherited the name, but this time it was the mineral we know as magnesium carbonate, and when Davy isolated the metal by electrolysis in 1808 he named it magnesium.

From the mid-19th century the spectroscope was developed and spectral analysis revealed a host of new elements, including the inert gases. Helium is the only element not to have been first identified on earth, but instead in the spectra of the sun, hence its name derived from Helios, the Greek sun God.

The identity of the third metal of the title, Jupiter's wolf? Well, a mineral is found in tin ore that is very difficult to separate but on smelting ruins the tin, so the German miners called it wolf metal from which we now know as wolfram, $(FeMn)WO_4$. The German chemist Henckel put this into Latin lupus Jovis, adding the Jovis because it was found in tin ores, and tin was associated with the planet Jupiter.

Meanwhile the Swedish chemist Cronstedt was studying a heavy mineral, tungste (Swedish for heavy stone) and from this Scheele isolated the metal he named tungsten, later to be given the elemental symbol W. Simple, isn't it?

Wothers tells us in the introduction that from his student days he has been an avid collector of early chemistry texts as well as works on the history of chemistry such that almost all of the very many original works cited are from his own library. He not only collects books- he reads them too and the result is a quite fascinating book of his own.

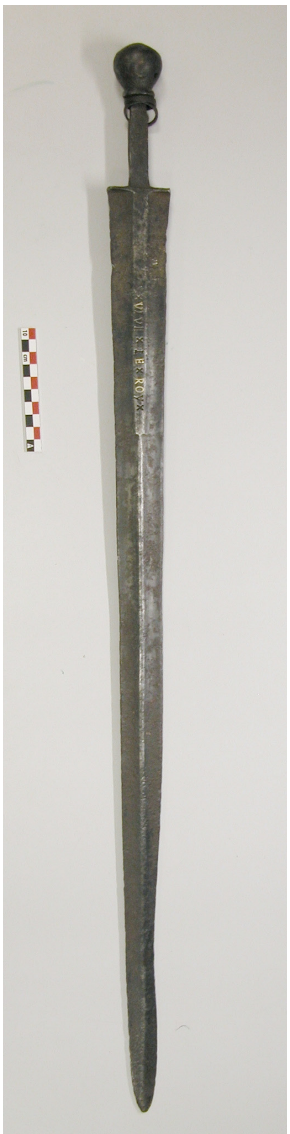
Paul Craddock

Chain Mail in Gujarat

During a visit to the 14th century World Heritage site of Champaner Fort in Gujarat some years back I spotted this heap of chain mail jackets (for want of the correct terminology) stashed behind a maintenance shed. There were probably at least 30-40 individual bundles, each carefully folded and stacked ready to be distributed and unfurled for use in times of adversary. The super-dry climate of Gujarat has retarded corrosion but it would be good to see them stored more securely and some put on display. *Gill Juleff*

17th Century French Sword

This is a central-European, probably French, sword blade. Tentatively dated to the last third of the 17th *c.*, its typology points at it being an infantry sword, featuring most probably a hilt of the so-called "Walloon" type, with two side shells in the guard and a single frontal knuckleguard. The inscription "X VIVE X LE X ROY X" is found in the first quarter of the blade's length, on both sides, inscribed in the central flat ridge and highlighted with inlaid copper alloy, probably brass, missing now in some of the letters. Preliminary metallographical research indicates that the blade was made of a piece of steel of about 0.3-0.5wt% C that had a piece of iron welded around its lower end, from which the base of the blade and the tang were formed. The blade was hardened by quenching, followed by tempering, and the inscription was created by punching the letters in place before heat-treating the blade (thanks to Thomas Mink for access to the specimen). *Marc Gener Moret*



(picture: Thomas Mink)

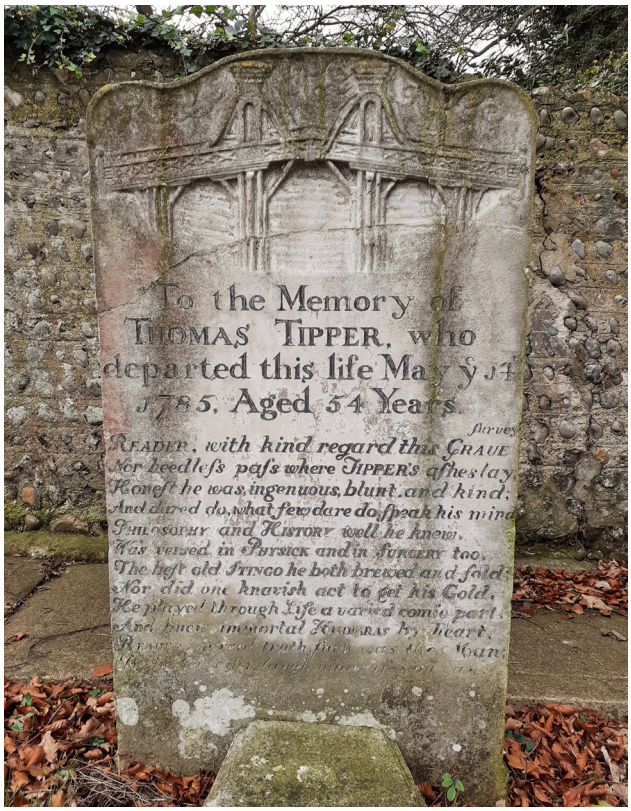
Zooming into Sn bronze production

The state of preservation of this crucible makes it my favourite out of all the assemblage found at Minferri (Juneda, Catalonia, Spain). It is dated between 2100-1650 BC and has a hole in its base to introduce a stick that facilitated casting. The assemblage that this crucible is part of is considered the first evidence of intentional Sn bronze production in Iberia based on previous pXRF analyses. However, it is unclear if metallurgists at this time were recycling bronze from elsewhere or actively alloying metal. This is of key importance when trying to asses the development of technological knowledge.

The second picture shows a cross-section of this specimen under an optical microscope (PPL). From bottom to top, it is possible to see the progressive alteration of the ceramic paste due to the heat contained in the inside of the vessel. In its inner-most part (top of the picture), we can observe a very thin layer of slag. Future SEM-EDS analyses will help to keep zooming in and chemically characterise this slag layer and the mineral/metallic phases in it. The study of this and other crucibles from Minferri and later sites will help to better understand the development of Sn bronze production in Western Europe. *Julia Montes-Landa*

Thomas Tipper and the Newhaven Iron Bascule Bridge

On a recent trip to Newhaven in Sussex, I visited the 12th century Church of St Michael. Standing prominently in the churchyard is the grave of one of Newhaven's most famous inhabitants, Thomas Tipper, a local brewer, well known in Sussex for 'the best old Stingo'. While his memorial stone records in profuse detail the character of Thomas, saying 'Honest he was, ingenious, blunt and kind. And dared do what few dare do, speak his mind', it also features a depiction of the Newhaven Bascule Bridge. The Bascule Bridge was constructed over the River Ouse in 1784, making it one of the earliest iron bridges in the country. It was built only five years after the famous Iron Bridge in Shropshire, an early pioneer in the use of iron within bridge construction. Prior to the the Bascule Bridge, crossing the River Ouse in the town could only be made by ferry, the nearest other bridge being eight miles north at Lewes. Thomas Tipper, an investor and driving force behind the construction of the bridge, no doubt saw the benefits that it brought to the town, and it was seen fit to depict the achievement on his memorial when he passed away the following year. While the Newhaven Bascule Bridge has long since been replaced (demolished in the 1860s), Thomas Tipper's tomb and its status as a Grade II listed monument, attests to its continued importance in the towns history. (See **historicengland.org.uk** list-entry: 1197488). *Jack Cranfield*



Conference, date and locations	Description	Website and emails
ICANMR 2021: 15. International Conference on Archaeometallurgy and Non-Metallurgical Residues **15/02/2021-16/02/2021** Dubai, United Arab Emirates	This conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Archaeometallurgy and Non-Metallurgical Residues, as well as practical challenges encountered and solutions adopted.	https://waset.org/archaeometallurgy-and-non-metallurgical-residues-conference-in-february-2021-in-dubai
12th Experimental Archaeology Conference **29/03/2021 - 31/03/2021** Exeter, United Kingdom	Now is a good moment to look at where we are and set an agenda for the future. We at EXARC and the Dept. of Archaeology at Exeter University invite you to come to Exeter and celebrate where we are now and map out the future developments. We plan to make this a memorable bringing together of all of the diverse interest groups that contribute to the field.	https://exarc.net/meetings/eac12 email: info@exarc.net
3RD Perspective on Balkan Archaeology- PeBA 2021 International Conference **Exact dates TBC (May 2021)** Ohrid, Republic of North Macedonia	The theme of this conference is centred on "the mechanism of power in bronze and iron ages in south-eastern Europe"	https://pebasite.wordpress.com/peba-2020/ email:pebaconference@gmail.com
43rd International Symposium on Archaeometry ISAS2020 **10/05/2021 - 14/05/2021** Lisbon, Portugal	The symposium aims to promote the engagement in the use of scientific techniques to improve the extraction of archaeological and historical information from historical sites.	https://www.isa2020-lisboa.pt email:isa2020@isa2020-lisboa.pt
Accidental and Experimental Archaeometallurgy 2.1 **04/06/2021- 06/06/2021** Dorset, United Kingdom	To celebrate the 10th anniversary of the hugely successful experimental conference at West Dean in 2010, and the subsequent volume of the same name, the Historical Metallurgy Society would like to invite submissions for both practical metallurgical experiments and oral presentations to be held over a two-and-a-half-day event at the Ancient Technology Centre in Dorset in June 2021.	https://exarc.net/events/accidental-and-experimental-archaeometallurgy-21
Iron in Archaeology **29/06/2021-2/07/2021** Fribourg, Switzerland	For all things iron in archaeometallurgy, hosted by the CPSA Comité pour la Sidérurgie Ancienne – the Committee for Ancient Ironworking.	
EAA Annual Meeting 2021 **08/09/2021 -11/09/2021** The University of Kiel, Germany		https://www.e-a-a.org/eaa2021 email: helpdesk@e-a-a.org
Science in Archaeology **Dates and location TBC**	Conference focuses on the scientific and non-invasive techniques which are revolutionize archaeology	https://www.nenevalleyarchaeology.co.uk/2020-conference

8th Balkan Symposium on Archaeometry **Dates TBC (2022)** Vinča Institute of Nuclear Sciences, Laboratory of Physics, Belgrade, Serbia.		https://bsa7.uniwa.gr
World Archaeology Congress WAC-9 **03/07/2022- 08/07/2022** Prague, Czech Republic	The World Archaeological Congress (WAC) seeks to promote interest in the past in all countries, to encourage the development of regionally-based histories and to foster international academic interaction. Its aims are based on the need to make archaeological studies relevant to the wider community.	https://www.wac-9.org email: wac-9@guarant.cz

Virtual Content

Conference, date and locations	Description	Website and emails
EMBERS 2021: Eurasian Metallurgy from Beginning to End 25/03/2021-26/03/2021	Virtual conference	http://flame.arch.ox.ac.uk/embers/index.html email: Embers2021@gmail.com

Online Content

Title (Media Format)	Description	Website
ArchaeoCafe (Podcast)	ArchaeoCafé brings you news, interviews, and public discussions about the latest topics in archaeology and prehistory. Tune in to episode 16 for an insight into maritime archaeology in India; and episode 25 for talks about experimental archaeology.	https://anchor.fm/archaeocafe https://www.facebook.com/archaeocafe/
A Life in Ruins (Podcast)	ALiRP is a dialogue between archaeologists and their guests, asking why they have chosen to live a Life in Ruins.	https://alifeinruins.com/
Ancient Iron, Experimental Archaeology in Sudan (Documentary)	Interesting research of the iron production remains at Meroe and at the Meroitic site of Hamadab conducted by UCL Qatar.	https://www.youtube.com/watch?v=SPU8Uwa-jBQ
Combining Experimental Archaeology with Archaeometry (Webinar)	Heritage's Wavelength is a webinar series about archaeometry, where archaeology and analytical sciences meet and team together. We address different types of archaeological materials, analytical techniques and their applications. What information is hidden inside the materials?	https://www.youtube.com/watch?v=RY53SMFJQJ0
Ologies (Podcast)	Interested in all thing -ology? Host Alie Ward invites guests from varying fields and asks all the questions that we might all be too embarrassed to ask. Have a listen to talks with an experimental archaeologist , a volcanologist and many more.	https://www.alieward.com/ologies