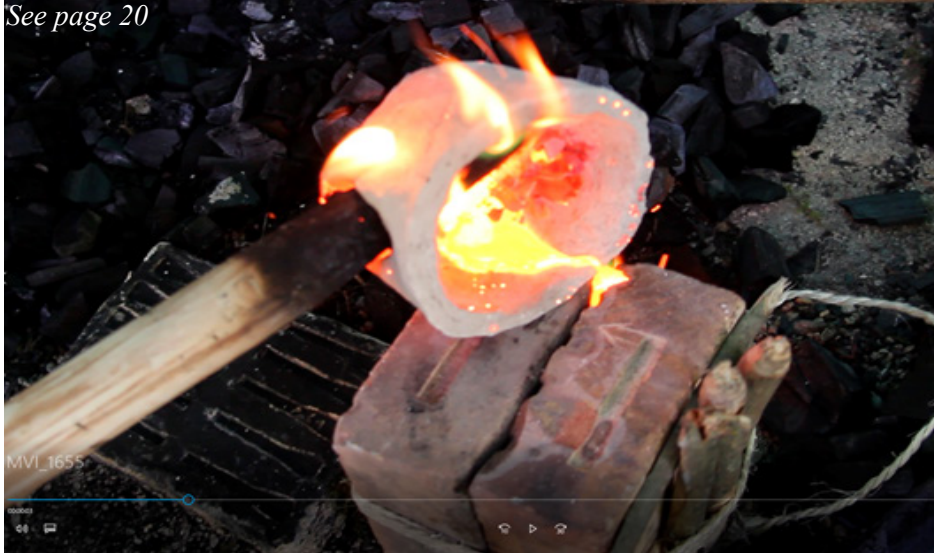


THE CRUCIBLE

**Historical Metallurgy Society News
Issue 98**

Summer 2018

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The **HISTORICAL
METALLURGY**
Society



It has been one year now since Gill and I took over the task of editing *The Crucible* from the capable hands of Marcos. It is certainly proving a very interesting experience and our learning curve remains steep. Nevertheless, with the support of our editorial team, we are enjoying it very much!

As you might notice in this issue we are adding a new section called ‘HMS Supported Projects’. These are short reports on projects that have received one of the awards offered by HMS. We encourage you to look at the HMS award page (<http://hist-met.org/about-hms/hms-grants.html>) to see if you are eligible to one of the HMS grants and of course then send a report on your activities to *The Crucible* in order to share your experiences and results with the whole community.

We would like to draw your attention also to our ‘Out and About’ section and ‘From the back of the filing cabinet’ section. These two sections are there so we can all share with the community interesting historical metallurgy sites that we might come across for research or touristic reasons. ‘Out and About’ is an opportunity to widen our horizons on historical metallurgy heritage, highlight interesting sites and enjoy our common passion. ‘From the back of the filing cabinet’ is there to bring back to the spotlight projects that might have started a long time ago and have then been left behind because of change in priorities or lack of time. Bringing them back to life can spark new thoughts and collaborations within the community, creating new exciting research ideas! So share, share, share – *The Crucible* is as good as its contributors.

Of course, continue to send us “letters from...” and short “archaeometallurgical news” so we can engage with each other and foster discussion.

We are thinking about a job opportunities section to advertise jobs and roles available for historical metallurgists. This would also give space to indicate who is moving where and what posts are being taken by the members of the historical metallurgy community in academia, museums, commercial archaeology or policy-making institutions, so please let us know.

Finally, we would like to share our thanks to the out-going Historical metallurgy Society chairman, Tim Young, who has done the most fantastic job for HMS and supporting *The Crucible*. We now welcome our new chairman, Paul Rondelez, and look forward to hearing from him in the next issue of *The Crucible*.

Lorna Anguilano

Editors

Gill Juleff

Lorna Anguilano

Assistant Editors

Danny Aryani

Carlotta Farci

Amy Flynn

Susanna Venditti

MEETING NOTICE: RESEARCH IN PROGRESS

Tuesday 6th November 2018,

Kings Manor, University of York

This meeting is aimed at a wide variety of contributors, from historical and archaeological metallurgists to excavators, historians, and economists. If you are working on a project related to archaeological or historical metallurgy, we would like to hear from you. We are particularly interested in bringing together contract and public-sector archaeologists with academic researchers, and in fostering links between the different disciplines studying metallurgy and related activities. Whether you are a student, a researcher, an interested non-specialist, or a professional excavator, we invite you to meet others working in this field and present your research to an interested community.

For more information and the programme please visit the HMS website <http://hist-met.org/meetings/research-in-progress-meeting-2018.html>. Or contact the organiser Vanessa src505@york.ac.uk

The call for papers has finished but there may still be space to present a poster.

HMS WEBSITE - TELL US WHAT YOU THINK

In 2012 we launched the Historical Metallurgy website, five years on and a new web team has been created by HMS Council. The aim is to update, improve and potentially restructure the website so that it suits the needs and wants of our members. Changes in technology and web designs mean we have to constantly review our system. The web team has a number of ideas which we intend to implement over the coming years but we would be interested in hearing what our members think of the current website.

- Is it easy to use?
- Does it perform its function?
- Can you find what you are looking for?
- What would you like to see added to the website?
- Photo galleries, member profiles, research or conservation projects, a member's area?
- What resources would you like to see added?

Let us know

Please email the web team webteam@hist-met.org with your thoughts, comments and feedback

HMS RESEARCH IN PROGRESS MEETINGS (RIP)

Since 2008 the Historical Metallurgy Society has successfully been organising Research in Progress meetings. These have become increasingly popular, with contributors and attendees coming from far and wide, and from a many different walks of life. There is deliberately no theme, which means that any new or ongoing research can be presented, be it the results from archaeological sites, scientific analysis, historical research or a new interpretations of existing data. The atmosphere is deliberately informal and friendly, so RIP is a great venue for a student's, and especially those presenting their work for the first time.

The format has been such a success that it could easily be taken, adapted and run by groups in other countries. The meetings are often run by students from the host university using readily available facilities and are therefore cheap to run, and not labour intensive. If anyone is interested in using the Research in Progress format please feel free to get in touch and I can provide you with guidance, support and example forms. HMS will gladly advertise the event on our website and we may also be able to provide funding for a prize for the Best Student Research.

Eleanor Blakelock
HMS Events Officer
events@hist-met.org

Submissions

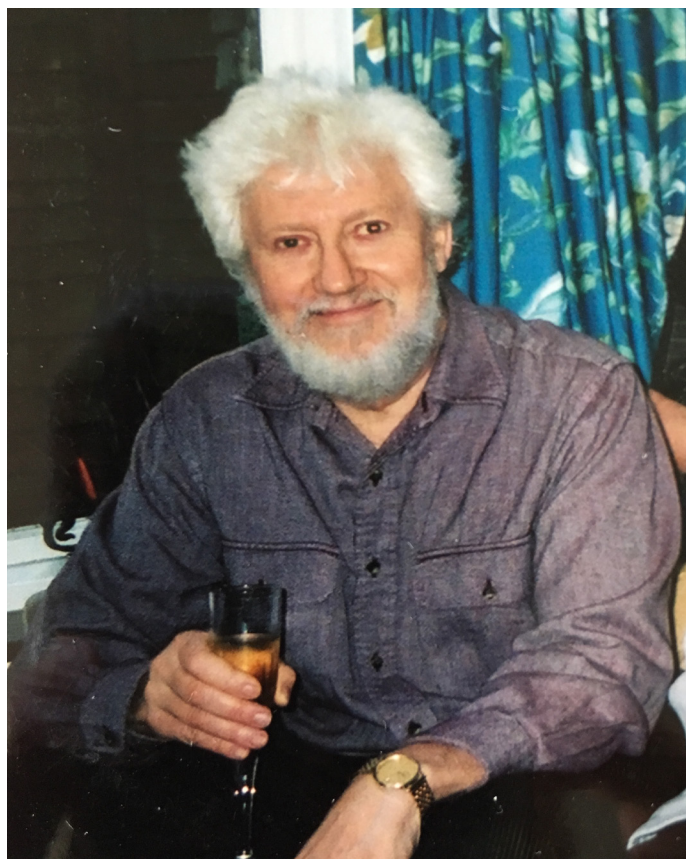
Submissions to *The Crucible* are welcome at any time, but deadlines for each issue are 1st March, 1st July and 1st November every year. Contributions can be sent in any format, but we prefer digital if possible. Images should be sent as high resolution jpeg or tiff files.

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.

The Crucible
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OBITUARY - SAM MURPHY



Samuel Murphy, known to all as Sam, died on 16th June 2018 at the age of 78. He was a long-term HMS member and served on Council from 1998 as Production Editor, redesigning and setting Historical Metallurgy and also Occasional Publication No 6: Metals and Metalworking, a research framework for Archaeometallurgy. His Honorary Membership was approved by Council in 2013 following his retirement as editor.

Sam was a native Lakelander with a lifelong interest in mining, metallurgy and things mechanical – especially motor cycles. He was educated at Windermere Grammar School, where one of his teachers was Mike Davies-Shiel. He then went to Sheffield University where he read Metallurgy and obtained BMet, MMet and PhD degrees. This was followed by two years at the University of Zambia, working for the RST mining company, which operated some of the rich mines of the Zambian Copperbelt. In 1972 he joined the Metallurgy Department of Aston University in Birmingham where he remained until taking early retirement in 1998.

His academic research was in zinc alloy metallurgy for which he became an internationally recognised expert but he also developed wide-ranging interests in archaeometallurgy.

Sam was passionately interested in non-ferrous metal mining in the North of England and in early smelting techniques and is best known for Grey Gold, his

outstanding history of the Greenside mine and smelting works in Patterdale, Cumbria, published in 1996. Sam also researched medieval lead smelting, the Elizabethan mines of Silver Gill, Cumbria, and the mines of the West Pennines; he jointly published several papers in Historical Metallurgy and British Mining.

In life, Sam was an easy-going character with whom it was a joy to spend time. He could converse on a very wide range of subjects, was enthusiastic, encouraging and shared his knowledge freely. He carried out many of his field visits with a casual disregard for inclement weather and terrain; he expressed the firm belief that ‘the human being was waterproof – it was only clothing which got wet’.

Richard Smith and Justine Bayley

ONE MINUTE INTERVIEW

PETER NORTHOVER

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

I have been involved in archaeology since volunteering on the excavations at Wolvesey Palace, Winchester in 1963 and in metallurgy since working in the metallurgy lab at Westland Aircraft/British Hovercraft Corporation (remember it?) at Cowes between school and university in 1966. This was when the first cross-Channel hovercraft were being built – and they are now in a museum. After my DPhil I started work on the metallurgy of Welsh Bronze Age in 1974 and have been pursuing the applications of physical metallurgy in archaeology ever since. Now allegedly retired I am researching for a PhD in landscape archaeology.

THE CRUCIBLE: What is your most memorable professional moment?

After 40 years and well north of 20,000 samples there have been many but I think the most satisfying was the study of the grave goods from the Bischofshofen-Pestfriedhof cemetery from the 1st millennium BC in Austria. Optical metallography enabled the changes with time of the cremation ritual to be characterised, a result which no other method could have achieved.

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

I am going to be greedy and pick two. The first would be the late Dr Hubert Savory, Keeper of Archaeology at the National Museum of Wales in Cardiff in the 1970s who provided the framework which allowed me to begin to integrate archaeological and metallurgical typologies in ever-growing detail.

PETER NORTHOVER



The second is Chris Salter at the Department of Materials, University of Oxford without whose immense skill, experience, and interest in the microanalysis of metallography of ancient and historic metals I could not have achieved what I have.

THE CRUCIBLE: What is your main current project?

The copper sheathing and fastening of ships in the second half of the eighteenth century and the first half of the nineteenth century, combining the analysis and metallography of shipwreck finds and archival research, especially in the papers of William Forbes and Simon Goodrich. The main conclusion is that a lot of the accepted history of this is wrong, and the metallurgy is fun too, especially using current techniques such as electron back scattered diffraction and neutron diffraction, areas where I can collaborate with my wife.

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

I general archaeology is great need of adopting modern developments in radiography, especially in CT scanning. Where this has been done the results are stunning, but they could go much further both using the highest energies (e.g. 750kV) on big objects but also the highest resolution to look, say, at the dispersion of inclusions and porosity in bronzes. It may get us nearer non-destructive metallography but, more practically, it would allow much better targeted sampling. Instrument time is expensive, hence the millions.

THE CRUCIBLE: Which publication should every HMS member read?

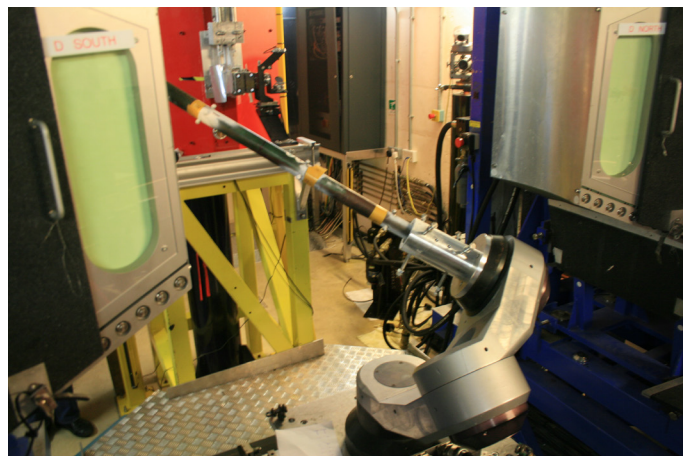
The ASM Materials Handbook volumes (formerly Metals Handbook). They contain a huge amount of data and information on metals, alloys, processes, and characterisation methods which are as relevant to ancient and historic metals as they are to modern.

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

Remember that we are part of the wider world of metallurgy and that we can contribute to it and in return there is much we can learn. An example is that there is currently a lot of interest in silver alloy microstructures in the world of lead-free solders and the resulting research is equally applicable in archaeology.

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

The first time I prepared and studied a metal microstructure 50 years ago (a magnesium alloy) I was hooked, and still am. I hope you get the same excitement out of our subject.



Peter's latest project

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

FAKE NEWS? – STONEY HAZEL FORGE

Stoney Hazel Forge, located 0.25 miles WNW of Rusland church, in the southern Lake District of Cumbria (NGR SD 336 897) has long held a mystery as to the purpose of a square hole in the back wall of the hearth. In April, members of the Wealden Iron Research Group made a visit to various iron-making sites in the southern lakes, including Stoney Hazel Forge.

Documentation researched by David Cranstone (pers comm) indicated the site to be a short-lived bloom forge, operating from 1718 to 1725 when the lease was purchased jointly by the Backbarrow Co. and Cunsey Co. Following the collapse of the dam probably in the flood of September 1729 which also destroyed the dam of Force Forge a mile or so upstream, the new partnership then took Stoney Hazel out of commission and dismantled it over the next 11 years - even using the dry pond to grow hazel for charcoal production. These documents show that, unlike some other bloom forges in the area, such as Cunsey, Stoney Hazel was never converted to refine pig iron from the blast furnaces when that technology arrived in the early 18 century.

The site has two buildings separated by about 18m. The northern building contains a single hearth and was excavated by the late Michael Davies- Shiel in 1968-69. An interim report appears in BHMS Vol 4 Pt 1 (1970) 28-32. The well-constructed hole in the back wall (Figure 1) of the hearth, approximately 300mm square, led him to interpret the site as a Walloon-type forge – a technology developed to refine blast furnace iron. Davies-Shiel's interpretation that the site was used to refine blast furnace pig iron led him to extend the active life of the forge from 1718 to about 1825.

In a Walloon forge, the purpose of the hole in the back wall of the hearth was to feed iron sows through, the tip of the sow being burnt off in the hearth bit by bit and refined. These sows weighed 500kg or more and were thus far too large to be accommodated in the hearth as a single piece. In contrast, much smaller pig iron was produced by the Lake's blast furnaces, even the largest not being more than about a metre long and light enough for a man to handle. These could readily be broken into shorter lengths and fed directly into the hearth without the need for the hole in the back wall, which has the disadvantage of being a cause of heat loss unless nearly fully blocked by a much larger sow. In addition, the Walloon forge normally has a second hearth for reheating the fined metal, known as the chafery hearth, located near the finery hearth, so that hot refined metal could be transferred to the chafery for reheating prior to hammering to consolidate the iron and drive out remaining slag.

The excavation also revealed an ore bin and ore stains on the hearth wall, indicating that ore was added to the hearth. Again, not a method used in the Walloon technology, although similar to the addition of iron oxide, as in the wet puddling process which, developed in 1816 by Cort, came 100 years after the initial date of Stoney Hazel. An inventory of the site recorded by David Cranstone included an 'iron plate', an essential component for the bottom of a wet puddling hearth. Also, in wet puddling, iron oxide was added to the hearth to aid decarburisation – the rich haematite ores of Cumbria possibly acting here as the iron oxide source. Alternatively, the presence of ore does support the idea that the site was, at least originally, a bloom forge.

In 1973, J D Marshall, who evidently worked with or was familiar with the work of Davies-Shiel, published a call for volunteers in the Lancashire Archaeology and



Fig 1: The hole in the back wall of the hearth, tuyere entry from left

Historical Society Journal (Vol 1 Issue 2 1973) to extend the excavation to the southern range of buildings. He stated that the University of Lancaster was granted a 25-year lease of the site. He included a plan which claims that a chafery hearth was located in the southern range of buildings. While he refers to a 'dig' in 1973, the plan appears to be a speculation. Indeed, since the aim of the chafery is to reheat the hot fined material from the finery hearth, to place the two hearths in separate buildings some 18m apart is not only inefficient but not known in any other Walloon Forge. In addition, a further two water wheels would be required for the chafery, one for the bellows and the other for a second hammer,



neither of which are evident in Marshall's plan or evident from our field visit to the site. Marshall claims that pig iron was brought to the site from Backbarrow blast furnace, that company then owning Stoney Hazel, but no evidence of this has been found in the Backbarrow Accounts (Peter King, pers comm). Marshall also refers to the reconstruction of the walls in the 'forge' building, presumably the northern building, which is a worrying comment as to the integratory of the existing remains. In a later article on Backbarrow Furnace, published in 1994 (WIRG Newsletter No 19 Spring 1994, 1-2), Marshall makes passing reference to Stoney Hazel, saying it probably operated between 1719 to 1730, dates much closer to those proposed by David Cranstone derived from his search of the records, and contradicting Davies-Shiel's assertion that the forge operated for a much longer period, 1718 to 1825.

In 1982, Alex den Ouden offered an alternative interpretation saying that the forge was a cross between a German Forge and a Walloon forge, the German forge operated using a single hearth but with no hole in the back wall (JHMS Vol16 No2 (1982) 76-81). David Cranstone also re-excavated the northern building (Figure 2) following the work of Davies-Shiel and concluded that the site operated only as a bloom forge, based on the existence of the ore bin in the northern building. The hole in the back wall of the hearth, he speculates, may have been for levers to pass through to control the water sluice to the wheel. However, these levers would pass through the hearth, an unlikely occurrence due to the heat, and why such a large hole? Unfortunately, David lost his excavation notes when a victim of a computer ransomware attack. On our visit to the site we discovered quantities of slag indicative of a fining process.

Fig 2: The range of buildings. Northern range is closest, showing hole through wall

However, it is very difficult to distinguish between slag produced when refining bloom compared with that produced when refining charcoal pig iron, although a comparison of Stoney Hazel slag with Cunsey refining slag, which was converted to refine pig iron, shows very similar chemistry and morphology. Marshall reports that Stoney Hazel slag examined by the renowned slag expert, George R Morton, was identified by him as a 'mosser' of chafery slag by its shape – 'like the rounded top and shoulders of a bell'.

Indeed, in a later paper by Morton and Wingrove (JHMS 5 i 1971 24-28) they reproduce Davies-Shiel's excavation of the hearth at Stoney Hazel, complete with a 'pig hole', while accepting that no chafery had been 'yet' located. They quote evidence that fine ore was used in the refining process and that microstructural and chemical analysis are consistent with a fining slag, but that differentiation between finery slags of the Stoney Hazel type, and Roman and some medieval slags is extremely difficult.

Enquiries to Oxford Archaeology (North), who took over the University of Lancaster Archaeology Department, drew only the comment that they have no knowledge that the University ever conducted an excavation there and that it was unlikely since it is a scheduled monument. Likewise, enquiries of the Lancashire Historic Environment Record have no record of any excavations of the site. If any of our older members were involved in any excavations of the site and can provide any further information it would be most appreciated. Please contact Tim Smith at secretary@wealdeniron.org.uk

Tim Smith

HMS SUPPORTED PROJECTS

In issue 96 of *The Crucible* we drew attention to the Society's grants and in this section we highlight some of the work and activities reported on by awardees who have had HMS support. If you receive a grant, HMS members will be interested to know how they have been able to help in new research and widening the reach of Historical Metallurgy. *Editors*



A short tour of the University Museum, Schloss Hohentübingen

20TH INTERNATIONAL CONGRESS ON ANCIENT BRONZES

April 2018

Institute of Classical Archaeology (Institut für Klassische Archäologie), University of Tübingen, Germany

The 20th International Congress on Ancient Bronzes was held at Institute for Classical Archaeology, University of Tübingen between 17th and 21st April, 2018. Previously, the congress has been held in Los Angeles (19th, 2015), Zurich (18th, 2013), Izmir (17th, 2011) and also other cities. The congress was first held in Nijmegen in 1970 and has continued over 38 years, with twenty congresses focusing on archaeology, technology and art of bronze during the ancient time. The 20th congress was organized by the Institute for Classical Archaeology, University of Tübingen and was held in Schloss

Hohentübingen, with more than 100 attendees from different institutes and universities from around the world. Over 5 days, about 80 oral presentations, including the keynote lecture, and 13 poster presentations, were given on diverse aspects of ancient bronzes. There were also tours of the University Museum of Tübingen and Landesmuseum Württemberg and Altes Schloss, Stuttgart.

The conference opened with a short welcome and introduction lectures from Jürgen Leonhardt (Head of the Faculty of Philosophy, University of Tübingen), Thomas Schäfer (Head of the Institute of Classical Archaeology), Carol Mattusch (Chair of the Advisory Board of the Congress) and Philipp Baas (Organizer of the Congress) that summarized previous congresses and presented useful information about the program. After that, the congress programme started with the first session which including six lectures in the field of manufacturing, casting methods, history and introducing large and medium-scale bronze sculptures from India, Egypt and Iran to Europe with presentations by experts such as Paul Craddock (British Museum), Lisa Anderson-Zhu (Walters Art Museum) and Gunvor Lindström (German Archaeological Institute). The first day's presentations finished with the keynote lecture by Gerhard Zimmer (University of Eichstätt) with the title: Innovation und Tradition – Anmerkungen zum antiken Bronzeguss.

The congress proceeded with two sessions in the morning and two sessions in the afternoon over three days, with a final morning session on the last day. The sessions included two general sessions and 11 special sessions entitled:

Applied science for analysis of bronze objects; Production, manufacturing and Ffrgery; Iconography of small scale objects; Recycling, trade, repair and re-use; Investigations on metallurgy, production and form; Striking evidence; New approaches to ancient coin production; Gods, emperors and senators; Bronze objects in sacred contexts; Bronze(s) in private, public and sacred Contexts; Reconstruction of use and contexts; Rare objects in context.

The titles of the sessions show that the congress covered different interesting aspects of art, archaeology, technology and history of bronze alloy from western world to Asia and North Africa. For example, presentations about the history of metallurgical technology and techniques were very interesting, such as Paul Craddock's lecture on ancient casting techniques for big bronze sculpture in ancient India and Egypt, and the lecture by Jean-Marie Welter about the metallurgy of high-tin bronzes in Europe. On the other hand, lectures in the field of recycling methods also presented novel and updated data about re-use of bronze material in the ancient world, such as the impressive lecture by Frank Willer and Roland Schwab about recently obtained results of the Limes Region and bronze recycling during the Roman period. Nevertheless, a large amount of the research presented at the congress was focused on



Welcome lecture by Jürgen Leonhardt (Head of the Faculty of Philosophy, University of Tübingen)

archaeology, technology and art history of bronze during ancient times, especially regarding large and medium-size sculptures and other objects from the Greek and Roman periods, although there were presentations that looked at aspects of bronze technology and history in other regions such as Iran, Egypt and the Near East.

As a congress with a special focus on bronze history and archaeology, it was substantial in volume and number of presentations and attendees. In fact, it was impressive for an attendee to the congress to listen to new results on the study of ancient bronzes, talking to various experts with different experiences, and sharing knowledge about history of bronze, as the first alloy used in ancient times.

The congress finished on the morning of the fifth day with a session of final remarks. The conference proceedings will be published in the future, although abstracts of all presented papers were published in one volume before the start of the congress. I was able to participate in the congress with the support of a travel grant awarded by Historical Metallurgy Society (HMS) that helped me to cover part of my costs to travel to Germany and to attend the conference and share my experience with experts from other countries and disciplines, and also to obtain updated information about bronze history and technology from around the world.



Café break time at the Institute of Classical Archaeology

Omid Oudbashi
(Art University of Isfahan, Iran)

PLACEMENT AT THE DEPARTMENT OF ANTIQUITIES OF CYPRUS

The AHRC Northern Bridge Doctoral Training Partnership (NBDTP) provides its award-holders with a wide range of opportunities, including a placement scheme, to apply their knowledge, skills and research in non-academic environments, gain new skills that complement their postgraduate research, and generate impact from their research, sharing the knowledge with non-academic audiences. This placement was funded by NBDTP, CIAS (Cluster for Interdisciplinary Artefact Studies, Newcastle University) and an award from HMS (Historical Metallurgy Society).

The Project

The Department of Antiquities of Cyprus (DAC) is currently updating the galleries of the Cyprus Museum and preparing for the New Cyprus Museum in Nicosia. Several other district museums will also be modified and updated. I was invited to collaborate in a specific project dedicated to the permanent exhibition of artefacts related to the ancient metallurgy of the Island. The main project concerns the Cyprus Museum, but includes other permanent galleries in the district museums of the Island. The entire placement was undertaken, in accordance with the Director of the Department of Antiquities, Dr Marina Solomidou-Ieronymidou, under the supervision of the Curator of Antiquities, Dr Despina Pilides and the Senior Archaeological Officer Ms Eftychia Zachariou.

Initially, I was introduced to the Department's building and its facilities. The DAC kindly provided me with a dedicated office with internet access, which facilitated considerably my work during the placement. I was trained in how to use the archives and store-rooms under the supervision and with the support of the Archaeological Officers in charge of the various museums. The placement was articulated in four phases, but it slightly changed in its original structure (now five phases) as follows.

Phase 1: The Research

During this phase I created a catalogue of published metallurgical artefacts and residues dating mainly from Chalcolithic to Roman Times (c. 3000 BC – 500 AD), to implement the DAC archives. This phase was mostly dedicated to the selection, collection and organization of the available data. Once the preliminary data collection was completed I undertook training in the use of the archives and storerooms under the supervision of DAC staff. In the building of the general database, I could consider as a starting point a list of artefacts (provided to me by the DAC) once in display in the old metallurgy room (room XII), but now dismantled. The database created, essential to provide me with a complete knowledge of the materials

available for the display, will be useful to eventually implement the Cyprus Archaeological Digitization Programme (CADiP). Forty-four archaeological sites with metallurgical evidence were identified, from Chalcolithic to the Roman Period. A longer period at DAC would have probably allowed more complete and systematic research within the storerooms, and more sites could have been found.

Phase 2: The Record and Analysis

After the preliminary literature review and subsequent data-collecting phase, during the second phase of the project I selected specific artefacts from the general database and identified them in the storerooms of Nicosia. A data-collection period was also spent in the district museums of Larnaka, Limassol (whose storeroom also contains the metallurgical artefacts for the Episkopi Museum) and Paphos. For the Paphos Museum and the Cyprus Museum, the data collected were reorganised in a dossier and will be submitted as part of new museological proposals. The data pertaining the last three museums, were collected with the main aim to start the creation of a database as a support for future museological renovations of the museums. For each item a dedicated form has been filled in, the content of which could be used for the panels connected with the display.

Phase 3: The Display

Because Paphos Museum, at the time of the placement, was going through a radical renovation, the first efforts of this phase were spent in re-designing two show-cases dedicated to the metallurgy of Chalcolithic and Bronze Age of the Paphos District. Because of the urgency of this job, the results were submitted separately, before the general dossier. The results obtained during phases 1 and 2, pertaining to the design of the metallurgical display for the Cyprus Museum, were processed after the end of my stay in Cyprus, once I was back at Newcastle University. A complete dossier of the museological suggestions will be submitted soon to DAC. The dossier will contain:

1. New Cyprus Museum Metallurgy Room (text and concept)
2. Graphic view of the showcase 1 (Zomenia Zomeni)
3. Catalogue of materials showcase 1 (Zomenia Zomeni)
4. Graphic view of the showcase 2
5. Catalogue of materials showcase 2
6. Graphic view of the showcase 3
7. Catalogue of materials showcase 3
8. Graphic view of the showcase 4
9. Catalogue of materials showcase 4
10. Graphic view of the showcase 5
11. Catalogue of materials showcase 5
12. Graphic view of the showcase 6
13. Catalogue of materials showcase 6

14. Graphic view of the showcase 7
15. Catalogue of materials showcase 7
16. Preliminary LIST of metallurgical artefacts LEMESOS
17. Preliminary LIST of metallurgical artefacts LARNAKA
18. Preliminary LIST of metallurgical artefacts EPISKOPI
19. Educational Archaeology

Phase 4: Public Engagement

In the original plan, this phase was dedicated to the outcomes of the new display and the research involved. Unfortunately, for timing reasons, I was not able to design the Educational Archaeology workshops for schools, hands-on experimental archaeology events, and public talks as planned. Although, I was able to give a lecture about experimental archaeometallurgy at the University of Cyprus, within the module of Archaeometry, and I am planning a future hands-on experimental archaeology event in collaboration with the University of Cyprus. In regard to the Educational Archaeology programme, I am still in touch with the DAC to collaborate in the creation of specific workshops for schools.

Phase 5: Metal Conservation Training

The last month of the placement was dedicated to a training in metal conservation certified by the DAC. The training was carried out at the Metals and Other Archaeological Materials Conservation Lab, Cyprus Museum (Nicosia), and at the Laboratory for the Conservation of Underwater Finds (Larnaca). The following topics were covered:

- Identification of different metals
- Identification of different kinds of patinas and corrosion products
- Mechanical and chemical cleaning techniques
- Stabilization and passivation techniques
- Treatment of organic remains on metals
- Desalination and conservation of metal (and other) artefacts from underwater excavations
- Set up of the “Oddy Test” for display/storage materials

Placement Achievements

During this placement I benefitted from real work experience in the Cultural Heritage environment. I was able to work in a team, mainly based in such a prestigious institutions as the Cyprus Museum, where I received a warm welcome and great support. It was very formative in terms of learning the internal dynamics of the DAC, and how to interact with the different “offices” of a government institution dedicated to cultural heritage and deepening my knowledge of the ancient metallurgy of Cyprus. I acquired advanced skills in metal (and other materials) conservation.

Giving a lecture in a foreigner university increased my self-confidence in communicating my research to undergraduate students. I was also able to access to a large network within not only the DAC, but also the major cultural institutions involved in the archaeological research on the Island such as the University of Cyprus, the Cyprus Institute, the Cyprus American Archaeological Research Institute (CAARI), the Pierides Museum, and the Leventis Foundation.

Marco Romeo Pitone

5th Symposium Arch_RNT

Archaeological Research & New Technologies



Electron Microscopy

Research & Applications in

Archaeology and Cultural Heritage

Aim. 5th ARCH_RNT is towards the research and applications in the field of Electron Microscopy (Scanning, Probe and Transmission) covering all themes within the spectrum of archaeological, geological and Cultural Heritage Material.



Kalamata 4-5 October 2018

Abstracts must be submitted electronically by August 30, 2018, using the template given at <http://kalamata.uop.gr/~archaeolab/symposia.html>
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Laboratory
Archaeometry

Organisation:

Laboratory of Archaeometry
University of the Peloponnese
Co-Organisers:
Prefecture of Peloponnese, Kalamata Municipality





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MEET YOUR COUNCIL



WILLIAM HAWKES (BILL)

Bill is a professional conservator and trained jeweller holding a Masters' Degree from the University of Sussex in Conservation Studies. He aspires to work towards his doctorate in Conservation Sciences, concentrating on the structure, cleaning and conservation of silver and gilded objects of a historical nature. His conservation practice has encompassed a wide array of projects, spanning Roman and Anglo-Saxon stone-set jewellery in both precious and copper alloy metals, to Napoleonic carriage guns. Bill's clients have included His Grace, the Duke of Norfolk, and the Honourable Society of the Middle Temple. As part of his work, Bill regularly provides consultation services to various organisations in relation to researching historic objects and their metallurgy, providing reports for the purposes of preventative and remedial conservation. He is a member of the Institute of Conservation, and the International Institute for Conservation of Historic and Artistic Works. As a smaller part of his business, Bill hand-makes fine jewellery, selling his pieces world-wide. To this end he is a Fellow of the National Association of Jewellers, a member of the Guild of Jewellery Designers and the Society of British Jewellers.

Another skill that Bill brings HMS is that he is a communication and public speaking coach, having gained qualifications from both The New Zealand Speech Board, and from the London Academy of Music and Dramatic Arts (LAMDA), in both public speaking and debating. He is a past Club and Area President of the Association of Speakers Clubs and a regular communication skills

lecturer for Middle Temple, coaching new barristers in the art of public speaking. He has also been elected a fellow of the New Zealand Speech Board.

Bills involvement with HMS has been an absolute eye opener for him. From the first conference he attended, on jewellery and held in Birmingham, Bill has developed contacts and the ability to network. He has been able to consider points of view on research topics that otherwise he would never have considered. It is also very true that without his involvement in HMS Bill may never have met his future PhD supervisor! With this in mind, and important to Bill is that HMS has presented the ability to communicate his own conservation-based research in an academic context, and in a professional manner, a skill that is of the greatest importance.

In return Bill has the ambition to give back to HMS and its members, and the role that he sees himself in on the HMS Council is one of raising awareness of the care of historic objects. The objects of metal that are so often studied, yet rarely considered as a long-standing piece of our cultural heritage. Bill hopes to be able to facilitate a conference with this very consideration of our heritage in mind. Bill looks forward to contributing to the council, taking the responsibility of Data Protection Officer, a role he is growing into and learning a lot from already!

Please feel free to contact Bill and have a chat.... It would be most welcome!

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



HMS RESEARCH IN PROGRESS MEETINGS FROM THE EVENTS OFFICER

The 2017 Historical Metallurgy Research in Progress meeting was held in the Faculty Library at the University of Liverpool on the 9th of November. The meeting was well attended and had a great atmosphere.

The meeting kicked off with the first talk *'The spatial organisation of Roman Lead production in the Hope Valley, Derbyshire'* given by student Nicholas Clarke. Using chemical analysis it was possible to look at relative differences in lead content of the soil from within a Roman fort and the surrounding vicus. This revealed a larger concentration of lead within the fort itself, perhaps showing where the lead was being stored or potentially where the workers washed their clothes. The next talk was by Alan Williams on 'Characterising Bronze Age copper from the Great Orme mine to reveal its spatial and temporal distribution'. This presentation discussed the potential wide ranging trade networks within Britain using a new methodology for looking at mine-based metal groups rather than artefact-based groups, using chemical composition and lead isotopes.

In Vanda Morton's presentation, 'Types of evidence available at successive periods and places, for the production, use and trade of brass, up to AD1800', we were given a broad sweep overview of brass production through time. The presentation focused primarily on the different clues hidden in a range of evidence, from archaeology and artefacts to documents and paintings. After a short break, Peter Cloughton provided an insightful presentation on the 'Iron and steel production during the First World War'. This talk discussed the production of iron and changes in the ores sourced for the industry, from imported to home production.

In addition, the demands of war meant that many skilled workers were drawn into military service, and the consequences were shown in this presentation.

From Poland, Kamila Brodowska came to share her experiences of the extremely large bloomery fields in a presentation entitled 'From fieldwork to experiment - what we know today about ancient furnaces from The Mazovian Centre of Metallurgy, Poland'. The amazing archaeological evidence was then followed by results of experimental work at the Mazovian Centre of Metallurgy to build an understanding of the processes involved. The next talk was given by Peter Gethin on 'Compositional trends within diagnostic and non-diagnostic smithing slag assemblages; examining contemporary materials from Middle Islamic Tell Dhiban and the Old City of Jerusalem'. Peter presented the results of the analysis of smithing slags to investigate differences between the two sites.

Lunch was served in the library which allowed everyone to network. Following lunch there was an opportunity to visit the Garstang Museum of Archaeology which houses archaeological material from the ancient Near East, Mediterranean and Europe.

In the afternoon we had three presentations from colleagues from the University of Liverpool on recent research into ancient coinage. The first talk, given by Jake Morley-Stone, was on 'Late Pre-Roman Iron Age pellet moulds from Scotch Corner' and detailed experimental work carried out to investigate the production and use of pellet moulds, providing comparative material for those from Scotch Corner. The next talk, by Nicola George, was also based on 'Experiments in Roman minting technology'. Here she investigated how different mould materials affected the process of inverse segregation seen in many debased coins. The final talk of the day was by Diana Nikolova, who discussed the 'Debasement and Economic Fluctuation in Hellenistic Egypt: Chemical Analysis of Ptolemaic Coinage' and introduced an alternative methodology for the examination of the Ptolemaic economy by investigating the composition of silver and bronze coins, and their degree of debasement.

All in all, it was a fantastic day, with excellent presentations and a really friendly environment. The student presentations, as usual, were excellent and this made it difficult for the HMS council members to choose the best. However, we felt that Alan Williams presentation, with well-argued discussion and contribution to a larger debate, was worthy of the HMS student prize. Thanks must go to Matthew Ponting and his team of students for arranging a successful and interesting meeting.

Ellie Blakelock

WEALDEN IRON - BULLETIN OF THE WEALDEN IRON RESEARCH GROUP

A summary of Volume 38, 2nd series, 2018

It is sad that the 50th year of the group should have been marred by the death of one of its founders, David Crossley, for 43 years editor of Wealden Iron, whose important contribution to study in the region is recorded in the Bulletin's opening pages.

Field notes briefly describe a newly discovered bloomery site in Mountfield, and extensive iron ore workings in Sedlescombe, both in East Sussex, and further evidence of medieval iron working in the heart of urban Crawley in West Sussex.

An embossed bronze strip discovered in 1848 on a Romano-Celtic temple site at Farley Heath, near Guildford has been interpreted as a sceptre binding bearing symbols and objects that could be associated with gods of possible importance to ironworkers. An article discusses this interpretation and considers other deities linked with ironworking in the prehistoric and later periods.

David Crossley's first excavation in the Weald was of Panningridge Furnace, which was built for Sir William

Sidney in the 1540s to supply cast iron to his forge at Robertsbridge, 11km distant. The way between the two sites has, beyond living memory, been known as the Sow Track, but its precise route has never been identified. An article draws on field investigation, documentary research and the recent technology of LiDAR to plot the path of the sows from Panningridge along the Sussex ridgeways.

Perhaps the most elaborate product of the Wealden iron industry were the railings that were erected around the re-built St Paul's Cathedral in London in the early-18th century.

Costing over £11,000 at the time, and attended by a degree of controversy, their construction has not been previously examined. An article describes the background to their commissioning, the people involved and a detailed description of a section of the original railings to show how they were assembled from components which included threaded and turned elements.

For further information about the Wealden Iron Research Group, and downloadable pdfs of past volumes of Wealden Iron, see www.wealdeniron.org.uk.

Jeremy Hodgkinson

42ND INTERNATIONAL SYMPOSIUM ON ARCHAEOMETRY (ISA2018)

20-26 May, Mérida, Mexico

The 42nd Symposium on Archaeometry was held between the 20th and 26th of May, 2018, at the historic building of the Autonomous University of Yucatan in Mérida, Mexico (Fig. 1), making this the second time the symposium has been hosted in Mexico (the first time being in Mexico City in 2000). It was a successful meeting that brought together 256 participants from 41 countries and five continents, with 280 abstracts submitted. Contributions bridged a wide range of archaeometric applications including geophysical and dating methods, human-environment interactions, organic and inorganic materials. Amongst the main aims of ISA2018 was the further enhancement of its collaboration with the Society for Archaeological Science (SAS).

A session devoted to the memory of Professor Aitken opened the Symposium. Professor Aitken, who passed away in 2017, contributed greatly to archaeometry from its founding days and, in particular, to applications of archaeomagnetic and thermoluminescence dating. We heard about Professor Aitken's work and life from his colleagues and students who spoke warmly and enthusiastically about the 'godfather of archaeometry' (Maniatis, opening ceremony) and the person behind the foundation of the journal Archaeometry.



Volume 38
Second Series
2018

WEALDEN
IRON



ISA2018

ARCHAEOMETALLURGY

Archaeometallurgy was represented with a total of 16 oral presentations and 40 posters. Oral papers were delivered in three sessions, which spanned the conference week, including a special session on Ancient Metallurgy in the Americas. They focused on a range of periods and regions from the Late Copper Age Alpine region to 19th century East Africa, and from Predynastic/New Kingdom Egypt to the Moche culture in Peru. Topics discussed a wide range of interests from landscape (Iles; East Africa) and fuel management (Verly et al.; Egypt) to resource procurement (Rademakers et al.; Egypt), and from casting and metalworking (Paris et al.; casting technologies at Yucatan) to conservation strategies (Hayley; the Mary Rose cannon balls).



Fig 1. The interior of the historical building of the Autonomous University of Yucatan where the poster sessions and social activities were held

METAL NETWORKS OVER TIME

A number of papers explored past metal networks through their diachronic development and how these connected communities. Ferretti et al. (The production of metal artifacts in southern Etruria) conducted an archaeometallurgical survey of artefacts from the Copper to the Bronze and the Early Iron Age in Central Italy. They found a development of technological practices possibly reflecting the exploitation of variable sources and/or techniques as seen in the trace and minor element concentrations, for example, in lead. Angelini (The diffusion of early copper in southern Europe) investigated the diffusion of early copper in the Italian Alpine region and Tuscany, concluding in the exploitation of local ores (Trentino) and large-scale smelting activity in Tuscany (S. Carlo). Lead isotope data from Tuscany also matched those from the Iceman's axe dating to 3200 BC. Montero Ruiz (Copper-lead ingots and the high leaded bronze production during the Early Iron Age in NW Iberian Peninsula) discussed the possibility of the circulation of plano-convex and sheet copper-lead ingots in Early Iron Age northwest Iberia as a potential source for the first high-leaded (ternary) bronzes produced in the area. The ingots could have originated from Rio Tinto or perhaps have even been traded by the Phoenicians. Further east from Europe, Radivojevic and Grushin (Early Bronze Age Afanasyevo culture metal production in the Altai Mountains) explored the north-south circulation of early copper in southwest Asia/eastern Eurasia and the inner Asian mountain corridor as a major route of interaction.

INSTRUMENT CALIBRATION

One paper (Wilke et al., Inter-instrument calibration of three different pXRF spectrometer brands) tested comparatively three pXRF spectrometers

(Bruker, Olympus, Oxford Instruments) in terms of accuracy, calibration methods and their behaviour in heterogeneous materials. Geochemical provenancing with the use of pXRF under certain circumstances was also discussed.

FUEL MANAGEMENT AND RAW MATERIAL

PROCUREMENT

A group of papers focused on aspects of forest management, fuel and raw materials acquisition and processing. Isles (Exploring the impact of iron production on forest resources from slag chemistry) discussed environment and fuel management in Tanzania. She employed magnetometry to survey an iron producing landscape in order to establish the scale of metalworking and understand past stresses on the local woodland area. Verly et al. (The chaîne opératoire of Middle Kingdom batteries and the problem of fuel) discussed the use of fuel and waste management in Middle Kingdom Egyptian furnaces with no bellows. Their detailed, large-scale experimental work agreed with the use of green wood and animal dung as opposed to charcoal as a fuel source. Bassiakos and Philippaki (Perforated metallurgical furnaces in the Aegean) presented new data for the operation of Prehistoric perforated furnaces from the Athenian Acropolis, previously falsely thought to be strainers. Perforated furnaces, along with the use of bellows, took advantage of natural winds, and experiments replicated the process successfully.

Rademakers et al. (Copper provenance in ancient Egypt) investigated the exploitation of Egyptian copper sources. They noted a shift in the metal technology from the Predynastic to the New Kingdom period, as well as the exploitation of Sinai and Eastern Desert sources previously neglected by scholarship. Wood et al. (Arguments for the exploration of silver in ancient Cyprus) re-considered past lead isotope data from silver objects recovered on Cyprus from antiquity and discussed the possibility of exploitation of local silver sources. The team argued that existing lead isotope results in this case are inconclusive due to the technique's inherent limitations, and that they do not prove the absence of local silver extraction, which is possible but still not analytically proven. Dillis et al. (Provenancing antimony in metal and vitreous materials) addressed the interesting question of sources of antimony (which is currently still unknown despite the mineral's widespread use in antiquity) by analysing material from Central Italy and the Caucasus.

METALLURGY IN THE AMERICAS

Three papers presented new data from the Central and South Americas. Paris et al. (A technical study of metallurgical ceramics and casting technologies at

Mayapán, Yucatan) presented evidence of secondary metal production and casting, including crucibles, moulds, pestles, small objects and tripods, from Mayapan, a mineral-free area in the Yucatan Peninsula. Raw metal would have been imported from west Central Mexico or east South America. Copper prills of up to 4 mm found in the core of the crucible fabric, were interpreted as the remnants of crushed crucibles used as grog in the production of new crucibles. Fernández (The metallurgy of South Central America) examined, compositionally and metallographically, objects from Colombia, and illustrated the output of local workshops as well as connections with neighbouring regions. Zambrano Alva et al. (Characterisation of metallic ornaments of the Moche culture) showed some interesting examples of depletion gilding from metallic ornaments from the Moche culture, Peru.

CONSERVATION AND CORROSION

STUDIES

Simon et al. (The archaeometry of conservation) studied the cast iron cannon balls (with diameters up to 20cm) found with the Mary Rose, a 16th century warship. The team investigated the impact of past conservation treatments on archaeological iron at a molecular level and presented more efficient treatments for the long-term preservation of iron objects. González Parra et al. (Dating of bronze alloys by electrochemical noise measurement) discussed the possibility for the dating of copper-based objects by examining the corrosion patinas of archaeological objects via electrochemical noise measurements. The team though acknowledged that it is the corrosion layers that are being dated and not necessarily the objects themselves. Such an approach could, for example, prove useful in cases of dubious authenticity.

Overall, ISA2018 brought together scholars from across the globe and sparked fruitful discussions on the present state and future of archaeometallurgy. A significant proportion of the archaeometallurgical papers discussed experimental work showing a keen interest for the replication of past metallurgical processes. Contributions dealt with a wide range of materials from green wood used as fuel to artefact patination. However, we did not see papers involving inter-laboratory comparisons/procedures and it would be something to look forward to at the next ISA. Finally, for those wondering, yes, Mérida was hot and humid, but also charming and welcoming, and the venue itself conveyed the long history of the host city. The 43rd ISA will be held at Lisbon, Portugal, in May 2020 and we are already looking forward to it.

Vana Orfanou

METAL CASTING AS IT WAS DONE 4000 YEARS AGO: EXPERIMENTING GESTURE



The transformation of ore into metal is one of the major events in the history of humanity. Copper and bronze gradually replaces the stone tools that man has taken millennia to develop. The metallurgy of bronze grows rapidly and provokes an unprecedented technological revolution throughout Europe that will give birth to a brilliant civilization: the Bronze Age. In the first part, the book exposes a comprehensive overview of the evidence and implements found in Bronze Age deposits in Eastern France. From remains and traces, archaeological experimentation brings valuable knowledge about ancient technologies, such as the behavior and interaction of materials and the spatial organization of the workshops. The three authors, engaged in archaeological excavations, revisit the results of their investigations. Embellished with rich iconography, this book presents a panorama of techniques and illustrates the clear determination to include experimental archaeology in a scientific historical perspective. Experimenting with metal allows the construction of explanatory models and is an authentic laboratory of gesture and technical thought. This book is the result of many years of research in experimental archaeology and accompanies the academic exhibition “Pouring the metal as it was done 4,000 years ago”.

This book is part of a new series, ‘*Experimental Archaeology*’ from PUN Editions Universitaires de Lorraine, directed by Denis Morin and Jean Sainty. Prefaced by B. Schnitzler, curator of the Strasbourg Archaeological Museum and magnificently illustrated, it completes the exhibition “Pouring the metal like 4000 years ago”. It also extends the reflections and activities that emerged from the International Conference “Indices and Traces, memory of gestures”, organized at the University of Lorraine.

About the authors

Dr. Denis MORIN, archaeologist, is a senior lecturer and director of research at the University of Lorraine, in the laboratory HISCANT MA EA1132. His investigations in Greece aims to explore and to study some of the oldest silver and copper mines in the Aegean area.

Jean SAINTY, is an ethno/archaeologist and prehistorian who worked for many years at the Cultural Department of Alsace. He was the founder of the Experimental Center of Prehistory (CEPA). The experimental archeological platform of Holtzeim was one of the first to be created in Europe.

Dr H el ene MORIN-HAMON, archaeologist, is a scientific researcher in the Laboratory CNRS 5608 TRACES (Works and Archaeological Research on Cultures Spaces and Societies) of the University Jean Jaur es of Toulouse. Specialist in archaeology of technology, her work on minerallurgy led her to publish a reference book on palaeo/landscapes and landmarks related to mining activity.

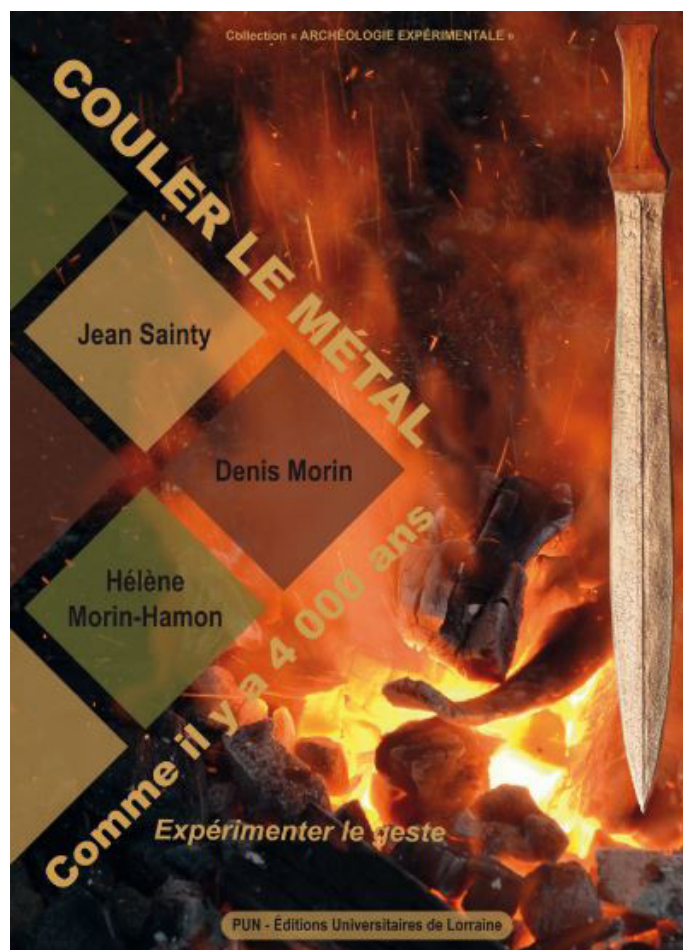
Links

<http://www.archeologies.net/>

<http://factuel.univ-lorraine.fr/node/4271>

<http://factuel.univ-lorraine.fr/node/7986>

Denis Morin, Jean Sainty and H el ene Morin-Hamon



A LETTER FROM ... (EGYPT IN) BELGIUM

Since 2015, the EACOM project has been researching Early Egyptian and African Copper Metallurgy through a collaboration of the Royal Museums of Art and History in Brussels, the Royal Museum for Central Africa in Tervuren, and the Archaeometry research group at the KU Leuven in Leuven. The project has adopted an integrated methodology (Verly & Longelinin, in press) for the study of copper production chains, incorporating excavation, museum studies, archaeometric analysis and experimental archaeology. We aim to continuously circulate between these different research components, with results from each one improving the others iteratively. For example, excavation protocols for metallurgical furnaces at Ayn Soukhna (Egypt) have improved significantly over the past years thanks to better understanding obtained through experimental smelting. Our interpretation of this smelting process has changed through repetitive experimentation which, in turn, has benefited from the archaeometric analysis of experimental production remains. This integration has helped us to embed our results of chemical and lead isotope analysis of copper alloys from the museum collections (e.g., Rademakers et al. 2018a, b) into a reconstructed chaîne opératoire specific to early Egypt.

In this letter, we would like to present the experimental work we have been undertaking as part of our research into early Egyptian metallurgy. The majority of this work takes place at the Archéosite d'Aubechies in the Hainaut province of Belgium. This site, under continuous development since 1983, is an open-air Gallo-Roman museum hosting not only various architectural reconstructions, but also



Fig 1: Middle Kingdom smelting furnaces dedicated to wood (left) and charcoal (right) at Aubechies

workshops for a range of artisans. Amongst these is a metallurgical workshop, geared primarily to secondary bronze metallurgy. Whilst open to the public every day,

on Sundays all workshops are active, with bronze casting demonstrations being one of the main attractions. Beyond these demonstrations, the bronze casters (Hugues Paridans and Georges Verly) have been actively experimenting with a range of early bronze making and casting techniques for years. In the context of this workshop, the EACOM project has found the perfect host to elaborate and crystallise a series of specific research questions, stemming from archaeological research, which range from primary copper smelting through bronze alloying and casting.



Fig 2: Recovery of copper prills from the Middle Kingdom smelting process (Aubechies)

A LETTER FROM ... (EGYPT IN) BELGIUM

Beyond the support from the Archéosite d'Aubechies, we further enjoy a stimulating collaboration with the Plateforme expérimentale des mines d'argent- CNRS (Florian Téreygeol - UMR 5060 IRAMAT) in Melle, France.

Our research on primary metallurgy focuses on the technology of copper smelting witnessed at Ayn Soukhna, a primarily Middle Kingdom (ca. 2000-1850 BCE) site by the Red Sea (Abd el-Raziq et al. 2011, Tallet 2012, Verly 2017b). At this site, over fifty smelting furnaces have been unearthed, all in workshops containing batteries of three to four furnaces. Following a first complete reconstruction of such a furnace at Ayn Soukhna, a more precise model was built at Melle in 2016 and a battery of two furnaces was constructed at Aubechies in 2017 (Figs 1 and 2). Eight thermocouples were incorporated into each furnace in order to monitor their thermal behaviour at key points during operation.

While these furnaces were initially presumed to be wind-powered, the experimental archaeology soon showed that they work entirely on a structural draft system, requiring no external ventilation efforts. In fact, the chimney effect works so well that temperatures easily exceed those necessary for copper reduction, which led us to establish an experimental protocol to test a variety of fuel types, and combinations. At Aubechies, one furnace is dedicated to wood-based smelting operations, while the other is reserved for charcoal.



Fig 3: Experimental mould, with different layers indicated (comparable to QH207-42)

Recording temperature profiles as well as environmental conditions, fuel consumption, charge distribution and other parameters throughout dozens of these smelting operations, typically lasting around 10 to 15 hours, has provided invaluable raw data towards reconstructing their behaviour. Having reached a high repeatability of results after more than 50 experimental runs, we are now quite satisfied and confident in our understanding of this process. Essential to our research is the validation of our experimental results with the archaeological data, which form the absolute standard to which they should adhere.

As mentioned, this repeated experimentation has equally highlighted minute process-dependent material reflections (e.g., localised ash deposition, zoned discolouring of the furnace lining) which are now being documented in more detail at the ongoing excavations in Egypt. Another important aspect under study is the geochemical balance of these furnaces. As a fundamental part of the protocol, all starting products, smelted copper and waste materials are sampled and a selection is analysed in Leuven. This not only helps us to understand this particular smelting process itself, but illustrates possible geochemical pathways from ore to metal that are relevant to Middle Kingdom metallurgy.

Such information is essential in improving the way we look at copper provenance, as the road between mine and artefact often remains very obscure, not least in terms of process-related compositional changes. Whilst we have already presented preliminary results of these smelting experiments at various conferences,

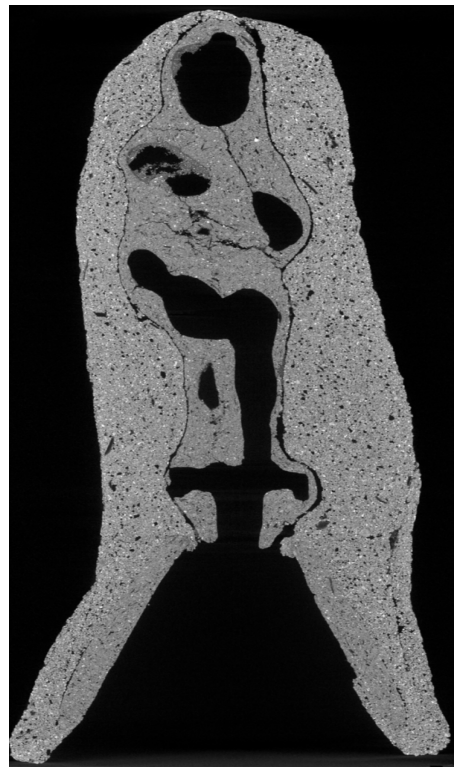


Fig 4: µCT-scan of Qubbet el-Hawa mould QH207-42, showing internal layering (Bonn project)

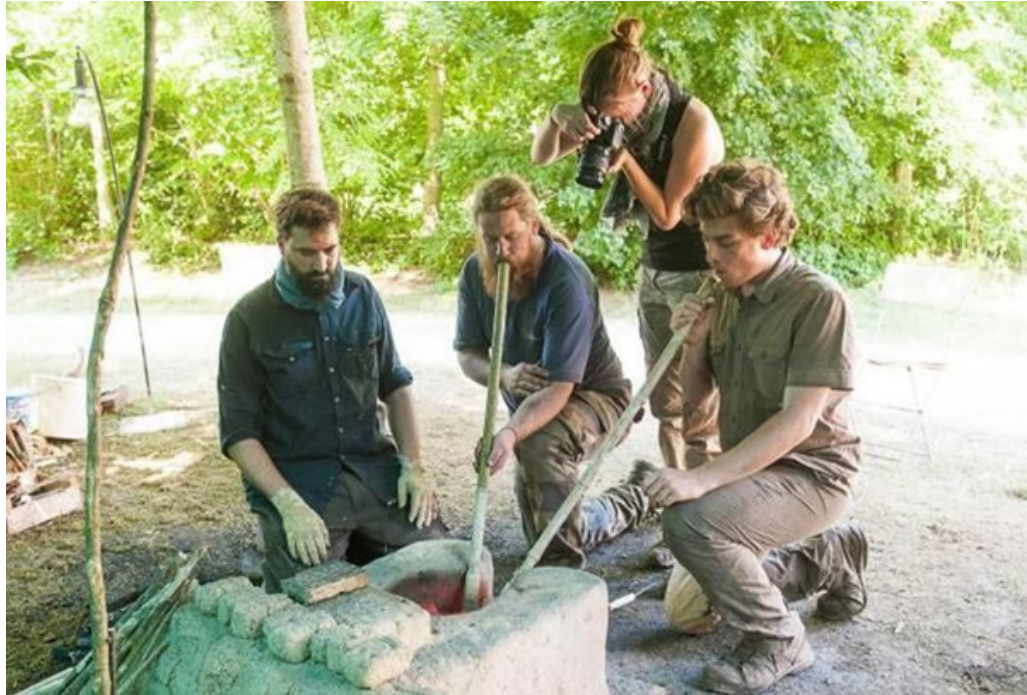


Fig 5: Middle Kingdom melting furnace (Melle), process start

their formal publication is still underway. We are currently preparing manuscripts on the functioning of these furnaces as illustrated by the experiments, as well as the geochemical changes that occur under the main operating modes, and we hope to share them with you soon!

A first paper on our collaboration with Johannes Auenmüller concerning Late Period Egyptian casting (Auenmüller et al. in press) will appear shortly. This Late Period Egyptian casting forms the second main axis of our experimental research. It is focused around the casting remains discovered at a tomb in Qubbet el-Hawa (near Aswan in Egypt), dated to the Late Period (ca. 6th-5th century BCE). This assemblage comprises a unique set of complete lost-wax casting moulds, exemplifying almost every step of their preparation process: some have not been de-waxed, while others were fired and some of them (partially) filled with bronze.

An interdisciplinary research project at Bonn, started in 2014, employed a range of archaeometric methods to gain insight into the mould material technology and revealed remarkable cases for the mending of bronze Osirises (Fitzenreiter et al. 2016). Now, a collaborative follow-up project with EACOM, supported by the Fonds Comhaire, has been setup to look specifically at the application methods of the different clay layers and to understand their functionality in each step of the production process. New μ CT analyses at Gent University expand on the existing μ CT data from the Bonn project to provide a non-invasive characterisation of the ceramic fabrics of each mould layer (Fig. 3). Structural recurrences observed from this data provide the blueprint for over 200 experimental moulds

(Fig. 4). Within these, a range of clay mixing and fermentation modes, clay application methods, drying and de-waxing procedures, mould pre-heating and tilting, casting temperatures and de-moulding are tested. In each step of the production, the validation for a particular method is obtained through repeatable functionality and compatibility with the archaeological remains. Thus, we are closing in on the most likely chaîne opératoire, backed by a combination of archaeological, archaeometric and experimental data.

A major difficulty in field smelting experiments is the huge amount of time (and money – a large part of which is too often personal) that needs to be invested before repeatable results are obtained, as a wide range of variables need to be taken into account. The time-depth required for such work is often not covered within the scope of a research project: while we are extremely lucky to have four years of project funding, we benefit greatly by building on established protocols at Aubéchies and Melle (Figs 5, 6 and front cover). Furthermore, our experiments would never proceed as quickly if it wasn't for the archaeology students joining us in the field each year to prepare clays, chop wood and calibrate charcoal, and keep us on point by asking (often) perceptive questions. All students learn how to cast bronze in a self-made sand-mould by the end of the season (using antique Egyptian fire protection: Verly 2017a), and gain an appreciation for the complexities of archaeometallurgy. Finally, working on a public site means we spend a good deal of our time explaining what we are doing (and why?!) to visitors, which is a welcome and healthy diversion not usually obtained in the office or lab.

A LETTER FROM ... (EGYPT IN) BELGIUM

We are thus very happy to be involved in such a richly varied project, in which we get to study examples of nearly every step of an (Egyptian) copper production chain. While each researcher brings their expertise to the team, it is the involvement of the entire team in each axis of the project that allows us to look at early metallurgy from a fresh perspective and build a holistic methodology ranging from the field to the museum and into lab, then back into the field and around again. We greatly look forward to sharing our published results with you soon and are of course always keen to hear from anyone interested in collaborating on experimental archaeometallurgy!

Frederik Rademakers and Georges Verly

References

Abd el-Raziq, M., Castel, G., Tallet, P., and Fluzin, P. (2011): *Ayn SoukhnaII: les Ateliers Métallurgiques du Moyen Empire*, Cairo: Institut français d'archéologie orientale

Auenmüller, J., Verly, G. and Rademakers, F.W. (in press): Bronze casting artefacts from Qubbet el-Hawa – Moulds, materials, and experimental methods, in Clerbois, S., Rademakers, F.W. & Verly, G., eds., *Studies in Experimental Archaeometallurgy. Methodological Reflections from Non-Ferrous Metallurgies*, Brussels: CReA-Patrimoine

Fitzenreiter, M., Willer, F. and Auenmüller, J. (2016): *Materialien einer Gusswerkstatt von der Qubbet el-Hawa*, Bonner Sammlung von Aegyptiaca, Berlin

Rademakers, F.W., Nikis, N., De Putter, T. and Degryse, P. (2018a): Copper production and trade in the Niari Basin (Republic of Congo) from the 13th-19th century CE: chemical and lead isotope characterization, *Archaeometry*

Rademakers, F.W., Verly, G., Delvaux, L., and Degryse, P. (2018b): Copper for the afterlife in Predynastic to Old Kingdom Egypt: Provenance characterization by chemical and lead isotope analysis (RMAH collection, Belgium), *Journal of Archaeological Science*, 96, 175-190

Tallet, P. (2012): Ayn Sukhna and Wadi el-Jarf: two newly discovered pharaonic harbours on the Suez Gulf, *British Museum Studies in Ancient Egypt and Sudan*, 18, 147-168

Verly G. and Longelin A. (in press): Méthodologie en Archéologie expérimentale – Définition et Protocole. Methodology in Experimental Archaeology – Definition and Protocol, in Clerbois, S., Rademakers, F.W. & Verly, G., eds., *Studies in Experimental Archaeometallurgy. Methodological Reflections from Non-Ferrous Metallurgies*, Brussels: CReA-Patrimoine

Verly, G. (2017a): Khety or the Satire of Trades, mud and experimental archaeology. The use of mud as protection by metallurgists in Pharaonic Egypt, *Göttinger Miszellen*, 252, 135-144

Verly, G. (2017b): The smelting furnaces of Ayn Soukhna: The excavations of 2013, 2014 and 2015 in Montero Ruiz I. & Perea A. (eds.), *Archaeometallurgy in Europe IV*, Bibliotheca Praehistorica Hispana, vol. XXXIII, Madrid, 143-157



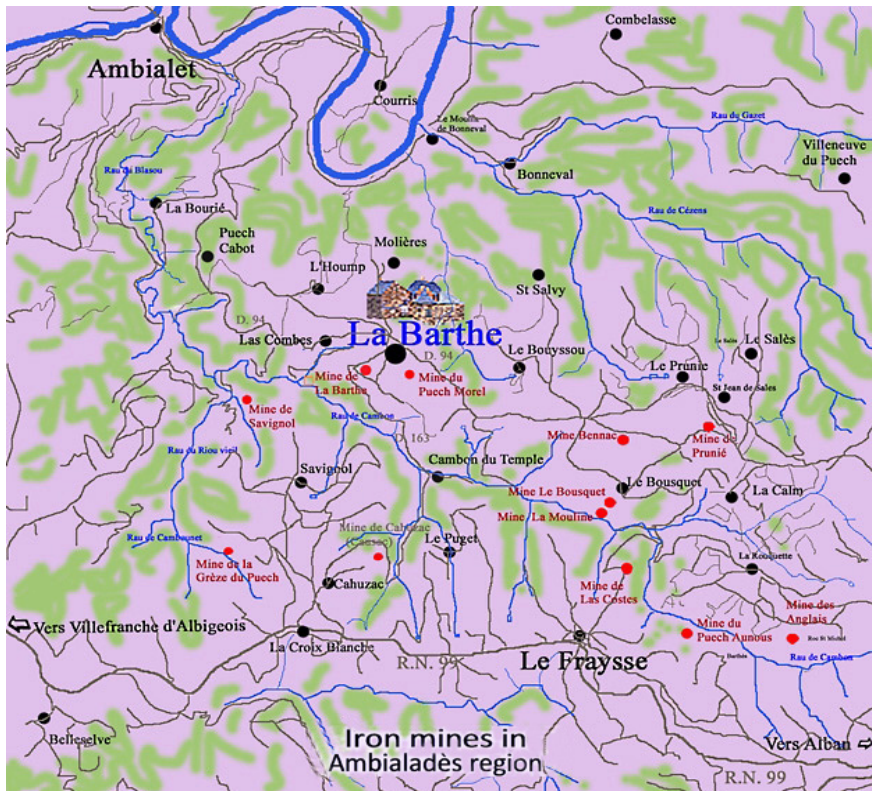
Fig 6: Middle Kingdom melting furnace (Melle), at 1200°C

OUT AND ABOUT

PIERRE-FRANCOIS PUECH (IPH), BERNARD PUECH (IPH) AND ROGER NOTONIER (UP) writes: with news on the Detection and conservation of metallic traces of past iron industry from La Barthe, France. Forges from pre-20th century, in the area of La Barthe near Ambialet, Tarn in France, arose close to iron mines, where charcoal (from forests) and hydropower were also present. Data were collected in order to create a record of this mining district. Recording pits that were dug in the countryside for extracting iron ore and detecting rotating millstones for grinding ore, with evidence of use in detection of metallic traces, allow understanding the cultural unity of that group over several centuries. For the identification and conservation of the deposits on the dynamic surface of the grinding wheels we used surface impressions. The technique is similar to nitro-cellulose varnish replicas that allow the use of various analytical microscopy techniques. SEM observation allows detection and keeping track of the metallic elements present in trace amounts.

(IPH) Institut de Paléontologie Humaine, Paris

(UP) Université de Provence



Iron mines in Ambialadès region



Millstone for grinding ore



BRIGITTE CECH, in Vienna, sends news of her **RESEARCH PROJECT ON A ROMAN GOLD MINING DISTRICT IN EASTERN AUSTRIA**. Work on the four year project (FWF project P30790-G25) on a Roman gold mining district about 70km to the south of Vienna has begun this year. The mining district, including the catchment area of the leats, covers at least 60km². The still visible remains of hushing are huge water reservoirs at the top of the deposit, heavily washed-out opencasts and the courses of the leats. Apart from archaeology, the following disciplines are involved: survey and cartography, geology, geophysics, hydraulic engineering and pollen analysis. Geoelectric measurements carried out at the reservoirs show that the dams were sealed towards the inside of the reservoirs. The first excavations will take place in August 2018 on one of the reservoirs, with the aim of studying its construction, especially the sluice gate at the outlet towards the opencast.

http://stremke-archaeology.net/goldbergbau_en/index.html



MIKE CHARLTON says: I have, since 2014, been working with Jane Humphris on an experimental archaeology project to help illuminate the technology and production economy of ironmaking at Meroe, Sudan. Other members of the team include Jake Keen and Lee Sauder, an international team of archaeologists and more than a dozen local participants. Our last campaign took place in November of 2017, during

which we mined a rich oolitic ore, collected Nile and kaolin clays, and obtained a coarse-grained sand—an essential ingredient for making an archaeologically relevant furnace lining. Our smelts were successful in producing the characteristic slag morphologies of Meroe, but little in the way of a familiar bloom—just masses of gromp. This led us to consider a secondary consolidation procedure, modelled from Wagner’s (1990) translation of Ole Evenstad’s description of a similar process. By this method, we transformed our masses of nearly forgeable gromp into consolidated cakes of iron. Such a process could explain the unique Meroitic furnace workshops with two opposing furnaces located on opposite sides of a sunken floor. With all the materials categorized, counted, and weighed, I am now using SEM-EDS at UCL-Qatar to detail their microstructures and quantify their chemistry. Our efforts and the questions they raise are bringing us incrementally closer to a model of Meroitic ironmaking and the technology’s relationship to the resources scattered across the surrounding landscape.

Wagner, D. B., 1990, Ancient Carburization of Iron to Steel: A comment, Archaeomaterials 4; 111-117.

FORTHCOMING EVENTS

conference, date and locations	Description	websites, emails and prices
Furnace Festival 25th-26th August 2018 Ireland	Smelters from around the world will meet for this 2 days furnace festival.	prondelez@yahoo.com
Bolgar International Archaeological Field School 28th August-2nd September Russia	The School aims to provide a combination of practical training and academic content for students and young archaeologists in a multi-national environment.	http://archtat.ru/en/arch-school/newsletters/
Association for Industrial Archaeology (AIA) Conference 31st August-4th September Nottingham	This year's AIA Annual Conference will be held in Nottingham from 31st August to 4th September, starting with a Seminar on 'Revised Research Frameworks in Industrial Archaeology', then the conference from Friday evening to Sunday lunchtime, and afterwards with coach visits from Sunday afternoon to Tuesday or Wednesday (which will include colliery sites, railway viaducts, steam engines, canals and bell founding).	https://industrial-archaeology.org/aia-annual-conference-2018-nottingham/
EAA Conference 5th-9th September Spain	The Annual meeting of the European Archaeologists Association is a space for updates and debates on all the aspect of the discipline.	https://eaa.klinkhamergroup.com/eaa2018/
HMS Research in Progress 06 November 2018 York,	This meeting is aimed at a wide variety of contributors, from historical and archaeological metallurgists to excavators, historians, and economists.	
Archaeometallurgy in Europe 19th-21st September Hungary	These conferences represent the most important forum for scientific discussion on early metalworking in Europe and other related regions of the Old World. The most important goal of this scientific symposium is to present new insights, new approaches and new results of complex examinations in the field of archaeometallurgy.	http://www.aie2019.argum.hu/