THE CRUCIBLE

Historical Metallurgy Society News
Issue 110 Summer 2023

Buzaglo's cast iron stove See Out and About page 19

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The HISTORICAL METALLURGY Society

Muckross Blast Furnace seen on the HMS visit to Killarney. See Archaeometallurgical News page 6

From the Editors

A note from the Hon. Gen. Secretary

Dear Readers of the Crucible

2023 has seen a few changes behind the scenes at the HMS. Paul Rondelez reached the end of his term of office as Chair of HMS and stepped neatly into the roles of Managing Editor of the Journal and deputy Events Officer. He has also started a special interest group, SIG-Iron, and earned our grateful thanks for steering the Society forward for the past few years.

Instructions for asking questions via SIG-Iron can be found on the HMS website: https://historicalmetallurgy.org/hmsspecialinterestgroups/ .

We welcome our new Chair, Mike Charlton, and five new council members: Rowan Taylor, Therese Kearns, Eric Nordgren, Raluca Lazarescu and Maria Becerra. In due course they will appear on the 'Meet Your Council' pages.

As 40% of HMS membership do not live in England, some of the future meetings will be electronic (via Zoom) and hybrid (electronic & human) as well as in-person. The Research In Progress meeting was very well organised from Germany by Thomas Rose in April and he will organise the next RiP for 24th November 2023.

The AGM was sandwiched between showings of historical & metallurgical videos in a 'Day at the Movies'. The videos covered a range of techniques, including photogrammetry, and the metals silver, mercury, iron, steel and copper alloy. Anybody wishing to see the videos should ask for the links from secretary@historicalmetallurgy.org.

The first HMS Networking Event was organised by Eddie Birch and took place in Sheffield in early June. A full write up will appear in a later edition of ***The Crucible***. It wasn't a conference so the fee was £0 and everyone was responsible for their own travel, accommodation and meals. The weekend started with a pre-dinner drinks at the Sheffield Tap, Sheffield Railway Station bar on Friday 2nd June. Saturday had visits to Abbeydale Industrial Hamlet and a 'Metal Industry in Sheffield along the Canal & River Don' walk.

Sunday started at Wortley Top Forge with a site visit: a water powered heavy iron forge whose history can be traced back to at least 1640 and has been used for bloomeries and fineries. The afternoon visit was to Kelham Island Museum which is housed in a very early Electricity Power Station (1899). The weekend was a resounding success and Networking Events will occur annually or more often.

The secretary has been asked to notify HMS members of what's on by email as not everyone uses the website as a diary so occasional e-messages will be sent.

Vanessa Cheel

Dear all

It is a great privilege to take on the editing of the Crucible. I have been an assistant editor since 2018 and during this time I have enjoyed reading the many articles which capture a snapshot of current and pioneering work in the field of archaeometallurgy. As a way of introduction, I am an archaeologist and PhD researcher at the University of Exeter and my research focusses on the medieval iron industry of the Weald in Southern England. I recently submitted my thesis and I'm afraid the intense writing up process led to the delays with this edition of the Crucible, for which I do apologise.

Raluca Lazarescu has kindly agreed to take on the second editor role and will be joining ***the Crucible*** team for our Winter Edition. Our editorial team is still very small so it would be wonderful to recruit some assistant editors to proof-read content or source future articles. If you would like to help, we would love to hear from you!

We are also always seeking content for ***the Crucible***, which remains a perfect place to present research and advertise projects, conferences and events. Archaeometallurgical News features a diverse range of articles covering scientific analysis, historical and archaeological projects and metallurgical experiments. The Out and About section allows members to briefly discuss places, sites and artefacts that you have come across and feel would be of interest to others.We are also always welcome book reviews and willing volunteers to be interviewed for the One Minute Interview. Email or write to us with anything you would like us to include.

Jack Cranfield

Editors: *Jack Cranfield and Raluca Lazarescu*

Submissions

Submissions to ***The Crucible*** are welcome at any time, but deadlines for each issue are 1st March and 1st September each 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. We accept a maximum of 5 Harvard-style references per article only.

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 Website: Can you help maintain it?

The webteam need help running historicalmetallurgy.org

We need someone with html, CSS and PHP coding skills and a good general knowledge of Wordpress.The time commitment is relatively small, but likely to be irregular, coming as individual problems crop up. Joining this team does not involve face-to-face meetings but, typically, exchanges via email and Zoom meetings. So physical location is unimportant.

If you would like to talk this over, please email Jonathan Prus: webteam@historicalmetallurgy.org

HMS Crucible: Articles needed!

The Crucible has had a huge diversity of articles over the years covering the many sub-fields of archaeometallurgy, however it is often a challenge for the editors to source new content. If you are able to spare some time to review a book, record an 'Out and About' visit, be interviewed for our One Minute Interview, or produce an article for the Archaeometallurgical News we would love to hear from you. Articles do not have to be long, and should have no more than 5 references. Please email us with your articles or for more information. crucible@historicalmetallurgy.org

Kennet Aviation: Can anyone help?

At Kennet Aviation we are currently restoring to flight a Navy Seafire. This aircraft is the British Navy's version of its famous sister the Spitfire. We currently have 4 projects that are in various stages of restoration.

Kennet Aviation has invested in a CNC machine shop to remanufacture the very many missing, or failed parts. We have many of the original drawings, and have the ability to reverse engineer most items on the airframes.

The biggest area we are having issues with at present is sourcing the steel to machine. Would anyone be able to help us to find an alternative material? We are currently using S154 steel, as a replacement for the long obsolete S1 grade. If you could help us find another alternative that would be great, as at present the supplies of S154 have pretty much run dry.

We would be very grateful of any help and would welcome any correspondence to help us continue work, to get these very historic aircraft back into the sky again, and to be used as an education tool for the many crews and pilots that served with them.

Contact: Kennet Aviation, Home Farm, Old Warden Park, Biggleswade, Bedfordshire, SG18 9DU

Andy Elliott

Special Interest Group – Iron

By the time you receive this edition of ***the Crucible***, the first of the Historical Metallurgy Society Membership engagement initatives will have been launched. The Outreach and Value Committee of the Society has created a platform allowing for discussions, queries and ideas exchange. Initially this is on the topic of iron but others are in the pipeline.

The Special Interest Group – Iron will cover any topic related to the history of the production of iron and its alloys; from slag identification, metallography of iron objects to research on 19th century steel production. Importantly, the forum allows for the sharing of pictures and pdf and Word files.

There are two routes for members with questions on iron-related topics. If the query is specific, it can be sent directly to the admin of the group who will forward it to one or more specialists in the field. These specialists may or may not be subscribed to the forum or even be Members of the Society.

The forum is for questions of a more general nature to be read by a wider audience. It can also be used to post notifications of upcoming events related to the history of iron, to solicite copies of papers from Members or to share new research results. When the forum is launched, all HMS Members will be sent, by email, a link to the portal which includes detailed instructions on how to use it.

While subscribing to the Special Interest Group is limited to Members of the Society only, the plan is to make available the most relevant discussions and resolved queries. The platform for publishing these will be chosen based on the nature and volume of interactions within the Group.

We sincerely hope that the Special Interest Group – Iron will appeal to our Members, assist with their research and bring us all a little closer together!

Paul Rondelez

admin for the Special Interest Group - Iron

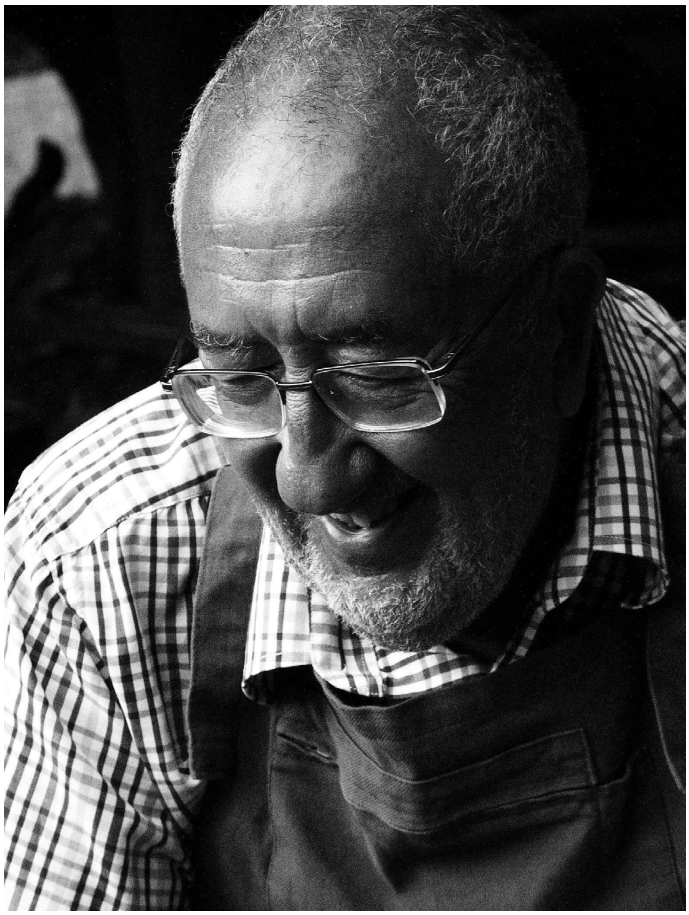
JEAN-MARIE WELTER (1944-2022)

We are sad to share the news that our esteemed colleague, Jean-Marie Welter, passed away on July 3 2022. He had become a well-respected and cherished figure in our community of researchers in the field of ancient and historical metallurgy of non-ferrous metals. Many of us remember a man who was curious about everything, who asked insightful questions at scientific meetings, and who could switch from English to French, German or Italian with great facility. Indeed, he was deeply European at heart, a polyglot and a man open to the world and to other cultures. He was formed as a researcher in materials science, then worked in industry, and came to historical research only later in life.

Jean-Marie Welter was born in Alexandria on January 20, 1944. His father, a Luxembourg officer serving with the Allies, had met his Italian-Egyptian mother there. Jean-Marie then spent most of his childhood in Luxembourg. After his high school diploma, he was admitted to the Ecole Polytechnique in Paris. After receiving his engineering degree, he started a thesis in solid state physics in Munich in 1966, studying the influence of neutron radiation on the magnetoresistance of metals at low temperatures. He received his Ph.D. in 1969 and began his research career at the Crystallography Laboratory of the Jülich Nuclear Research Center (Aachen), where he became director in 1978 after a one-year stay at the IBM Research Center in Yorktown Heights, USA.

In 1985, Jean-Marie began a new career in industry as director of the research centre of Tréfimétaux, a French manufacturer of semi-finished copper products. As a result of mergers and acquisitions, Jean-Marie ended up coordinating the research activities of a group of allied companies around Europe: Tréfimétaux in Serifontaine (F), Europa Metalli Spa in Fornaci di Barga (I) and Kabelmetall AG in Osnabrück (D). In 1998, Jean-Marie became the Research Director of the world's largest manufacturer of semi-finished copper products, now called KM Europa Metal AG (KME). Though he left industry in 2005 for early retirement, he kept his contact to it in numerous ways. He was a member of the International Wrought Copper Council (IWCC). He carried out assignments for the European Copper Institute (ECI), and for the Deutsches Kupferinstitut (DKI). And he was also president of the French Society of Metallurgy and Materials (SF2M) in 2006 and 2007.

Jean-Marie Welter began his third career as a "copper historian" long before he retired from industry. His passion turned into real research when he participated in the restoration of Giambologna's equestrian statue of Cosimo I in Florence in the 1990s. Since then, he has never ceased to be interested in the composition of alloys, in their production and their shaping, and often drew on resources available in the industry for the benefit of historical research. Topics that Jean-Marie focused on include Renaissance statuary, trevira tableware and the Statue of Liberty. He was fascinated by the manufacture of brass by the cementation process, and by the questions related to metal recycling. More recently, he participated in the preparation of two publications (still in press): the history of the Berlin foundry Martin & Piltzing and the Guidelines for the Technical Study of Bronze Sculpture to be published by the Getty, which he collaborated on as member of the CAST:ING (Copper Alloy Sculpture Techniques and history: an International iNterdisciplinary Group) project.



Barsy (Belgium), 2013, during experimental investigation of the brass cementation process

For many of us, Jean-Marie was much more than a colleague; he was, above all, a friend. He was very kind and incredibly generous in sharing his knowledge and enthusiasm with everyone, including the youngest researchers, always available to proofread a paper, a thesis chapter, to answer a very precise question on the behavior of an alloy. Our community will miss Jean-Marie, but we will keep in our minds the sparkling and curious eyes he cast on our world. Our thoughts are with his family, and in particular Magdalena, his wife, and Isabelle, his daughter.

Nicolas Thomas, Jane Bassett and Dorothea Diemer

International Symposium on Archaeometry

My name is Nelly Kladouri and I am a PhD candidate in Archaeometallurgy at the University of the Peloponnese, Greece, having previously studied Conservation Science (BSc) and Archaeological Science (MSc). My PhD research focuses on the study of the copper-based technology of votive offerings from four sanctuaries in Tegea, Arcadia, Greece. As I am currently in my 4th year of research, I feel that I have benefited most from attending the 43rd International Symposium on Archaeometry (16-20 May 2022) in Lisbon.

The study I presented constituted an attempt to assess the technological parameters of archaeometallurgical practises in the wider Tegea area on the basis of an assemblage of bronze finds that are considered unique in terms of context and dating. Specifically, an assemblage of 182 copper-based votive objects of various types, including miniature weapons, secular utensils and jewellery, from the sanctuaries of Athena Alea and Demeter and Kore (Persephone) Karpophoroi at Tegea, Arcadia, Greece, dating from the 9th to 7th centuries BCE, was examined using optical microscopy and elemental characterisation techniques. The aim of the study was to:

a. investigate different technological aspects of alloying and metalworking in the sanctuaries and

b. compare the elemental data obtained with two techniques.

Elemental analyses of the samples were carried out using a portable micro-X-ray fluorescence spectrometer (μ-XRF) in the X-ray fluorescence Laboratory of the Institute of Nuclear and Particle Physics at NCSR"Demokritos" and the external scanning μ-PIXE (micro-Particle Induced X-ray Emission) technique in the facility of the Accélérateur Grand Louvre d' Analyse Élémentaire (AGLAE), C2RMF, Paris.

The combined analysis provided comparable data to critically evaluate the complementarity and applicability of the two techniques in the analysis of copper alloys. Given the relative lack of comparative data, the present systematic analytical study was successful in revealing the continuous use of tin bronze in the sanctuaries of Tegea during the Geometric and Early Archaic periods. With respect to technology, the results from elemental analysis and microscopic examination confirmed that the bronzes from Tegea are cast and/or hammered Cu-Sn binary alloys. In a broader context, this technological study offers insights into the role of sanctuaries in the local community and the agents involved in a complex social, political and economic landscape.

I am, therefore, grateful to have been able to present this study in Lisbon, having received financial support from the HMS. Presenting my work at the conference gave me valuable experience to continue my research, both because of the process I underwent in order to successfully deliver this study and due to the valuable input I received. Moreover, by interacting with the conference participants and engaging with their work, I was able to broaden my perspective on contemporary research in the field of archaeological sciences.

Nelly Kladouri

The International Symposium on Archaeometry is a unique forum to present and listen to the latest research on the application of natural science in the study of cultural heritage. It is also a networking opportunity for those who specialise in archaeometry and archaeometallurgy.

After the pandemic, there were some congresses, including ISA 2020 that were canceled or postponed. However, finally in May 2022 ISA was celebrated. The 5-day symposium, hosted by the Instituto Superior Tecnico at Lisbon, included 350 works from keynote speakers, plenary talks and poster presentations from an international gathering of scientists in the field of archaeometry from all over the world.

ISA 2020 was organised in a dual-mode, online and in-person. Both modalities allowed participants to interact with researchers. The online platform allowed me to ask questions and promoted discussions and interactions with colleagues and students.

Through the grant given by the Historical Metallurgy Society, I had the opportunity to present advances of my thesis research in a poster presentation named “Metal sheathing and fastenings for wooden ships: An Archeometallurgical study of Carron, Ancla Macuca, RMS Forth, and El Pesquero sites located in the Gulf of Mexico (late-18th to mid-19th Centuries)” which was accompanied by a five-minute video. I participated in the poster Martin Aitken Award, a contest for students that encourage clarity of content, quality of research, and best use of the poster format. I also could listen to oral presentations, the most relevant for my research was the symposium on metals and alloys’ provenance and characterization.

Participants in the congress, are given the opportunity to publish the proceeding in an open-access journal by Taylor & Francis by Science and Technology of Archaeological Research (STAR).

I would like to express my sincere gratitude to the Historical Metallurgy Society for the grant to participate in the 43rd International Symposium on Archaeometry.

Diana E. Arano Recio

HMS VISIT TO KILLARNEY 6-8 MAY 2022

6th May

The visit started with the first arrivals: Vanessa, Vaughan, Sue, Richard, Aoibheann (pronounced Even) and the organiser Paul meeting at Scott's Hotel in Killarney. A wet morning greeted us, so a change of plan was in order. Hence the first visit was to the fascinating Muckross blast furnace. In 2013 the Muckross 18th century blast furnace was considered the best preserved in Co. Kerry. This furnace was here because of the abundant supply of oak (for charcoal), locally. The ironworks at Muckross likely used about 'one sixth part of English red mine (haematite) to one of the native ore, which renders it less brittle and more malleable than the Irish (bog iron) ore would be if it was used alone.' The iron ore was imported from Lancashire and the iron exported via the nearby Lough Leane. The industry possibly started around 1725, but the operation was short-lived as around 1750 the pyrolysis process was developing in England which allowed coal to be converted into coke and used instead of charcoal. As charcoal sources were exhausted the industry declined and the last charcoal furnace in Ireland closed around 1780.

Figure 2: Copper mine on the Muckross Peninsula

Killarney National Park is divided into a mountainous area of Devonian Old Red Sandstone to the south and west with Carboniferous rocks (limestone) in the north and east with Lough Leane and Muckross Lake marking the boundary between.

Walking on past Dinis Cottage, the next visit was to the Muckross limestone peninsula between the two lakes, where we were joined and guided by Ed Lyne. We walked along the ridge peninsula from Dinis cottage towards Muckross house. The weather improved and we were soon able to shed our waterproofs. Disregarding the 'keep on the path' signs Ed guided us to several 18th century copper mines; one an apparently bottomless deep hole with a scrap of wire fencing hidden in the undergrowth.

Figure 3: Copper mine on the Muckross Peninsula

After a long scramble we were rewarded with a view of a mine which we were able to explore to several metres underground. There was a narrow open trench into the hillside and the tunnel had side shafts following the seam of ore (Figs 2-3).

The main ore was chalcopyrites (CuFeS2) and remains could be seen within the mines and on the adjacent spoil heaps. The mines were only metres from the beach which would have facilitated removal of ore. The ore was exported rather than processed locally. There are beautiful views over the lakes from this area.

Irish mines were an important source of copper during the Final Neolithic/Early Bronze Age (c.2400-1500 B.C.). It has been established that primitive copper mines were worked in SW Ireland in the period c.2400-1500 B.C, predominantly between about 1700-1500 B.C. These mines were located both in mineralized quartz veins and sedimentary copper beds, where workings rarely exceeded 10m in depth. The ore was probably smelted nearby; the copper production making Ireland an important producer of bronze axes and other utilitarian products for Europe. The subsequent decline was probably due to the exhaustion of accessible mineralization.

Returning to the tarmac track, Ed and Paul led us on to another beach. Here there was ample evidence of processing, the removal of excess waste material from the pieces of ore, and of the quality of the copper ore, as well as the range of minerals present. The beach was littered with small pieces obviously not worth the effort of handling when there was plenty of good ore.

Figure 5: Furnace or Folly? Muckross Ridge

Irish metal working was small-scale and localised, dependent on geological outcrops and woodland. It relied on high quality ores that could be manually dressed as evidenced by the debris on the beaches (Fig. 4).

Moving on we then visited a building marked on maps as a "furnace" but there are doubts about this as, among other things, it was out of scale with the small copper mines nearby. It may have been a folly but this also seems unlikely as the walls were over 1m thick. There are a number of chimney flues and too many openings, however there was slag to be found outside one wall. A more likely suggestion is that it had been a workshop. A proper study is required (Fig. 5).

After the 'furnace' we again left the tarmac path for the woods and a bog before reaching the beautiful lake shore via a challenging scramble. Paul showed us evidence of likely prehistoric or early medieval copper smelting with distinctive samples of thin copper slag with flow structure (plattenschlacken) and more lovely views over the lake. We arrived back at Muckross house about 6 pm very tired but uplifted after a wonderful day (Figs 6-7).

Figure 4: Processing waste

Figure 6: Evidence for site of early copper smelting

Figure 7: Site of early copper smelting

7th May.

We were joined today by Jeremy, Jonathan and Theo and spent the day touring the scenic Iveragh peninsula by minibus. We passed through Killorglin which hosts the famous Puck's fair in August where a wild goat is brought into the town and crowned King Puck. Various legends 'explain' the origins of the fair: a pre-Christian fertility rite since Puck (as the Greek Pan) is the pagan god of fertility, or that a he-goat warned the townspeople of the impending arrival of Oliver Cromwell's troops. There is a lovely King Puck statue and the town celebrates for three days with extended drinking hours (Fig. 8).

Figure 8: Lough Caragh

We continued to the beautiful Lough Caragh to admire the view before driving on to our next stop at the Blackstone blast furnace built in 1701. This furnace used local charcoal and some local iron ore but also iron ore imported from Lancashire. The walls are still standing and there are even large pieces of cast iron left there. There were many examples of slag and cinder littering the ground below the furnace. The heavy consumption of the local wood supply meant that operation was only for a few decades. Remains of a loading pier could be seen at the river nearby. In the (20th century) woods around the furnace are the remains of what may have been a village housing the supporting craftsmen and families necessary to maintain a small-scale industry. This would have been typical of the 18th century mining industry in Ireland (Figs 9-13).

A short drive took us to a picnic lunch (thanks Ewelina) at the renowned Climbers Inn, Glencar. Afterward, we drove over the rugged Ballaghbeama Gap and stopped shortly beyond where Aoibheann gave us a guided tour of a standing stone and some very interesting examples of prehistoric rock art which had only recently been uncovered. The cup marks with concentric rings and rosettes were clearly visible. This area is rich in prehistoric work which is becoming exposed due to changing forms of land management (Figs 14-15).

Figure 9: Blackstone Blast Furnace

We had a very scenic journey back to the hotel in time for really interesting lectures spanning the ages:

Dr Linda Boutoille (Queen's University Belfast): The coppersmith and the caster: techniques and tools used by the first metalworkers in prehistoric Ireland

Dr Brendan O'Neill (University College Dublin): Moynagh Lough Crannog and Making: detailing early medieval non-ferrous metalworking

Dr Griffin Murray (University College Cork): St Manchan's shrine: the manufacturing techniques of an early 12th century Irish reliquary

Dr Paul Rondelez (Independent researcher): The blast furnace iron industry in Co. Kerry (17th and 18th centuries).

These were followed by the conference dinner.

Figures 10, 11 , 12, 13: Blackstone Blast Furnace, slag and an abandoned casting

From the castle we made a walking tour of Ross Island visiting many of the historic mining and associated sites. Copper has been mined there from prehistoric and medieval times and in the 18th to 20th centuries. We followed a mining trail showing clear evidence of all periods although most of the structures were removed during the 19th century to beautify the area in keeping with its new status as a country estate. Paul and Theo gave great insights into the mine workings.

8th May.

It was our last day and the weather was kind again. We were treated to a very enjoyable jaunting car ride from Killarney out to Ross Castle. Mike the guide explained the history of the area with Tyson the horse providing the pulling power (Figs 16-17).

The Herbert Estate at Muckross through which we jaunted had accommodated small estate-based smelters until the 1760s when the iron works closed due to the exhaustion of the estate's supply of useful wood. The deforestation remained until the 19th century when tourism and Queen Victoria's influence resulted in the gentrification of country estates. The estate was sold to the Guinness family in 1899 and in 1910 to William Bowers Bourn as a wedding present for his daughter Maud. By 1932 Maud had died and her husband gifted the estate to the fledgling Irish Free State (present day Republic of Ireland) as being too expensive for an individual family to maintain. It now forms part of the Killarney National Park.

Figure 14: Standing Stone on the Iveragh Peninsula

The Ross Island copper ores, principally chalcopyrite, have a characteristic arsenical composition (tennanite) and most of the earliest surviving copper artefacts in Ireland can be traced back to this source. The Bronze Age mines were in use from about 2400 BC to 1900 BC. They were worked by fire setting: building a wood-fuelled fire against a rock face showing traces of copper mineral and using stone hammers to pound the heat-fractured rock. High temperatures would have caused cracking and wooden wedges beaten into the cracks would have freed chunks of ore-bearing rock. The rock fragments were sorted manually outside the mine and then the copper ore was further sorted nearby. Smelting would also have taken place in nearby furnaces and the resulting metal distributed around Killarney and further afield (Fig. 18).

Figure 15: Rock Art on the Iveragh Peninsula

We were very fortunate to discover on the beach the remains of a stone age hammer head with a distinctive band where it was tied on with a rope. Until the 20th century, the Bronze Age mine was assumed to be only a few hundred years old based on the evidence of musket balls and 17th century artefacts found in the vicinity. We left the head in place for others to enjoy (Figs 19-20).

Figures 16 and 17: Ross Castle and the view from the jaunting car.

The Industrial Revolution created demand for ore, so the Ross Island sites were reopened. Pumps, explosives and iron tools were now available and used to sink shafts up to 15m deep. The woods are riddled with shafts, most of which have been loosely fenced but visitors are recommended to stay on the path (Fig. 21).

Theo treated us to a more thorough understanding of the 19th century mining techniques than was available on the trail plaques, explaining how 2 or 3 men drilled holes by hand, packed them with gunpowder and a long fuse to blast away the rock. The ore was collected, crushed, sorted manually, washed and sent to Wales for smelting. The mine entrances were barely above the lake level and flooding presented a serious problem. That and the remodelling of the estate to cater for increase in tourism led to the closure of the mines.

Figure 18: Bronze Age mine

The beautiful Blue Hole is a large, water-filled open mine. The ores worked in the Blue Hole were chalcopyrite, galena, pyrite and sphalerite.

We returned to the castle for a picnic lunch before most people left, whilst those who had not seen the Muckross blast furnace on the first day were able to do so and the site of Derrycunnihy furnace, further up the valley, was thrown in for good measure.

It was a very rewarding and educational three-days of activities in a beautiful setting.

Vaughan Thompson

Figure 19: Theo Describing a Ross Island Copper Mine

Figures 20-22: Stone Age Hammer Head on Ross Island (top left), A fenced shaft (top right), The Blue Hole (below)

LEAVING THEIR MARK: VISUAL TRACES METALS LEAVE BEHIND ON BONE

The study of human remains, burial context and the presence/absence of grave goods provide archaeologists with a unique insight into the treatment and remembrance of the dead, burial rituals, and social status of the individual. People were often buried with personal items containing metal, such as brooches, pins, belts, bracelets, pendants, weaponry and/or armour. Grave goods containing the metals copper and iron are often found in abundance and are both metals known to stain bones (Bradfield 2018, 500-509). Different metals leave different coloured stains and being able to distinguish between them helps determine the positioning of the metal object at the time of burial; even if it has been removed from the grave, or has naturally deteriorated over time (Cheney 2021).

But how do they leave visual traces on bones? Metals corrode when exposed to air and/or water, causing them to oxidise. This chemical reaction causes traces of their presence to be left on the items they interact with, both on a molecular level and/or visually in the form of discolouration/staining. For instance, as copper corrodes it creates a thin protective green/green-blue layer around the metallic core, this is done to protect the object from further damage (Goffer 2007, 153-208; Morris 1981, 36-42). It is this green/green-blue layer which leaves the same colour staining on the bones and becomes more pronounced over time. Iron on the other hand creates a brownish-red rust colour layer, whilst aluminium leaves traces of a white stain (Borrini et al. 2012, 217-219; Cheney 2021).

Metal staining can be found in a variety of different locations on the bone, which can provide insight into what type of object was buried with the individual. This is particularly useful if the item is no longer present, either because it has not survived, or the grave goods have been separated from the skeletal remains. For example, human remains with copper staining on the radius and ulna (lower arm bones) might have been buried with a copper bracelet (Fig. 1). The Ford Warrior, a skeleton on display in the Salisbury Museum, has heavy staining on the bones in the region of the knee (Fig. 2). This is because the individual was buried with a copper bowl between their legs. If you were to visit the museum you would also notice that a bone comb that was also touching the bowl has the same green stain.

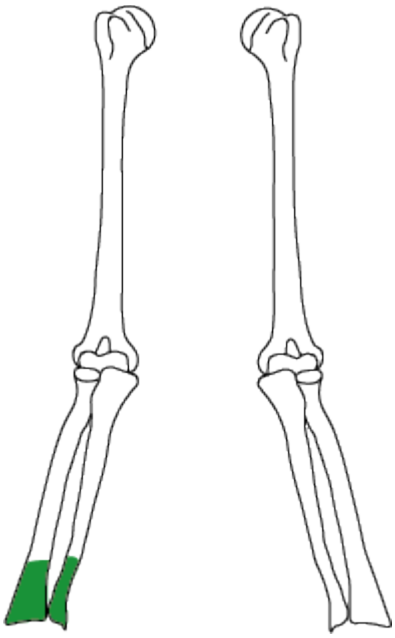


Figure 1: Example of copper staining in the wrist area of the right arm (Image Source: Author)

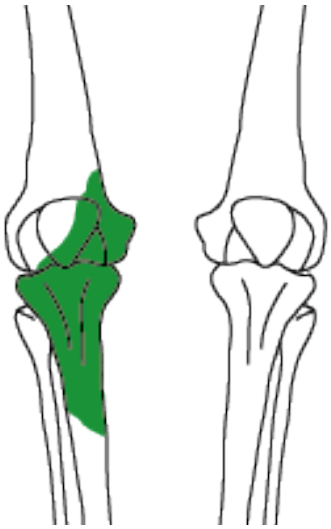


Figure 2: Example of copper staining on the knee region of the right leg (Image Source: Author)

In summary, metals leave visual traces on bone and other objects they come into contact with which can be used by archaeologists to reconstruct the burial context. Metal staining also provides evidence of the type of grave goods that were also buried within the grave.

Hayley Jayne Hayes

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EXPLORING THE RELATIONSHIPS OF EARLY BRONZE AGE SWORD AND DAGGER BLADES: A MULTI-PARAMETER APPROACH APPLIED ON LARGE SCALE FOR THE FIRST TIME

Figure 1: Two sword/dagger blades of the Sögel type from Baven, Germany (top), and the Wohlde type from Grethem, Germany (bottom) (photos: B. Cornelis).

The Nordic Bronze Age (NBA) is known for its wealth in material culture, which saw the ready adoption of metal and bronze in particular. During the first phase of the NBA – Period I according to Oskar Montelius – the territories of northern Germany, Denmark, southern Sweden and southern Norway developed from Neolithic societies using stone and flint tools to prosperous and transregional-acting societies using weapons, tools and jewellery made of bronze. This is all the more noteworthy because Northern Europe's rare copper deposits were not used during NBA and the region is devoid of tin sources.

People were therefore dependent on an external supply to meet their demand in metals. This dependency necessitates well-established trade networks across Europe that are becoming increasingly better understood through large-scale scientific programs, e.g. on metal artefacts (e.g. Ling et al. 2019; Nørgaard et al. 2021). However, it is still not known exactly how the materials, and in particular certain types of artefacts, found their way into the material culture of the NBA. One example is sword and dagger blades (originally with organic handles) of the so-called Sögel and Wohlde types (Fig. 1). They are widespread in the NBA towards the end of Period I (1600–1500) and are considered attributes of cultural elites (Fig. 2). They are frequently recovered as finds from graves (burial mounds), single finds and occasionally from hoards. Since these blades suddenly appear as sophisticated metal artefacts after a period without using metals, it is often questioned whether the objects were manufactured in the region of the NBA itself or whether they were imports from other areas in Europe. In fact, typologically similar sword and dagger blades are known from southern Germany, Switzerland, Austria, the Czech Republic, Hungary. The most prominent representatives come from the hoards from Apa (Romania) and Hajdúsámson (Hungary) or from the Nebra hoard (Germany) with its Sky Disk.

The question of the origin of the artefacts and their potential adoption in the north can hardly be answered with archaeological methods alone, which is not least reflected in the long-lasting and still ongoing discussion since their first description in the 1920s and 30s by Ernst Sprockhoff and Hans Piesker (Sprockhoff 1927; Piesker 1937). Modern, interdisciplinary approaches can help to better understand the history and development of the Sögel and Wohlde blades and the material culture as a whole. In a new interdisciplinary project at the Curt-Engelhorn-Zentrum Archäometrie Mannheim (CEZA), Germany, funded by the German Research Foundation (DFG) until 2025, we are addressing exactly this question by applying a recently developed multi-parameter approach that includes various isotopic systems and trace elements. This approach is based on the hypothesis that metal sources and bronzes were mixed and likely recycled already in the Early Bronze Age, for which there is increasing evidence (e.g. Nørgaard et al. 2021;

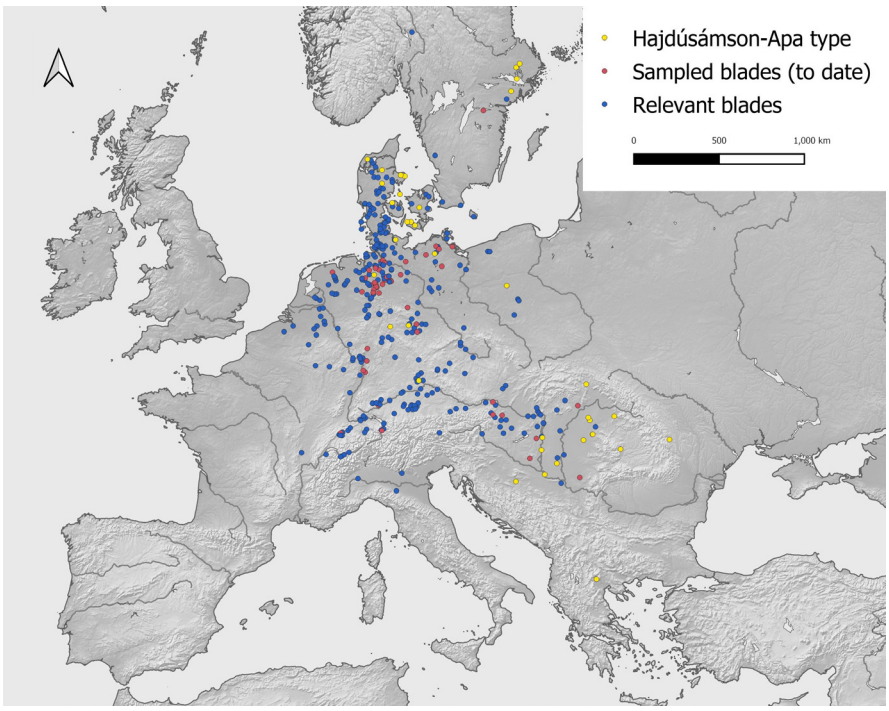

Figure 2: Distribution map of Sögel/Wohlde blades and swords of the type Apa-Hajdúsámson. Red dots are objects already sampled for the project (map: B. Cornelis).

In the new project, this approach is adopted for the archaeologically well-studied and characterised artefact groups of the Sögel and Wohlde blades. A total of 300 objects from the NBA will be analysed chemically and isotopically (lead, tin, copper) and the results compared with data of counterparts or potential prototypes from Central and South-Eastern Europe. Together with the study of tool marks and the archaeological context, this will result in a holistic concept providing new insights into the "Origin, development and technology of the Bronze Age Sögel-Wohlde blades" and their relationship to comparable blades in other regions. Moreover, the project will shed new light on the organisation of workshops, metallurgical practices, origin of metals, trade networks as well as the economy in the early NBA.

Daniel Berger, Bart Cornelis, Andreas Wittke

Berger et al. 2022). Theoretically, mixtures of two metals or ore batches are discernible from their isotopic and chemical data if so-called mixing lines (either linear or hyperbolic) occur (Fig. 3a), and it might even be possible to identify more-component mixtures if mathematic mixing models are applied. Ultimately, such mixing lines can help to better relate artefacts from the same sites, but also artefacts found far apart. For example, a recent study on the swords from Apa, Hajdúsámson, Nebra and from Denmark using lead, tin and copper isotope and trace elemental analysis shows that there were (indirect) relationships between the objects from the different locations, most likely owing to the procurement of bronzes from common suppliers (Berger et al. 2022). Furthermore, it turned out that typologically different objects from individual hoards are closely related to each other, in that they were once produced in the same workshops within a short period of time. This can be concluded from correlations across isotope systems and between isotope ratios and trace elements (Fig. 3b).

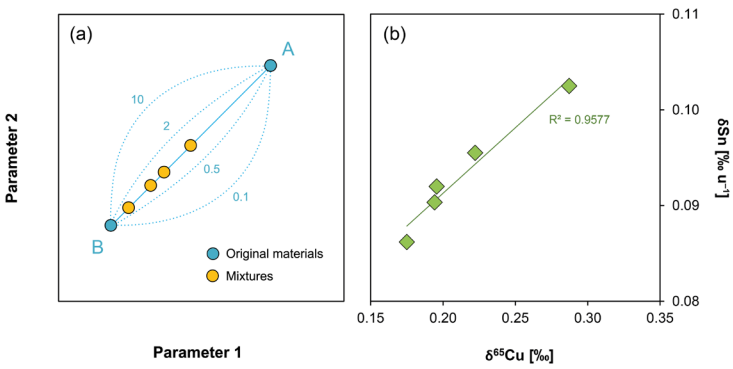

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Figure 3: (left) Theoretical mixing lines of two materials A and B (a) and practical example of a mixing line (b) established on the basis of copper and tin isotope values of the bronze artefacts from the Apa hoard. Curved lines as shown in (a) develop depending on the element ratios in the original materials when different isotope systems are combined (diagrams: D. Berger, G. Brügmann).

EMBOSSED STEEL CEILING TILES: A RARE SURVIVAL?

In a recent visit to Lewes in East Sussex, I came across a rather mouse nibbled cardboard box in one of the towns many antique shops. Experience has taught me that the most unassuming of boxes often turn out to hold exciting discoveries and while at first glance the box appeared to be filled with rusting and paint flaked sheets of metal, on closer inspection they turned out to be the remains of elaborately decorated embossed steel tiles (Fig. 1). These tiles were once the components of a 'steel ceiling'. Steel ceilings are likely to be familiar to our American colleagues who may have come across examples in houses and public buildings of the late 19th and early 20th century found across America. However, here in the UK such ceilings rarely survive and have gone relatively unrecognised in the country's architectural history.

Nineteenth century innovations led to an increased use of iron and steel in architecture and the tin tabernacles described in issue 109 of the Crucible are a famous example of its use. Corrugated iron panels (not tin) allowed buildings such as churches, chapels, meeting halls and barns to be constructed quickly and at reduced cost. It is within this context that embossed steel ceilings (sometimes referred to as 'tin ceilings') came into existence. These were ceilings that were constructed from individual pressed steel panels that were interlocked and pinned to wooden furring strips attached to the ceiling (Dierickx 1975, 85). These ceilings could be painted a flat white to imitate the appearance of plaster and yet had the advantage of being cheaper and easier to produce and install than their plaster counterpart (Dierickx 1975, 83; Simpson 1995, 152-159; Morgan 2001, 7-8).

Figure 1: Box containing curious sheets of steel.

Figure 2: An example of an unpainted steel ceiling tile. Pin holes are present to the edges from where it was fixed to wooden furring strips on the ceiling.

The tiles found in Lewes are 30x30cm and include four different designs of both Gothic and Art Nouveau motifs and presumably came from more than one room (Fig. 2). I purchased four tiles and as two of these had suffered considerable paint loss it was possible to restore these to their original base metal and reveal the detail masked under successive layers of paint (Fig. 3). The third tile was restored to its original painted finish to demonstrate how it appeared when new, while the fourth example was left in its original state, showing the wear and tear of the last hundred years (Figs 4-5). Examination showed the tiles had been painted in various shades of white and magnolia during their lives, which no doubt was an attempt to replicate the more expensive plasterwork. Dierickx (1975, 87) explains that ceiling tiles arrived pre-painted before being fixed to the ceilings and this was evidently the case in the Lewes examples, which had traces of paint in the interlocking margins used to fit the tiles together. Pin holes from where the tiles had been attached to wooden furring strips were also present within the interlocking margins, however other nail holes were haphazardly arranged on the embossed design, which may suggest these tiles were at one stage boarded over by a later ceiling, presumably when the they had fallen out of fashion.

Dierickx (1975) and Simpson (1995) have studied the use of embossed ceiling tiles in America, where these ceilings were particularly popular between 1895 and 1915 (Dierickx 1975). Unlike the UK, thousands of embossed ceilings survive and can be seen in both private and public buildings and were manufactured by companies based in Ohio, New York, and Pennsylvania (Dierickx 1975, 83; Simpson 1995, 152-155). Styles included Greek, Gothic, French, Renaissance, Rococo and Colonial and prospective clients could select ceiling designs from company catalogues or from samples provided by visiting salesman (Dierickx 1975, 83; Simpson 1995, 152-156). Morgan (2001, 7-8) suggests embossed ceiling tiles were also used on passenger ships, their period of use coinciding with a boom in transatlantic travel where public spaces such as the saloons and restaurants were often highly ornate, emulating the interiors of luxury hotels.

Despite their widespread use in America, steel ceilings appear to have been less popular in the UK with only a handful of examples recorded. Keith Morgan, the former curator of the Trostre Works Cottage & Industrial Museum in South Wales published his research on the use of embossed metal moundings in Britain in HMS News 49. In his article he identified examples at the Swansea Industrial and Maritime Museum and at the Curzon Cinema, Clevedon along with ceilings in a row of houses in London dating from the 1920s (Morgan 2001, 7-8). I was told that the tiles found in Lewes originally came from a shop in the town centre. One must question why such ceilings are so rare in the UK and yet so popular in America? It may simply be that many remain unrecorded and their architectural significance overlooked. Alternatively, it is possible they lacked the popularity they had in America. Since the current evidence indicates that their use in the UK was predominantly in commercial premises such as shops and cinemas, a more likely conclusion is that they haven't survived and subsequent phases of shop refitting as fashions changed has meant many were removed long ago. While durability was one of their major selling points, the extremely corroded condition of many of the Lewes tiles shows what can become of those left unmaintained and sourcing tiles to replace those that succumbed to rust was certainly not easily achieved.

The use of embossed steel tiles in the UK is something that warrants a more extensive study to determine how widespread their use was and whether it was restricted to commercial buildings. It would be interesting to identify other surviving examples and in instances where ceilings have remained intact, to emphasise their importance to architectural history and the need for their preservation.

Jack Cranfield

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Figures 3-5 (top to bottom): An unpainted steel ceiling tile, followed by a finished exampled painted to imitate plaster. The final example shows a tile in unrestored condition. Paint in the interlocking margins indicates that the tiles were pre-painted prior to assembly. Nail holes on the unrestored example suggests the ceiling was covered over at a later date.

EUROPE'S EARLIEST IRON BODY-ARMOUR: INVESTIGATING MAIL BY NEUTRONS

Introduction

The body armour of the Roman legionary, the lorica hamata, was based upon Celtic prototypes, (indeed, the Roman author, Varro, listed mail armour as a Celtic invention) but with an important difference (Robinson 1980).

Iron, of a suitable quality, was drawn into wire, formed into links, which were connected together, and then closed. Roman loricae were often made up half of riveted links and half of non-riveted links. These latter may have been made by joining rings by welding, although it has been suggested that they were punched from plate. In any event, there would have been a considerable saving in labour, and so such a method of construction would have been attractive to an army seeking to supply mail shirts in quantity (Sim 1997, 359-371).

The quality of the iron needed for this role is a topic for consideration. The Celtic smiths were well-known for employing a high-phosphorus iron (obtained by smelting bog ores, and more common in Northern Europe) as a substitute for steel. The hardness of such iron might be doubled (Stewart and Charles 2000, 275-303).

While such an iron is hardened by the presence of phosphorus, it may also be embrittled, and one might have expected wire-drawing to be made more difficult, although its successful use in musical wire has been reported (Goodway and Fisher 1988, 21-23).

Much experimental work has been carried out over the years with high-phosphorus iron. It has been found that, under suitable conditions, it is forgeable.

A team led by Dillmann studied a group of 27 phosphoric iron artefacts, from the Gallo-Roman period to the late 19th century, and from their experiments, it seems that forging of iron with a phosphorus content of over 0.5%, is not difficult, but if it is between 0.1 and 0.5%, and the forging temperature is over 900°C, then austenite and ferrite can cohabitate leading to forging difficulties due to the different mechanical behaviour of the two phases,

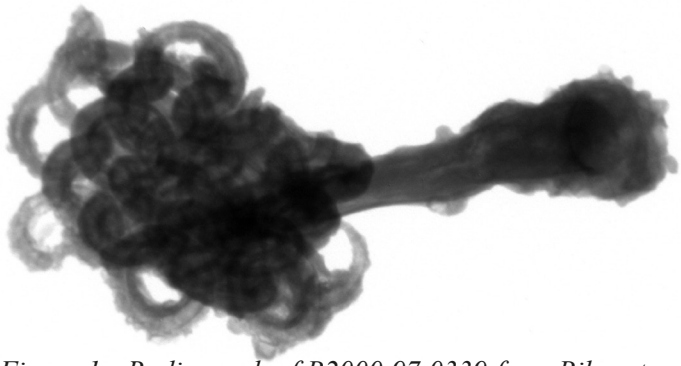
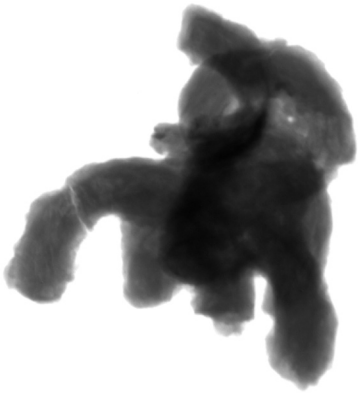


Figure 1: Radiograph of B2000 97 0339 from Bibracte. (overall length of fragment = 36 mm)



so it would be important to forge at temperatures under 900°C. Nevertheless, other parameters such as the presence of slag inclusions can also influence forging behaviour.

Figure 2: (left) Radiograph of B2001 32 1775 from Bibracte. (overall length of fragment =20mm)

Experimental methods

In order to attempt to determine the use of a high-phosphorus iron (or its avoidance) and establish the method of closure of the links, a quantity of Celtic mail was recently examined at the Budapest Neutron Centre, where numerous other examples of arms and armour have been studied by some of these authors recently.

The Natural History Museum, Vienna, supplied two massive specimens of corroded mail from the Late Iron Age site at Roseldorf (perhaps 2nd century BCE) inventoried 107654 and 100048.

The Bibracte Centre Archéologique Européen supplied three specimens, inventoried B993-17-162-166, B2001-32-177-5, B2000 9- 7033-9, from the Mont-Beuvray archaeological site, Celtic, 1st century BCE. This included both riveted and non-riveted examples, with a circular cross-section. The dimensions are given below.

Simon Metcalf also supplied some unprovenanced 14th century mail for comparative purposes, to help with calibration of the instruments.

These specimens were then examined by three different techniques.

(i) Neutron radiography: The non-riveted links show a discontinuity which suggests that they were welded to close them (Figs 1 & 2).

The examples from Roseldorf were so heavily corroded that radiography proved impossible. The extent of the penetration of the neutron beam for imaging was not the problem, but the interference from hydrogen (in bound water) from corrosion products.

However, they were examined by technique (ii).

(ii) Time-of-Flight Neutron Diffraction: The principal component was ferrite, as well as considerable amounts of corrosion products. The Roseldorf links were made of iron, not high in carbon nor phosphorus.

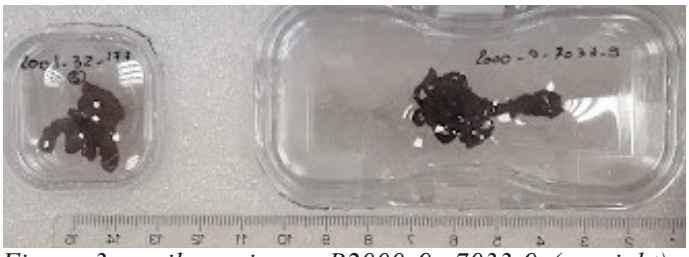


Figure 3: mail specimens B2000 9- 7033-9 (on right) and B2001-32-177-5 (on left) from Bibracte.

(iii) Prompt Gamma Activation Analysis: Phosphorus levels exceeding 0.5% have been reported in Celtic swords, so they would be within the detection levels for this technique.

CG 21 Roseldorf mail from NHM 107654 (P% 0.55)

CG 23 comparative specimen from Medieval mail (P% 0.69)

CG 25 from Bibracte 2001-32-177-5 (P % 0.93)

CG 27 Roseldorf mail from NHM 100048 (P % 0.62)

CG 30 from Bibracte (P % n.d)

CG 32 from Bibracte 2000-7033-9 (P % 0.81)

CG 70 comparative specimen from an experimental "Celtic" currency bar (XP17) (P = 1.16 %) Peter Crew supplied this sample from an experimental curency bar.

We can say that the samples from Bibracte CG25 and CG32 (but not G30) have a somewhat higher phosphorus content (0.93 +/- 0.09 m% and 0.81 +/- 0.12 m% respectively), than the earlier Celtic specimens, which were also high in phosphorus. The earliest mail armour found in Spain has been examined recently, and this seems to have been made from a low-phosphorus iron, but the scarcity of bog iron ores in Spain might well have been the reason for that (Sanz et al 2019, 155-173).

Conclusions

Bearing in mind the limitations of this rather small database, we may conclude that Celtic smiths in Northern Europe were able to identify high-phosphorus iron and then make use of it in the manufacture of mail.

Alan Williams, David Edge, Zsolt Kasztovsky and Simon Metcalf

Acknowledgements

The authors are grateful to Dr. Vincent Guichard, head of Bibracte /Centre archéologique européen, and Dr. Veronika Holzer of the Naturhistorisches Museum, Vienna, for their invaluable co-operation, as well as Peter Crew who supplied samples of high-phosphorus iron for comparison.

Dr. Zoltan Kis carried out the Neutron radiography. Dr. Gyorgi Kali carried out the Neutron diffraction. Dr.Zsolt Kasztovszky carried out the prompt GammaActivation Analysis.

Figure 4: Radiograph of specimen B993-17-162-166 from Bibracte

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Table 1 (below): Elemental composition of chainmail

	CG21 *Iron mail frag.*		**CG23** *Iron mail link with rivet*		**CG25** *chainmail frag. corroded*		**CG27** *Iron chainmail frag. corroded*		**CG30** *two chains of a mail*		**CG32** *small chainmail frag.*		**CH70** *iron bar*	
El	**m% el/el**	***unc %***	**m% el/el**	***unc %***	**m% el/el**	***unc %***	**m% el/el**	***unc %***	**m% el/el**	***unc %***	**m% el/el**	***unc %***	**m% el/el**	***unc %***
P	**0.55**	***36.***	**0.69**	***11.***	**0.93**	***10.***	**0.62**	***22.***			**0.81**	***15.***	**1.16**	***9.***
S							**0.23**	***6.***						
Mn			**0.018**	***3.9***			**0.033**	***5.***	**0.0083**	***6.***	**0.029**	***5.***		
Fe	**99.3**	***0.3***	**98.9**	***0.1***	**98.8**	***0.2***	**98.9**	***0.2***	**99.9**	***0.0***	**99.0**	***0.2***	**98.8**	***0.1***
Co	**0.053**	***2.9***	**0.062**	***2.6***	**0.092**	***3.2***	**0.016**	***6.***	**0.011**	***4.***	**0.090**	***3.4***	**0.015**	***5.***
Ni	**0.081**	***7.***	**0.230**	***4.***	**0.078**	***8.***	**0.056**	***9.***	**0.060**	***8.***	**0.093**	***7.***		
Cu			**0.099**	***12.***	**0.081**	***12.***	**0.17**	***11.***	**0.06**	***25.***				

P/Fe	0.0055		0.0070		0.0094		0.0062		0		0.0082		0.0118	
Co/Fe	0.00053		0.00062		0.00094		0.00016		0.00011		0.00091		0.00015	
Ni/Fe	0.00082		0.00233		0.00079		0.00057		0.00060		0.00094		0	

HMS Research in Progress

24 November 2023

The next Research in Progress Meeting of the Historical Metallurgy Society will take place online on Friday, November 24. Participation is free of charge. It provides a forum for everyone working on topics related to ancient and historical metallurgical practices, the past use of metal objects, and related fields. We are keen to learn more about your ongoing or recently finished projects! The meeting aims to foster links between the different disciplines and geographical regions. Therefore, we particularly encourage submissions from early career researchers, contract archaeologists/conservators, and colleagues from outside Europe. There will be an HMS prize for the best student presentation.

Abstracts (up to 200 words) can be submitted between August 1 and October 1 through https://archaeothommy.github.io/hms-rip-meeting/. Presentations can be either 6 min or 15 min long (with time for questions added).

The programme and any updates will be announced on the meeting's webpage. General enquiries can be directed to Thomas Rose (t.rose@em.uni-frankfurt.de).

Archaeometallurgy in Europe 2024

11-14 June 2024 Falun, Sweden

The International Conference Archaeometallurgy in Europe has been organized every four years since 2003, in Milan (2003), Grado-Aquileia (2007), Bochum (2011), Madrid (2015) and Miskolc (2019). 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 from complex projects in the field of archaeometallurgy.

The 6th International Conference will be held in Falun, Sweden, from the 11th to the 14th of June 2024. It is organized by the Historical Metallurgy Group at Jernkontoret. Jernkontoret is the Swedish Iron and Steel producers' association. The Historical Metallurgy Group involve both archaeological and historical documentation and research as well as cultural heritage conservation relating to the production of metals.The focus is on the development and history of the iron and steel industry and cover all historical epochs in a Nordic scope

https://www.aie2024falun.com/

https://www.jernkontoret.se/en/about-us/councils-and-committees/historical-metallurgy-group/

Buzaglo's Cast Iron Stove

On a recent trip to Knole Park, on the outskirts of Sevenoaks in Kent, I was interested in the rare survival of a Buzaglo Stove on display in the Orangery (Fig. 1). Knole, which today is in the care of the National Trust was formerly an Archbishops Palace and was later passed to the Sackville Family who substatially remodeled the house from the 17th century. In keeping with the latest fashions and innovations of the 18th century, the Sackville's installed the Buzaglo Stove in the Great Hall where it is depicted in an engraving in 1796 (cover image and Fig. 2).

This unusual design of stove was patented in 1765 by its inventor Abraham Buzaglo, who was based in the Strand having emigrated to London from Moroco in 1760. Made from cast iron, the stove consists of three tiers in which coal, peat or wood was burnt in the lowest tier while a vent and chimney removed soot and smoke. Buzaglo's stoves were designed to provide a clean heat source in large public spaces and aristocratic homes and prevent the spread of soot and smoke, which would otherwise damage these lavish interiors. In an advert from the 1770s, Buzaglo's stoves are described as for use in 'Churches, Noblemen's Houses, Asembly-Rooms, Coffee-Houses, Halls, Parlours, Dining Rooms, Bed Chambers, Compting Houses, Public Offices, Large Shops, Hot-Houses, Green Houses, Wine-Vaults &c..' The advert goes on to emphasise their popular use in 'Gentlemens Country-Seats, to keep the damp out, preserve the furniture, & temperate the air to any wished degree' highlighting the issues of heating large country houses at this time.

The advert illustrates six stove designs which include the 'Small Single Tier' the 'Large Double Tier' and the largest 'Treble Tier' which is similar to the example at Knole. Others were pyramid shaped and included the 'Royal Pyramid'. Clearly the diversity of sizes and designs reflected their ability to suit the many settings described by the advert and blend in with their interiors.

Figure 2 - The Buzaglo Stove at Knole dating to 1774. It can be seen how the neoclassical design would have enabled an otherwise functional object to blend in with surrounding architecture.

Figure 1 – Knole Park, dating to the 15th century. The Buzaglo Stove was originally installed within the Great Hall but later moved to the Orangery where it stands today.

What is particularly interesting about the stove at Knole, which dates to 1774, is the combination of function and aesthetic design. Neoclassical motifs have been incorporated into its casting which include ionic collumns acting as its feet, porticos that frame the open vents on the two upper tiers and finally a set of four Grecian urns perched on top. None of these details are strictly necessary to the function of the stove, but enhance its aesthetic qualities and allowed it it blend with the architectural surroundings of the rooms in which such stoves were placed.

Jack Cranfield

Forthcoming events & Virtual content

Conference, date & locations	Description	Website, emails and prices
The World of Iron at 10 The British Institute in Eastern Africa. Nairobi, Kenya 6th-10th November 2023	Ten years on from the publication The World of Iron, this agenda-setting conference will move beyond the first by facilitating targeted discussion sessions to specifically consider the future of global archaeometallurgy, and how, by reflecting on the state of research in 2023, we can begin to link our findings across space and time to maximise our impact.	https://biea.ac.uk/the-world-of-iron-at-10 *Email:* iron@biea.ac.uk
HMS Research in Progress Online conference 24th November 2023	All information can be found on the meeting's webpage: https://archaeothommy.github.io/hms-rip-meeting/ Abstracts (up to 200 words) can be submitted between 1st August and 1st October through https://archaeothommy.github.io/hms-rip-meeting/. Presentations can be either 6 min or 15 min long (with time for questions added). The programme and any updates will be announced on the meeting's webpage.	https://archaeothommy.github.io/hms-rip-meeting/ *Email:* Thomas Rose t.rose@em.uni-frankfurt.de
Archaeometallurgy in Europe 2024 Falun, Sweden 11th -14th June 2024	The 6th International Conference will be held in Falun, Sweden, from the 11th to the 14th of June 2024. It is organized by the Historical Metallurgy Group at Jernkontoret. Jernkontoret is the Swedish Iron and Steel producers' association. The Historical Metallurgy Group involve both archaeological and historical documentation and research as well as cultural heritage conservation relating to the production of metals.The focus is on the development and history of the iron and steel industry and cover all historical epochs in a Nordic scope	https://www.aie2024falun.com/

For the latest conferences and events please see the HMS Website at ***https://historicalmetallurgy.org/hms-events/***