Venue

Leibniz-Zentrum für Archäologie (LEIZA)
Ludwig-Lindenschmit-Forum 1
55116 Mainz
Germany

sponsored by

DFG Deutsche Forschungsgemeinschaft

Freundeskreis des Leibniz-Zentrums für Archäologie (LEIZA) e.V.

Leibniz Gemeinschaft

leiza.de

28TH–30TH OCTOBER 2025

INTERNATIONAL SYMPOSIUM ON THE METALLURGY OF THE EUROPEAN IRON AGE II (SMEIA II)

PROGRAMME
ABSTRACTS

LEIZA

LEIBNIZ-ZENTRUM FÜR ARCHÄOLOGIE

INTERNATIONAL SYMPOSIUM ON THE METALLURGY OF THE EUROPEAN IRON AGE II (SMEIA II)

PROGRAMME
ABSTRACTS

Mainz
28 to 30 October 2025

Edited by
Martin Schönfelder
Roland Schwab

CONTENTS

SCIENTIFIC COMMITTEE ... 3

ORGANISERS ... 3

FOREWORD ... 3

PROGRAMME ... 4

ABSTRACTS ORAL SESSIONS ... 6

ABSTRACTS POSTER CONTRIBUTIONS ... 15

SCIENTIFIC COMMITTEE

Marion Berranger, Laboratoire "Métallurgies et Cultures", UMR 5060 - CNRS - IRAMAT, Université de Technologie Belfort Montbéliard, France

Alžběta Danielisová, Archeologický ústav AV ČR, Oddělení přírodních věd a archeometrie, Praha, Czechia

Aude Mongiatti, British Museum, Department of Scientific Research, London, Great Britain

Ignacio Montero Ruiz, Instituto de Historia-CSIC, Laboratorio de Arqueometría de Materiales, Madrid, Spain

Thilo Rehren, The Cyprus Institute, Science and Technology in Archaeology and Culture Research Center, Nicosia, Cyprus

Thomas Stöllner, Deutsches Bergbaumuseum Bochum, Germany

ORGANISERS

Roland Schwab, Leibniz-Zentrum für Archäologie (LEIZA)
Martin Schönfelder, Leibniz-Zentrum für Archäologie (LEIZA)

Many thanks for their support at LEIZA to:

Julia Berend, Annabella Di Barca, Jörg Drauschke, Doris Kaiser, Vera Kassühlke, Alexander Krings, Claudia Nickel, Christina Nitzsche and Michael Ober

Many thanks also to the student assistants:

Matthias Bemmann (Goethe-Universität, Frankfurt)

FOREWORD

During the 1st millennium BC, European metallurgy underwent several far-reaching innovations compared to the preceding Bronze Age. In addition to the development of iron metallurgy, which naturally also had an impact on the processing technology of other metals, all pre-industrial metals were known and utilised by the end of the European Iron Age. The introduction of the coinage industry in particular is associated with several metallurgical innovations, such as various plating techniques or the refining of gold and silver. In connection with the increasing importance of silver, lead was mined on a large scale, which also led to changes in copper alloys and the development of new joining techniques, such as soft soldering. During the Iron Age, almost all metallurgical techniques were developed that were used in the following epochs.

As the chronological structure of the Iron Age in the different cultural regions of Europe does not correlate everywhere, different archaeological disciplines sometimes deal with the respective materials. The aim of the conference is therefore to promote international and interdisciplinary exchange on the subject of Iron Age metallurgy in its entirety by placing regional metallurgical practices in a temporal and supra-regional context.

The four sections 'Transition Phenomena', 'Interaction between the Mediterranean and the North', 'Innovations in Iron Age metallurgy', and 'Trade and provenance' are designed to be international in content, as they highlight the interaction between the various Iron Age cultures.

The 'Symposium of the Metallurgy of the European Iron Age', organised in 2010, was the first to shed light on various aspects of Iron Age metallurgy in different regions at different time periods, whereby the individual contributions made it clear how incomplete the state of research is. Exactly 15 years have passed since this conference and since then several working groups have been formed in various countries, which are now conducting very intensive research on topics relating to Iron Age metallurgy — in some cases even inspired by contributions from this event. The 2025 conference is intended to offer the speakers an international platform to present their research and at the same time provide an opportunity for an intensive and international exchange. In particular, colleagues from the field of archaeology should also be given the opportunity to make contact with the field of metallurgy by attending the conference. Experience has shown that this provides an incentive to systematically analyse often inconspicuous metallurgical relics. For this reason, the conference programme was deliberately spread throughout the networks of Iron Age archaeology.

Roland Schwab & Martin Schönfelder

PROGRAMME

Tuesday
28TH OCTOBER 2025

18:00
OPENING LECTURE
Barbara Armbruster *(Toulouse)*
Archaeometallurgy and Archaeology of Celtic Gold

(FOLLOWED BY A WINE RECEPTION)

A GUIDED TOUR OF THE LIBRARY is available in advance (17:00; 17:30). Extended opening hours apply during the conference (8:00 to 18:00).

Wednesday
29TH OCTOBER 2025

9:00
WELCOME
Alexandra W. Busch
(general director of LEIZA)

OPENING BY THE ORGANISERS
Martin Schönfelder & Roland Schwab

SECTION TRANSITION PHENOMENA

9:30
Peter Turk & David Heath *(Ljubljana)*
The Early Iron Age hoards of the Bologna, San Francesco-Šempeter type from Central Slovenia: Archaeological and Chemical Investigations

10:00
Xosé-Lois Armada, María G. Faro & Ignacio Montero-Ruiz *(Madrid)*
Alloying Recipes and Social Dynamics in Atlantic Iberia during the Late Bronze Age — Iron Age transition: Palstave Hoards as Case Study

10:30
COFFEE BREAK

11:00
Sofia Serrano & Elin Figueiredo *(Lisbon/Caparica)*
Western Iberian Goldsmithing: A View from Late Bronze Age to Iron Age

11:30
Mathias Mehofer *(Wien)*, **Georg Tiefengraber** *(Wien)* **& Ernst Pernicka** *(Mannheim)*
Archaeometallurgical analyses on copper-based metals from the famous cemetery of Hallstatt, Austria — mixing and alloying practices during the Late Bronze and Early Iron Age in Central Europe

12:00
Justine Bayley *(London)* **& Thilo Rehren** *(Nicosia)*
Parting Precious Metals:
The Emergence of a Novel Process soon after the Roman Conquest of Britain

12:30
LUNCH

SECTION INTERACTION BETWEEN THE MEDITERRANEAN AND THE NORTH

13:30
Giacomo Bardelli *(Napoli)*, **Vincenzo Baldoni** *(Bologna)*, **Roland Schwab** *(Mainz)*, **Fabio Milazzo** *(Ancona)*, **Stefano Finocchi** *(Ancona)*
First Archaeometric Analyses of Copper Alloy Objects from the Iron Age Necropolis of Numana (Ancona, Italy)

Veronica Cicolani *(Paris)*, **Sibylle Manya** *(Paris)*, **Chiara Lucarelli** *(Padua)*, **Benoît Mille** *(Paris)*, **Jessica Legendre** *(Paris)*, **Gilberto Artioli** *(Padua)*, **Ivana Angelini** *(Padua)* **& Caterina Canovaro** *(Padua)*
"Re-tracing" Ancient Metallurgy in Northern Italy during the Early Iron Age. Elemental and Isotopic Analysis of Golasecca-type Ornaments

14:30
COFFEE BREAK

15:00
GUIDED TOURS THROUGH THE LEIZA INFRASTRUCTURE

17:00
APÉRO-POSTER

V. Baratella *(Ljubljana)*, **S. Dilaria** *(Padua)*, **I. Angelini** *(Padua)* **& M. Vidale** *(Padua)*
Preliminary in-depth Investigations of Metallurgical Production Indicators from the Early Iron Age Protourban Site of "Questura" in Padua (Italy)

L. Belhade *(Belfort)*, **M. Berranger** *(Belfort)* **& E. Dubreucq** *(Toulouse)*
Characterising Iron Metallurgy at Bragny-sur-Saône Based on an Interdisciplinary Study of Slag and Metal Waste: the Bragny II Sector (second half of the 5th century — beginning of the 4th century BC)

A. Giumlia-Mair *(Merano)*, **B. Grassi** *(Milano)*, **A. Gasparetto** *(Milano)* **& L. I. Mordeglia** *(Novara)*
Facsimiles of Fibulae from Monte San Zeno, Como, Italy

L. Gruškovnjak, P. Vojaković, J. Burja, B. Šetina Batič, A. Prijatelj, H. Grčman & M. Črešnar *(Ljubljana)*
An Early Iron Age smithy revealed by micro-artefact analysis at Pungrt Hillfort, Slovenia

R. De Pablo Martínez *(Berlanga de Duero)*, **M. Gener-Moret** *(Madrid)*, **S. De Luis Mariño** *(Madrid)*, **B. Culubret Worms** *(Madrid)* **& M. Arroyo** *(Madrid)*
Biographies of a Monte Bernorio-Type dagger. From Mine to Museum

T. Rose, K. J. Westner, M. Kottmann, T. Greifelt, A. Hornschuch, Y.-K. Hsu, H. Wiethoff & S. Klein *(Bochum)*
The TerraLID Metadata Profile: Towards a Uniform Description of Lead Isotope (Meta)Data

J. Schmidt *(Frankfurt/Main)*
Iron Age Bronze Craftsmanship at the Ohrenberg near Kirchheim am Ries (Ostalbkreis): Between Production and Import

PROGRAMME

Thursday

30TH OCTOBER 2025

SECTION **INNOVATIONS IN IRON AGE METALLURGY**

9:00

Demetrios Ioannides & Andreas Charalambous *(Nicosia)*
Reviving Copper Production:
New Insights into Iron Age Metallurgy at Asgata-Kalavasos, Cyprus

9.30

Jean Rodier *(Fribourg)*
From Hammerscale to Ore:
Towards a Paradigm Shift in Iron Production during the Early Iron Age

10:00

Paolo Piccardo, Roberto Spotorno, Camilla Criaco, Flavia Boragina, Jessica Catanzaro & Matilde Pedemonte *(Genoa)*
The Colour of Bronze:
Messages from the Metal Ages

10:30

COFFEE BREAK

11:00

Anna-Lena Jerg *(Tübingen)* **& Roland Schwab** *(Mainz/Tübingen)*
The Crucibles from Groß-Rohrheim and their Importance of Early La Tène Metalworking for the Region of South Hesse, Germany

11:30

Marc Gener-Moret *(Madrid)* **& Marcos Martinón-Torres** *(Cambridge)*, **Jaime Vives-Ferrándiz Sánchez** *(València)*, **Fernando Quesada Sanz** *(Madrid)* **& David Jimeno Jiménez** *(Barcelona)*
The Technology of Iron and Steel in Pre-Roman Iberian Peninsula

12:00

Michal Kotýnek *(Praha)*
Same or Different? A Comparative Study of La Tène Iron Artefacts from Hoards and Settlements using Osmium Isotopes and Slag Inclusions Composition Analyses

12:30

LUNCH

SECTION **TRADE AND PROVENANCE**

13:30

Peter Trebsche *(Innsbruck)*, **Marion Berranger** *(Belfort)* **& Léna Belhade** *(Belfort)*
A new Mass Find of Iron Age Bipyramidal Ingots from the Danube in Upper Austria

14:00

Ivan Stepanov *(Mannheim)*, **Michael Brauns** *(Mannheim)*, **Johannes Wintel** *(Mannheim)*, **Ronny Friedrich** *(Mannheim)*, **Markus Marquart** *(Aschaffenburg)* **& Ulrich Himmelmann** *(Speyer)*
Archaeometric Analyses of Celtic Bipyramidal Iron Ingots: Provenance, Production Technology, and Age Determination — A Case Study of the Speyer Depot (Southern Germany)

14:30

Marion Berranger *(Belfort)*, **Marc Leroy** *(Belfort)*, **Enrique Vega** *(Gif-sur-Yvette)*, **Maxime L'Héritier** *(Paris)*, **Philippe Dillmann** *(Paris)*
Iron Production and Circulation in north-eastern France and its Margins during the Iron Ages

15:00

COFFEE BREAK

15:30

Alžběta Danielisová *(Praha)*, **Daniel Bursák** *(Praha)*, **Samuel Kertes** *(Praha)*, **Ivan Čižmář (Brno)**, **Hana Čižmářová** *(Brno)*, **Jana Čižmářová** *(Brno)*, **Tomáš Mangel** *(Hradec Králové)*, **Ladislav Strnad** *(Praha)* **& Jakub Trubač** *(Praha)*
Iron Age Communities in the Contact Zone — Technological Advances in the 3rd Century BC along the Amber Road

16:00

Raimon Graells i Fabregat *(Alicante)* **& Ignacio Montero-Ruiz** *(Madrid)*
Etruscan type Olpai and Situlae in elemental and Pb Isotope Analytical Perspective

16:30

Katrin J. Westner *(Bochum/Lyon)*, **Janne Blichert-Toft** *(Lyon)*, **Liesel Gentelli** *(Lyon)*, **Eftimija Pavlovska** *(Skopje)*, **François de Callataÿ** *(Bruxelles/Paris)* **& Francis Albarède** *(Lyon)*
Tracing Metallurgical Links and Silver Provenance in Balkan Coinage (5th-1st centuries BCE)

17:00

CONCLUDING REMARKS BY THE CHAIRS AND THE ORGANISERS

Organisers

Roland Schwab *(LEIZA)*, roland.schwab@leiza.de
Martin Schönfelder *(LEIZA)*, martin.schoenfelder@leiza.de

Scientific Committee

Marion Berranger *(Laboratoire "Métallurgies et Cultures", UMR 5060 – CNRS – IRAMAT, Université de Technologie Belfort Montbéliard, France)*, marion.berranger@utbm.fr

Alžběta Danielisová *(Archeologický ústav AV ČR, Oddělení přírodních věd a archeometrie, Praha, Czechia)*, danielisova@arup.cas.cz

Aude Mongiatti *(British Museum, Department of Scientific Research, London, Great Britain)*, amongiatti@britishmuseum.org

Ignacio Montero Ruiz *(Instituto de Historia-CSIC, Laboratorio de Arqueometría de Materiales, Madrid, Spain)*, ignacio.montero@cchs.csic.es

Thilo Rehren *(The Cyprus Institute, Science and Technology in Archaeology and Culture Research Center, Nicosia, Cyprus)*, th.rehren@cyi.ac.cy

Thomas Stöllner *(Deutsches Bergbaumuseum Bochum, Germany)*, thomas.stoellner@bergbaumuseum.de

Further information

The Early Iron Age Hoards of the Bologna, San Francesco-Šempeter type from Central Slovenia: Archaeological and Chemical Investigations

Peter Turk[1] & David Heath[2]

[1] *Narodni muzej Slovenije, Ljubljana, Slovenia, peter.turk@nms.si*
[2] *Institut "Jožef Stefan", Ljubljana, Slovenia, david.heath@ijs.si*

Two distinct types of hoards occur in central and western Slovenia between the 8th and the 6th cent. BC:

1. Hoards of the Tržišče-Porpetto type with prevalent iron weapons (spearheads, socketed axes, single-edged swords with a curved blade) and a minor share of bronze winged axes and dress pins.

2. Hoards of the Bologna, San Francesco-Šempeter type with exclusively bronze and extremely fragmented items. Fragments of shaft-hole axes predominate in these hoards, followed by ingots, other axes, and some pieces of dress. The majority of these hoards were located within contemporaneous hillfort settlements.

Examples of the second type include the Mengeš I–II and Dragomelj II hoards. They are discussed in this article in connection with the chemical ICP-IAS analysis of the objects in them. The results reveal an unusual elementary composition with extremely high portions of lead, especially among shaft-hole axes (between 20 and 60%). Such a lead alloy makes the metal impractical for working purposes. Instead, these axes probably had a role in votive and/or premonetary spheres of activity.

Alloying Recipes and Social Dynamics in Atlantic Iberia during the Late Bronze Age-Iron Age transition: Palstave Hoards as Case Study

Xosé-Lois Armanda[1], María G. Faro[2] & Ignacio Montero-Ruiz[3]

[1] *Instituto de Ciencias del Patrimonio (INCIPIT), Consejo Superior de Investigaciones Científicas (CSIC), Spain, xose-lois.armada@incipit.csic.es*
[2] *Instituto de Ciencias del Patrimonio (INCIPIT), Consejo Superior de Investigaciones Científicas (CSIC), Spain, mariag.faro@incipit.csic.es*
[3] *Instituto de Historia (IH), Consejo Superior de Investigaciones Científicas (CSIC), Spain, ignacio.montero@cchs.csic.es*

Palstaves are the most abundant metal object in the hoards of Atlantic Iberia from the Late Bronze and Early Iron Ages. These hoards provide relevant information about the technology and provenance of copper-based metalwork, as well as its social implications, but relatively few of them have been systematically studied using current approaches.

In the northwest of the Iberian Peninsula, during the Late Bronze Age-Iron Age transition these palstaves were characterised by their ternary composition (Cu-Sn-Pb) with high lead content, a trend that is also detected in other areas of Western Europe. We have recently had the opportunity to study numerous specimens from this area, determining their elemental composition using pXRF and approaching the origin of the metal through lead isotopes. The results show that, although high-leaded ternary alloys are indeed predominant, the picture is somewhat more diverse. Despite the difficulties posed by the quantification of lead in copper-based alloys, palstaves made from copper-lead alloys or even from unalloyed copper have been detected. Similar composition patterns occur in other areas of the Iberian Peninsula, such as in the ingot axes of the southeastern area.

These similarities, together with the results provided by lead isotope analyses, open up new perspectives on the circulation of metal in the Iberian Peninsula during the Late Bronze Age-Iron Age transition, as well as on the social dynamics linked to this phenomenon.

Western Iberian Goldsmithing: A View from Late Bronze Age to Iron Age

Sofia Serrano[1,2] & Elin Figueiredo[1,2]

[1] Centre of Materials Research (CENIMAT/i3N), NOVA School of Science and Technology (FCT-NOVA), Lisbon, Portugal, spe.serrano@campus.fct.unl.pt
[2] Department of Conservation and Restoration, School of Science and Technology, NOVA University of Lisbon (NOVA FCT), Caparica, Portugal, esf@fct.unl.pt

The western Iberian Peninsula is very rich in gold sources, both in primary and secondary contexts. Numerous gold artefacts have been found in the region dating back to Bronze Age and Iron Age. They include a large variety of typologies and some display remarkable technical skills and aesthetic value. The collection Treasures of Portuguese Archaeology from the National Museum of Archaeology in Lisbon, Portugal (MNA), holds the largest collection of gold and silver artefacts of the region spanning from the Chalcolithic to the Roman period.

This presentation examines a selection of Bronze and Iron Age gold artefacts from the MNA's collection, highlighting differences in composition and manufacturing techniques. The study employs multifocus optical microscopy and X-ray fluorescence spectrometry analyses. The results reveal that in both periods the gold alloy shows compositional variations. However, in Iron Age there is a tendency for a larger variation on silver contents and in some objects a higher copper content. Regarding decoration techniques, some Iron Age objects include very fine detailed work, such as extremely thin wires and small size granulation, under 0.5 millimetre. Also, the use of very thin sheets to produce light artefacts but with significant volume becomes recurrent during Iron Age.

Archaeometallurgical analyses on copper-based metals from the famous cemetery of Hallstatt, Austria — mixing and alloying practices during the Late Bronze and Early Iron Age in Central Europe

Mathias Mehofer[1], Georg Tiefengraber[2] & Ernst Pernicka[3]

[1] VIAS Vienna Institute for Archaeological Science, Archaeometallurgy, University Vienna, Austria, mathias.mehofer@univie.ac.at
[2] Naturhistorisches Museum Wien, Austria
[3] Curt-Engelhorn-Zentrum Archäometrie gGmbH, Mannheim, Germany

This interdisciplinary project investigates copper and bronze use during the beginning of the Iron Age in Central Europe. The metal finds from the famous site Hallstatt, nowadays housed in the Naturhistorisches Museum Vienna (A), will serve as case study. The richness of the grave goods and material culture served as the basis for defining the "Hallstatt culture" – typical for the Early Iron Age. A set of 94 copper-based objects like ingots, tools, swords, daggers or personal implements were sampled. Furthermore, to investigate the exchange systems over a longer period of time, Late Bronze Age objects and ingots from Hallstatt and the surrounding regions (Upper Austria, Styria and Salzburg) were also included. ED-XRF and lead isotope analyses were carried out at the CEZA Mannheim.

The preliminary results show, that tin bronzes, leaded bronzes and raw copper are present. The element patterns indicate both, chalcopyrite-based and fahlore-dominated copper, which was used for the production of the artefacts. This in good accordance with previous research results for Central Europe, which describe a noticeable increase in fahlore dominated copper from Ha A/B onwards. The tin concentration decreases since the Late Bronze Age and lead becomes an important alloying agent in the younger periods (Ha C-D). In a conclusive review the data will be compared to analytical data from the Bischofshofen-Pestfriedhof cemetery, the Fliess hoard and other important sites.

The financial support by the Horizon 2020 Programme of the EU (IPERION HS Grant Agreement n.871034) is gratefully acknowledged.

Parting Precious Metals: The Emergence of a Novel Process soon after the Roman Conquest of Britain

Justine Bayley[1] & Thilo Rehren[2]

[1] *University College London, Institute of Archaeology, United Kingdom, mail@justine-bayley.co.uk, j.bayley@ucl.ac.uk*
[2] *Science & Technology in Archaeology and Culture Research Center, The Cyprus Institute, Cyprus*

Parting is the process by which gold and silver were separated. It came into widespread use in Britain in the later first century AD to 'Romanise' the pre-existing pool of mixed precious metal alloys in use in the late (pre-Roman) Iron Age (Bayley 2009). There are a number of sites scattered across southern England that have produced good evidence for parting precious metals in the decades immediately following the Claudian conquest in 43 AD. New analyses are expanding our understanding of details of the processes that were carried out at Chichester, Exeter, London and Colchester. Ceramic vessels of varied designs were used as reaction vessels. Most are small, hand-made forms, probably manufactured by the metalworkers themselves, but others are competently wheel-thrown, suggesting cross-craft interactions with professional potters working in a fully Roman tradition. The physical evidence thus suggests the craftsmen were familiar with both pre-Roman and Romano-British metalworking traditions but there is as yet no certainty who they were working for.

Bayley, J. 2009: The discovery of precious metal refining in Roman Chichester. In: J.-F. Moreau, R. Auger, J. Chabot & A. Herzog (eds), Proceedings of the 36th International Symposium on Archaeometry. Cahiers d'Archéologie du CELAT 25 (Québec 2009) 425-432.

Tracing Metallurgical Links and Silver Provenance in Balkan Coinage (5th-1st centuries BCE)

Katrin Julia Westner[1*], Janne Blichert-Toft[1], Liesel Gentelli[1], Eftimija Pavlovska[2], François de Callataÿ[3] & Francis Albarède[1]

[1] *Ecole Normale Supérieure de Lyon and CNRS, Lyon, France*
** Current address: Deutsches Bergbau-Museum Bochum, Forschungsbereich Archäometallurgie, Germany, katrin.westner@bergbaumuseum.de*
[2] *National Bank of the Republic of North Macedonia, Skopje, North Macedonia*
[3] *Université Libre de Bruxelles, Brussels, Belgium and Ecole Pratique des Hautes Etudes, Paris, France*

Local types of silver coinage testify to the emerging use of silver in the Balkan interior, possibly related to abundant ore deposits in the region. Here, we present Pb isotope data for silver coins minted by local tribes and settlements between the 5th and 3rd centuries BCE, i.e. anepigraphic coins attributed to the Derrones/Laeaei, Damastion, Pelagia and the Kings of Paeonia. Coinage of the city-states Dyrrhachium and Apollonia (5th-1st centuries BCE), which are considered as potential Greek emporia involved in trade with the Balkan interior and later issued large-scale coin series for the Romans, was analysed for its main element and Pb-Ag isotope compositions.

Based on statistical data evaluation, this contribution 1) reconstructs potential raw material sources of the investigated coins with respect to chronology/typology and assesses the prevalence of mixing, 2) evaluates material relations between the minting authorities and with the circum-Mediterranean silver circulation, and 3) investigates transformations in monetary customs and technology associated with Rome's growing influence in the region.

First Archaeometric Analyses of Copper Alloy Objects from the Iron Age Necropolis of Numana (Ancona, Italy)

Giacomo Bardelli[1], Vincenzo Baldoni[2], Roland Schwab[3], Fabio Milazzo[4] & Stefano Finocchi[4]

[1] *University of Naples "Federico II", giacomo.bardelli@unina.it*
[2] *University of Bologna, Vincenzo.baldoni@unibo.it*
[3] *LEIZA, roland.schwab@leiza.de*
[4] *Soprintendenza Archeologia, Belle Arti e Paesaggio province Ancona e Pesaro-Urbino, fabio.milazzo@culturagov.it; stefano.finocchi@culturagov.it*

Several tombs from the Picene necropolis of the ancient Numana (Ancona, Italy) were characterized during the Iron Age by the deposition of a great number of bronze objects, especially personal adornments. This burial custom was specific of some rich female tombs especially during the 6th century BC, when hundreds of fibulae were placed all around the bodies of the deceased. In addition to the deposition of items of personal adornment also bronze vessels and utensils were placed in increasing number among the grave goods between the 6th and the 5th century BC.

While an Etruscan origin for many among the latter is very likely, it is still unclear where the metals for the casting of the ornamental elements came from, since the Marche region does not offer the necessary raw materials. A first sampling campaign of a large number of bronze objects from the tombs of the necropolis areas "Quagliotti-Davanzali" and "I Pini" of Numana aims to offer an initial chemical and isotopic characterization of the local alloys. These data should help to develop future research on the features and the sources of the metallurgy in Picenum during the Iron Age.

SECTION INTERACTION BETWEEN MEDITERRANEAN AND THE NORTH

"Re-tracing" ancient metallurgy in Northern Italy during the Early Iron Age: elemental and isotopic analysis of Golasecca-type ornaments

Veronica Cicolani[1], Sibylle Manya[1,2], Chiara Lucarelli[3], Benoît Mille[2], Jessica Legendre[2], Gilberto Artioli[3], Ivana Angelini[4], Caterina Canovaro[3]

[1] *AOROC UMR 8546 CNRS-PSL, Ecole Normale Supérieure, Paris, France, veronica.cicolani@ens.fr*
[2] *Centre de Recherche et de Restauration des Musées de France (C2RMF), Paris, France*
[3] *Department of Geosciences, University of Padua, Italy*
[4] *Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music, University of Padua, Italy*

The ITINERIS project focuses on daily objects (ornaments), their makers and dissemination patterns, adopting a strong continental and technological perspective. Thus, the characterization of Nord-italic bronze metalwork, a topic still poorly known, is the new paradigm structuring the investigation of cultural interactions and a multilevel model of the Protohistoric trade in the early Iron Age. The study of daily objects, features and technical traits, from both empirical and social perspectives, would lead to a contextualised understanding of artisanal, economic and cultural practices within a broader narrative about life-styles and (trans)-actions of European Iron Age communities.

Combining different methodological approaches used in Humanities, Physics, Chemistry and Computational Sciences, this project shifts the traditional paradigm pointing out the definition of metalwork traditions as a new key to a critical review of cultural interactions, emphasizing the role of artisans in Protohistoric transfers and their involvement in the process of cultural identity formation. To achieve this major goal, a specific workpackage is focused on a multiproxy archaeometric approach, pooling elemental, isotopic and metallographic analysis, to produce the first compositional & metallographic referential of the copper alloys for Northern Italy. Proceeding by this chemical and isotopic signature it will be possible to identify the presence of different artisans or workshops in the same cultural area and compare their features. It will also be possible to determine the nature of raw materials used, and the manufacturing process, verify the possible existence of multiple active workshops and try finding sites of copper supply.

This paper presents the first results of the WP1 based on the analysis of copper alloy ornaments coming from the three cultural areas here investigated: Golasecca culture, Inner Liguria (today Southern Piedmont) and Western Emilia and held in three museums, the National Archaeological Museum of Saint-Germain-en-Laye, the Musei Reali of Turin, and the Civic Museum of Reggio Emilia. To date, over 130 objects have been sampled and 151 samples have been already analysed: 117 for elemental analysis and 34 for provenance, out of the 1200 objects in the entire dataset. Moreover, the current sampling campaign will allow us to increase the number analyses (elemental as well as isotopic and metallographic) and, in this way, to establish a solid initial base of reference. From a historical standpoint, since these productions are linked to the same models and are widespread among the communities settled in north-western Italy, this approach should make it possible to overcome the current impasse in understanding all the stages of the bronze craft process, from the creation to the dissemination of the finished artefacts. What's more, bringing together different but complementary approaches and laboratories — the C2RMF and the Department of Geosciences of Padua University — will promote the development of innovative and adapted protocols, potentially useful and reusable for future comprehensive archaeometric studies.

Reviving Copper Production: New Insights into Iron Age Metallurgy at Asgata-Kalavasos, Cyprus

Demetrios Ioannides[1] & Andreas Charalambous[1,2]

[1] *Science and Technology in Archaeology and Culture Research Centre, The Cyprus Institute, Nicosia, Cyprus, d.ioannides@cyi.ac.cy*
[2] *Archaeological Research Unit, Department of History and Archaeology, University of Cyprus, Nicosia, Cyprus*

Cyprus' economy has long depended on its copper resources, but production intensity varied over time. While its role as the primary copper producer in the eastern Mediterranean during the Late Bronze Age (1650–1050 BCE) is well established (Muhly 1989; Kassianidou 2013), Iron Age (1050–310 BCE) copper exploitation remains poorly understood. The re-emergence of statehood in this period has been linked to competition over mineral wealth, a strategic asset shaping power dynamics among city-kingdoms (Petit 2001; Iacovou 2013). This study presents archaeometric analyses of slag heaps from the Asgata-Kalavasos mining area, likely controlled by Amathus, a city famed for its mineral wealth (Ovid, Met 10.220). Radiocarbon dating indicates intensified copper production from the second half of the 8th century BCE, coinciding with the decline of metallurgical activities in the Arabah Valley (Ben-Yosef et al. 2012). Slag analyses reveal technological advancements over Late Bronze Age smelting, including Zn-bearing slag phases, suggesting the use of sphalerite-rich ores. These findings indicate that Cyprus re-emerged as a key copper producer in the Iron Age eastern Mediterranean.

Ben-Yosef, E., Shaar, R., Tauxe L. & Ron, H. 2012: A new chronological framework for Iron Age copper production at Timna (Israel). Bulletin of the American Society of Overseas Research 367, 2012, 31-71. DOI: 10.5615/bullamerschoorie.367.0031.

Iacovou, M. 2013: Historically elusive and internally fragile island polities: the intricacies of Cyprus's political geography in the Iron Age. Bulletin of the American Society of Overseas Research 370, 2013, 15-47.
https://doi.org/10.5615/bullamerschoorie.370.0015.

Kassianidou, V. 2013: The production and trade of Cypriot copper in the Late Bronze Age. An analysis of the evidence. Pasiphae VII, 2013, 133-146.

Muhly, J. D. 1989: The organisation of the copper industry in Late Bronze Age Cyprus. In: E. Peltenburg (ed.), Early society in Cyprus (Edinburgh 1989) 298-314.

Petit, T. 2001: The First Palace of Amathus and the Cypriot Poleogenesis. In: I. Nielsen (ed.), The royal palace institution in the first millennium BC: regional development and cultural interchange between East and West. Monographs of the Danish Institute at Athens 4 (Athens, Århus 2001) 53-75.

SECTION INNOVATIONS IN IRON AGE METALLURGY

From Hammerscale to Ore: Towards a Paradigm Shift in Iron Production during the Early Iron Age

Jean Rodier

Département des Géosciences, Université de Fribourg, Suisse, jean.rodier@unifr.ch

The question of the origin and circulation of iron during the Early Iron Age remains central to understanding the social and economic structures of this period. Existing models suggest a decentralized production system involving the exploitation of various types of ore. However, new geochemical data, including analyses of hammerscale, bi-pyramidal ingots, and ore, lead us to reconsider this model. Here, we propose a new perspective: a largely dominant production based on a single, specific type of ore, which appears to correspond to a paleo-lateritic formation known as "sidérolithique or Bohnerz." This production may well have been controlled by the ruling elite, whose influence was particularly strong between the Hallstatt period and the beginning of the La Tène period, thereby reinforcing their power and the centralization of wealth.

The Colour of Bronze: Messages from the Metal Ages

Paolo Piccardo, Roberto Spotorno, Camilla Criaco, Flavia Boragina, Jessica Catanzaro & Matilde Pedemonte

M.E.T.A.L. research group, Department of Chemistry and Industrial Chemistry, University of Genoa, Italy, via Dodecaneso 31, 16146 Genoa, Italy, paolo.piccardo@unige.it

In our everyday life we are used to metal objects properties but we rarely notice that they are elected in alternative to other potentially equivalent materials to craft objects especially when the appearance rules. Furthermore, the colour is the preliminary indicator of the state of health of an object and that is fundamental to define the good behaviour of a material. Among the metals used since ancient times, the noble and precious ones stand out for their low or non-existent tendency to react, and thus for their intrinsic inalterability of their aspect. Alongside them, copper alloys play a key role, representing an excellent example of a versatile material used both in artistic and sacred production, and in the production of specific and technologically advanced objects. Their colour depends on the composition and contains more information than one might expect, like those regarding the solid solution homogeneity of the alloy and the state of its alteration. In the case of as-cast objects, information can be collected on the cooling speed and, therefore, on the mould material used. This communication will present the first results of a study aimed at placing colour at the center of metallurgical research applied to archaeological artefacts with a strong contribution from experimental metallurgy.

SECTION INNOVATIONS IN IRON AGE METALLURGY

The Crucibles from Groß-Rohrheim and their Importance of Early La Tène Metalworking for the Region of South Hesse, Germany

Anna-Lena Jerg[1] & Roland Schwab[1,2]

[1] *Eberhard Karls Universität Tübingen, Urgeschichte & Naturwissenschaftliche Archäologie, Tübingen, Germany, anna-lena.jerg@student.uni-tuebingen.de*
[2] *LEIZA, Mainz, Germany, roland.schwab@leiza.de*

Archaeological excavations of the site of "Groß-Rohrheim" (South Hesse, Germany) revealed un unexpected ensemble of Early Iron Age metalworking. Within an Iron Age settlement, several pits have been excavated, which contain among other archaeological remains, about 180 slags and almost one hundred mostly well-preserved crucibles. Their specific morphological appearance is well known from different sites of the early La Tène period. Nevertheless, the finding deserves special attention, as it is the largest assemblage of early La Tène crucibles known for this period, which is of particular interest, as the complex comes from a region, in which the Iron Age was usually perceived to be of lesser intensity than in neighbouring areas.

However, recent research implies that the region must have been characterised by some sort of centralised settlement to which a workshop may have belonged. Groß-Rohrheim itself is known for some remarkable finds like two gold-plated bronze rings with coral inlay and a golden disc, which all were most probably drinking horn components. Exceptional objects like drinking horns and the presence of a protentional workshop have led to speculation that the crucibles could be melting crucibles for precious metals. This impression is reinforced by the circumstance, that most crucibles belong to the same type, which is quite small.

Therefore, all crucibles are systematically investigated to explore the questions of standardization, clay composition and the identification of the metals molten within. X-ray radiography and computer tomography, light and scanning electron microscopy and micro-X-Ray fluorescence analysis (μ-XRF) are applied to reveal the secrets of the crucibles. Indeed, first radiological examinations indicate, that only a few adhering metal residues are still preserved.

By reflecting on the current state of research for the wider geographical region and on early La Tène metalworking, we seek to adress not just the distribution and technological properties of the crucibles, but also hope to gain further insight into the underlying social structures and the wider archaeological landscape in which the complex is embedded and to understand the importance of metalworking for early La Tène societies of South Hesse.

The technology of Iron and Steel in Pre-Roman Iberian Peninsula

Marc Gener-Moret[1], Marcos Martinón-Torres[2], Jaime Vives-Ferrándiz Sánchez[3], Fernando Quesada Sanz[4], David Jimeno Jiménez[5]

[1] Centro Nacional de Investigaciones Metalúrgicas – Consejo Superior de Investigaciones Científicas (CENIM-CSIC) / National Centre for Metallurgical Research - Spanish National Research Council (CENIM-CSIC) – Madrid, SPAIN.
[2] McDonald Institute for Archaeological Research, University of Cambridge - Cambridge, UK
[3] Museu de Prehistòria de València
[4] Departamento de Prehistoria y Arqueología, Universidad Autónoma de Madrid
[5] Departament d'Història i Arqueologia, Universitat de Barcelona

Production and use of iron and steel as technologically differentiated materials, selected by their mechanical properties, during the Iron Age in the Iberian Peninsula has been an historically underresearched subject, especially if compared with other metals. This is due to many reasons, including that this is question with severe structural analytical problems related to the general low level of conservation of this type of metals due to corrosion, the relative invasiveness of some of the analytical techniques needed to obtain the most significant information and the prevalent occurrence of fire in the peridepositional circumstances of most of the finds, with the consequent loss of technological information.

This study approaches the problem from a wide territorial scale perspective for the first time, overcoming many of these structural analytical problems and offering an overview on the use of steel as a mechanically singular material. The results provide information on iron and steel technological applications, highlighting their intentional and selective use, hinting at the most probable methodology of production, and leading to a discussion on the implications of this technological framework in terms of control of resources and knowledge, social impact in the territory and exchange of technical expertise at a European and Mediterranean dimension.

SECTION INNOVATIONS IN IRON AGE METALLURGY

Same or Different? A Comparative Study of La Tène Iron Artefacts from Hoards and Settlements using Osmium Isotopes and Slag Inclusions Composition Analyses

Michal Kotýnek

Charles University, Faculty of Arts, Department of Archaeology, Celetná 20, 110 00 Prague 1, Czech Republic, michal.kotynek@seznam.cz, mkotynek@zcm.cz

Hoards of iron objects are one of the most common types of hoards in the La Tène period, but despite this, they are not usually the subject of detailed research. Presented research aims to answer (1) whether the items in the individual hoards examined are of the same or different provenance, (2) to determine whether differences can be found between analogous artefacts in hoards and settlements, (3) verify that items deposited in hoards could have been manufactured only for the purpose of deposition. To achieve this goal, several artefacts from sites Pohanská (SK), Buchlovice (CZ), Staré Hradisko (CZ) and Hostýn (CZ) were analysed using a multidisciplinary approach combining analysis of osmium isotopes ratio (N-TIMS), slag inclusions composition (SEM-EDS) and metallography. The results show a surprising heterogeneity of iron sources within individual assemblages. However, they also show that some iron sources were used to produce artefacts from all the studied sites, even though they are located tens or even hundreds of kilometres apart. No significant difference between artefacts from hoardes and settlements or evidence of the production of objects solely for their deposition was found. This probably means that common items rather than special ones were deposited in these hoards.

A new mass find of Iron Age bipyramidal iron bars from the Danube in Upper Austria

Peter Trebsche[1], Marion Berranger[2] & Léna Belhade[2]

[1] *University of Innsbruck, Department of Archaeologies, Innrain 52a, Innsbruck, Austria, peter.trebsche@uibk.ac.at*
[2] *Institut de Recherche sur les Archéomatériaux (IRAMAT_LMC) UMR 7065-CNRS Université de Technologie Belfort-Montbéliard, Site de Sévenans, 90010 Belfort Cedex, marion.berranger@utbm.fr; lena.belhade@gmail.com*

In spring 2019, numerous iron semi-products were found in the Deinham gravel works (municipality of Hartkirchen an der Donau, district of Eferding) in Upper Austria and reported to the Austrian Federal Monuments Office. The iron bars were discovered during gravel dredging at a water depth of between 1 and 10 metres. A rapid investigation of the site by archaeological divers did not reveal any further underwater features.

The findspot is located in the area of a silted-up oxbow of the Danube, which was still filled with water in places at the beginning of the 19th century. The site of Deinham is located at the entrance to the Eferding Basin, where the Danube branches into numerous arms and the water loses its flow velocity. As a result, large stone stones were deposited, and sand banks were formed which were dangerous for shipping.

In total, at least 519 bipyramidal iron semi-products weighing approximately 1035 kg were recovered. The iron bars are long and symmetrical in shape, with two pointed ends and a rectangular cross-section. Typological features indicate a dating to the late Hallstatt or La Tène period. The mass find is one of the largest find complexes of Iron Age bars from the whole of Europe. Based on comparisons with other iron semi-products and analyses of prehistoric river finds in Upper Austria, there are no indications that the bars were ritually deposited. It is more likely that they represent the cargo of an Iron Age ship that sank in the Danube on its way from the iron producers to the customers.

Currently, a sample of 10 bars is under investigation in the IRAMAT laboratory at Belfort. The archaeometallurgical analyses aim at clarifying the manufacture, the dating and the provenance of this outstanding find complex. The first results of metallographical analyses, giving information on fabrication techniques will be presented.

Archaeometric Analyses of Celtic Bipyramidal Iron Ingots: Provenance, Production Technology, and Age Determination — A Case Study of the Speyer Depot (Southern Germany)

Ivan Stepanov[1], Michael Brauns[1], Johannes Wintel[1], Ronny Friedrich[1], Markus Marquart[2] & Ulrich Himmelmann[3]

[1] *Curt-Engelhorn-Zentrum Archäometrie gGmbH, Mannheim, Germany, ivan.stepanov@ceza.de*
[2] *Museen der Stadt Aschaffenburg, Aschaffenburg, Germany*
[3] *Generaldirektion Kulturelles Erbe Rheinland-Pfalz, Speyer, Germany*

Celtic bipyramidal ingots are commonly found in northern France, Switzerland, and southern Germany, providing evidence of iron trade conducted via rivers during the 9th to 4th centuries BCE. As most of these ingots were discovered without associated artifacts, their cultural attribution relies on typological, radiocarbon, and provenance analyses. An integrated archaeometric approach was applied to 20 ingots discovered in a depot near Speyer, on the bank of the Rhine. The ingots exhibit similar typology (BLS 4, according to Berranger, 2014) and nearly identical morphometric characteristics. In terms of microstructure, all ingots — except for one (No. 16) — are composed of phosphoric iron. Trace element analyses of slag inclusions (LA-ICP-MS), metal matrices (ICP-MS), and osmium isotope ratios (NTIMS) also indicate a common origin for all ingots except No. 16. Given the close morphological characteristics, all 20 ingots were likely produced in a same workshop. This workshop was supplied by at least one major bloom producer linked to a single ore source. Additionally, the presence of the outlier (No. 16) suggests a link to a supplementary bloom producer relying on a different ore source. Ultimately, the batch of ingots must have been sold to a trader operating along the Rhine.

Iron Production and Circulation in north-eastern France and its Margins during the Iron Ages

Marion Berranger[1], Marc Leroy[1], Enrique Vega[2], Maxime L'Héritier[3] & Philippe Dillmann[2]

[1] Institut de Recherche sur les Archéomatériaux (IRAMAT_LMC) UMR7065-CNRS Utbm, Site de Sévenans, 90010 Belfort Cedex, marion.berranger@utbm.fr
[2] IRAMAT-LAPA/NIMBE-CNRS6CEA-UMR7065
[3] Université Paris 8, ArScAn UMR7041

The aim of this paper is to present the work carried out over the last ten years in north-eastern France, in an area corresponding to the present-day Burgundy-Franche-Comté region and the Swiss Jura plateaux, where numerous iron semi-finished products and several smelting production areas dating to the Iron Ages have been studied.

Firstly, we will present the results of the study conducted on the smelting zones dated to the iron age, which are centralized in the same area. The chronology, techniques and production volumes of these workshops will be addressed.

Secondly, the question of the circulation of iron at a regional scale and of the organization of production will be addressed, based on archaeometric analysis of a corpus of some fifty semi-finished products from the Iron Ages. This approach is based on the comparison of the chemical signature (trace lithophile elements) of the production areas (slag collected in the smelting workshops) with the one of the slag inclusions (SI) trapped in the metallic matrix of iron objects. The aim will be to present the chemical characteristics of this production zone and to attempt to discriminate, using various statistical approaches, different types of sources.

For a large number of these objects, the same supply zone has been identified, extending over a vast area from the south of the Paris basin to the plains of Berry.

SECTION TRADE AND PROVENANCE

Iron Age Communities in the Contact Zone — Technological Advances in the 3rd Century BC along the Amber Road

Alžběta Danielisová[1], Daniel Bursák[1], Samuel Kertes, Ivan Čižmář, Hana Čižmářová, Jana Čižmářová, Tomáš Mangel, Ladislav Strnad, Jakub Trubač

[1] Presenting authors: Institute of Archaeology of the Czech Academy of Sciences, Letenská 4, 118 00 Prague 1, Czech Republic, danielisova@arup.cas.cz, bursak@arup.cas.cz

Recent archaeometric research in the Middle Danube region has revealed a significant technological transformation during the 3rd century BC, particularly in the use of copper alloys for personal adornments. Leaded bronze, with its excellent casting properties, became a key innovation in jewellery production, enabling the emergence of the so-called plastic decorative style. Through chemical and isotopic analyses of over 300 artefacts from cemeteries and the industrial agglomeration at Němčice nad Hanou, we traced the provenance of metals and mapped changing resource strategies over time.

The results demonstrate a shift from heterogeneous material sources in the 4th century BC to more homogeneous supplies in the 3rd century BC, particularly from the Rhenish Massif. This reflects new technological preferences and likely changes in trade networks. The adoption of leaded bronze technology appears to precede the rise of agglomerations and may reflect the agency of local communities engaging with long-distance networks.

This study illustrates how innovation, resource accessibility, and social transformation intersected along the Amber Road corridor, reshaping Iron Age society and laying the foundations for later economic and cultural developments.

Etruscan type Olpai and Situlae in elemental and Pb Isotope Analytical Perspective

Raimon Graells i Fabregat[1] & Ignacio Montero-Ruiz[2]

[1] *Universitat d'Alacant Carretera de San Vicente del Raspeig s/n Alicante, 03690, Spain, raimon.graells@ua.es*
[2] *Instituto de Historia (IH), Consejo Superior de Investigaciones Científicas (CSIC), Spain, ignacio.montero@cchs.csic.es*

The National Archaeological Museum of Madrid holds a collection of over a hundred Etruscan bronze vessels. Comparing the metal used in the production of the Olpai and situlae enhances our understanding of both types, which have been thoroughly studied from a typological and chronological standpoint. Additionally, the timeframe covered, from the 6th to the 4th century BC, adds valuable insights into the technological evolution of Etruscan metal tableware across time. Both types are made of tin bronze without significant levels of lead (<1% Pb), and the amount of tin in the alloy is not standarized (from 1 to 16 % Sn). However, the body and the handle in the Situlae seems to be produced with different alloy, but also in at least the case of the situla MAN-9965 with copper of different provenance (values of 18.7744 and 18.4671 in the 206Pb/204Pb). Arsenic is the main minor element in the metal. Lead isotopes confirms a diversity of metal provenance.

Preliminary in-depth Investigations of Metallurgical Production Indicators from the Early Iron Age Protourban Site of "Questura" in Padua (Italy)

Vanessa Baratella[1], Simone Dilaria[2, 3], Ivana Angelini[2] & Massimo Vidale[2]

[1] *University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia, Vanessa.Baratella@ff.uni-lj.si*
[2] *University of Padua, Department of Cultural Heritage, Padua, Italy*
[3] *University of Padua, Inter-Departmental Research Centre for the Study of Cement Materials and Hydraulic Binders (CIRCe), Padua, Italy*

The site identified in the courtyard of the current Police Headquarters ("Questura") in Padua represents one of the most significant testimonies of Padua's proto-urban settlement, dating between the late 9th century BCE and the early 8th century BCE. Of primary importance is its strategic location, near the counter-bend of the Brenta/Meduacus river, as well as its artisanal vocation, particularly related to ceramic production, antler working, and most notably, bronze metallurgy. During the 8th century BCE, a metallurgical workshop was active at the site, characterized by pyrotechnological facilities for bronze production, such as hearths and pits intended for the melting of copper and its alloys. Various production indicators are present, including bronze prills and semifinished object waste, but above all, numerous fragments of ceramic crucibles and stone casting molds. Typological and archaeometric studies have been conducted on these two categories of artifacts to understand the technical choices and technological knowledge of ancient artisans. The analysis of crucibles (OM-XRPD) has allowed the identification of two distinct types (A and B) based on their fabric and texture, reflecting the rapid technical evolution necessary to support the increasing production intensity of the proto-urban center. The stone casting molds — for which polarized light transmitted optical microscopy analyses were performed — represent one of the most significant samples of this artifact category for the Early Iron Age in Veneto. These molds, worked on multiple faces, were primarily intended for the production of craft tools — axes, chisels — or weapons — spearheads, knives. The molds were crafted from various lithotypes sourced from supply basins located also at considerable distances from Padua's center, reflecting specific technological requirements and, consequently, particular choices in raw material procurement for the production of various supports. These initial analyses of metallurgical production indicators at the Questura site pave the way for multiple scenarios linked to the in-depth study of both ancient production methods and the socio-political dynamics and exchange economy of protourban communities in pre-Roman Veneto.

Characterising iron metallurgy at Bragny-sur-Saône based on an interdisciplinary study of slag and metal waste: the Bragny II sector (second half of the 5th century — beginning of the 4th century BC)

Léna Belhade[1], Marion Berranger[1], Emilie Dubreucq[2]

[1] *Institut de Recherche sur les Archéomatériaux (IRAMAT_LMC) UMR7065-CNRS Utbm, Site de Sévenans, 90010 Belfort Cedex, lena.belhade@gmail.com, marion.berranger@utbm.fr*
[2] *Eveha, UMR 5608 TRACES, Toulouse, emiliedubreucq@yahoo.fr*

The Bragny-sur-Saône "Sous-Moussières" site (Saône-et-Loire), located at the confluence of the Saône, Doubs and Dheune rivers, has been dated between the late 6th and early 4th centuries BC. It has been interpreted as an open agglomeration with an artisanal and commercial vocation, characterized by remarkable remains: including imports and an exceptional quantity of metallurgical waste.

A part of the study of material from ancient excavations, an interdisciplinary study has been carried out on ironworking waste from the Bragny II sector, excavated by Antonin Guillot in 1973 and 1974. This area revealed a large pit, that was filled, with a lot of archaeological artefact, dated from LT A-B1. Nearly 140 kg of slag were discovered in this area of barely 14 m^2. In order to understand the nature and scale of the metallurgical activities present, macroscopic, metallographic and chemical analyses were carried out on the ironworking waste.

Facsimiles of Fibulae from Monte San Zeno, Como, Italy

Alessandra Giumlia-Mair[1], Barbara Grassi[2], Annalisa Gasparetto[2] & Lucia Isabella Mordeglia[3]

[1] AGM-Archeoanalisi, Merano, BZ, Italy, giumlia@yahoo.it
[2] Soprintendenza Archeologia Belle Arti e Paesaggio per le province di Como, Lecco, Monza Brianza, Pavia, Sondrio e Varese
[3] Soprintendenza Archeologia Belle Arti e Paesaggio per le province di Biella, Novara, Verbano-Cusio-Ossola e Vercelli

Monte San Zeno is a hill in the municipality of Cerano d'Intelvi, located in a panoramic position above the Lake of Como in the Italian Alps. At its summit, there are an active spring, and a Romanesque church dated at least to the beginning of the 13th century AD. On August 30, 2015, some hikers found 'several bronze objects' on a steep slope towards the summit and notified the Archaeological Superintendency. An archaeologist was immediately sent for an emergency excavation with the aim of recovering the objects. Unfortunately, the hoard had been removed and later repositioned in the hole by the finders, therefore the exact documentation of the original positions of the single objects and of the method of deposition was no longer possible. The objects were clearly imitations of large 'sanguisuga' type fibulae, typical of the later phase of the Golasecca culture (IIIA), but without a pin and a catch-pin. The Italian Golasecca culture phase IIIA is generally dated between the second decade of the 5th century BC and the beginning of the 4th century BC, i.e., roughly from 480-475 BC to 390/380 BC.

Later the Superintendency carried out further excavations to verify that the deposit had been completely emptied, and to check if there were any other archaeological remains nearby, but none were found. The excavation recovered eighty whole specimens, some incomplete, along with a few fragments of other pieces. From the literature it was already known that similar hoards of facsimiles of fibulae had been found in other areas of the region and in the Canton of Ticino, some consisting of large groups of facsimiles, but usually including only one or a couple of specimens. This paper presents the analytical data obtained non-destructively by employing a transportable X-ray fluorescence spectrometry (XRF) system, consisting of the head with the actual X-rays source, equipped with a collimator, a laser pointer indicating the exact spot on the objects and an acoustic device to control the right distance from the sample. The stable tripod on which the head is mounted also contains built in devices for correcting the position of the beam. Several standards of known composition, as similar as possible to Iron Age alloys, were employed during the measurements to obtain reliable data. The surprising results showed that the facsimiles are made of arsenical copper and only few of them also contain small amounts of tin. Some Iron Age comparisons will be also mentioned and the meaning of the hoard evaluated.

An Early Iron Age smithy revealed by micro-artefact analysis at Pungrt Hillfort, Slovenia

Luka Gruškovnjak[1], Petra Vojaković[1], Jaka Burja[2], Barbara Šetina Batič[2], Agni Prijatelj[1,3], Helena Grčman[3] & Matija Črešnar[1]

[1] University of Ljubljana, Faculty of Arts, Department of Archaeology, Centre for Interdisciplinary Research in Archaeology (CIRA), Ljubljana, Slovenia, Luka.Gruskovnjak@ff.uni-lj.si
[2] Institute of Metals and Technology (IMT), Ljubljana, Slovenia
[3] University of Ljubljana, Biotechnical Faculty, Department of Soil and Environmental Science, Ljubljana, Slovenia

At the Pungrt Hillfort — an early urban settlement in central Slovenia occupied from the 8th/7th century BC to the 2nd century AD — the abundant macro-remains of iron slag, found primarily in secondary refuse contexts, provide clear evidence that iron metallurgy played a significant role in the settlement's economy. Yet, it is only through an integrated geoarchaeological approach that we can reliably identify the primary locations of metallurgical production within the site. This is exemplified by Building 24, which, during excavation, offered no indications of its function, beyond pottery fragments of seemingly domestic use. However, subsequent micro-artefact analysis revealed that it was used as a smithy during the late 6th and early 5th century BC. Moreover, spatial analysis of micro-debris and geochemical signals enabled a detailed reconstruction of the workshop's internal organisation, including the probable locations of the anvil, forge, and charcoal storage. Significantly, scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) examination of the iron-working debris (hammerscale and slag) provided what we believe to be the earliest clear evidence for the use of flux in iron welding during the Early Iron Age.

Biographies of a Monte Bernorio-Type dagger. From Mine to Museum

Roberto De Pablo Martínez[1], Marc Gener-Moret[2], Susana De Luis Mariño[3], Barbara Culubret Worms[3] & Margarita Arroyo[4]

[1] *Instituto de Estudios Históricos y Arqueológicos Caetra, Berlanga de Duero, Spain, roberto_de_pablo@hotmail.com*
[2] *Centro Nacional de Investigaciones Metalúrgicas – Consejo Superior de Investigaciones Científicas (CENIM-CSIC), Madrid, Spain*
[3] *Museo Arqueológico Nacional, Madrid, Spain*
[4] *Museo Nacional de Artes Decorativas, Madrid, Spain*

On July 16, 1930, the labourers excavating the necropolis of Trasguija in Las Cogotas (Ávila, Spain), under the direction of Juan Cabré, discovered tomb 418. Within it, they found a Monte Bernorio-Type dagger adorned with silver damascening, which sparked considerable fascination at the time.

This study explores the two lives of this extraordinary Mid-North Iberian Peninsula Iron Age artefact. On the one hand, its biography as a weapon and a symbolic and as a symbol of status and power, dating back approximately 2,200 years. In this regard, we examine its entire *chaîne opératoire*, from its manufacture to its final deposition in the tomb, attempting to uncover some of the events it may have shared with its bearer. On the other hand, we consider its second life, which began with the discovery of the piece—when the weapon became an archaeological object, bridging two societies separated by over two millennia and offering new insights into one of them through a modern lens.

POSTER

The TerraLID Metadata Profile: Towards a Uniform Description of Lead Isotope (Meta)Data

Thomas Rose[1], Katrin J. Westner[1], Malte Kottmann[2], Tim Greifelt[1], Annette Hornschuch[3], Yiu-Kang Hsu[1], Helge Wiethoff[2] & Sabine Klein[1,4]

[1] *Deutsches Bergbau-Museum Bochum, Leibniz-Forschungsmuseum für Georessourcen, Forschungsbereich Archäometallurgie, Bochum, Germany, Thomas.Rose@bergbaumuseum.de*
[2] *Technische Hochschule Georg Agricola, Rechenzentrum, Bochum, Germany*
[3] *Deutsches Bergbau-Museum Bochum, Leibniz-Forschungsmuseum für Georessourcen, Forschungsbereich Montanarchäologie, Bochum, Germany*
[4] *Ruhr-Universität Bochum, Institut für Archäologische Wissenschaften, Bochum, Germany*

Lead isotope analysis is nowadays the default method for reconstructing the raw material provenance of non-ferrous metals. Pre-requisite is a collection of reference data, i.e., data of known raw material provenance. Combining such data from different sources is usually hampered or even made impossible by the large variety of metadata, their varying levels of detail or ambiguous definition. TerraLID aims to overcome these hindrances by developing a research data infrastructure which serves as a central storage and access point for these data. Pivotal for this aim is the development of a metadata profile for the uniform description of lead isotope data and their metadata. To facilitate its reuse and extension, the metadata profile follows a modular design. Its hierarchical structure ensures efficient storage of information. Its development is driven by the TerraLID Editors, representatives of the lead isotope community with a wide range of expertise, and coordinated by the TerraLID project team.

Large parts of the TerraLID metadata profile are now completed. The contribution will present the overall structure and takes a closer look on some aspects. In addition, potential connections to similar ongoing developments in e.g., the German NFDI4 Objects will be discussed.