GOETHE UNIVERSITÄT FRANKFURT AM MAIN

UNIVERSITY OF OXFORD

FLAME

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1–2ND OCTOBER 2019

GOETHE-UNIVERSITÄT FRANKFURT AM MAIN

CAMPUS WESTEND, PEG-GEBÄUDE, RAUM 1.G 191, 10AM - 5PM

THE FLOW OF ANCIENT METAL ACROSS EURASIA

INTERNATIONAL CONFERENCE ON ARCHAEOMETALLURGY

INTERNATIONALE KONFERENZ ZUR ARCHÄOMETALLURGIE

DER FLUSS VON ALTEN METALLEN DURCH EURASIEN

KOSTEN FREIE REGISTRIERUNG ERFORDERLICH

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VORTRÄGE IN ENGLISCHER SPRACHE

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FLAME V

Flow of Ancient Metal Across Eurasia
Der Fluss von Alten Metallen durch Eurasien

1st and 2nd October 2019
Goethe Universität, Frankfurt-am-Main

Tuesday 1st October 2019

	10am to 10.10am	Mark Pollard	Welcome and conference opening
1	10.10am to 10.50am	Rüdiger Krause	Welcome to Goethe-University Frankfurt, and the results of our archaeometallurgical research project in the Urals, Russian Federation

Coffee

Chair: Peter Hommel

2	11.10am to 11.35am	Ruiliang Liu	A revised chronology for the development of metallurgy in early dynastic China: from Erlitou to Erligang
3	11.35am to 12.00pm	Chen Kunlong and Mei Jianjun	Early bronze finds from the Mogou site in Gansu, Northwest China.
4	12pm to 12.25pm	Tsagaan Turbat	Ochre paintings of Bronze age Mongolia and its Cultural attribitions

Lunch

Chair: John Pouncett

5	2pm to 2.25pm	Anton Gontscharov and Hande Özyarkent	Aryans on the search for metals? Andronovo mobility updated. New data and research from Bronze Age mining and metallurgical communities in Central Asia
6	2.25pm to 2.50pm	Natalia Shishlina	Metal, animals and isotope: The Mikhailovka-Ovsyanka case study
7	2.50pm to 3.15pm	Peter Hommel	The Metals of the Borodino Hoard: Investigating choices/ understanding connections

Coffee

Chair: Ruiliang Liu

8	3.35pm to 4pm	Viktor Trifonov	New excavations and analyses at Tsarskaya and their implications for the study of the Maikop Culture
9	4pm to 4.25pm	Nathaniel Erb-Satullo	Merging Myths and Metallurgy: Iron Smelting Landscapes of Black Sea Region
10	4.25pm to 4.50pm	Chris Gosden	Movement and Connections in the Bronze Age

Free Discussion and Close

Wednesday 2nd October 2019

Chair: Mark Pollard

11	10am to 10.25am	Shadreck Chirikure	Material connections: explorations of local and globally shared histories using African archaeomaterials
12	10.25am to 10.50am	Philly Howarth	Does my data look big in this? Reflections on scale in Big Data approaches

Coffee

Chair: Nathaniel Erb-Satullo

13	11.10am to 11.35am	John Pouncett	The Living Dead: Beaker Communities on the Yorkshire Wolds
14	11.35am to 12pm	Bianka Nessel	The Late Bronze Age metal workshop from Teleac, Transsylvania.
15	12pm to 12.25pm	Roland Schwab	Copper and copper alloys from Southern Germany and the Alps in the Iron Age

Lunch

Chair: Philly Howarth

16	2pm to 2.25pm	Steven Matthews	Bronze Age types and classes: A materialist approach to measuring form and flow
17	2.25pm to 2.50pm	Peter Bray	Seahenge: Linking the extraordinary with everyday metal use in the British Early Bronze Age
18	2.50pm to 3.15pm	Heide Nørgaard	Provenance, transfer and mixing of metal in Scandinavia´s early Bronze Age: 2000 -1600 BC

Coffee

19	3.35pm to 4pm	Mark Pollard	New Ways of Thinking about Alloys
	4pm to 4.30pm	Mark Pollard	Final remarks, thanks and close

A revised chronology for the development of metallurgy in early dynastic China: from Erlitou to Erligang

Ruiliang Liu

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Metallurgy in Bronze Age China shows remarkable differences from other parts of Eurasia in the second millennium BC. As a foreign technology, its localisation process can make crucial contributions to our understanding of the development of complex societies in early Bronze Age Central China. Based on 177 radiocarbon dates, new Bayesian modelling has significantly improved the chronological resolution for the key changes of early metallurgy in Central China. Together with a large number of chemical analyses of metal objects and associated archaeological information, we show that it took around 40-130 years (95.4% confidence) to set up the *Chinese* metallurgical practice at Erlitou but 210-340 years (95.4% confidence) to produce a fully developed system with a complete inventory of Chinese characteristics including producing ritual vessels and using primary leaded-bronze alloying technology.

Scientific Studies of Bronze Objects Unearthed from the Mogou Site in Gansu and their Significance

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A systematic scientific examination of copper and bronze objects excavated from the Mogou site in Lintan County has been carried out in recent years in order to reveal their material and manufacturing characteristics. It has been shown that these characteristics are correspondent with the object types. The ornaments were mostly manufactured by hot-forging, while the implements were mainly made by casting, with cold-working being applied at the final stage of shaping. Tin bronze is the most important alloy which was mainly used for the ornaments in Mogou, while copper was largely used for implements. In the meantime, other alloy materials were also in use, such as Cu-As, Cu-Pb, Cu-Sn-Pb and Cu-Sn-As. It seems that copper and bronze technologies in other regions of the Qijia culture were different from what has been seen in Mogou. Arsenical copper seemed to have played a more important role in the Qinghai region, while Cu-Sn-Pb became prevalent in the Tao River Basin. The new studies of the Mogou bronzes provide crucial scientific evidence for understanding the development of early bronze metallurgy in Northwest China.

Animals, metal and isotopes: Mikhailovka-Ovsyanka I, the Late Bronze Age mining site of the steppe Volga region

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Mikhailovka-Ovsyanka, which is a production settlement of metal workers, was excavated in the south of the Samara Trans-Volga region. The 14C data obtained suggest that this settlement was in operation throughout the 18th–16th centuries BC. Miners used mines to search and extract copper ore. The occupation layer yielded a lot of ceramics, more than one hundred stone implements and around two hundred bone tools related to production and treatment of copper minerals as well as fragments of ore, slag, crucibles, casting moulds and tool fragments. Thousands of bones of domesticated animals are a peculiar trait of this occupation layer. Practically all bones are kitchen refuse. The question is where the cattle were kept, and who grazed the cattle consumed as food at the settlement? The stable isotope study and determination of the season when the animals were slaughtered and the age of the slaughtered animals provide an opportunity to discuss the organization of a specific annual/seasonal production cycle that both the miners and the residents from the settlements located nearby and at a distance from Mikhailovka-Ovsyanka (manual workers and cattle breeders) were, probably, involved in.

The Metals of the Borodino Hoard: Investigating choices/understanding connections

Peter Hommel, Peter Bray, and Natalia Shishlina

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The Borodino Hoard is one of the most striking collections of artefacts from eastern Europe in the 2nd Millennium BC. Discovered by chance in the early 20th century, the main part of this collection consists of five polished stone axe-hammers, three mace heads, five composite metal artefacts made from gold and silver alloys, and a few fragments of copper alloy sheet.

Much has already been written about this assemblage, but by adapting the systems developed by the FLAME project to accommodate silver and gold alloys, we were able to use high quality lead isotope and trace element analysis to test existing assumptions and to explore the technological choices made in the production of these artefacts. The results offer a more complete understanding of the metal components of the assemblage and new insight into its coherence as a group.

Merging Myths and Metallurgy: Iron Smelting Landscapes of Black Sea Region

Nathaniel Erb-Satullo

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Recent work has shined new light into the extensive copper metallurgical landscapes of the Caucasian Late Bronze and Early Iron Age, while at the same time revising earlier claims for precocious iron smelting in the area. Yet, Classical mythical and ethno-historic texts frequently mention the areas to the south or southeast of the Black Sea as a major iron metallurgical center. A group known as the Chalybes, whose very name is intimately connected with the Greek word for steel, are often referenced in these texts, but little is known about them beyond their connection with metallurgy.
For the first time, archaeological survey and laboratory analysis of production debris has documented numerous iron smelting sites in the Southeastern Black Sea region. Some of these iron smelting sites date to the 5th-3rd centuries BC, precisely the period when Classical authors began to write about the region's iron metallurgy, while others date to the Medieval period. Analysis of metallurgical debris from these sites show that while the technology in both periods is fundamentally one of bloomery smelting, furnace conditions were such that metalworkers occasionally produced liquid iron, likely facilitated by the high phosphorus and carbon content of the metal. Evidence of liquid iron in the slags from these sites correlates with the presence of vitreous low-iron slags (<30 wt% FeO), which are found in significant quantities at some sites.
The results of survey, dating, and laboratory analysis provide archaeologically grounded evidence for the metallurgical industry that inspired the metallurgical admiration of the Classical world. Indeed, the Chalybes may be more a distinct social class of metalworkers who may have been active across a wide area to the south and southeast of the Black Sea, rather than a territorially-fixed, geographically-discreet tribe. The research has implications not just for the interpretation of Classical texts, but also for understanding the interactions between various liquid iron technologies of Central, South, and East Asia (e.g. cast iron, crucible steel) and the bloomery traditions of western Eurasia. Antique-period and Medieval iron smelting in the Near East and Central Asia is poorly documented archaeologically, meaning that the types and sources of the metal feedstock for the well-known crucible steel process are based largely on the interpretation of textual sources. Studies of primary iron smelting sites are thus essential for understanding both the technology and organization behind the iron economy these regions.

Movement and Connections in the Bronze Age

Chris Gosden

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This paper offers a few thoughts on the variety of Bronze Ages we can see across Eurasia, which are occasioned partly by the FLAME project and might possibly also be helpful to FLAME members in thinking through their results.

It is, of course, obvious that the Bronze Age is a blanket term which covers many cultural groupings that happen to use bronze. My initial question is 'can we distinguish between various bronze using cultures in a useful and systematic manner?' My starting point was wondering whether there was any similarity between the Mesopotamian and Chinese Bronze Ages, despite the fact that the former is much earlier than the latter. In both cases bronze comes from the outside – Anatolia in the case of Mesopotamia, the steppe with China. Once introduced to these larger scale societies remarkable innovations occur, which in the Chinese case centre around large ritual vessels, but without much influence outside China and in Mesopotamia result in the first use of a range of a great range of techniques, later to become basic to metalworking in many places. On the steppe, the Bronze Age is connected with increasingly mobile societies and large-scale connections across Eurasia but focusing on a restricted range of metal forms. A similar restriction in the range of forms was found in temperate Europe, this time with a mosaic of mobile and more sedentary societies and with much emphasis on the deliberate deposition of some material.

In the paper I will try to tease out some of these distinctions in history, technique and form, as well as asking some questions about the implications of each for the flow of metals.

Material connections: explorations of local and globally shared histories using African archaeomaterials

Shadreck Chirikure

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As set in the archaeological record, the production, use, reuse and discard of materials is one of the most long-established human behaviours. In Africa south of the Sahara, the late Holocene witnessed significant lifeway transformations from hunting and gathering to crop and animal domestication as well as sedentism. This was accompanied by the adoption of innovations in essential areas such as pyrotechnology, especially ceramics and metallurgical production and use. From the mid-first millennium AD onwards, material circulations between Africa and regions such as Eurasia intensified. This was built on pre-existing internal networks of trade and exchange. Traditional scholarship tends to emphasise the view that in its encounters with the external, Africa mostly supplied raw materials and labour in the form of slaves. However, this one-sided view raises a series of questions. For example, what innovations and improvisations did Africans make in the field of pre-industrial metallurgy? As a follow on, did some of these technological interventions end up in Eurasia? If so, how may we approach the identification of such African contributions? Informed by nearly two decades of field based, laboratory-inspired and theoretically grounded studies of pottery, metallurgical remains and glass beads, this talk engages with these and other highly provocative questions. It argues that a significant mindset shift is required to understand the contributions of African materials to local and global histories from within the continent looking outside. Failure to achieve this closes off a potentially interesting exploration of Africa’s material and intellectual contribution to globally shared histories.

Does my data look big in this? Reflections on scale in Big Data approaches.

Philippa Howarth

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The application of the FLAME methodology to the chemical data-set of Bronze Age Southwest Asia was not as successful as when it was applied to the data collected from other regions of Eurasia. In order to understand why this was so, this talk will focus on current theories and terminology of other disciplines which successfully incorporate 'big data' approaches into research, such as neuroscience and sociology. The term 'big data' itself has become increasingly nebulous since its inception in the late 90s, when it referred to any data too large to fit onto a computer, and in recent years there has been some contention around how it ought to be defined. The disparity between database size and character grows ever larger, with collections of smaller and more defined research projects into one uniform database to the harvesting of exhaustive data produced daily by social media accounts. There are also many different forms of information that are collected which have differing parameters or levels of completeness. By comparing the FLAME subset of Southwest Asian data which contains less than 10,000 copper objects to types of data within these various research projects, we will explore what it is that determines the level of success of some analytical research, to what extend the factors are unanimously transferable despite these disparities, and whether the size of the data-set really is pivotal to meaningful investigation

The Living Dead:
Beaker Communities on the Yorkshire Wolds

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While genetic evidence has breathed new life into the recurrent spectre of major population replacements at pivotal moments in European prehistory including the introduction of copper metal working during the transition from the Neolithic to the Bronze Age, isotopic evidence from the Beaker People Project is more nuanced and suggests that the introduction of copper metal working to Britain is embedded in a complex network of interactions between local communities. This paper explores the isotopic evidence from Beaker burials on the Yorkshire Wolds, highlighting problems with the baselines routinely used to determine the possible geographic origins of individuals and rebalancing narratives about mobility and migration to include both locals and non-locals. The interactions between communities that can be inferred from the Beaker isotopes are rooted in the past and tell us as much about stone as they do about the introduction of metal.

The Late Bronze Age metal workshop from Teleac, Transsylvania

Bianka Nessel, Claes Uhnér, Horia Ciugudean, and Svend Hansen

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During recent excavations and geophysical surveys at the Late Bronze and Early Iron Age fortified hilltop settlement in Teleac, jud. Alba in Transylvania a large specialised area for high temperature production activities was found. A comparatively small area included the remains of a building adjacent to the fortification system with several ovens and hearths, burned soil, charcoal and ashes. The building also contained slag and technical ceramics probably used for metal casting, which indicate that it was a metal workshop. Comparable finds of production areas in settlements from this period are very rare in south-eastern Europe and not much is known about the structure and organization of production activities. The presentation focuses on what materials were worked in this workshop and how important it was for the economy of the settlement using archaeological, geophysical and archaeometallurgical methods.

Copper and copper alloys from Southern Germany and the Alps in the Iron Age

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Broad analyses of copper alloys from different sites from Southern Germany and the Alps dating from Bronze Age to the Early Roman times has been performed during the last decades. The data clearly indicate several changes in copper sources, alloying practice and supply. The rising demand for copper during late Bronze Age comes along with the decline of the large chalcopyrite mines, a renaissance of fahlore copper and a change in smelting practices during late Bronze Age. There is analytical and archaeological evidence for the mixing of copper from different sources and the mixing of raw material with scrap. With the beginning of the Iron Age, there are no fundamental changes, but places like the salt mine of Hallstatt shows a distinct change in copper supply from the late Bronze Age to the Early Iron Age. During the Early Iron Age, leaded bronze appear, but due to the lacking of substantial data sets, we can only observe a sporadic use. The oppidum of Manching in southern Bavaria had an unusual longevity over most likely three hundred years. The earliest brooches from the graveyards clearly show fahlore signatures and some of the lead isotopes would match the fahlores from the Inn valley in Austria. During the Middle La Tène period the impurity pattern indicates new sources and less fahlore copper, but by the end of the 2nd century BC a very special kind of highly leaded antimony-bronze came into use, which was deliberately used for special items. During the last decades of the settlement, there is ample evidence for recycling of metal and the analysis show that some Roman republican tableware has been mixed with regional copper alloys.

Bronze Age types and classes: A materialist approach to measuring form and flow

Steven Matthews

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The relationship between individual metallurgical samples and the Copper-Groups or 'Spaces' of the Oxford System posit the latter as theoretical or 'materialist' classes, arbitrary units carved out of the continuum of variation for measuring change within the constant flow of compositional variation.

The study of metallurgical systems during the European Bronze Age, however, is severely hindered by the fact that these Copper-Spaces must make reference to classificatory units of artefacts that are instead commonly perceived to be historical or 'essentialist' in nature. As a consequence, change is modelled as abrupt, as the total replacement of one 'type' by another 'type'. This is in part due to a failure to differentiate between types, as theoretical classes, and the artefacts, as an empirical group, from which the type concept is derived. As a result, types and other classes are treated as essentialist rather than materialist phenomenon.

We suggest that the study of variation in time and space would be better served by these materialist units, where the emphasis is upon a constant flow of dimensional change within classes, rather than a scheme modelled on the successive replacement of types alone. This change is best achieved not by the replacement of traditional schemes of classification by some new or fashionable approach but rather by an expansion of these traditional schemes, pre-existing within the history of archaeological thought. There are, of course, different kinds of classes, and some classes are types and others are not. Some of these classes, such as types, have proved excellent for dividing up time, by delineating chronological phases, and space, as the basis for style-zones, complexes and archaeological cultures, whilst other classes are better suited for measuring change over time.

Here we will demonstrate the value of a materialist perspective by exploring the use of types and other less commonly used classes for studying the flow of variation amongst Late Bronze Age grip-tang swords within Atlantic Europe, and the relationship of these to changing Copper-Space classes.

Seahenge: Linking the extraordinary with everyday metal use in the British Early Bronze Age

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The first Holme-next-the-Sea timber site, popularly known as Seahenge, is a striking and powerful monument. Originally placed near high tide on the north Norfolk coastline, it is now housed (not uncontroversially) in a bespoke gallery in Kings Lynn. The upturned tree stump and surrounding wall of timber is a remarkable survival from the summer of 2049 B.C., which falls close to the widespread adoption of bronze in Britain. Though no metal objects were found in the rescue excavations, the woodworking marks attest to the use of 51 distinct axes and similar tools. This surprisingly high number contrasts with the few contemporary axes in our museum collections. Not only this, but the shape of the tool marks are systematically different from those we have recovered. Seahenge is therefore an extraordinary site, which might help us better understand the very ordinary reality of metal use. It also helps question what the extant, museum held, bronze axes really represent. This has challenging implications for the scientific study of early bronze. Are we really analysing the metal prehistoric people allowed us to find, rather than what they were actually using?

Provenance, transfer and mixing of metal in Scandinavia's early Bronze Age: 2000 -1600 BC

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The rich and long-lasting Nordic Bronze Age was dependent throughout on incoming flows of copper and tin. Already in the second phase of the Late Neolithic (LN II, c. 2000–1700 BC) the availability and use of metal increased markedly and marked the crucial turning point for the development of the NBA.

As the precise provenance of copper reaching Scandinavia in the early second millennium was unclear, and our knowledge about the driving force leading to the establishment of the Bronze Age in southern Scandinavia was fragmentary and incomplete a new large scale study on the metal supply networks of the earliest Scandinavian Bronze Age was called into life. Here, the first results are presented, drawing on an extensive data set of 210 samples representing almost 50% of all existing metal objects known from this period in Denmark. The aim was to investigate the copperbased artefacts using trace element (EDXRF) and isotope analyses (MC-ICP-MS) in combination with substantial typological knowledge to profoundly illuminate the contact directions, networks and routes of the earliest metal supplies.

The results indicate the use of artefact metal within the local metallurgy and the local recycling or mixing of metals originating from different ore regions. Both continuity and change emerge clearly in the metal-trading networks of the Late Neolithic to the first Bronze Age period.

New Ways of Thinking about Alloys

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This paper will present some thoughts about new ways of thinking about data on copper alloying which is particularly suited to sites which have complex alloys (those alloys which contain more than one alloying element). It is a development of the alloying categorization used for Cu-Pb-Sn alloys in both Central Chinese and Roman metalwork. A case study will be presented on a small (c. 90) dataset of Steppe-type alloys, and a larger dataset (c. 8,400) from Western Asia. Whilst this approach is in no way a substitute for detailed site-by-site analysis of metalwork and associated metallworking debris, it does allow large-scale geographical and chronological patterns to be visualized.