



Research in Progress Meeting



Abstract Book



**Tuesday the 29th November,
2016**

**Department of Metallurgy and
Materials Building,
University of Birmingham**



**UNIVERSITY OF
BIRMINGHAM**



Programme

9.20-9.50	Registration with tea/coffee	
9.50-10.00	Introduction & welcome	
10.00-10.20	Umberto Veronesi, Miljana Radivojević, Antonina Ermolaeva, Albina Eržanova	Bronze Age Metal Production in the site of Taldysaj, central Kazakhstan
10.20-10.40	Raphael Hermann	Unlocking Bronze Age Swordsmanship
10.40-11.00	Steffan Golby	Regional variation in iron production practices in the English Iron Age
11.00-11.20	Elisa Grassi	Metalworking in the medieval town: the case of San Tommaso in Pavia
Break 11.20-11.50		
11.50-12.10	María Teresa Plaza	Technology, use and reuse of gold in San Pedro de Atacama, northern Chile: The case of Casa Parroquial
12.10-12.30	Jasmine Vieri	Regional and Temporal Patterns in the Composition of Pre-Columbian Goldwork
12.30-12.50	Yi-Ting Hsu	Analysis of cupels and minting materials from the late medieval Mint of Porto (Portugal)
Lunch and poster session 12.50-14.00		
14.00-14.20	William Hawkes	Silver cleaning with saponin project
14.20-14.40	Andy Cuckson, David Poyner and Mike Shaw	Lead and Silver in South West Shropshire
14.40-15.00	Martin Roberts	Alloys Used by London Pewterers in the 16th Century: emerging evidence from the analysis of pewter from recent shipwreck excavations
15.00-15.20	Peter King	Shadrach Fox and greensand ironfounding
15.20-15.40	Kay Smith	South-east Asian cannon project
Break 15.40-16.00		
16.00-16.40	Keynote speaker Prof Murakami	New fieldwork on the transmission of iron technology across Asia – Kazakhstan to Japan, via Siberia, Mongolia, and China
16.40-16.50	Final Words	

Posters will be on display throughout the meeting and a dedicated poster session will be held during the extended lunch break.

Poster presentations

Ben Price	3D scanning of Iron Age mould fragments and the recreation of the resulting artefact using 3D printing (TBC)
Ethan Greenwood	The iron industry of the weald (TBC)
Joan Unwin and Marion Unwin	Ultrasonic non-destructive investigations of the internal structure of metal artefacts: multiple layers and complex interfaces
Hector Cole and Richard Henry	Forging an archaeological copy of a miniature Roman sword
Yasufumi Sasazawa	Experimental reconstruction of a 6 th century Japanese box-type iron furnace
Seiji Manabe	An Asian box-type steel furnace of the 17th - 19th century

Bronze Age Metal Production in the site of Taldysaj, central Kazakhstan
Umberto Veronesi (UCL Institute of Archaeology), ***Miljana Radivojević, Antonina***
Ermolaeva, Albina Eržanova

The Bronze Age settlement of Taldysaj is situated in the vicinity of copper-rich deposits of Jezkazgan-Ulytau, oblast Karaganda in central Kazakhstan. Its convenient location next to the sources of copper prompted extensive research campaigns starting from 1994, which uncovered substantial remains of massive metal production throughout this settlement. Two horizons of occupation reveal intensive metallurgical activities belonging to the Andronovo cultural complex (c. 1700 -1500 BC) and LBA culture of Alekseevka-Sargary (c. 1300 – 1000 BC). Large workshop areas dotted with a number of pit-furnaces and slags evidence intensive metallurgical activities, which, along with the discoveries of numerous metal artefacts, shed light on the scope of metal production at this site and its wider importance in the Karaganda oblast, and beyond. Previous metallurgical studies have thus far concentrated on detailed archaeological interpretation of field finds as well as experimental reconstructions of pit-furnace operating. However, little has been done to investigate the knowledge of Taldysaj smiths involved in the process of metal-making.

Here we present preliminary results of analyses of copper slag samples coming from four different smelting installations / furnaces. We investigated them for microstructure and composition, and explored similarities and differences in relation to their context. Our main questions target the knowledge of metal making, and how standardised it became at the time of flourishing of metal production in the wider area of central Asian steppes, which is understood to make a core part of the Eurasian Metallurgical Province, as termed by E.N. Chernykh. The preliminary analytical study we conducted on this settlement is set to pose more questions on the character of organisation of metal production in the central Asian steppes, in which the site of Taldysaj seemingly occupied an important niche.

Unlocking Bronze Age Swordsmanship
Experimental archaeology and use-wear analysis of Late Bronze Age swords
***Raphael Hermann* (Newcastle University)**

The study of prehistoric warfare has seen renewed interest over the last two decades; this has allowed a reappraisal of the role of warfare and interpersonal violence in Bronze Age Europe, but more research is needed to understand how weaponry was used in combat both quantitatively and qualitatively. Championing a use-wear analysis approach backed by rigorous field tests this project seeks to investigate the macro- and microscopic marks left on swords in Bronze Age sword fighting encounters. The aim is to understand how swords were used, in what kind of combat situations and with what weapon strikes and body motions.

The project is carried out in two steps: initial fully controlled and replicable field experiments with replica weapons were carried out in 2013, following a strict protocol in order to create a collection of reference marks. This summer will see further tests which for the first time combine Bronze Age swords with mediaeval sword fighting techniques to assess the capabilities and limitations of interpreting prehistoric swordsmanship through historical combat texts. The second step is the use-wear analysis of 71 Late Bronze age swords from British museums, and thanks to the generous funding of HMS also of 30 Italian Bronze Age swords from Verona. The swords and their marks are then interpreted in the light of the reference marks created during the experiments. Finally a comparative study between the swords, their marks and possible differences in combat styles is carried out between Britain and Italy is carried out.

In this paper I will discuss the experimental methodology and highlight what I see as the advantages and limitations of the experiments. I will offer insight into what can be learned about carrying out tests to create reference collections of combat marks. Finally I will illustrate the results from the experiments and address the issue of regional differences in sword fighting.

This research is part of a big project researching Bronze Age combat with a variety of weapons. I took part in the field tests and carried out some initial analysis of swords as part of my MA research project in 2014. Being now a PhD student I have massively expanded my research on the topic, looking at a much wider range of British swords in the first step, and comparing them to Italian swords in the second step (thanks to HMS funding 30 Italian Bronze Age swords could be analysed to date) before carrying out further combat experiments and testing the practicality of historical analogy.

Details about the general project can be found under <https://sites.google.com/site/bronzeagecombat/> and more information about my current PhD research project can be found under <http://www.ncl.ac.uk/historical/study/postgraduate/research/phdstudents/RaphaelHermann.htm> Being a PhD student at Newcastle University I would like to be considered for travel reimbursements to attend the conference. I am a current member of HMS.

Regional variation in iron production practices in the English Iron Age

Steffan Golby

The inception of iron technology within Britain follows dramatic and widespread social transformation at the end of the Late Bronze Age, yet the adoption of iron is a process of which we have little detailed understanding. Despite welcome efforts to admit a social dimension within technology and metallurgy, early iron metallurgy in Britain, particularly primary production, is still understood largely in terms of the parameters of the technical process. What has been less forthcoming, and what this research seeks to provide is a contextual analysis of Iron Age iron technology, in which the parameters of what we consider technology are expanded to include elements of the located environment. How metalworkers chose to situate their craft in the landscape and social dynamics of Iron Age society is seen as integral to understanding how the changes in the Late Bronze Age impacted the adoption and reproduction of iron-working practices.

This study examines a holistic range of archaeometallurgical, spatial and cultural data and evidence associated with production sites from several regions in England, and attempts to characterise regional production practices. This is supported by quantitative analysis which intends to elucidate regional variation and to identify patterns in the data which are compared and interpreted in terms of the production practices they relate to. This has allowed for a broader insight into regional traditions of iron production which can be more readily understood in relation to their located environment, and in the wider context of social transformation and change emanating from the Bronze Age-Iron Age transition.

Metalworking in the medieval town: the case of San Tommaso in Pavia

Elisa Grassi (Università Cattolica del Sacro Cuore, Milan)

In 2013, extensive excavations were carried out in the historical centre of Pavia, one of the oldest cities in Northern Italy, bringing to light substantial remains of the Roman and Medieval town. While the attention of public and media was drawn by the monumental remains of late-Roman buildings, other potentially highly informative finds were initially disregarded. A few assemblages of metalworking debris, mainly fragments of furnaces and slags belonging to the late-medieval layers, were recently re-discovered in the storages. They testify that both iron and non-ferrous metals were worked here: even though the study is still in its preliminary phase, it appears clearly that this evidence will be capable to shed light on a few aspects of the economy, trades and productions of the medieval town.

Technology, use and reuse of gold in San Pedro de Atacama, northern Chile: The case of Casa Parroquial

María Teresa Plaza (UCL Institute of Archaeology)

The Middle Horizon (AD 400-900) in the South Central Andes is characterised by dynamic interaction between different areas, using long distance exchange routes that connected the Bolivian highlands, southern Puna, northwest Argentina and the valleys of the pacific coast. In this picture, San Pedro de Atacama appears as strategic node where many of these routes linked, becoming an important political, religious and economic centre. During this period large quantities of foreign items and exotic raw materials appear in the cemeteries of San Pedro; and amongst them a series of gold and silver grave goods. The quantity of these items, nearly 200 (2.5kg), all concentrated in one locality is striking for the Middle Horizon. In general, gold findings are not very common in the South Central Andes; and when they are found, they are usually grave goods or offerings associated to specific individuals. Therefore, the presence of several cemeteries in San Pedro with a number of individuals bearing gold (and silver) offerings is very special and different from contemporary contexts. Nevertheless, there has been no previous attempt to investigate the technical characteristics of this assemblage, its use and the role of precious metals in San Pedro.

In my research I am studying the gold and silver technology and their use in San Pedro de Atacama, during the Middle Horizon; and here I would like to present some preliminary results from a specific cemetery, Casa Parroquial. The analyses -including pXRF, SEM-EDS, PIXE and the recording of manufacture traits- suggest that objects deposited in San Pedro were made of natural gold, as well as by artificial gold-silver alloys. Two technological groups were identified, both containing objects that were most probably imported from the Bolivian altiplano and northwest Argentina. Furthermore, within both groups there are reused and modified objects, which point out to a local tradition that is re-shaping imported objects according to their needs and tastes. The characteristics of this work however, -using simple mechanical means such as punching, cutting and folding- suggest that the figure of the goldsmith (or silversmith) was not necessary. The distribution of the gold offerings also shows interesting patterns, where most people bearing gold, have 1 or 2 artefacts, whereas two burials (a man and two newborns) concentrated most of the offerings. These patterns would support the idea of the development of social classes and inheritable wealth in San Pedro for the period.

Regional and Temporal Patterns in the Composition of Pre-Columbian Goldwork
Jasmine Vieri (UCL Institute of Archaeology)

With an increasing number of archaeological research being conducted on pre-Columbian gold metallurgy, our understanding of metallurgical practices involving the use of gold in different parts of the Americas is continuously improved; in particular, style and iconography have received scholarly attention, leading to the establishment of several different metallurgical 'traditions' throughout the area. Simultaneously, chemical and technical analyses of gold alloys are increasingly allowing syntheses of technological and ideological practices within the different metallurgical areas. However, until now a large-scale synthesis bringing all this compositional data together has yet to be put forward. Through the collection and analysis of legacy data, this study aims to examine inter-regional and temporal patterns in gold metallurgy north of Peru through to Central Mexico. In addition to identifying and mapping preferred alloys, the data allows us to explore possible correlations of alloy compositions and their properties such as colour, hardness, malleability and melting point, with artefact function, form, manufacturing technique, dimensions, or archaeological context.

Analysis of cupels and minting materials from the late medieval Mint of Porto
(Portugal)

Yi-Ting Hsu (UCL Institute of Archaeology)

In operation between the 14th and 17th centuries, the Porto Mint is one of the most extensively excavated coin minting sites in Europe. Using archaeological, archaeometric and historical information, this project focuses on the practical dimensions of minting technologies carried out at the Porto Mint, with a special focus on fire-assay.

Cupels, coin blanks and struck coins from the Porto Mint, representing different stages in the minting process, are examined. Chemical and microstructural analyses of the cupels have allowed a reconstruction of their raw materials, utilisation and performance, leading to the identification of two possible activity areas with different technical functions. With the ongoing analysis on coin blanks and struck coins, the characterisation of metallurgical processes practiced within the cupels and broader minting technologies will be expanded. The degrees of standardisation and efficiency of metallurgical processes will be discussed as well. By referring to historical studies on mints and previous work on relevant archaeological materials, the broader significance of this study will be discussed.

“Shiny, safe and... Green!”
William Hawkes

Since around 400 BC mankind has worked silver into evermore elaborate and decorated objects. As time has progressed these objects have found a status in the stately homes and museums around the world, as objects of importance, objects that recall events, societal changes and prevailing thoughts down the millennia.

Despit this importance and since 1953, very little thought has been given to how these objects of silver, and other noble metals, have been cared for. The prevailing treatment, through previous Masters research by the author has been proven to be detrimental to the surface of objects and is, in fact, very limited in its methods of use.

As part of the author’s research for his masters in Conservation Studies, the saponin molecule, derived from *saponica* sp. plants as part of the plants immune system, was assessed against acidified thiourea to compare the etching effect of each of the two reagents. The clear result of the study was that saponin was less degradative to the surface of the silver object, and that this method warranted further research.

Therefore, the proposed PhD research, intends to examine more closely the ability of a green and sustainable solution, based on saponin, to clean these objects that we hold dear. Where possible it is intended that the new treatment solution should replace the existing, detrimental solution, and to provide a sound alternative treatment option to conservators across the globe.

Lead and Silver in South West Shropshire
Andy Cuckson, David Poyner and Mike Shaw

The authors are active in the research and writing of Shropshire metal mining history.

A number of historic lead and perhaps silver-lead mines in the county are now controlled to preserve physical evidence.

Archaeological investigation, including often-neglected underground aspects, can still tell us much about the metals produced and the general history of these mines. The results will need incorporating into new historical accounts.

Open cast works at Roman Gravels mine and smelting boles on the hillside above Snailbeach mine could yield metallurgical information from the medieval and Roman periods.

The actual ages of these two mines, and whether or not they produced silver-rich lead, are still unknown. Thorough archaeological work might provide the answers.

Alloys Used by London Pewterers in the 16th Century: emerging evidence from the analysis of pewter from recent shipwreck excavations

Martin Roberts

Independent Researcher and Consultant on the Pewter Wreck Project

Several previous studies of alloy compositions of 16th century pewter assemblages – notably that from the Mary Rose – have established a general picture of typical practice.

Drawing on evidence from pewter recovered during more recent excavations of 16th century shipwrecks, this paper discusses the trade secret in the alloy which built the reputation of London-made pewter both domestically and in export markets. Then, exploiting documentary and historical sources, it discusses the likely process of covert transmission by which pewterers in the Low Countries came to know and exploit this obscure technology.

Shadrach Fox and greensand ironfounding

Dr Peter King

Shadrach Fox preceded Abraham Darby as tenant of Coalbrookdale Furnace. His business there included ironfounding. His brother Thomas has worked as a founder for the Company for Running Iron with Pitcoal and Shadrach made 'bullets' (cannon balls) and grenado shells in the Dale in the 1690s. Traditions recorded at Coalbrookdale indicated that the furnace exploded during his time as a result of water entering the hearth. In 1701, Shadrach employed Thomas to operate a furnace at Wombridge, one probably not used since about 1670. For this, he contracted for a supply of coal from Isaac Hawkins' Malinslee mines. I argued in a Newcomen Society paper that this pointed to Fox smelting iron with pitcoal. I have recently found evidence that he also engaged in sand founding. He recruited Roger Downes, a brass founder from London to cast iron pots at Coalbrookdale. Fox failed financially and 'went away', after which Downes went to work for Zachary Downing, casting pots in sand for him, Hales and Cradley Furnaces in the West Midlands, and at Gwendrath near Kidwelly. While Cradley was out of blast, Downes made loam moulds and then went to work for a brassfounder in Birmingham, until the furnace was blown in. He then met Abraham Darby at Stourbridge and was recruited by him, being paid £100 at once and a further £650, perhaps £50 per year for the remaining 13 years of Darby's patent. The proceedings concerned a dispute as to who owned certain 'tools', apparently patterns, which Downes surreptitiously removed from Cradley, when the clerk and stocktaker had gone to bed.

South-east Asian cannon project
Kay Smith, Ruth Rhynas Brown, Pauljac Verhoeven

Bronze cannon were made in a wide area of south-east Asia ranging from north-west India to Borneo, Java, Indonesia and the Philippines. However, little work has been carried out on them and they are little understood. Their origins, dating, development, technology and their ornament are all areas which need to be researched. Although there are many examples throughout Europe, one of the largest collections is that in the collection of Museum Bronbeek in Arnhem who have a collection of some 70 pieces. Work has started to catalogue the collection and try to establish a baseline for further research.

Integral to the project is the analysis of the entire group and it is hoped that at least 3 samples of each will be obtained and analysed. Work has started on their identification and already some interesting information is coming to light. For example it has been noted that many of the pieces are magnetic to a greater or lesser extent. This is not due to an internal frame of iron but appears to be a property of the metal itself.

All the cannon were cast with a core, forming the bore, in situ and this was held in place by chaplets made of iron. The pattern of chaplets, ranging from the simple, two sets of two chaplets, to complex arrangements of sets of chaplets along the entire length of the piece are also being studied. This paper will present the project and some of the, as yet, very preliminary results and observations.

Ultrasonic non-destructive investigations of the internal structure of metal artefacts: multiple layers and complex interfaces

Dr M. Joan Unwin (Archivist to the Cutlers' Company, Sheffield) and **Dr Marion E. Unwin**
(Assistant Professor, Department of Electrical and Electronic Engineering, University of
Nottingham)

The aim of this project is to learn more about the manufacturing processes of quality metal items using objects from the collections of the Cutlers' Company of Hallamshire.

Historically, Sheffield cutlery and silverwares involved the production of multiple layers of iron and steel or copper and silver respectively. The complex geometry and thickness of these internal layers gives information as to the manufacturing processes and resulting quality. However, previous studies have often required physical damage to artefacts to determine internal characteristics.

Here, we are developing a non-destructive ultrasound technique that can be applied to multiple and high value museum quality artefacts. Sophisticated ultrasound techniques are routinely used to analyse complex engineering structures in the aerospace and automotive industries. These techniques are now being applied in an archaeological context.

Forging an archaeological copy of a miniature Roman sword *Hector Cole MBE FWCB and Richard Henry.*

In 2010 a Roman site was identified near Tisbury in South Wiltshire. The site was identified through meticulous metal detecting where every piece was recorded with a GPS and then recorded with the Portable Antiquities Scheme.

In 2015 a furnace was excavated which is likely to be of late Roman or early post-Roman date and almost a tonne of slag was recovered which is being analysed by David Dungworth. The iron smelting and evidence of iron working through the discovery of a substantial cross-peen hammer highlights the importance of the site. The Roman shrine is of particular interest as it includes the largest known assemblage of iron miniature objects in Britain. These include miniature spears, ballista bolt heads, hammers, axes, anvils, padlocks and swords. Of the three potential swords, one was part of a blade, the other was the blade with an iron hilt cap and the third one was a complete sword, small finds number 41378 from context 12004.

It was decided to reproduce the complete sword based on the archaeological evidence of the analysis of this sword.



The walking route shown – on exiting the station turn left, and follow the main road into the campus, going through a tunnel next to a bicycle maintenance shop. It then opens up into a park area, if you turn left and head between the new and old library you will end up opposite the metallurgy department. Alternatively for a route that requires fewer stairs if you follow University Road West to the sport centre, then take a left turn past the sports centre you will also end up on Pritchatts Road.