Beyond the miniature: An exploration of the artistic and religious dimensions of Tamil Nadu's bronze scupltures

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Keywords: miniature bronzes, lost wax technique, South India

The production of bronzes in early medieval Tamil Nadu was linked with political and religious developments. The images were produced in large number from the 8th to the 18th century, principally in the Thanjavur and Tiruchchirappalli districts of modern Tamil Nadu and maintained a high standard of excellence for almost 1,000 years. The bronze images of South India are classified into three sections: "Chala" that is moveable, which are in bronze and are easily portable; utsava beras, or procession deities; Achala (immoveable), in stone, large and heavy. In this paper, the researcher will explore the fascinating world of miniature Chala (movable) bronzes from the 17th to 18th centuries AD. The study aims to delve into the complexities of Silpasastra, the traditional art of sculpture-making, to uncover the techniques and processes involved in crafting these exquisite bronze sculptures. By examining historical context, artistic methods, and cultural significance, this research seeks to provide a comprehensive understanding of the craftsmanship and heritage embedded in these remarkable artifact.

Surface enrichment and deterioration patterns of two silver punch-marked coins from Tekttha, Naogaon, Bangladesh: An X-ray diffraction analysis

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Keywords: silver punch-marked coins, X-ray diffraction, surface enrichment, deterioration patterns, Tekttha, Naogaon

The study presents a detailed analysis of two silver punch-marked coins from recently discovered early historic site Tekttha, Naogaon, Bangladesh. Using X-ray diffraction (XRD) techniques, this study attempts to provide a thorough understanding of the surface enrichment and deterioration patterns of these coins. Numerous compounds are found in the investigation, including tenorite (CuO), copper oxide (CuO), silver (Ag), copper zinc (CuZn), and zincite (ZnO).

The XRD analysis highlights the long-term effects of chemical and environmental interactions, revealing a sophisticated understanding of the surface composition. The presence of zincite indicates complex metallurgical processes, while the detection of copper compounds and their oxides suggests significant corrosion processes. With their insights into the mechanisms of degradation affecting these artifacts, these findings are crucial for conservation efforts.

This study provides insights into the metallurgical practices and post-depositional alterations of ancient coinage within a region. These results contribute to a broader understanding of the culture and economy of ancient Tekttha, revealing technological capacities and substance dynamics in antiquity. The use of XRD in this context highlights its effective-ness for archaeological science, encouraging non-invasive research that preserves the integrity of artifacts while unveiling their historical narratives.

Degradation of tin foils on historic Leyden jars

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Keywords: tin, metal foil, Leyden jar, SEM-EDX, conservation

The Rijksmuseum Boerhaave's collection of scientific instruments contains around 60 Leyden jars. These objects are common to scientific instrument collections across the world and are notorious for developing problems with their metal foil layers, often leading to total loss of external foil. A collaborative research project between the University of Amsterdam, Rijksmuseum Boerhaave, and the Dutch Cultural Heritage Agency (RCE), aimed to investigate and develop a treatment strategy for this problem. Three representative Leyden jars were selected as case study objects, and loose foil flakes were collected from a total of 11 separate Leyden jars in the Boerhaave's collection. Using UV irradiation, SEM-EDX, micro-XRF, and FTIR, the metals foils, original adhesives used to adhere the foils and remnants of past consolidation treatments were analysed, providing better understanding of the jars' production, history, and the degradation processes taking place. The results from these analyses were then used to develop a suitable treatment protocol for the fragile foil layers.

Characterising the corrosion of the SS Great Britain using handheld XRF

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Keywords: historic ship, corrosion, iron

The SS Great Britain, designed by Isambard Kingdom Brunel and the largest ship afloat when launched in 1843, is Bristol's top-rated tourist attraction and makes a vital contribution to the UK's cultural heritage. However, preserving the salt-water impregnated iron hull remains a challenge. To develop effective and sustainable conservation strategies, a corrosion baseline must be established against which to assess future changes. However, conventional methods for characterising corrosion, which typically involve transporting samples to a laboratory, are impractical for large heritage and often require sample destruction. Therefore, developing in-situ techniques for corrosion assessment is essential for the preservation of cultural heritage. Here, we propose using handheld X-Ray fluorescence (hXRF) as a new approach to characterise corrosion of large-scale heritage iron. The hXRF data offers a comprehensive elemental analysis of the SS Great Britain's hull, enabling the identification of spatial variations in the corrosion extent. Furthermore, supporting laboratory measurements show that the corrosion layer comprises not only the anticipated iron (oxyhydr)oxides, but also a significant portion of carbonate and silicate minerals. Crucially, the presence of these impermeable phases may inhibit corrosion by acting as a passivation layer that impedes moisture and oxygen from reaching the metallic iron below.

Reconstructing letterpress technology through the Baskerville punches: new scientific data to reverse-engineer a practically lost craft

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Keywords: John Baskerville, iron, printing press, pXRF, optical microscopy

John Baskerville (1707-75), England's foremost printer, was the designer of the famous Baskerville typeface. His designs for roman and italic, upper- and lower-case, and numbers and symbols, were cut into small iron bars (punches) of various sizes which were then used to produce the types for the printing press. >3,000 Baskerville punches have survived until today, representing one of the most complete collections. However, very little is known about punch-making, nowadays a practically lost skill at the core of printing technology, cross-cutting black smithing, engraving and other crafts.

As part of the AHRC-funded project "Small Performances", and with the aim of reverse-engineering punch-making technology, we developed an ad hoc calibration to conduct surface pXRF analyses on >300 punches. These analyses served to identify distinct compositional groups that correlate with typological, macroscopic features. The groups were cross-referenced with observations under the optical microscope to understand letter cut techniques. As a result, we propose a series of hypothesis on how different metal batches interlinked with individual ways of forging and cutting these iron bars. This will ultimately allow us to better understand this technology, as well as the organisation of the workshop where these punches were manufactured in 18th century Birmingham.

Race and civilisation in John Percy's Metallurgy (1864)

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Keywords: iron smelting, race, technology, colonialism

In the Victorian 'Age of Metallurgy', more metals were 'discovered' than in any era before. With the influx of these new materials along with metal-based technological developments of the First and Second Industrial Revolutions, metallurgy became a key science and practice in British industrial imperialism. Metal-dependent industries, such as transportation, arms, and communications boomed as the British Empire expanded over the globe's surface and subsurface, increasing extraction and production of more metal-based technologies that would optimize further exploitation of colonised land and labour.

In his 1886 President's address to the Iron and Steel Institute, metallurgist John Percy proclaimed that "the history of the metallurgic arts is involved in the history of the civilisation of man". Using this quote and Percy's seminal text Metallurgy: Iron and Steel (1864) as a point of departure, I will be investigating Percy's work on coal, iron, and civilisation and its material consequences in the context of British industrial imperialism. This work in progress investigates the interweaving of racialised ethnological beliefs about civilisation with the creation of metallurgical knowledge as applied to late 19th century British hierarchies of iron smelting technologies with a particular focus on India.

The archaeometallurgy of iron: An introduction for students of archaeology

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Keywords: archaeometallurgy, iron, textbook, China

I have written this on-line multimedia textbook at the request of the Department of Archaeology, Sichuan University. It is far from complete, but after ten years I believe it is as complete as I am able to make it. The most significant lack is a discussion of slag. The Department is now translating the textbook into Chinese. Though the emphasis is naturally on the Chinese scene, I believe it will be useful to European students as well. At the conference I will introduce the textbook, show some samples of the contents, and ask for corrections and suggestions. The address is: https://donwagner.dk/arch-iron.

Comparative optical, chemical, and mechanical characterisation of 18th century and modern re-rolled wrought irons

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Keywords: wrought iron, Blenheim Palace, cramps, metallography

Wrought iron assemblages from Blenheim Palace (18th century) and Topp & Co (modern re-rolled) were subject to optical, chemical, and mechanical analysis to determine their properties. Samples were prepared using standard metallographic techniques and investigated using optical microscopy, scanning electron microscopy, energy dispersive X-ray spectroscopy, Vicker's hardness testing, and tensile testing. A MATLAB code was developed to automatically segment and quantify grain and slag inclusion sizes from micrographs. Chemical properties of samples, processed using principal component analysis, highlighted that the iron and slag components have broadly similar chemical compositions. Differences arise due to different manufacturing techniques used in historic (indirect method with charcoal) and modern (indirect method with coal) samples. More importantly, image analysis revealed that both sets of samples feature similar sized slag inclusions and ferrite grains. The Topp & Co assemblage had greater mechanical properties when compared to the Blenheim Palace samples, although this is again explained by manufacturing methods. Based on this analysis, it is judged that the modern Topp & Co wrought iron can sufficiently capture the chemistry and microstructural characteristics of historic 18th century wrought irons.

Acies Ferri: Construction and provenance of Merovingian seaxes from 5th-8th century Alsace

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Keywords: archaeometallurgy, seaxes, bladed weapons, early middle ages, provenance

Bladed weapons have a means of capturing the imagination that is unrivalled by most other archaeological finds. Not only do they possess a certain romantic flair, as prominent markers of social status, they are an opulent display of the techniques available at a given place and time when funding is no object. Swords have typically taken centre stage of both public fancy and academic study, which has sometimes eclipsed interest in other weapons. To wit, seaxes, the characteristic single edged blades found across Early Medieval Western and Central Europe. A scant few from the continent have undergone metallurgical analysis but wide scale studies, comparing typology, chaîne opératoire and provenance have yet to be undertaken. The Acies Ferri PhD is one such study, focusing on 5th-9th weapons between the Seine and Rhine Rivers. The project currently has access to seven swords and thirty-two seaxes, found across the Alsace region of Eastern France. The present paper aims to cover the progress of the PhD project with particular focus on two aspects of the creation of seaxes in Merovingian Alsace: what links, if any, exist between chronology, typology and sword construction? Where did the iron used for these swords come from?

Improving our knowledge of the circulation of copper and its alloys: the case of the French Pyrenees at the end of the Middle Ages

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Keywords: archaeometallurgy, archaeometry, copper, circulation, trace elements, Middle Ages

The end of the Middle Ages (13th-15th centuries) was a period of profound political, demographic and economic changes in France. In this context, copper and its alloys were available to all social classes in Europe from the 13th century onwards. However, our knowledge of the production and circulation of copper during this period remains limited. A number of mines in the French Pyrenees that may have contributed to copper production at the end of the Middle Ages have already been identified. Compositional analyses (ICP-MS with laser ablation) have been carried out on selections of archaeological objects dating from this period and found in the area where Pyrenean productions were most widespread. These analyses have made it possible to determine the nature of the alloys and to identify potential minor and trace elements that indicate the use of particular ores or enable metal stocks to be traced. This study will enable to investigate the filiation between ores and objects, in order to study changes in circulation areas and supply circuits for copper alloy products.

Recent and ongoing developments of a database related to iron metallurgy

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Keywords: Chemical data, global, iron

For more than 40 years now, numerous researchers in archaeometallurgy have been producing chemical data relating to the exploitation of iron ores, as well as smelting and smithing activities. The aim of the CHIPS database is to bring all this data together and harmonise it in order to facilitate data sharing among archaeometallurgists. Extensive documentation work has also been carried out in order to assess the quality of the data as accurately as possible. We also hope that this database will help to support collaborative research on an international scale in the near future.

Marginalization and perception: The role of disabled in archaeometallurgical societies of Southern highlands, Tanzania

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Keywords: archaeometallurgy, disability

This topic based on the proposed study will examine the perceptions and treatment of people with disability and other marginalized populations within archaeometallurgical societies in the Southern Highlands of Tanzania. The primary objective is to understand how societal attitudes towards disability influenced participation in iron working activities, a crucial aspect of these communities' economic and cultural life. Utilizing a mixed-methods approach, this research will combine archaeological evidence, ethnographic interviews, and historical accounts to investigate the social dynamics surrounding disability in the context of ironworking rituals. Preliminary archaeological findings indicate that marginalized groups often faced systemic exclusion due to prevailing taboos, reflecting broader societal attitudes. However, some archaeological evidence suggests that individuals with disabilities were integrated into specific community roles, challenging narratives of total exclusion. The significance of this research lies in its contribution to contemporary discussions on inclusivity and representation in archaeological narratives. By highlighting the complexities of social inclusion and identity within these ancient societies, this study will advocate for a more nuanced understanding of how perceptions of disability shaped technological practices and social dynamics.

Historical Metallurgy Society Projects: Glossary of Terms and Atlas of Microstructures

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Keywords: archaeometallurgy, historical metallurgy, glossary, microstructure atlas

The Outreach and Value Committee (OVC) of the Historical Metallurgy Society is creating two collaborative projects to provide, on our website, resources for all working in archaeometallurgy: a glossary of terms for these disciplines and an atlas of microstructures from ancient and historic metals and alloys. We invite the community to participate in identifying the words and structures that we need to include and to take part in the research needed to develop the entries in both. At present we are at the design stage and invite participation here too. Examples of typical entries will be given for discussion (for example the whole family of tin alloys used in the past). The atlas is being developed in collaboration with the Archaeometallurgy Committee of ASM International and the format of the pages will match that of their own online atlas of structures, but we invite members to add their own micrographs and take part in the design and editing. We believe the results of these two collaborative projects will be a rich source of knowledge into the future.

Studying the different mineralizations of Laurion through a combined geological and archaeological approach

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Keywords: lead-silver mineralization, archaeometallurgy, mineralogy

Since prehistoric times, the Greek Laurion region supplied the Aegean and particularly the Athenians with silver. Around 500 BC, the yield of the mines was considerably expanded, allowing the city-state of Athens to build a new fleet, thus defeating the Persians in 480 BC. This has been linked to the discovery of a deeper, subsurface mineralization, the so-called ‘Third Contact’. Through my Marie Skłodowska Curie Postdoc project at the National Centre for Scientific Research “Demokritos” at Athens I will explore the feasibility of examining any age and geochemical disparities in the different mineralizations at Laurion. This will be achieved by studying ore-samples using mineralogical, chemical as well as lead-isotope analyses, the latter to be conducted at the German Mining Museum. Additionally, the project seeks to correlate ores from distinct contacts with archaeological artefacts crafted from Laurion ores (silver coins, lead, also litharges, slags etc) exhibiting the same lead isotopic signatures. This will make the chronological sequence of mining in the various mineralizations comprehensible, namely the begin of the exploitation of the ‘Third Contact’.

The first insight into the origins of Ammonite iron through Os isotope analyses of iron arrowheads from the Late Iron Age cemetery of Tell El Mazar, Jordan

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Keywords: iron provenance, osmium isotopes, Iron Age, Levant, Ammon

Located on the eastern edge of the Jordan River Valley, the Tell El Mazar cemetery dates to the 6th–5th centuries BCE. During this time, despite the growing influence of Babylonian and Persian powers in the region, the Kingdom of Ammon retained a degree of autonomy. The research focuses on the provenance of 12 iron arrowheads from Tell El Mazar. Although the artefacts are heavily corroded, they are suitable for provenance investigation through Os isotope analysis, as osmium remains immobile during corrosion. The results reveal a diverse range of Os isotope ratios (187Os/188Os) across the assemblage, which can be classified into five distinct groups. These findings are further supported by siderophile trace element analyses performed by ICP-MS, indicating the use of multiple ore sources for the production of these weapons. Interestingly, none of the objects are consistent with ores from the Mugharet el-Wardeh, a major ore mine situated just 10 km from Tell El Mazar. Notably, two arrowheads exhibit highly radiogenic isotope compositions (5.255-6.124), which align with the isotope characteristics of copper production waste from the Faynan. This allows to raise new questions about the factors, which contributed to the adoption of iron metallurgy in the Levant.

New insights in early bloom processing

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Keywords: iron, bloomery, bloom processing, prehistory

Recent archaeological excavations in Ireland have contributed to our understanding of early bloom processing. The presentation will include insights in the organisation of bloom processing, its technology and the installations and tools used.

An experimental Investigation of Medieval Helmet Forging Techniques

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Keywords: Medieval, armour, experimental archeology

This project focuses on the fabrication techniques of one-piece helmets in Europe between the 12th and 15th centuries. The common assumption is that these would be formed from iron and steel sheet using a process called angle raising, which involves hammering from the outside over a stake anvil. However, modern reproductions made in this way deviate significantly from the originals in both interior texture and, most critically, thickness distribution. Our proposed technique, known as stretch raising, produces much closer results by starting from thick plate and working from the inside against a flat anvil. The implicit advantage from a medieval perspective is that this technique can be applied directly to a refined bloom without the need for an intermediate step of sheet metal production. We compare our results against interior textures and thickness data collected from extant examples. We also draw on contemporary artistic depictions and written records, as well as later evidence of comparable techniques from the early modern period, up to the early 20th century.

Characteristics of malleable irons by the fining techniques used in their manufacture

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Keywords: fining, malleable, iron

There has been a great deal of work done on the characterisation of malleable irons made by the direct, bloomery, process, much less on indirect iron generally and even less on the indirect iron specifically used in Britain between 1500 and 1900. Five processes were used to produce such iron. Classical charcoal hearths came in two variants, known in the 18th Century as the French (or Walloon) method, and the German. The difference was that some form of iron oxide was added in the latter when the pig iron feedstock contained higher silicon levels. Then there were the coal/coke fired processes, firstly potting and stamping, where the pig was treated before the main process to remove silicon, then dry puddling, with an identical pre-treatment, and wet puddling, where iron oxide additions formed a part of the bath. The proposition is that all these processes left characteristic clues in the body of the iron, including the amount and chemical nature of the included slag and in the overall bulk composition.

The author is a research student at the University of Warwick where he has at his disposal (in the Advanced Materials laboratory!) a very impressive array of analytical equipment.