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Session ID	13
Session Title	Micro-worlds, materiality and human behaviour: Magnifying material science in explanations of technology
Start Time	Wed Dec 18 14:00:00
Room	828

Studies of innovation and cultural transmission in material culture are scholarly obsessions as well as fundamental building blocks for regional and global archaeological narratives. The traditional emphasis on macroscopic artefact traits to explore shifting patterns of cultural variation remains dominant whilst the use of material science data to examine these questions, particularly in the context of production technology, has been slow to develop. Traits that define style and form take precedent over composition and texture.This session explores how we can better utilise material science data in building explanatory models for the evolution of technologies worldwide. It brings together a range of cross-disciplinary research projects that span different materials and continents, yet all using elemental and microscopic analyses to investigate variability in artefact production processes. Participants will demonstrate the utility of micro-scale characterizations for exploring themes ranging from purely aesthetical and sensorial to environmental and mechanical stimulants of change. Seeing no fundamental difference in the abilities of micro- and macro-scale artefact traits to address archaeological problems, we wish to probe the extent to which materials science data can generate new insights on patterns of technological behaviour.

14:00	Miljana Radivojević, UCL Institute of Archaeology	Intro	
14:05	Sally Herriett, Anthropology and Archaeology, University of Bristol / Truro College, University of Plymouth	What sort of fibre is that? An experimental approach to distinguishing aspects of skin-based material culture.	When a deer skin is processed using the brain of the animal, the resulting material can be described as soft, warm, and flexible. Whilst these terms could also be used to describe leather, when viewed microscopically they are very different materials. This in itself would not be a problem were it not for the need to understand that not all archaeological or ethnographic examples of skin-based material are leather. Whilst this may be due to a lack of experience with these materials, it is also be compounded by a depositional environment that has the potential to alter the original nature of all skin. Hence it is important that the manufacture, use, and deposition of such materials is understood as fully as possible, as this has significant implications for the care and conservation of such objects. This study has applied primitive processing methods to create a series of skin-based materials that are linked to the archaeological and ethnographic record. The samples have been examined microscopically and compared with material that has undergone additional treatments and bog-deposition. This has enabled the individual processing methodologies to be better understood and has enabled the diversity of the resulting material culture to be more fully understood and appreciated. This paper will reveal these microscopic differences and endorses the need for sincerer reconsideration of the appreciation of the diversity of these materials and the current terminology used to describe all skin-based material culture.
14:20	Kate Fulcher, British Museum	Molecular evidence for the use of complex organic preparation methods for the treatment of the dead in Egypt in the 1st millennium BC	Ancient Egyptian coffins, mummy cases, and wrapped mummies of the 22nd Dynasty (c. 960-730 BC) were painted or anointed with yellow and black varnishes with an organic origin. Molecular analyses of these varnishes has revealed the original organic materials from which they were made, and the plant family and sometimes genus from which the materials were obtained. Many of the ingredients had to have been imported from the eastern Mediterranean, which indicates large scale trade routes in organic products. A working knowledge of the materials identified using molecular analysis allows the various technologies employed to render the materials usable in these formats to be suggested. This is turn has implications for the practicalities of the ritual application of these materials in Egypt. Microscale analysis can be used to infer wider patterns of trade, contact, technology, and the organisation of products for ritual purposes at their point of use.

14:35	Waka Kuboyama, University of Southampton	The Society Behind Crafting: Technologies and Chaîne Opératoire of Costa Rican Axe-god Jade Pendants	Axe-god jade pendants (500B.C.- 700A.D.) form the majority of Costa Rican jade artifacts. These pendants are carved from highly polished axes, andthe superior region is typified by human or animal carving while the inferior axe portion is not decorated. In previous studies, theaxe-god's fine design has attracted scholars, and led to several morphological and symbolic studies, butit hasn't answered a basic question, "how did crafting people behave with the artifact". Most of axe-gods are collections (obtained by looters or Spanish conquistadors) without any archaeological context. However, axe-godsthemselves have plenty of crafting traits which would help us to reconstruct the crafting activity and its procedure. Each axe-god shows various crafting marks such as polish, groove-snap, perforating striation, etc., hence a technological approach can elucidate the past society andchaîne opératoire of the crafting. Based on the theory of chaîne opératoire, the material analyses and approach to the technology allows us to reconstruct material-forming procedures and producers' gestures, such as hand and body movements.This paper studiescrafting marks through a digital microscope and RTI (Reflectance Transformation Imaging), as a way to reconstruct the chaîne opératoire of axe-gods. An RTI image is created though several photographs with different angles of lighting, and emphasizes shadow and highlights of the artefact. In this way, RTI enables us to see the 3D surface of axe-god.
14:50	Maja Miše, UCL Institute of Archaeology	Imitate, Assimilate, Innovate: technological aspects of ceramic production in Mediterranean city-states in the last centuries BC	The movement of ceramic vessels has been main source of identifying regional and inter-regional trade and exchange systems in the ancient Mediterranean, especially in the last centuries of the last millennium BC. During this time, the increase of trade in the Mediterranean, marked the expansion of ceramic production centres, leading to specialisation of production and the emergence of urban ceramic manufacturers. The current state of research on ceramic vessels in the Greco- Hellenistic Mediterranean is twofold; an archaeological approach with macroscopic analysis and a scientific approach with microstructural and compositional analysis. Despite recent developments in both fields, there is still a visible gap between them that deprives us of gaining the overall picture of the complex circulation of ceramic vessels in the Mediterranean basin. Although the traditional approach acknowledges systems of trade and movement of vessels, it still relies on descriptive comparative analysis. On the other hand, the scientific approach often restricts its focus to single sites or regions, making it difficult to identify provenance or reconstruct complex economic trade systems. This is due to regional imitations of vessels from major production centres, not only in shapes and decorations, but also in production technique. The paper will discuss different approaches in studies of provenance and technology of Mediterranean ceramic vessels. It will address new theoretical and scientific strategies in answering complex questions of production, technological imitation and innovations in diverse Mediterranean economic and political landscape at the turn of a new era.
15:05	Patrick Degryse, Katholieke Universiteit Leuven and Leiden University; Andrew J. Shortland, Cranfield University; Sarah Dillis, Katholieke Universiteit Leuven; Katholieke Universiteit Leuven and Vrije Universiteit Brussel; Alicia van Ham-Meert, University of Exeter; Peter Leeming, University of Exeter	Isotopic evidence for the equivalence of gold and yellow glass in the late Bronze Age	Antimony (Sb) is considered a rare metal in the archaeological record, and is found only in unusual circumstances. Nevertheless, it was utilised over several millennia as the prime material to opacify or decolour glass and glazes, as well as in copper (Cu) alloys. In this way, Sb spread throughout the known world from the late Bronze Age onward. In glassmaking, stibnite was the only available mineral raw material that could achieve the desired opacified colour of the earliest glass, whereas complex polymetallic ores were also suitable for metallurgical applications. Sb isotope analysis has allowed late Bronze Age Egyptian and Mesopotamian glass vessels and Caucasian Sb beads to be compared to the ore sources possibly known and extracted in the ancient world. The only known matches for the isotopic composition of the glass are stibnite ores from the Racha-Lechkumi district in the Caucasus (present-day Georgia), near the Zopkhito mine, which was used for Sb extraction from the 17th century BCE. However, the Sb beads represent several compositional groups, one of which one matches the Racha-Lechkumi stibnite. Others, showing different trace element associations, originate from Cu-rich ores. These data, together with the equivalence of yellow glass and gold in the earliest glass objects, show that Sb extraction for glassmaking was probably separated from copper metallurgy, but associated with the mining of precious metals.
15:20	**BREAK**	**BREAK**	**BREAK**

15:50	Ian Freestone, UCL Institute of Archaeology	The Origins and Evolution of Early Glass-making Technologies: The Near East and China	Understanding of the early development of glass is dependent upon the perspective adopted.Was the innovation the attainment of an artificial material that was bright and shiny and emulated precious stone; was it a material that could be shaped when hot and plastic but which was rigid when cold; or was the breakthrough the attainment of a low melting “eutectic” composition which allowed the development of the desirable physical properties?Each of these interpretations has its merits, but can lead to very different conclusions. Glass technology is thought to have originated in Bronze Age Mesopotamia, as part of a package of soda-lime-silica technologies including ceramics and pigments (“vitreous materials”), and was based upon mixing plant ash with quartz.Early evidence of its discovery is extremely limited due to poor preservation and recovery.However, glass technology appears to have been developed independently in China in the first millennium BCE, based upon a completely different chemical system, barium oxide-lead oxide-silica, similarly in conjunction with pigments and glazed ceramics. A comparison of the technologies of early Near Eastern vitreous materials with those of China offers new perspectives into the likely trajectory of early glass-making technology in the Near East and provides insight into how the available material can both constrain and stimulate the development of a technology.
16:05	Ole F. Nordland, UCL	Slag chemistry to fill the gaps	When studying ironmaking remains, macroscopic studies of remains on a site can inform about what processes were used at the site, and to an extent inform us about the choices made by the operators on a site. At the same time however, several of these apparent choices are in fact influenced by limitations or restrictions imposed by the material. Here, a close microscopic and chemical analysis of the material can highlight what options the smelters had, and which ones were forced upon them by circumstances. In the study of ironmaking in Norway, three phases are discerned based on how slag was handled. In most cases, vast slag heaps with large quantities of fragments provide an easy approach to identifying myriad variables used in the processes. However, for individual loose finds, qualified guesswork is often the only way to interpret the material without invasive sampling. Through a detailed study of both microstructures and chemistry, however, variables such as operating temperature, slag viscosity at said temperature, air supply needed for said temperature, and, deducting from this, how slag separation was achieved, can place material from uncertain contexts, or help provide answers where no furnace remains were found.
16:20	Peter Northover, School of archaeology, Oxford University	The Empirical Metallurgist	In principle everything that happens to copper and copper alloys from the moment they leave the crucible to when they are recovered from their archaeological context leaves a trace that can be recovered and interpreted. To do this requires the availability of appropriate metallographic techniques and a deep knowledge of their physical, thermal, and mechanical behaviour. With this we can explore such questions as the original appearance of an object, how it may have been reworked or repaired, and its condition when deposited. Further, we can begin to understand the metallurgical knowledge of the metalworkers and consider the empirical steps by which they acquired it. Those steps could have included a variety of experiments from trying out new alloys, to new patterns of hammering, and, in later eras, adopting methods such as rolling. Cases where traditions appear conservative might simply mean that change was not seen as necessary but also might mean experiment was discouraged. This paper will present two case studies, one looking at how an ideal alloy might have been found at the beginning of the Middle Bronze Age and, the second, how the engineering and materials problems of designing and building Late Bronze Age cauldrons may have been solved. It will also be shown how useful insights can be gained from workshop archives of the industrial revolution. The metallurgy is the same, the only difference is an increase in scale.

16:35	Mike Charlton, UCL Institute of Archaeology	Bending the law:exploring technological opportunities in bloomery ironmaking	Ironmaking, like all metallurgical systems , must conform to scientific laws that govern chemical, physical and thermodynamic interactions.These laws place clear limitations on technical possibility.Perhaps less appreciated, the same laws also create technological opportunities; ways of manipulating processes to exploit some 'legal' loopholes. Models derived from the combined insights of materials science, geology, and behavioural science can be used to identify metallurgical opportunities in the archaeological record.Further, such models can be used to predict the kinds of environments in which particular forms of resource exploitation would be optimal and therefore hypothesise the trajectories of metallurgical traditions. Archaeometallurgists have long used ternary phase diagrams to model thermochemical parameters of smelting processes from the primary chemical components of slag—an essential by-product obtained from the reduction of ores.The structure of ternary phase diagrams also serve as simple models of technological possibility that, when combined with an understanding of material properties and human behaviour, become a kind of fitness landscape model.Application of one such model to slag from an Iron Age and Medieval bloomeries in northwest Wales reveals how the histories of ironmaking processes are shaped through the interplay between scientific law, sociocultural processes and the environment.
16:50	Miljana Radivojević, UCL Institute of Archaeology; Mike Charlton, UCL Institute of Archaeology	Discussion	
17:30	**END**	**END**	**END**