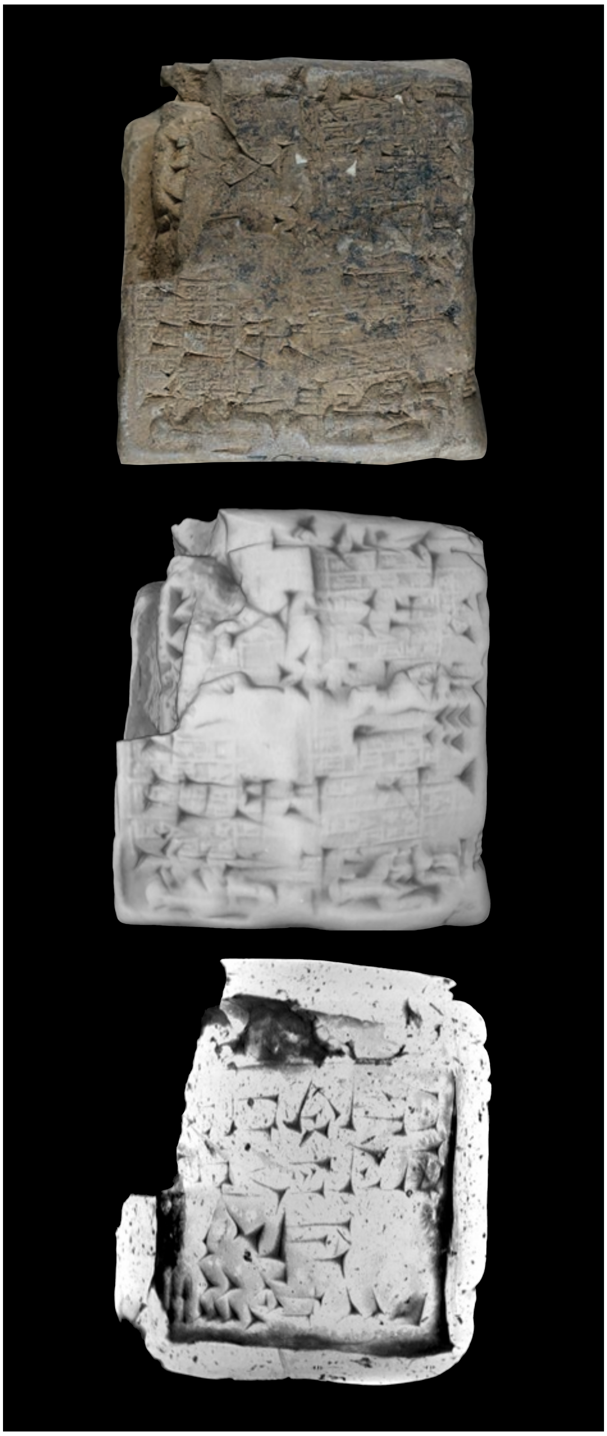
The British Museum

Newsletter
Scientific Research

Number 4, 2018

Cuneiform under the surface



Cuneiform tablet made of clay, surrounded by a clay envelope (1896,0612.112). The tablet is partially exposed by historic damage to the upper-left corner of the envelope. The text on the envelope is difficult to read, because a cylinder seal was rolled across it in antiquity.

A full 3D model of the tablet and envelope, produced by X-ray CT scanning.

The previously unseen text on the tablet, made visible by processing the CT scan.

Daniel O'Flynn, Scientist

Cuneiform is an ancient Mesopotamian script dating back to c. 3300 BC, making it one of the earliest forms of writing. Details of administration were often recorded in cuneiform impressed into clay tablets, and these tablets were sometimes sealed inside clay envelopes. It is thought that the tablets were sealed in order to protect their contents from tampering, for example, during their transfer between officials. Many cuneiform tablets still survive to this day - with thousands housed in the British Museum – providing fascinating insights into ancient Mesopotamian civilisation.

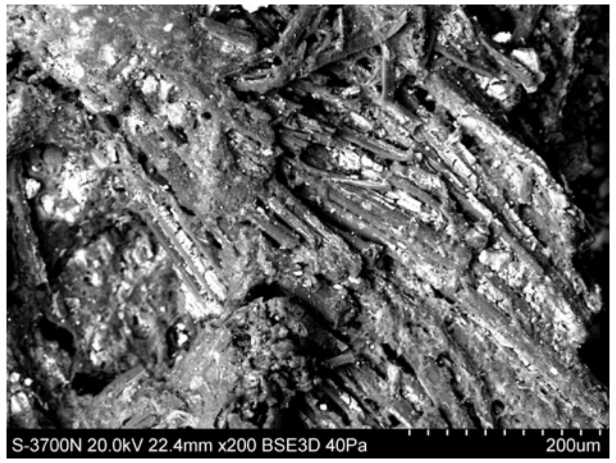
Scientific Research is now able to carry out in-house X-ray CT scanning. CT scans help generate a 3D image of an object, including not only surface detail, but also every layer underneath. By taking a CT scan of the tablet pictured, the surrounding envelope could be digitally 'stripped away', revealing the text within. The text, translated by Jonathan Taylor in the Museum's Department of the Middle East, provides details of the transfer of a large quantity of wool from the city of Girsu to the village of Gaka, almost 4000 years ago:

2427kg wool, as rations for the men of (the village) Gaka, under the supervision of the chief minister, via (Mr) Shesh-Utumu, from (Mr) Aradmu, governor of (the city) Girsu, have been withdrawn. (Sealed with) the seal of (Mr) Babati. Year Shu-Sin became king.

The X-ray CT data also allows us to view the dense mineral inclusions in the clay used to make the tablets. The size and quantity of inclusions provides important information on the production technology of the tablets, including whether the inclusions are naturally-occurring or added during the manufacturing process. When they are identified by complementary techniques (e.g. optical polarised microscopy), distinctive mineral inclusions can be used to pinpoint the origin of the clay.

Most importantly, all of this information has been obtained with no damage to the tablet or envelope, preserving it for future generations.

A silver bowl of the Tang Dynasty, how was it made?



Quanyu Wang

A silver bowl (1938,0524.704) of the Tang dynasty in the Museum collection could have been made by the Jinyin pingtuo (金银平脱) technique but has never been scientifically confirmed. Jinyin pingtuo refers to a technique used in the Tang dynasty of China for making luxury wares, e.g. metal, ceramic and wood, objects, decorated with a lacquered surface with thick silver or/and gold inlays. An investigation to determine the manufacturing techniques was undertaken to inform the redisplay of The Hotung Gallery (Room 33). Non-destructive examination using microscopy and SEM-EDX showed that the surface decoration consists of an underlying layer and a top black layer with metal decors set in (Fig. 1). The metal decors on the bowl are silver, as identified by XRF, and the underlying layer was identified as woven silk with a binder, as identified by SEM (Fig. 2). Micro-scale samples taken from the top black layer were analysed using Py(HMDS)-GC-MS but lacquer was not clearly detected, although some organic materials such as egg protein? and probably starch was found. The relatively thick metal decors that were levelled with the rest of the surface decoration indicate the application of the Jinyin pingtuo technique to the object but the analytical results were not conclusive on the use of lacquer in the object. This could also open questions about the Jinyin pingtuo technique as generally described, as materials other than lacquer were identified. Further comparative study by scientific analysis of similar objects in other museum collections or from excavations is required to confirm the use or absence of lacquer in this technique.

The side of the silver bowl, showing the profile of the surface decoration.

SEM image of the textile on the silver bowl.

An ancient Egyptian coffin at the Nicholson Museum, University of Sydney

Caroline Cartwright

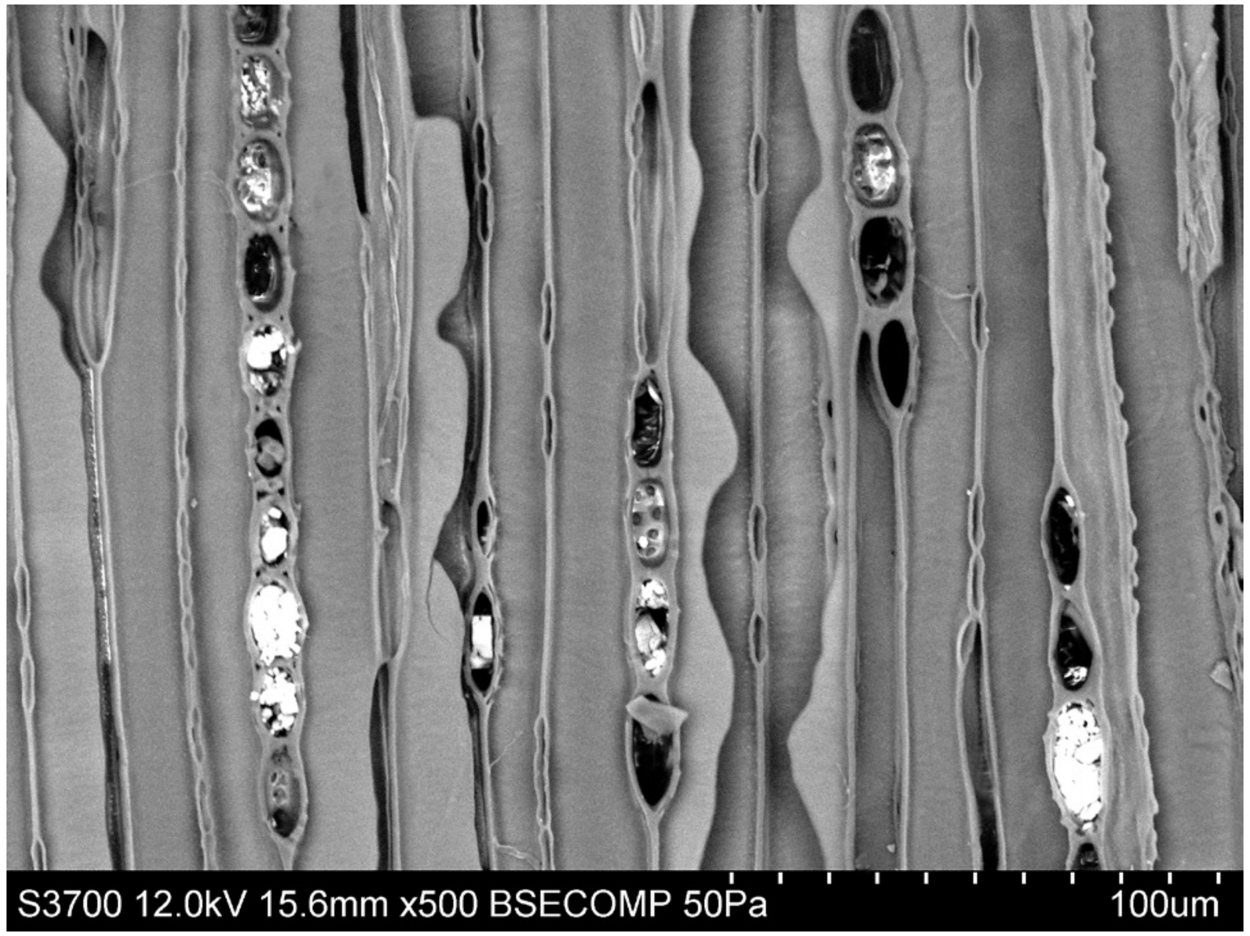
I was invited by Dr James Fraser, Senior Curator at Nicholson Museum (University of Sydney) to carry out wood species identification of four samples from the 26th Dynasty coffin of Mer-Neith-it-es, NMR.29, from Saqqara in Lower Egypt. This study forms part of a broader project centred on coffin NMR.29 and its contents, whose research is intended to help inform the development of a new Mummy Room in the Chau Chak Wing Museum, due to open in late 2019 at the University of Sydney.

Ancient Egyptian coffins are composite objects, and different woods were frequently selected for various elements, so for the purpose of scientific identification of species, wood samples always need to be taken from the main coffin elements as well as from dowels, tenons and battens (if accessible for sampling). As it is well known that local wood resources were scarce in ancient Egypt, careful consideration must always be given to sample areas of possible wood re-use.

Using variable pressure scanning electron microscopy of tiny samples, I was able to identify the wood of the main components of the coffin as imported, high-status *Cedrus libani*, cedar of Lebanon wood, and one of the dowels as a local fig wood.

One of the most renowned timber imports into ancient Egypt was cedar of Lebanon. This coniferous wood is reputed to be easy to carve, plane and polish, although it can be rather brittle; large knots and ingrowing bark within the timber may also be problematic to the carpenter. Although many species of *Cedrus* are renowned for being strongly aromatic and resinous (therefore insect-repellent), there is some debate as to the extent to which *Cedrus libani* trees routinely develop resin canals. Through trade in the ancient world bordering the Mediterranean Sea, cedar of Lebanon timber was often available in long lengths, well suited for use as coffin planks. The popularity of cedar of Lebanon wood in ancient Egypt for use in high-status coffins and for other funerary objects may be as much a measure of the expense and prestige of acquiring this imported resource as of its natural wood properties. In early April 2018, after the CT-scanning of the coffin at Macquarie Medical Imaging news media were buzzing with the revelation that this coffin, formerly thought to be empty, actually contained human remains – see https://sydney.edu.au/news-opinion/news/2018/04/03/the-mummy-within.html and http://www.abc.net.au/news/2018-03-26/mummy-found-in-what-was-thought-to-be-an-empty-coffin/9589110

Research continues into the coffin and its contents, with me as part of the collaborative team; the wood of the face still needs to be sampled and identified.



VP SEM image of a tangential longitudinal section of a sample of wood from the Mer-Neith-it-es coffin, showing the presence of crystallised resin in the rays. Scale bar in microns. Image: C.R. Cartwright, ©Trustees of the British Museum.

The origins, adoption and use of Early Neolithic pottery in hunter-gatherer communities in NW Eurasia

Sampling of a ceramic vessel by drilling.

Blandine Courel

The existence of mobile hunter-gatherer communities making pottery in China, Japan and Far East Russia during the Upper Palaeolithic counters the initial belief of Western European scholars that the invention of pottery was an outcome of the emergence of settled farming societies in the Levant. The dispersal of this technology across the Eurasian steppes lead to its adoption by pre-agricultural societies in Western Russia and Eastern Europe as early as the 7th millennium BC. Nowadays, Eurasian archaeologists show a growing interest in understanding the origin and the use of ceramics crafted by these early hunter-gatherer groups. In this context, an important research programme, named INDUCE (the INnovation, Dispersal and Use of Ceramics in NE Europe, 2016-2021) and funded by the European Research Council, aims at bringing new insights to those questions through a multidisciplinary approach involving organic residue analysis at The British Museum (in collaboration with the University of York and the Centre for Baltic and Scandinavian Archaeology, Schleswig, Germany). In addition, typological and technological analysis of pottery and 14C dating measurements will allow us to reconstruct chronologically the spread of the technology and to explore technological and cultural exchanges among hunter-gatherer groups. Overall, this work represents a unique opportunity to investigate the origin and use of pottery on a large scale and from different perspectives. My role in this project is to characterise the fatty materials (lipids) preserved over time within the clay matrix and within charred residues formed at the surface of the vessel during cooking which can provide important information about the function of the pottery. Indeed, the specificity of some lipids, called biomarkers, provides a valuable taxonomic tool to discriminate between different food products. To achieve that, lipids are extracted with an acidified methanol solution and, then, identified individually using gas chromatography-mass spectrometry (GC-MS). In addition, carbon stable isotope ratios of the main fatty acids present in our samples - palmitic and stearic acids comprising 16 and 18 carbon atoms respectively - are measured using GC-c-IRMS (GC-isotope ratio mass spectrometry), at the BioArCh Laboratory, University of York. Indeed, in part due to differences in biosynthetic pathways and carbon source, lipids from living organisms displays different values allowing distinction to be made between, among others, ruminant and non-ruminant animal tissues or marine and freshwater resources.

Archaeological sites from which Early Neolithic pottery were sampled as part of the research programme.

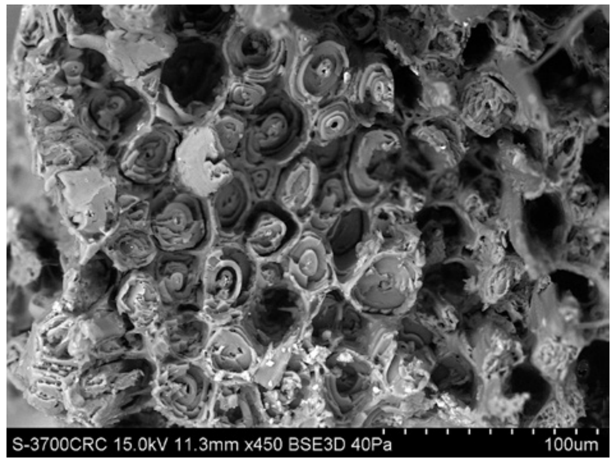
The analyses done so far on more than 300 samples reveal the importance of aquatic resources exploited and cooked in the pottery vessels, based largely on the identification of ω-(o-alkylphenyl)alkanoic acids. These are well-known aquatic markers formed when the temperature in the vessels reached 270°C or above. Among the pottery assemblage studied, consumption of fish and/or other aquatic products has been detected in a substantial number of vessels (between 50% to 80%) originating from Sakhtysh 2a and Veksa 3 (Upper Volga culture, Russia), sites of the Elshanka culture (Middle Volga, Russia), Serteya (Dnepr-Dvina region, Russia) and Rosenhof (Ertebølle culture, Germany). In more rare cases, ruminant adipose fat and possibly terrestrial plant sources have been identified.

A Cook voyage spear from Australia in Stockholm?

Caroline Cartwright, Scientist

As part of the current, on-going collaborative project of wood identification of historical artefacts from the Central Coast area of New South Wales, Australia, I was invited in December 2017 by Dr Aoife O'Brien, Curator, Oceania, Världskulturmuseerna Museum of Ethnography in Stockholm to examine and sample wooden spear 1848.01.0060 for scientific analysis. This spear is thought by some to be one of the objects collected by James Cook during his HMS Endeavour voyage to Australia, and may possibly be associated with Gweagal indigenous Australian Aboriginal people who are traditional custodians of the southern geographical areas of Sydney, New South Wales (http://collections.smvk.se/carlotta-em/web/object/1825371).

Using variable pressure scanning electron microscopy of a tiny sample from the spear, I was able to identify the wood as *Allocasuarina verticillata*, drooping sheoak. This wood is tough and durable, partly because it has very thick-walled fibres, as can be seen in the VP SEM image (Figure 1). Choosing wood that is hard and long-lasting was clearly very important in the historical past for effective Aboriginal spear manufacture and use. Whilst many Aboriginal artefacts have been made from various different woods that are representative of the highly diverse vegetation of their region, some may be indicative of long-distance trade in wood amongst different Aboriginal tribes (see https://australianmuseum.net.au/blogpost/amri-news/amri-a-wooden-shield-from-kamay-botany-bay). Given the fact that wood is most often selected for its properties in order to match it to the shape and purpose of the artefact, identification of wood (whether to Family, Genus or Species level) can only be used to suggest provenance with extreme caution. Furthermore, the composition of vegetation can change over time, and this can complicate the already complex process of interpretation. According to modern records (Atlas of Living Australia https://www.ala.org.au/), *Allocasuarina verticillata* is present in many parts of south-eastern Australia; so on the basis of wood identification alone, this spear made of Allocasuarina verticillata wood cannot be provenanced to a specific location within that geographical area.

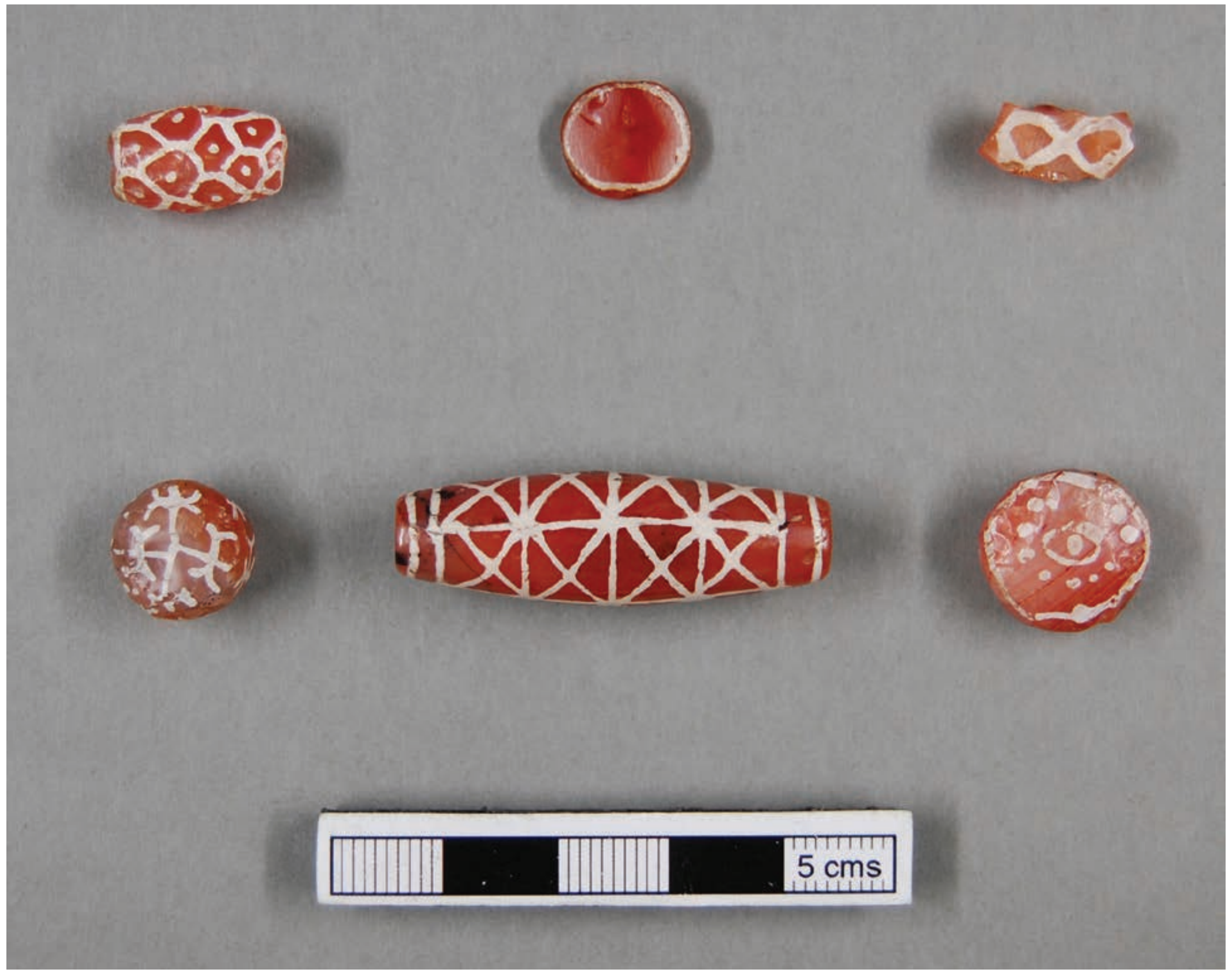


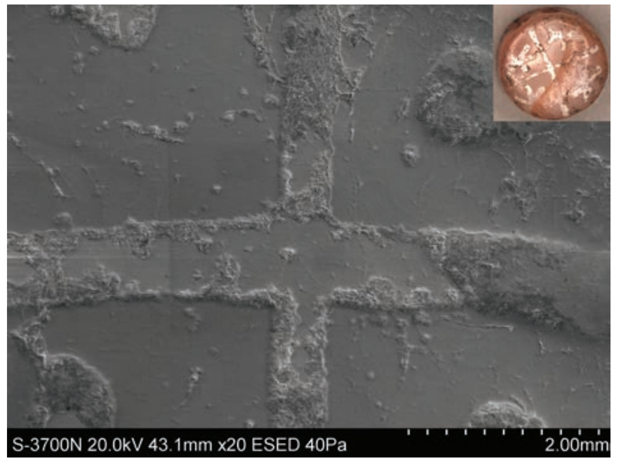
VP SEM image of part of the transverse section of a tiny sample of Allocasuarina verticillata wood from spear 1848.01.0060 showing very thick-walled fibres. Scale bar in microns. Image: C.R. Cartwright, ©Trustees of the British Museum.

'Etched' carnelian beads: from archaeological evidence to experiment

Clément Holé, Aude Mongiatti, St John Simpson

A characteristic type of decorated beads known as 'alkali-etched carnelian' beads (Figure 1), were first made in the Indus valley in the mid-third millennium BC. Different versions of these continued to be made up until the early 20th century but the styles of the later ones vary so much that multiple centres of production ranging from South Asia to Iran and the Caucasus have been suggested. However, despite some early studies, the technological process used to decorate them and the composition of the 'etchant' does not seem to have been fully identified. Some have been found in Scythian graves in southern Siberia and it was their exhibition in the BP exhibition *Scythians: Warriors of ancient Siberia* that led to this project being established. This research project aims to identify the composition of the 'etching' agent applied to the carnelian beads by analysing archaeological artefacts from the British Museum collection. In parallel, this project will also seek to understand the chaîne opératoire involved in the decoration of these beads, from raw materials to finished artefacts, by testing recipes of 'etchants' experimentally under laboratory conditions. These recipes come from historical and ethnographical sources and from the analytical results obtained from the present scientific study. The surface texture of the beads and of their etched areas is studied using a digital microscope (Figure 2). Photomicrographs acquired with this microscope give a good overview of possible manufacturing tool marks and weathering of the beads and will help to understand when the decorative process happened during the making of the beads. A variable pressure scanning electron microscope (VP SEM) is also used to further emphasise surface texture details and potential tool marks (Figure 3) and to analyse the chemical composition of decorated and plain areas of the beads through energy dispersive X-ray analysis (EDX). A few 'etched' semi-precious stones found in the BM collections are dark or black. They are regarded in the literature as being transformed through heating but these are being analysed by Raman spectroscopy to confirm the nature of the stone.





Investigating traditional leather tanneries in Africa and the Middle-East

Lucy Skinner

As part of my PhD research, I have visited traditional leather tanneries in Africa and the Middle-East to see whether any of the ancient Egyptian leather working traditions live on, today. This photograph of two tanners (one wearing flip-flops) in Cairo, Egypt are processing camel hides. The fresh hides arrive outside the door in the morning and begin the tanning process, starting with the removal of hair, by the afternoon.

The tanners' centuries-old home of Magra Al-Ayoon in Old Islamic Cairo, which runs along the city's ancient aqueduct, will soon be closing and moving to a modern facility, outside the city. One feels regret, seeing historic craft workings disappear; but overcrowding and a lack of effluent treatment facilities mean that the old tanneries of Magra Al-Ayoon are a genuine health hazard, so there's an element of optimism, for the tanners' future, too.

Lucy recently won 1st place in the University of Northampton "Images of Research" competition, with this photograph.

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