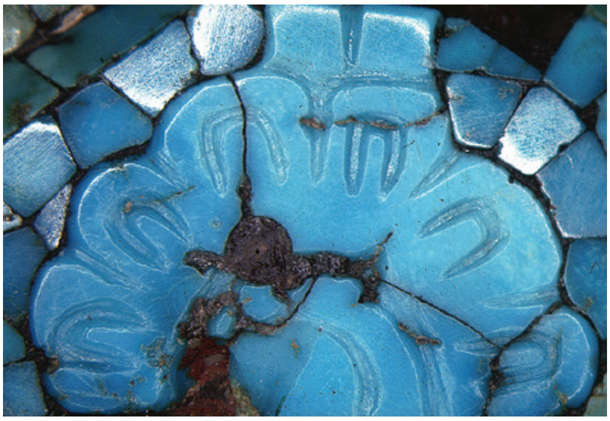
The British Museum

Newsletter
Scientific Research

Number 6, 2020



Serpent mask of Tlaloc (Am1987,Q.3), in the form of two intertwined and looped serpents worked in contrasting colours of turquoise mosaic. A large decorated turquoise tessera from a different mosaic object has been reused here on the forehead. From Mexico, 15-16thcentury AD.

Reuse, recycling and repair

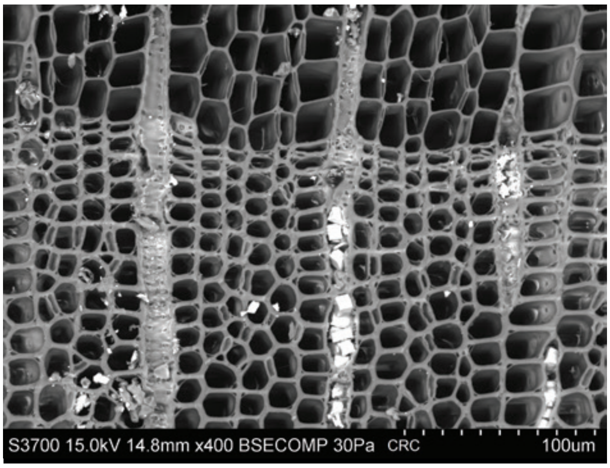
As the contemporary world struggles with unprecedented levels of waste, the first British Museum/Asahi Shimbun Display of 2020, *Disposable? Rubbish* and us, explores our changing relationship with the things we throw away. The exhibition opens with a pair of cups: a single-use, waxed paper cup, made in the 1990s, stands alongside a small Minoan pottery cup made on Crete around 3500 years ago. The ancient cup was most likely also a disposable object, used to serve wine to guests at the palace of Knossos, and thrown away rather than being re-used. The exhibition invites the audience to think about disposables, past and present, and to consider how we might respond to the challenge of waste in the future. Other objects on display show the creativity and resilience of communities both past and present, including an ancient spindle whorl made from a piece of broken pottery, and a fishing basket from Guam woven in traditional style but using a very modern material – discarded plastic construction wrapping. The physical exhibition itself was constructed from recycled materials, with the display cases and plinths reused from the 2019 exhibition, *Manga*. The labels were screen-printed onto paper cut from Manga banners that originally hung in the Museum's Great Court.

This prompted staff in the Department of Scientific Research to consider some related themes, notably re-use, repair and recycling. For example, what evidence is there across the collection for these activities? What approaches do we employ to reveal this evidence and how does this inform on the changing motivations of people in the past who mediated these acts of modification to objects and materials? The reasons why we repair, re-use and recycle in industrialised societies are likely to be different to practices in the past. Such acts of modification often changed the function and meaning of objects. In doing so, they make us who we are. By highlighting these traditions in the past, it is important to pause and to reflect on our motivations and practices today as we seek to address the contemporary challenges of resource utilisation and their impact on the planet.

This newsletter highlights a small number of examples drawn from recent research into the collection. These include the re-use of 500,000 year old stone tools at Boxgrove, recycling metal in the Bronze Age and different ways of repairing Roman tableware. We are grateful to the curators with whom we have worked on these projects. One of the features is written by Nick Ashton (Curator: Palaeolithic and Mesolithic Collections) together with his colleague Rob Davis, and Matt Pope (University College London). Another has been contributed by Peter Bray, University of Reading. The remainder are contributed by staff in the Department of Scientific Research.

Carl Heron, Director of Scientific Research, British Museum

Re-using wood in ancient Egyptian coffins



Ancient Egyptian wooden coffins are composite objects, with different timbers specifically selected for the various elements. For identification of the range of woods, tiny samples are required from all main components and planks as well as from dowels, tenons, pegs, battens and carved elements, including faces, beards and hands. As regular supplies of local timbers such as fig, acacia, sidr and tamarisk could sometimes be scarce in ancient Egypt, it is important to understand how these woody resources were used. Carpenters knew what properties to look for when choosing wood to make the different coffin elements. Part of the selection was determined by how different trees grow. Local fig trees were useful for long planks; whereas the twisted, knotty wood of sidr and acacia trees were better suited for dowels and tenons.

Given that wood was a precious resource, it is not surprising to see that offcuts were used for connective carpentry elements, presumably to minimise waste, or maximise profits. Repairs, patches, wedges and inserts are frequently present on coffins; these also require sampling for species identification.

Some coffins were partially or completely made from timbers imported from Sudan, East Africa, and areas near the Mediterranean (for cedar of Lebanon, Figure 1). Often, even with prized cedar coffins, hard and dense local woods (sidr and acacia) were still used for connective carpentry – mostly because their different properties ensured a close fit. Whilst many coffins that were constructed of imported cedar wood reflected the status of the mummified individual, and display highly skilled craftsmanship, it is not just this category of coffin that testifies to woodworking skill in ancient Egypt.

We have already noted that availability of woody resources and working properties of different timbers were major factors in coffin-making, but carpentry skills were put to a severe test when, perhaps due to economic restraints or having to provide a coffin for a lower-status person, it was necessary to use wood that had flaws, resin/gum, knots, or was prone to insect infestation. One option was the re-use or re-purposing of timber that may formerly have had a domestic function – such as a door or roof beam. Examples of this can be seen where dowels, pegs and holes are present but they have no structural function when re-used for a coffin. Another option was to utilise 'second grade' imported cedar wood, presumably rejected for the higher-status cedar coffins. There is a striking 22nd Dynasty example of this in the British Museum collection: EA29577, which consists of the mummy of Djedameniufankh in a cartonnage case and one wooden coffin. Figure 2 shows just how many pieces of various shapes and sizes of wood were assembled for this coffin. Over 56 elements were sampled, and all were cedar of Lebanon, although not high-quality grade timber (Figure 3). We may consider this particular coffin less visually appealing than some others, but the persistence and skill of the carpenter who certainly made the best of the available resources should be admired.

Caroline Cartwright, Scientist

Figure 1: Scanning electron microscope image of a transverse section of cedar of Lebanon wood from EA29577

Figure 2: Cedar of Lebanon tree

Figure 3: Lid of wooden coffin of EA29577

Recycled glass

The recycling and reuse of glass is not a modern idea, it has been practiced for millennia. The application of scientific analysis has allowed us to identify compositional characteristics which can be linked to particular recipes, time periods or regions. These studies have shown that during the first millennium AD glass was produced from raw materials at a relatively small number of primary production sites and widely distributed to workshops where it was formed into finished objects. Over time the glass which formed these original objects has been reused and recycled to form new objects. Using scientific analysis it is now possible to identify which objects are produced from recycled or reused glass.

Recycling can be identified by the appearance of traces of colourants and opacifiers, such as cobalt or antimony, found in glass objects where they serve no purpose signifying the remelting of glass of multiple colours to produce a single new object. Evidence of this practice has been found in Anglo Saxon glass objects produced in Britain. The supply of glass from primary production sites in the eastern Mediterranean region to Britain dwindled in the second half of the first millennium AD, reflecting disruptions in trading networks. As well as simple recycling and reuse, the available supplies of glass were also mixed with a plant ash-based material to extend the amount available to produce new objects. Evidence of this practice has been found in a variety of objects ranging from beakers to jewellery inlays.

It is also possible to identify the reuse of glass objects in new contexts. A recently published study on objects in the British Museum collection was able to show that some of the glass mosaic tesserae found in the 9th century AD Great Mosque at Samarra, Iraq, were originally produced centuries earlier in Syria-Palestine and Egypt. They are likely to have been scavenged from buildings no longer in use and transported to the Abbasid capital for use in the building of the Great Mosque. These were used alongside other tesserae produced in Mesopotamia, and perhaps at Samarra itself.

These two examples show how scientific analysis can help to build a clearer picture of the life of objects in the Museum collections and the journeys they have taken. One object can hold a vast range of information about the people who created it, used it, recycled it, reused it and finally deposited it.

Andrew Meek, Scientist

Figure 1: Glass mosaic tesserae embedded in gypsum plaster from the Great Mosque at Samarra. These mosaics included both new and reused glass tesserae (British Museum OA+.12456.1-600).

Schibille, N., Meek, A., Wypyski, M.T., Kröger, J., Rosser-Owen, M. and Wade Haddon, R. 2018. 'Glass walls: the selective use of glass in 9th-century Samarra (Iraq)' *PLOS One*, https://doi.org/10.1371/journal.pone.0201749

Meek, A. 2016. 'Ion beam analysis of glass inlays from the Staffordshire Hoard', *Journal of Archaeological Science: Reports*, 7, 324-329, https://doi.org/10.1016/j.jasrep.2016.05.014

Freestone, I.C., Hughes, M.J., Stapleton, C.P., 2008. 'The composition and production of Anglo-Saxon glass'. In: Evison, V.I. (Ed.), *Catalogue of Anglo-Saxon Glass in the British Museum*. British Museum Research Publication 167.

British Museum Press, London, pp. 29-46.

Figure 2: Anglo Saxon glass drinking horn found at Rainham, London. Produced in the 7th century CE from glass with a plant ash-based addition, as discussed in the text (British Museum 1952,0205.1).

Red then blue? The changing faces of an ancient Greek temple in Egypt

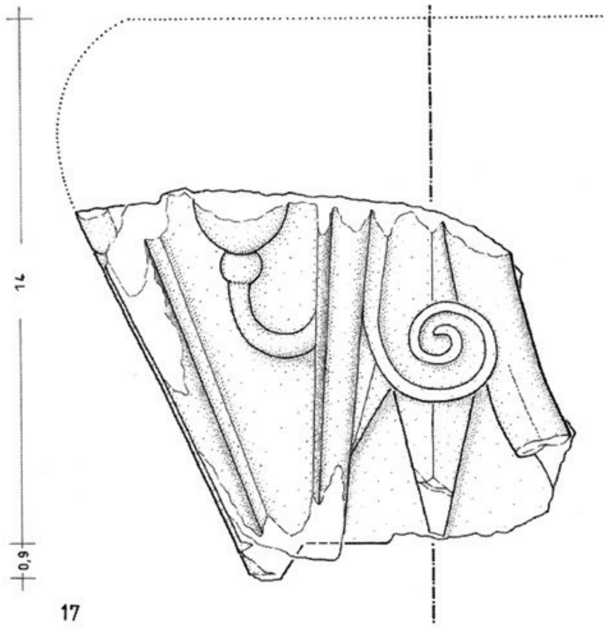


Figure 1: A fragment of an exterior angle-piece (1886,0401.42; B409) from the temple of Apollo at Naukratis observed to have significant traces of Egyptian blue pigment, as shown by the regions of 'bright white' luminescence in the VIL image (Figure 2b). Detailed microscopy and analysis also revealed that this had been applied over a layer of red paint containing the high-status pigment, cinnabar (Figures 3a and b).

The Egyptian-Greek town of Naukratis in the Nile Delta was a major centre of cross-cultural contact in the ancient world. The site was rediscovered in 1884 by W. M. Flinders Petrie, who conducted two excavation seasons there in 1884 and 1885/86, followed by two further seasons directed by David Hogarth in 1899 and 1903. Together they uncovered the Greek sanctuaries of Aphrodite, Apollo, Hera and the Dioskouroi, the Hellenion sanctuary, a faience workshop, a (mostly Greek) cemetery, streets and houses, as well as the large 'Great Temenos', later identified as an Egyptian temple complex for the god Amun-Ra. Many of the finds are today in the British Museum.

More than 100 years later, the site and its finds underwent a systematic re-evaluation as part of the British Museum research project Naukratis: Greeks in Egypt, led by Alexandra Villing. At the department of Scientific Research, a series of marble architectural elements (Figure 1), were examined using scientific methods for the first time since their discovery. They all probably belonged to a temple, or monumental altar, that the inhabitants of Miletus built in the city's sanctuary of Apollo, and dated to between 530–510 BC.

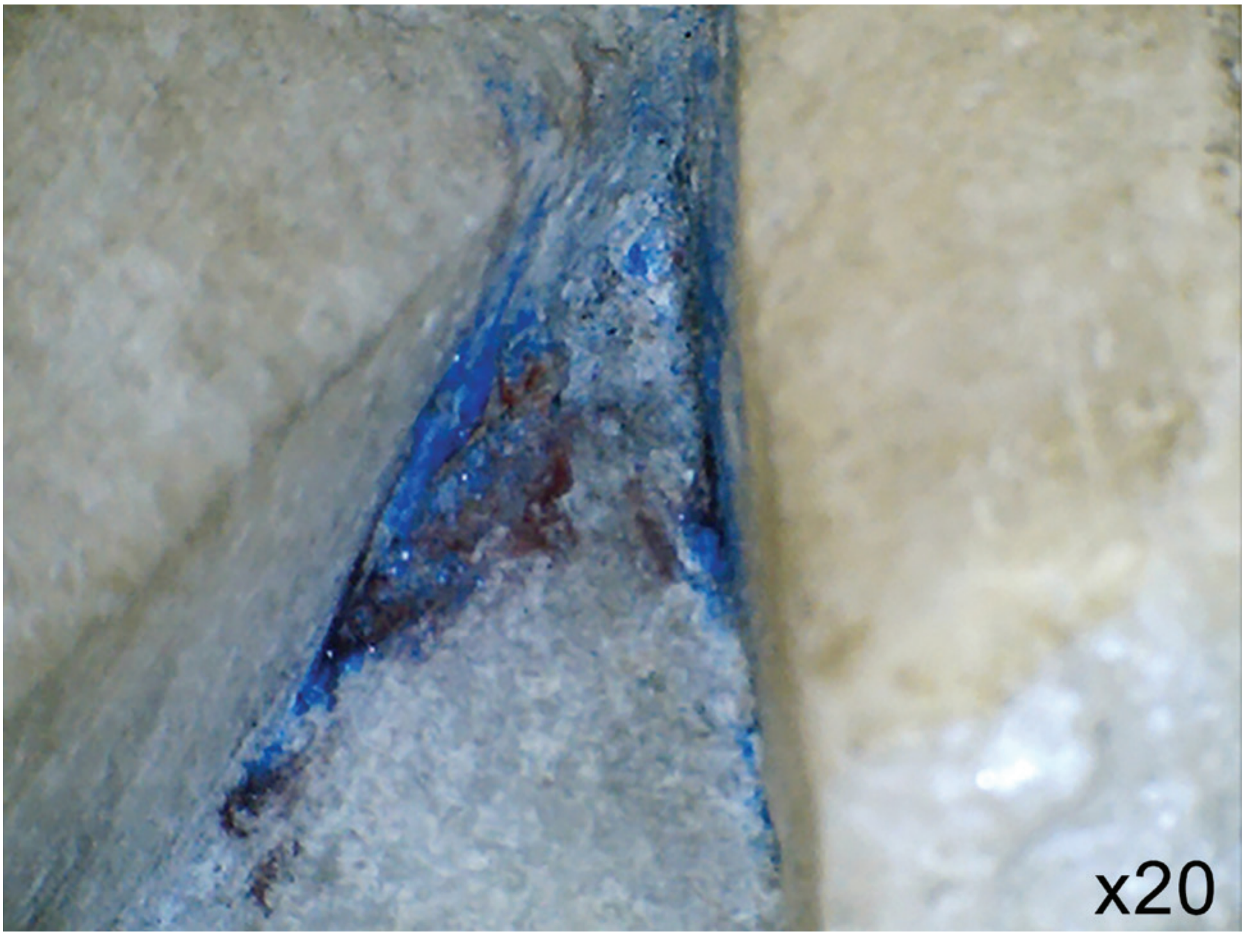
Visible pigment traces were observed on some of the fragments (Figure 2a), but technical imaging techniques, such as visible-induced infrared luminescence, or VIL, which can detect even single particles of a pigment known as Egyptian blue, revealed that more elaborate remains than suggested by the naked eye were present (Figure 2b). In fragments such as the exterior angle-piece (1886,0401.42; B409) shown in Figure 1, Egyptian blue pigment (which appears bright white in the VIL images) probably extended along the entire background beneath the egg and dart pattern and along some of the edges.

Digital microscopy of this fragment also revealed that this blue paint had been applied over a layer of red paint (Figures 3a and b). Samples of the red pigment were shown to contain cinnabar, a pigment not known in Dynastic Egypt, and rarely identified in this period, even in Greek contexts. The presence of this high-status pigment is significant; Dioscorides (De materia medica, 5-109) reports that because of the high price of cinnabar, painters would use it only to paint the outlines. Aside from placing the decorative scheme firmly within the traditions of Greek polychromy in the Archaic period, its use to embellish another prestigious material, the imported Ephesian marble decorative elements of the temple, also speaks to the importance which its Milesian builders wished to give this structure within the context of the complex of sanctuaries at Naukratis.

But why the change of colour scheme from red to blue?

The reasons for this are unclear: the pigments may have been layered to create a particular effect, but their opacity suggests this would have been ineffective. More likely, it was the result of maintenance and repair, which saw a dramatic change in the colour scheme of the relief background from red to blue. It is tempting to think that this repainting campaign may have been prompted by changing trends in the colouring of the relief background from red to blue in the Late Archaic period, as suggested by some scholars. Comparisons to contemporaneous temples on the Greek Islands and in Asia Minor may shed further light on this and indeed on the well-documented practice of Archaic temple-builders to transport materials and possibly craftsmen to the sites of such commissions, even as far away as Egypt.

Joanne Dyer, Scientist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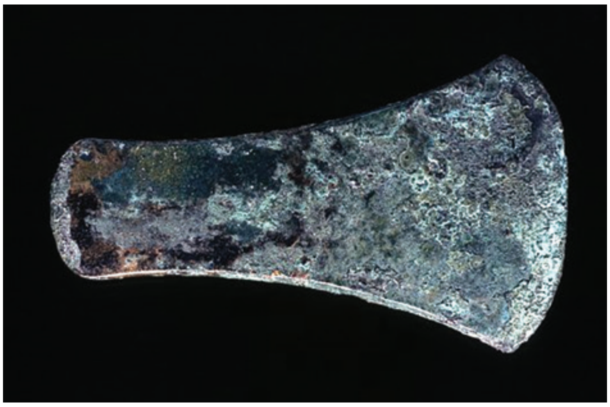
Recycling metals: Ancient and modern values



For the study of ancient copper-alloys, such as bronze, brass and other mixtures, recycling is sometimes obvious. For example, there are bun-shaped ingots from Late Bronze Age western Switzerland that contain half-melted pieces of identifiable objects. With a bit more heat and patience it is clear that the recycling of those objects would have left no visual trace. Instead, we would have to turn to scientific analysis to infer the full life history of the metal.

Copper ores, despite their name, often contain small amounts of other metals, which then pass through the smelt and into the final object. After over one hundred years of analysing the chemical composition of Bronze Age objects, it is clear that some patterns of these low level impurities are linked to a source mine. This is essentially the 'Provenance' hypothesis: that a recognisable chemical pattern can link the origin of the raw material with the final object. What is more controversial, and the focus of my research, is whether these chemical patterns are actually more complicated and reveal longer, more complex chains of use.

From around 2400 BC to 1900 BC, the Ross Island mine in County Kerry, Ireland, produced much of the copper in the Museum's British and Irish bronze collections. For the period it was active, 530 out of 865 analysed axes, daggers and halberds show the mine's distinctive low level arsenic-antimony-silver pattern (24 of the 51 analysed objects from the Museum). However, buried within that consistency is a hidden world of recycling and identity. Firstly, there is the evidence of the shape of the objects, with each region having distinct artefact styles. Though the very first axes made from Ross Island metal are moving, unaltered, from Ireland before burial further afield, such as Durham [BM 1873.6-2.3]. The following generations increasingly show local shapes, identity and technique [Butterwick, BM 1879.12-9.383].

This shift to regional traditions of metal casting is accompanied by changing chemical patterns, which demonstrate that the metal has been re-melted, sometimes mixed, and recast. Crucially, this happened progressively, meaning there has been a chain of melting objects into other objects, rather than ingots moving directly to each area to be used once in local forms. In other words, craftspeople in Scotland were melting Irish objects to make their own axes, while further down the chain, Eastern English objects were using northern and Scottish objects for their materials. This can be shown chemically as the Ross Island metal contains arsenic, which is vulnerable to loss when the metal is molten, progressively falling away as metal is used and reused. Also when molten metal was mixed from other less arsenic rich sources, the losses were compounded, leaving us with identifiable trends of down-the-line metal use and reuse.

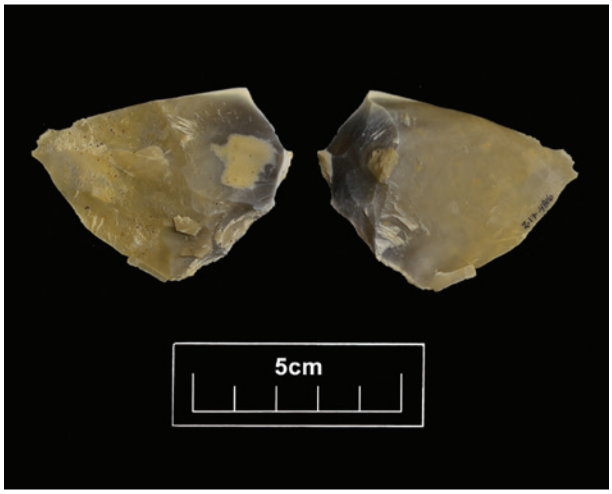
Finally, the reason why these objects are preserved in the Museum and available for scientific study, is the care with which they were buried. Either in axe hoards, or daggers accompanying the body in inhumations, it is clear that these were special objects that were selected and deliberately placed in the ground. Linking this care, with the local object designs, and the underlying flow of metal use, exchange and reuse, serves to build a different picture of what recycling can mean in the past. It appears intimately linked with identity, through changing other people's material culture and casting it your own forms, and then hoping to preserve that voice in the grave or hoard. Rather than eeking out a precious resource, or preventing waste, recycling becomes the reimagining of material, negotiating and shifting the influence of other people, and a process of imbuing metal with new values.

Peter Bray, Senior Research Fellow, University of Reading

Figure 1. Beaker culture copper mine at Ross Island, Killarney, Co. Kerry, Ireland.

Figure 2: Axe from the Butterwick hoard, BM 1879.12-9.383. Made from copper that can be linked with the Ross Island Mine, County Kerry, Ireland, this axe was cast and deposited in England around 2000 BC, likely from metal that was recycled from a previous generation of objects.

Linked moments in time



The study of early humans is sometimes thought to be limited to dry stones and bones, with the occasional surprise skull or footprints to hit the headlines. But in addition we sometimes get real glimpses into the lives of our distant relatives through refitting of stone artefacts; they can show the processes of manufacture, artefact modification or reuse, as well as the carrying of objects into and out of a site. This not only illustrates the mental and technical process of manufacture, but also begins to add a spatial dimension of how they operated in a landscape, occasionally through time.

One site with exceptional evidence is Boxgrove in Sussex. Dating to 500,000 years ago, it consists of a series of lagoonal silts and sands formerly in the shadow of a 100m chalk cliff. Sometimes described as the 'Pompeii of the Palaeolithic', the silts preserve a landscape of a few generations of human activity, represented by flint knapping scatters from handaxe manufacture associated with butchered bone around the edges of shallow pools. One location, coded GPT17 or the 'horse butchery site', has several such scatters, with one group telling a very specific story.

Group 50 consists of 17 refitting flakes from the final stages of manufacturing a handaxe. But the refitting shows a more complex history, partly determined by differences in surface patination of the outer (earlier) flakes. At Boxgrove, the chalk had rich seams of flint, which when eroded out could be picked up as nodules at the foot of the cliff. One such nodule was selected and knapped into a partially-made handaxe, probably initially with a hard stone hammer and then finer flakes detached with bone or antler. There is no evidence of use at this stage, but for some reason it was discarded or lost in the landscape and later recovered. How much later is unclear, but it must have been for several decades or longer, giving enough time for patination to develop across its surface.

The partially-made handaxe was eventually re-found and carried to GPT17, where the 17 flakes were detached with a bone or antler hammer to complete the making of the handaxe. As the scatters are associated with horse bones with clear breakage and cut-marks, it is assumed that the finished handaxe was used to dismember and butcher the carcass. The flakes and the bones are all that remain, as this handaxe and several others were carried away from the locale, presumably for re-sharpening and reuse elsewhere in the Boxgrove landscape.

This is just one story of the journey and transformation of an object passing through the hands of at least two people of different generations half a million years ago. Ironically, the handaxe has never been found, but part of its human story can be told through a few simple flakes.

Nick Ashton, Curator of Palaeolithic and Mesolithic collections

Rob Davis, Research Assistant, Britain, Europe and Prehistory

Matt Pope, Institute of Archaeology, UCL

Figure 1: Flake from the sharpening of the handaxe tip. Differences in colour show distinctions in patination from earlier knapping.

Figure 2: The 17 refitting flakes from Group 50, Boxgrove.

Roman tableware repaired and reused?

Sometimes the Scientific Research team study material from external excavations to gain insights that are valuable for technological interpretation of the British Museum collection. Recent work in collaboration with Cambridge Archaeological Unit (CAU) studied repaired Roman Samian pottery from excavations in North West Cambridge (NWC) see http://www-cau.arch.cam.ac.uk/NWC.htm. Samian was a mould-made tableware produced in Italy and in Gaul on an industrial scale and widely exported. It is glossy, red/orange in colour and was made in plain and highly decorative forms. It seems to have been mended much more frequently than other Roman pottery types. Repairs were typically made with lead rivets but some Samian sherds from NWC display a different repair technology, using a black adhesive. Analysis using gas chromatography - mass spectrometry allowed the adhesive to be identified as birch bark tar, based on molecular composition. Some fatty material detected might have been mixed with the tar to modify its properties or deposited by later use of the repaired vessels. Birch bark tar is manufactured by thermal treatment of birch bark. It has an ancient history of use throughout European prehistory and evidence is accumulating for its continued use during the Roman period, perhaps by small-scale local production. The relationship between tar production and pottery mending practice, whether undertaken by specialist repairers or as part of domestic maintenance is unclear. Assessment of Roman pottery repair has predominantly focussed on the more common lead rivet/cleat technologies, with repair linked to decorated forms and differing between rural and urban sites. Such observations point to differences in value placed on vessels and perhaps in access to markets for Samian ware. The relative performance of different mending technologies has received less attention; adhesive repairs using birch bark tar would be watertight, although not suitable for heating, and thus appropriate for table wares which might be intended to be used. It may be significant then that the repaired Samian wares from NWC are all plain forms, which perhaps would only be worth mending if they could be used.

Rebecca Stacey, Scientist

Figure 1: Samian pottery with lead staples, excavated at New Hall in Cambridgeshire

Figure 2: Samian pottery from Great Chesterford. 1868,0812.1

Figure 3: close up showing birch bark tar adhesive on the broken surface of a bowl fragment from excavations at North West Cambridge, it is one of the samples we analysed.

How you can help
If you wish to support any aspect of scientific research at the British Museum, please contact the Development Office on development@britishmuseum.org or +44 (0)20 7323 8194

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