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Investigating technological and environmental evidence from plant remains and molluscs in cuneiform tablets

Caroline Cartwright and Jon Taylor

Summary This contribution examines the presence of organic remains in and on selected clay cuneiform tablets, drawing on recent detailed scientific examination of these materials using optical and variable pressure scanning electron microscopy. This research has revealed unexpected evidence for aspects of the natural environment and available resources at the time the tablets were created. Identification of charcoal flecks in the tablets, for example, indicates those trees and shrubs present in the areas from which the clay was selected. Fragmented plant remains or impressions of plants on the surfaces of the tablets show how the tablets might have been stored in antiquity – wrapped in linen cloth or between layers of cereal straw. Land snails and freshwater molluscs have also been found in the clay matrices of some tablets. As many of these molluscs have very specific habitats, useful information has been gained about the raw materials and their ecological sources. Some of the challenges for the ongoing study of organic materials associated with these objects are discussed.

INTRODUCTION

Between *c*.3400 bc and *c*.ad 100, ancient Mesopotamian scribes produced a wide range of documents using the cuneiform writing system in which a stylus was pressed into the surface of a tablet made from moist clay. The British Museum's collection of cuneiform tablets is among the most important in the world; it contains approximately 130000 tablets and fragments, making it probably the largest collection outside Iraq. The centrepiece of the collection is the 'Library of Ashurbanipal', comprising around 30000 of the most important tablets yet found. There are also large archives from third millennium Girsu and Umma, second millennium Sippar, first millennium Babylon and Sippar, as well as numerous smaller collections of tablets spanning 3000 years of history in the ancient Near East.

As the British Museum has an open access policy with regard to cuneiform tablets, with all texts being available to all researchers, curators and conservators constantly survey and assess the condition of the tablets and undertake conservation to ensure that they remain accessible for study. In 2004, as part of this ongoing care and monitoring of the collection, selected cuneiform tablets were submitted for identification of the organic material surviving on some surfaces, Figure 1. The identification of this material is not only of potential scientific significance in its own right, but the results are also extremely useful in an ongoing re-evaluation of the practice of controlled re-firing of selected tablets for conservation reasons. Over the course of three years, more tablets were submitted for scientific examination as part of a parallel curatorial study of the technological processes of making, and possibly re-making, cuneiform tablets, Figure 2 [1].

METHODS

Some of the tablets were examined with reflected light in dark field mode using the Leica Aristomet biological optical microscope at magnifications ranging from ×20 to ×200. Others were examined using the backscatter detector in the Hitachi S-3700N variable pressure scanning electron microscope (VP-SEM) with an accelerating voltage of 15 kV, a chamber pressure of 40 or 50 Pa and at working distances ranging between 20 and 30 mm. Depending on which was most informative for individual samples, either the compositional or 3D mode of the VP-SEM was selected to examine the specimens.

figure 1. Tablet ME 113474 showing an area of charred reeds adhering to the surface. At higher magnifications in the VP-SEM these were identified as *Phragmites australis* and *Arundo donax*

RESULTS AND DISCUSSION

Plant remains and impressions

Discrete areas of charred reed remains were present, adhering to the surface of tablets ME 113385 and ME 113474, two contracts from Neo-Babylonian Uruk. The reeds present, *Phragmites australis* and *Arundo donax*, grow abundantly in or near water, such as on wadi banks. Another contract from Neo-Babylonian Uruk (ME 113400), showed evidence for *Phragmites australis* in the form of impressions left in the tablet surface, Figure 3. Impressions of *Arundo donax* and cereal straw were also present in this tablet, the latter being remnants of crop processing. A Late Babylonian economic tablet from Sippar (ME 71760), also contained plant remains, including reed fragments.

It is not entirely clear what the presence of reed fragments, and their impressions on the surface of the tablets, signifies. One suggestion is that, after modelling, the tablets may have been placed in reed baskets on racks or shelves, when the still moist surfaces would have taken impressions of the reeds. Alternatively, the tablets could have been stored interleaved with reed matting specifically to keep them moist or to offer some protection to the inscribed surfaces from abrasion or contact with other tablets. In the case of the charred remains on tablet ME 113474, their association may be secondary rather than primary, perhaps resulting from a fire in a storage area during which plant remains became attached to the surface of tablets in the resulting debris. In this scenario, these reed remains might represent the construction materials of the storage area.

figure 2. Fragmented tablets, such as this example (ME 47449), provide the opportunity for studying the technology of manufacture as well as any included organic material

The issue of the burning of buildings is important for two reasons. First, the charring of organic remains can assist in their preservation and thus provide environmental and technological evidence to the modern researcher. Second, the clay cuneiform tablets within the burning buildings can be partially baked in such episodes, for example the great fire in 612 bc that destroyed Ashurbanipal's palace at Nineveh, including its library of cuneiform tablets.

Macroscopically, tablets ME 108546 and ME 108547, two *bullae* from the Ur III period, had what appeared to be traces of fibres or textile adhering to their external writing surfaces. VP-SEM examination revealed these to be *Linum usitatissimum*, flax fibres, Figure 4. Their presence could indicate wrapping of the tablets in a protective linen cloth to keep them moist or to protect the inscribed surfaces or result from resting the tablet on a cloth used as part of the sealing process. Tablet ND 2346, a clay tag from Nimrud, which declares that it once provided a label for a storage

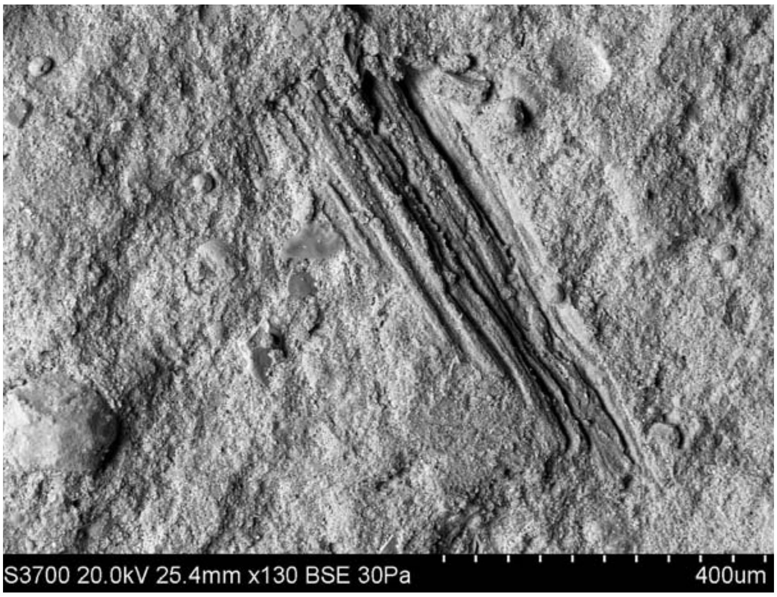

figure 3. Tablet ME 113400 in the VP-SEM showing evidence for the reed *Phragmites australis*, in the form of impressions left in the tablet surface. Also present in this tablet, but not in this image, were impressions of another reed, *Arundo donax*, and cereal straw

figure 4. VP-SEM image showing *Linum usitatissimum*, flax fibres, which might indicate wrapping of the tablet in a protective linen cloth to keep it moist or to protect the inscribed surfaces

container "for the palace", contained the remnants of flax cord in its central perforation, while tablet ND 2334 also has a flax cord.

Many of the tablets contained flecks or tiny fragments of charcoal within their silty clay matrix. These presumably became incorporated into the mix during modelling of the tablets on floors or benches and represent both the natural environment around the site and the woody species selected for use as fuel. From a Late Babylonian economic tablet from Borsippa (ME 46955) there are tiny charcoal fragments of *Tamarix* sp., tamarisk, a type of shrub often used for basketry, matting and fences, and from *Ziziphus spina-christi* (the sidr or Christ's thorn tree: Figure 5), a tree with edible fruit and useful timber for small carpentry items or fuel.

Although these charcoal fragments alone are unlikely to represent intentional tempering, the extent of the practice of deliberate addition of plant remains, visible as diagnostic impressions and voids left within the matrices, is currently being investigated as part of an ongoing study. Organic-rich silt, clay or mud might have been specifically collected from wadi banks and river beds, or plant remains deliberately added in order to create a more open-textured material that would not only have been easier to work but would also have inhibited shrinkage cracks on drying [2].

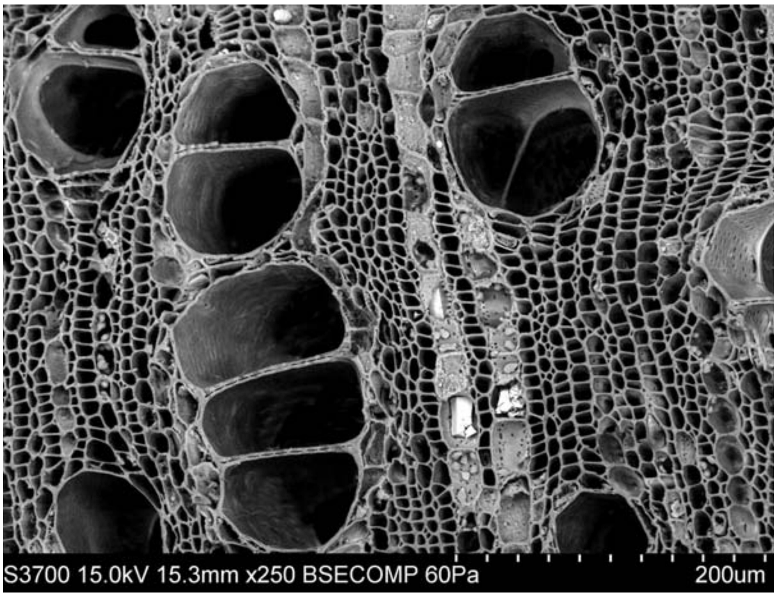

figure 5. VP-SEM image showing the transverse section of a charcoal fragment of *Ziziphus spina-christi*, sidr or Christ's thorn tree, from ME 46955, a Late Babylonian economic tablet from Borsippa

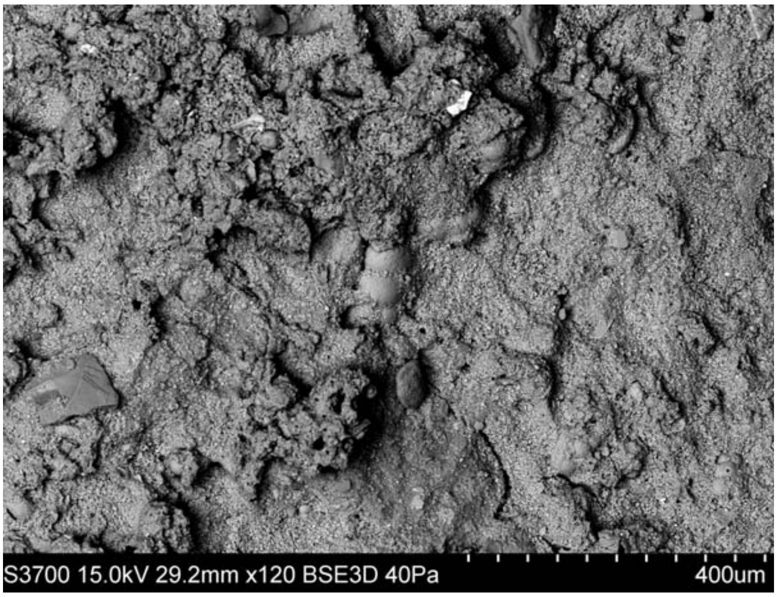

figure 6. VP-SEM image showing the matrix of tablet ME 46570 with the land snail *Opeas gracile*, an indicator of agriculture, at the centre of the image

Land and freshwater shells (molluscs)

Freshwater and land molluscs (particularly land snails or gastropods) can be highly informative environmental indicators as many taxa have distinct ecological preferences with regard to their habitat. The usual protocol for studying such land snails on archaeological sites is to sample directly in soil from a column cut into a cleaned stratigraphical section. Molluscs are then extracted in the laboratory using specialized processes, identified through microscopy and quantified. Using this method – plotting the percent abundance of selected species against time – meaningful changes in mollusc populations can be seen. By inference, light can be shed on local ecological changes, such as flooding, drought and increasing salinity. In this way these data on mollusc populations can also be used in reconstructions of regional environmental change.

The British Museum tablets cannot be linked to a sequence of soil samples that would offer the potential to use this method of stratigraphic molluscan analysis, but the information from the shells associated with these tablets can provide a different type of evidence. Of course, in ongoing and future field excavation work on sites containing clay tablets, it would be highly desirable to gather stratigraphic information that would allow both of these very different forms of molluscan investigation to be undertaken in tandem, and in association with other techniques of environmental archaeology.

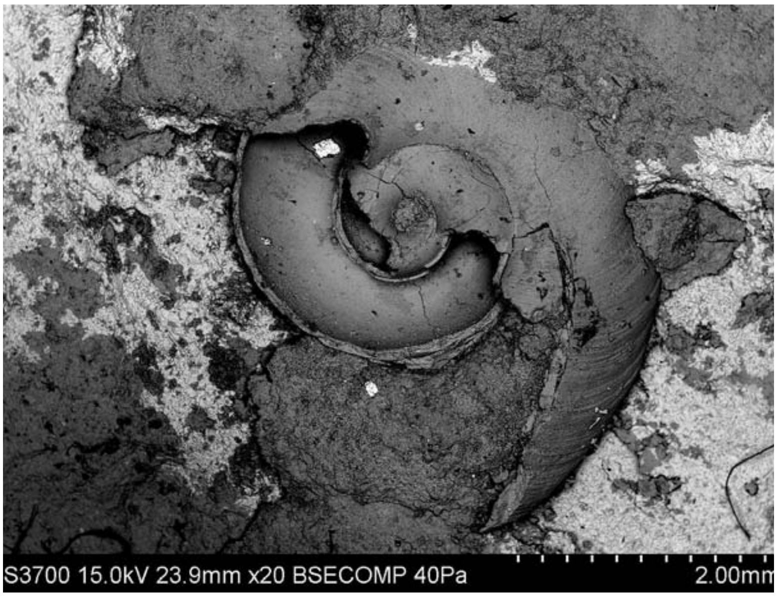

figure 7. VP-SEM image showing the matrix of tablet ME 87124 with the large freshwater snail *Indoplanorbis exustus*, commonly found in rivers, irrigation canals and stagnant water ponds

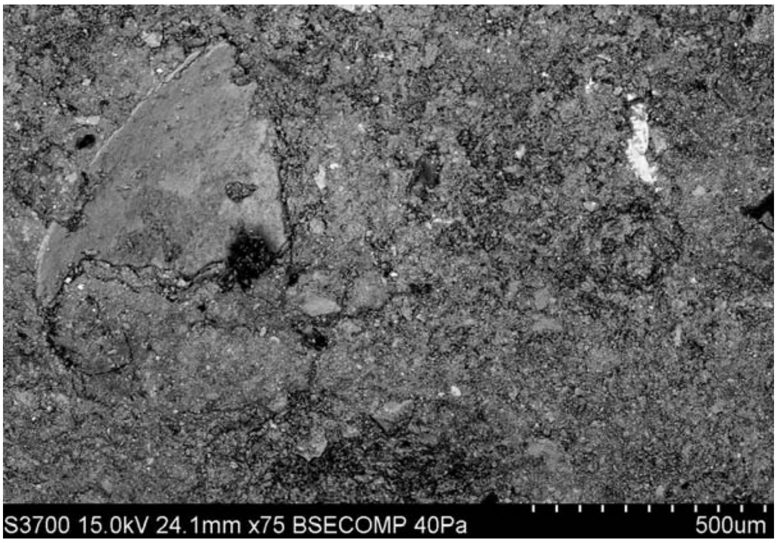

figure 8. VP-SEM image showing the matrix of tablet ME 87124 with a triangular fragment of the freshwater bivalve *Lamellidens* sp., one of the large family of Unionidae freshwater mussels, to the left of the image

Using non-destructive methods, a recent pilot study of diatoms on selected British Museum tablets by Tuji and Watanabe has provided another strand of complementary evidence that sheds light on salinity and changing water quality associated with possible clay sources [3].

Whole specimens and fragments of land and freshwater bivalve and gastropod shells can be found on the surface of tablets and also within their matrix. Two main categories of useful information can be obtained from their presence and also from the individual taxa represented: technological and environmental.

Much uncertainty still surrounds the assumed systematic reuse of old tablets, although it is clear that rehydration or re-levigation are the only plausible possibilities for such practices [1]. As the purpose of levigation is to refine the constituent parts of the raw clay by immersion in water, the presence of shells in tablets must indicate that the clay has not been levigated. Being light, any molluscs would have floated to the surface of the water during levigation and have been skimmed off. It can also be assumed that any molluscs present within the body of a tablet were present in the original mud, silt or clay and did not crawl there after manufacture, as such a migration would be evident from disruption to the script. Nor can they have entered after the tablets had been air dried (out of direct sunlight), as the matrix would by then be far too hard. The presence of well-preserved molluscs suggests that scribes must have used unprocessed clay in many instances, as the thin-walled land and freshwater shells would not

Proceedings of the 7th International Congress on the Archaeology of the Ancient Near East (ICAANE), London 2010: Scienze dell'Antichità 17 (2011) (in preparation).

2. Cartwright, C.R., 'Plant remains from the mud plaster', in *e Nebamun wall paintings: conservation, scienti c analysis and redisplay*, ed. A. Middleton and K. Uprichard, Archetype Publications, London (2008) 25–29.
3. Tuji, A. and Watanabe, C., 'Reconstructing the landscape of the ancient environment in Mesopotamia through biological indicators found in clay tablets', in *Proceedings of the 7th International Congress on the Archaeology of the Ancient Near East (ICAANE), London 2010: Scienze dell'Antichità* 17 (2011) (in preparation).