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A fresh assessment of a small stone plaque from China

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SUMMARY This contribution describes the analytical examination of a small stone trapezoidal plaque (1938,0524.400) in the British Museum collection. The plaque is poorly preserved: the reddish-brown and cream surfaces are damaged and much of the engraved design at the front has been lost. A total of 15 narrow circular perforations pierce the upper and lower edges and the carving was originally thought to be a jade component of a Chinese lute dating to the first millennium BC. However, studies of recently excavated finds from burials in central China by Jessica Rawson and Huang Tsue-me have allowed the British Museum artefact to be identified as part of a beaded headdress ornament. Further aspects of the material and origins of this plaque were investigated using a combination of Raman spectroscopy, optical microscopy and reflectance transformation imaging.

The finely banded material of the trapezoidal plaque was shown to be travertine, a variety of calcite. Originally, the stone appears to have been predominantly green with some grey areas. Although it was probably selected as a softer alternative to nephrite jade, the banding within the travertine was skilfully oriented to create attractive 'watered silk' patterns on the finished surfaces of the plaque. The current damaged state of the artefact is characteristic of weathering during an extended period of burial and the predominant reddish-brown colouration is largely due to the ritual use of powdered red cinnabar in burial. The study confirmed that the trapezoidal plaque (or *tixingpai*) formed part of a beaded headdress ornament made in China during the early first millennium. The style of engraving is typical of the Late Western Zhou and Early Eastern Zhou periods, indicating a date between *c.*850 and *c.*650 BC.

Introduction

A small, weathered trapezoidal plaque (1938,0524.400: Figure 1) was one of 273 Chinese jades purchased by the British Museum (BM) in 1937 from George Eumorfopoulos, an active collector of Asian antiquities during the 1920s and 1930s and a founder of the Oriental Ceramic Society [1]. The front face of this trapezoidal plaque bears the remains of an engraved curvilinear design. At the top of the plaque, six narrow perforations are formed by sets of interconnected holes drilled in the upper edge and the rear surface; nine perforations have similarly been worked along the longer base between the lower edge and the rear surface. At the time of purchase, this piece was thought to be part of a lute dating to the Zhou dynasty in China, 1046–221 BC. However, comparison with recently excavated material from central China and studies led by Jessica Rawson and Huang Tsue-me have allowed this small stone plaque to be placed in an entirely different context [2–11].

It is now clear that, following the Zhou conquest of the Shang in 1046 BC, a new fashion for brightly coloured beads – including red carnelian, blue faience and other stones and materials – grew among the Zhou and their allies. For several centuries, these beads were combined with plaques of jade, ivory and other materials to create an increasingly coherent set of complex composite costume ornaments that were buried with, and presumably had previously been worn by, both men and women of high social status [6]. One particular type of ornament found in female tombs comprises a perforated trapezoidal plaque (*tixingpai*) from which strings of beads were suspended. Some of these plaques are very similar to the BM plaque, which has been examined in the light of this new research and context.

Figure 1. Images of the weathered trapezoidal stone plaque 1938,0524.400 (81 mm high and 9 mm thick) showing: (a) the front surface; and, (b) the rear surface

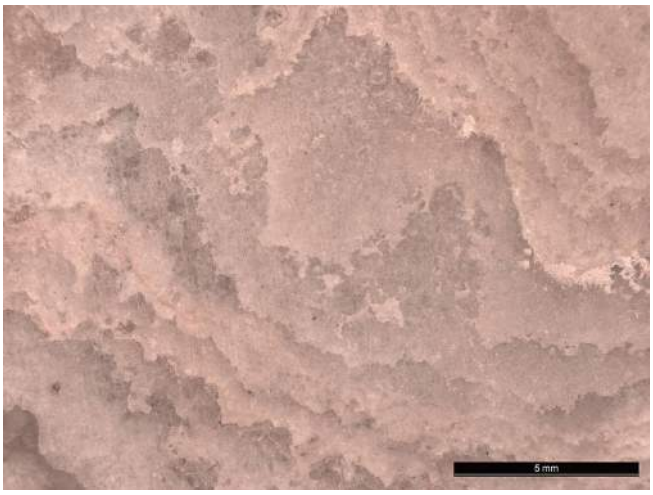

Figure 2. Photomicrograph showing details of the watered silk pattern preserved in the polished surface at the rear of the trapezoidal plaque

Appearance and composition

Observations using an optical microscope confirmed that the trapezoidal plaque has been extensively damaged by weathering, probably during a prolonged period of burial. On the front of the plaque the engraved design can be seen preserved along the right side, but elsewhere the surface is pitted and degraded. The rear of the object is less extensively damaged and the original polish is preserved on about half of the surface.

Also apparent was the loss of original colouring. The front surface is predominantly cream to reddish-brown and grey, whereas the polished areas of the rear surface retain a greenish colour. Minute red deposits, which are preserved on many areas (Figure 1), were confirmed to be cinnabar – mercury (II) sulphide – by Raman spectroscopy. The ritual use of cinnabar in China has a long tradition and has been confirmed in burials of the late Shang and Zhou periods [12]. The current overall reddish-brown colouring of the plaque appears to have been imparted by powdered red cinnabar during burial. What remains of the colour of the rear face suggests that the stone was originally green with some grey areas.

At the time of its purchase by the BM, the trapezoidal plaque was described as jade, but the mineral of which the stone is comprised has now been identified as calcite by Raman spectroscopy. The material is finely banded and the colouring and opacity of the bands vary, characteristics that indicate the stone to be travertine, a variety of calcite. Travertine is formed by the dissolution of calcium carbonate in ground water and subsequent deposition by rivers, natural springs or geysers.

Confusion arises over the term for jade (*yu*) in China. It may be used in a narrow sense to refer to nephrite, the variety of 'true jade' usually worked in ancient China, or jadeite, added to the material repertoire from the mid-eighteenth century. However, *yu* traditionally means 'beautiful stone' and the term *yu* or *yu shi* (jade stone) is often applied broadly to describe carvings of other rocks or minerals such as quartz, serpentine and calcite. Following the nomenclature recently adopted in China to differentiate between true jade and its imitators, the term 'calcite jade' is appropriate for the material of the BM plaque [13].

Unfortunately, calcite is readily soluble in acids and the extensive loss of polish and damage to the surface and underlying layers of the plaque are consistent with weathering during an extended period of burial in a wet, slightly acidic environment. Furthermore, the finely banded characteristics of the travertine are likely to have facilitated the penetration of acid solutions between layers at the surface, rendering the carving particularly vulnerable to weathering.

Calcareous stones have a hardness (H) of three on Mohs' scale; they are considerably softer and also less tough than nephrite (H of 6.0–6.5). Although the raw material for the trapezoidal plaque may have been selected as a softer alternative to nephrite, nephrite is usually relatively plain coloured and a factor governing the choice of travertine may have been its banding. The fine bands form undulating layers, which appear to have been oriented deliberately to produce attractive 'watered silk' patterns on the finished front and rear surfaces of the carving. About 12 fine bands lie within the plaque. At the centre, they are more or less parallel to the two principal faces and little patterning is seen. Elsewhere, the bands are oriented obliquely and variations between the colour and opacity of adjacent bands would have been highlighted

Figure 3. Images of the remains of the engraved design in the damaged front surface of the trapezoidal plaque, rendered from the RTI data: (a) in raking illumination; (b) in specular enhancement mode; and (c) in surface normal visualization mode (areas in the same plane are depicted in the same hue in this false-colour image)

and seen as patterns, similar to the pattern preserved in the polished surface at the rear, Figure 2.

The remains of the engraving on the more damaged front surface were recorded using reflectance transformation imaging (RTI), as described in the experimental appendix. With the help of the images produced using this technique, sufficient features were made visible to allow the design to be evaluated. Images rendered using different settings in the RTI viewing software show a symmetrical design of hooks and spirals in three registers, Figures 3a–3c.

Attribution

The shape and dimensions of the BM plaque closely resemble those of *tixingpai* that, when found in context in elite female burials in central China, form the defining component of a distinctive type of elaborate beaded ornament. These remarkable artefacts date from the latter part of the Early Western Zhou period (*c*.950 BC) to the Early Eastern Zhou period (*c*.650 BC) [6, 8, 11]. By analogy with excavated examples, nine strings of beads made of various materials would have been suspended from the perforations along the base of the BM *tixingpai*, hanging down as a dense tassel; different bead materials may have been ordered within the strings to create bold horizontal bands of colour. A smaller number of beads was probably strung together and threaded through the six perforations along the upper edge for suspension. The example illustrated in Figure 4 was excavated from tomb M31at the Jin Marquis cemetery, near Beizhao, Shanxi province [2, 14; p. 95]. This set is dated to *c*.800 BC and composed of nine strings of red carnelian, blue faience and grey-green steatite or pyrophyllite beads attached to a nephrite *tixingpai*. Plaques of ivory, sometimes inlaid with turquoise, are typical of graves predating the mid-ninth century BC; thereafter nephrite and other visually similar stones appear to have become the materials of choice.

The design of hooks and spirals engraved in the BM plaque (Figure 3) is comparable with those of several nephrite *tixingpai* dating from the late Western Zhou and early Eastern Zhou dynasties, *c*.850–*c*.650 BC, and exemplified by decorated plaques recovered from tombs M31 and M102 at the Jin

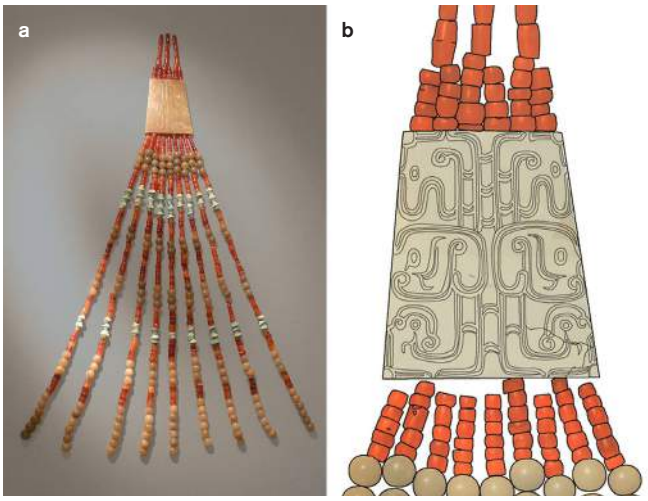

Figure 4. An elaborate beaded ornament comprising a nephrite jade *tixingpai* (87 mm high) and bead set from tomb M31 at Beizhao, Shanxi province, *c*.800 BC: (a) the complete assemblage (the red beads are carnelian, the blue beads are faience and the spherical beads are probably steatite or pyrophyllite); and (b) a drawing of the engraved design on the *tixingpai* from tomb M31

Marquis cemetery and tomb M27 at Liangdaicun, near Hancheng, Shanxi province, Figure 4 [6, 14; pp. 95 and 137].

Although complex beaded arrangements have been found in the graves of both men and women, the tasselled sets formed around *tixingpai* were associated exclusively with women. They are usually found in pairs running down from the area of the head and neck across the torso, and were probably originally attached to opposite sides of a headdress that has long since decayed. Unlike some elaborate beaded arrangements, *tixingpai* sets have no obvious heritage in China and their origin has been linked with the pastoral world of the Eurasian Steppe [6, 8, 15]. Structurally similar artefacts, identified as plait ornaments, that comprised metal and faience beads and pendants have been found widely in the graves of Late Bronze Age communities of the second millennium BC, and elaborate female headdresses continued to be an important feature of many later Eurasian pastoral societies [16, 17].

Conclusions

The results of analysis and examination showed that the perforated trapezoidal plaque in the BM was worked in travertine, a variety of calcite. The finely banded calcareous stone was originally predominantly green in colour, the banding skilfully oriented to create attractive watered silk patterns on the polished surfaces of the carving. The present damaged condition of the plaque is consistent with degradation in a slightly acidic burial environment, although the reddish-brown surface discolouration appears to be largely due to the ritual use of powdered red cinnabar in burial.

Based on comparison with excavated examples, this *tixingpai* was confidently re-identified as part of an elaborate beaded headdress ornament of a type widespread in central China during the early first millennium BC [6]. These ornaments were associated with high-status women and were usually worn in pairs, hanging down from opposite sides of the head as flowing tassels of coloured beads. The style of engraving seen on the BM *tixingpai* is consistent with a date within the Late Western Zhou or Early Eastern Zhou periods, *c*.850–*c*.650 BC. This study also allows the carving to be placed in a broader context as part of the evidence for extensive cross-cultural contact between China and its neighbours.

Experimental appendix

Raman spectroscopy

A Dilor Infinity Raman spectrometer was used to identify the material of the plaque and the superficial red deposit. Measurements were made directly on the samples with a green (532 nm) laser with maximum power of ≤2.0 mW at the sample and an internal beam path. Spectra were collected for 5–20 seconds, with at least five scans used to produce each spectrum; they were identified by comparison with reference spectra from an in-house database.

Optical microscopy

Examination was carried out using a Leica MZ APO optical microscope at magnifications of ×8 to ×40 and images were acquired with Leica Application Suite V4.2 software.

Reflectance transformation imaging

The RTI images were made using a custom-built dome manufactured by the Department of Electronics and Computer Science at the University of Southampton [18]. A series of images of the stone plaque was made using the Nikon D800 camera fitted to the top of the dome. In each image one of the 76 LED lamps distributed across the inner surface of the dome was illuminated. This series of images was built into a composite RTI image using the software provided with the dome. The RTI image was viewed using the 'RTIViewer' software downloaded from Cultural Heritage Imaging [19]. Views that show particular features of the engraving to good effect were rendered from the RTI file, saved as two-dimensional images, and are illustrated in Figures 3a–3c.

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References

1. Michaelson, C., 'A history of the Chinese jade collection in the British Museum', *Transactions of the Oriental Ceramic Society* 75 (2012) 65–81.
2. Shanxi Institute of Archaeology and Department of Archaeology, Peking University, 'Tianma Qucun yizhi Beizhao Jin hou mudi di san si ci fajue', *WENWU* 8 (1994) 4–33.
3. Department of Archaeology, Peking University, and Shanxi Institute of Archaeology, 'Tianma Qucun yizhi Beizhao Jin hou mudi di wu ci fajue', *WENWU* 7 (1995) 4–39.
4. Rawson, J., *Mysteries of ancient China: new discoveries from the early dynasties*, British Museum Press, London (1996).
5. Rawson, J., 'In search of ancient red beads and carved jade in modern China', *Cahiers d'Extrême-Asie* 17 (2008) 1–15.
6. Rawson, J., 'Ordering the exotic: ritual practices in the late Western Zhou and the early Eastern Zhou', *Artibus Asiae* 73 (2013) 1–76.
7. Huang, T., 'Wenhua – Jiyi chuanji xinshiqi shidai zhi Xizhou shiqi yuhuang ji zhushi', paper presented at the *4th International Conference on Sinology, Taipai, 20–22 June 2012* (unpublished).
8. Huang, T., 'Liuguang yicai, cuirao zhuwi – Xi Zhou zhi Chunqiu zaoqide tixingpai lianzhu chuanshi', in *Radiance between bronze and jade: archaeology, art and culture of the Shang and Zhou dynasties*, ed. K. Chen, Institute of History and Philology, Academia Sinica, Taipei (2013) 559–600.
9. Braghin, C., 'An archaeological investigation into ancient Chinese beads', in *Beads and bead makers: gender, material culture and meaning*, ed. L.D. Sciama and J.B. Eicher, Berg, Oxford (1998) 273–293.
10. Salviati, F., *The language of adornment: Chinese ornaments of jade, crystal, amber and glass*, Myrna Myers, Paris (2002).
11. Hommel, P. and Sax, M., 'Shifting materials: variability, homogeneity and change in the beaded ornaments of the Western Zhou', *Antiquity* 88 (2014) 1213–1228.
12. Needham, J. and Lu, G.-D., *Science and civilization in China. Volume 5: Chemistry and chemical technology. Part V, Spagyrical discovery and invention: physiological alchemy*, Cambridge University Press, Cambridge (1983) 222–223.
13. Wang, R., 'Progress review of the scientific study of Chinese ancient jade', *Archaeometry* 53 (2011) 674–692.
14. Gu, F., *The complete collection of jades unearthed in China. Volume 3: Shanxi*, Science Press, Beijing (2005).
15. Rawson, J., 'Carnelian beads, animal figures and exotic vessels: traces of contact between the Chinese states and Inner Asia, ca. 1000–650 BC', in *Archäologie in China. Volume 1: Bridging Eurasia*, ed. M. Wagner and W. Wei, German Institute of Archaeology, Berlin (2010) 1–42.
16. Gening, V.F., Zdanovitch, G.B. and Genning V.V., *Sintashta; arkheologicheskie pamyatniki arijskikh plemen Uralo-Kazakhstanskikh stepej*, Southern Ural Press, Chelyabinsk (1992).
17. Kupryanova, E.V., *Ten'zhenshchiny: zhenskij kostyum Yepokhi Bronzy kak 'tekst'*, Avto Graf, Chelyabinsk (2008).
18. 'PTM/RTI imaging of cultural heritage objects', http://users.ecs.soton.ac.uk/km/imaging/ptm/ (accessed 22 July 2015)
19. 'Cultural Heritage Imaging: downloads', http://culturalheritageimaging.org/What_We_Offer/Downloads (accessed 22 July 2015).