Archaeometry *Explore this journal >*

View issue TOC
Volume 59, Issue 3
June 2017
Pages 566–573

Original Article

The Carving Technology of the Handle-Shaped Artefacts from Yinxu (*c*.1300–1046 BC) in China

C. L. Yue, G. D. Song, J. Zhu , S. C. Ding, N. S. Li

First published:
9 December 2016 Full publication history

DOI:
10.1111/arcm.12276 View/save citation

Cited by (CrossRef):
Check for updates
0 articles Citation tools

Funding Information

Abstract

The handle-shaped artefact is a special jade object of the Three Dynasties (c.2000–200 BC) period. The manufacturing technology and function of the handle-shaped artefacts are widely questioned. In this paper, two handle-shaped artefacts from Yinxu (c.1300–1046 BC) are tested by digital microscope, Raman spectrometer and scanning electron microscope. The results indicate that the handle-shaped artefacts might be made in four steps, namely rough shape cutting, edge reforming, handle making and single-side polishing. It also suggests that the handle-shaped artefacts might be used as sacrificial offerings, but not as hairpins or handles.

Introduction

Chinese jade artefacts are very important in the study the history of the Three Dynasties (*c* .2000–200 BC) period. The Chinese word 'Yu' has been translated as 'jade' in English. The word 'Yu' means 'beautiful stone' in ancient Chinese. According to the available archaeological information, Chinese jades have been worked in a variety of stones of differing mineral composition (Xia **1983**; Institute of Archaeology, Chinese Academy of Social Sciences **2005**).

In any case, jade was a sign of nobility (Song **2004**; Gao **2010**). The jade artefacts are mostly found in the tombs of the nobles. The handle-shaped artefacts are special among all the jade artefacts. 'Handle-shaped' is an expedient name for the handle-like form. Mostly, a handle-shaped artefact is flat. Its upper end is narrower than the body, which looks like a handle (Fig. 1). Sometimes, the artefact is perforated.

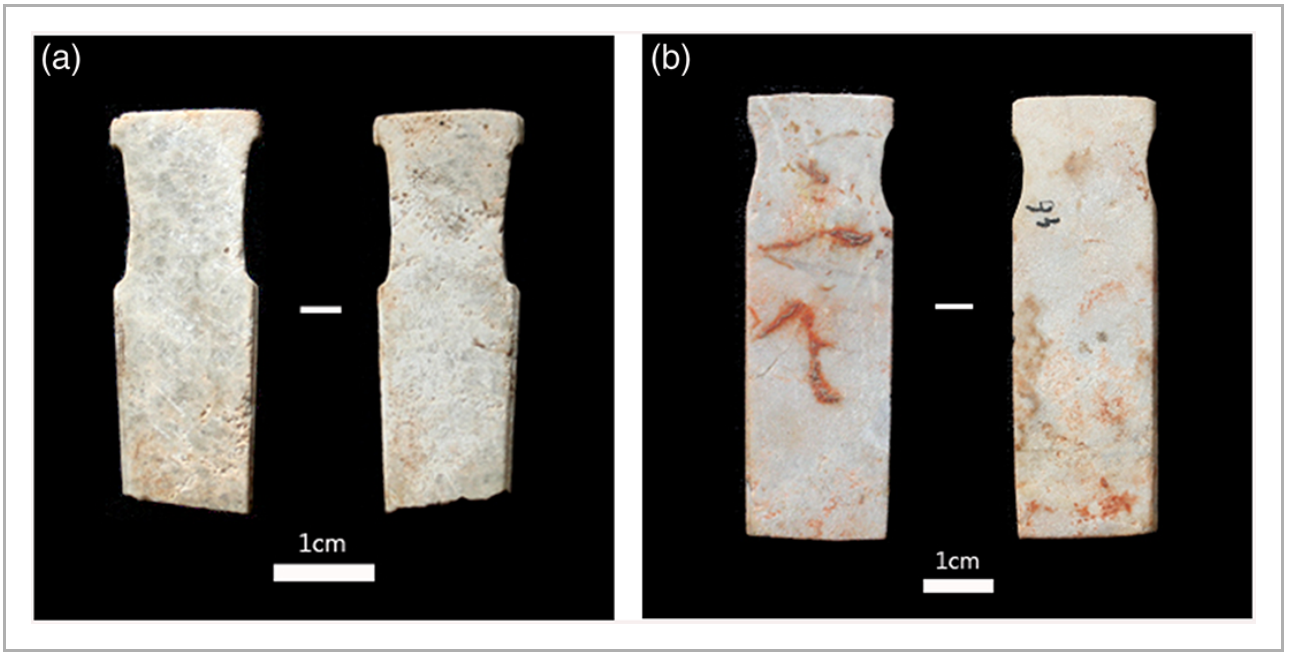

Figure 1.

Open in figure viewer

Photographs of the samples: (a) AY1; (b) AY2. [Colour figure can be viewed at wileyonlinelibrary.com]

By the year 2005, up to 751 pieces of handle-shaped artefacts had been found. All of them are made of jade and are dated back to the Three Dynasties (Li **2008**). The archaeological sites are considered to be capitals and political centres, such as Erlitou, Erligang, Yinxu and Fenghao. Among them, more than a quarter (about 200 pieces) are from Yinxu, which is a famous archaeological site of the late Shang dynasty (*c* .1300–1046 BC). It was the capital of Shang, which was also a political, economic and cultural centre. According to archaeological reports published between 1950 and 2000, as many as 2600 pieces of jades have been found at the Yinxu site. The increase in jade production is considered as a sign of technological development. The same situation had occurred during the Hongshan (*c* .5000–4000 BC) and Liangzhu (*c* .3000–2000 BC) periods (Yang **1988**; Institute of Archaeology, Chinese Academy of Social Sciences **2005**).

In typological studies, the technology of the handle-shaped artefacts can be traced back to the

Neolithic jade sceptres (Cao **2008**). In the late Shang dynasty, the technology was already well-developed.

Most of the studies are about the functions of the handle-shaped artefacts. There are three hypotheses, as follows:

1. The handle-shaped artefacts might have been used as sacrificial offerings, in celebrations and funerals (Wang **1988**; Zheng **1988**; Shi **2010**; Li and Jing **2012**).
2. As ancient Chinese people wore their hair long, the handle-shaped artefacts might be hairpins (Shi **1973**; Cui **2001**).
3. Because of their perforations, the handle-shaped artefacts could be attached to something else. They might be handles for swords, sceptres or tools (Guo **1951**; Zhang **1994**; Wei **2013**).

In light of the above questions, two samples of the handle-shaped artefacts from the Yinxu site are tested to deal with the following issues:

1. As the technology of the handle-shaped artefacts from the Yinxu site is considered to be well-developed, what is the detailed production process?
2. Is it possible to speculate about the function of the handle-shaped artefacts from their production process?

Materials and Methods

The archaeological context and the samples

The two handle-artefacts used as samples are from the Yinxu site (Table 1). The Yinxu site is in Anyan, Henan Province, in central China. The Yinxu site is divided into different functional areas, and the samples are from the area of the cemetery (Institute of Archaeology, Chinese Academy of Social Sciences **1980**; Yue *et al.* **2011**). Sample AY1 is plain, without any ornament (Fig. 1 (a)), while sample AY2 has ancient Chinese red characters on one side (Fig. 1 (b)). The characters are considered to be the name of a king in the late Shang dynasty. The AY1 type is common among all the handle-shaped artefacts, while the AY2 type only exists in the late Shang dynasty (Cao **2008**).

Table 1. Descriptions of the samples

	Size (cm)			Condition	Illustration
Number	**Length**	**Width**	**Height**		
AY1	4.3	1.4–1.6	0.5	Partly weathered	Figure 1 (a)
AY2	6.8	2.1–2.3	0.6	Partly weathered	Figure 1 (b)

Digital microscopy

The two handles were observed using a digital microscope (VHX-600ESO, Keyence, Japan). The technology of an extended depth of focus and a three-dimensional model were used. The extended depth of focus was used to present highly accurate images, and it could show the surface of the whole body. The three-dimensional model could compose and superimpose images captured at different focal positions, and it integrated recording, measurement and exhibition (Wu and Wang **2009**; Gu *et al.* **2014**). Regardless of cutting or polishing, the fundamental problem is about friction (abrasion), and the lines on the surface of jades are generated by abrasives. Therefore, the line width of the tool mark is approximately equal to the abrasive diameter. The particle sizes of the traces of jade sand were measured.

Raman spectroscopy

Micro-Raman spectroscopy was conducted on the samples to make sure of their mineral compositions. The Raman spectrometer (LabRam HR, JY Horiba, France) was coupled to a 785 nm argon-ion laser and to ×200 and ×500 objectives. All the accumulation times were 60 s. The obtained Raman spectra were compared with standard database and published materials.

Scanning electron microscopy

A block of marble was used for the simulation experiment (Fig. S1). The marble block was cut using flints without abrasives (sands) and copper chips with abrasives (sands). The copper chip, like a thin saw, is made from a piece of copper and wood. Marble and dolomite have similar structure and hardness values. The hardness is 3.0–3.5 on the Mohs scale, while the abrasives have a hardness of 7 and the copper chip has a hardness of 3. The treated marble block was moulded, and the moulds were examined using a scanning electron microscope (SEM, EVO25, Carl Zeiss, Germany). The moulding material was light-bodied 3 M ESPE REF.7302. The SEM was operated under a × 100 objective at an accelerating voltage of 8–15 kV.

Results and Discussion

Rough shape cutting

The Raman results show that the mineral composition of the samples is dolomite (Gunasekaran *et al.* **2006**). Dolomite is a common raw material of ancient Chinese jades (Dong *et al.* **2011**). The general production process of rough shape cutting of the ancient Chinese jades has been generally acknowledged. A small piece was removed from the main body of the jade material. Then, the small piece was ground into the basic shape (Institute of Archaeology, Chinese Academy of Social Sciences **2014**). However, there are different assumptions about how the small piece was removed, namely (1) wheel-cutting, (2) filing and (3) string sawing. Tool marks made by string sawing are entirely different with those made by wheel-cutting and filing. We have not found any evidence of string sawing in this case. For wheel-cutting, the line trace made on the side(s) of cuts will be curved; while for filing, the line trace will be linear (Sax *et al.* **2004**; Sax and Ji **2013**).

A tool mark was found on the obverse side of sample AY2. In Figure 1 (b), a group of coarse linear striations stretch across the central section. The red characters are above the linear striations. This indicates that the linear striations were made prior to the characters, and might be the trace of rough shape cutting. As a part of the line trace on sample AY2 has been worn out (Fig. 2 (a)), a

simulation experiment was conducted to provide more evidence (Fig. S2). The experiment shows that the trace consists of cross-curves for the wheel-cutting, but coarse linear striations for the filing (Fig. 2 (b)). Therefore, for the handle-shaped artefacts, the small piece might be removed from the main body by filing.

Figure 2.

Open in figure viewer

The tool marks of AY2 and the moulds: (a) the tool marks of AY2, observed using the digital microscope, and a group of coarse linear striations stretch across the central section; (b) the scanning electron micrograph of the moulds used in the simulated experiment, and the line traces are linear. [Colour figure can be viewed at wileyonlinelibrary.com]

Edge reforming and handle making

As in Figures 3 (a) and 3 (b), there are long shallow grooves on the edges of the samples. These indicate that the edges may have been reformed after the samples were generally shaped. In Figure 3 (c), points A and B are on the same plane, and the curves of their tool marks are similar to each other (Fig. 3 (d)). This suggests that the concave dip between points A and B was made after edge reforming. This makes a sample look like a handle.

Figure 3.

Open in figure viewer

Observations of sample AY1 and AY2 by the digital microscope. (a) The micrograph for point A; the upper half is the surface of point A, and the cross-sectional profiles along the points C,D in the lower part. (b) The micrograph for point B; the two cross-sectional profiles in 3(a) and 3(b) are compatible with each other, which gives credible evidence about the order of steps and handles. (c) The micrograph for the positions of points A, B. (d) The bottom of AY1. [Colour figure can be viewed at wileyonlinelibrary.com]

These steps might be the result of rough shape cutting rather than intentional carving. Each edge of the body was formed by face-to-face cuts, and the artefact was broken from the initial block. The fracture surfaces would then have been filed to achieve evenness. If the ancient people filed more, we have not observed these steps. In Figures 4 and 5, the traces of the tool marks are coarse linear striations. Just in as rough shape cutting, the edge and handle parts of the samples might be reformed by filing.

Figure 4.

Open in figure viewer

Micrographs of the grooves on the edges of samples AY1 and AY2. Though the traces are both coarse linear striations, the size of the traces are different. The different sizes show that various abrasives have been applied on samples AY1 and AY2. [Colour figure can be viewed at wileyonlinelibrary.com]

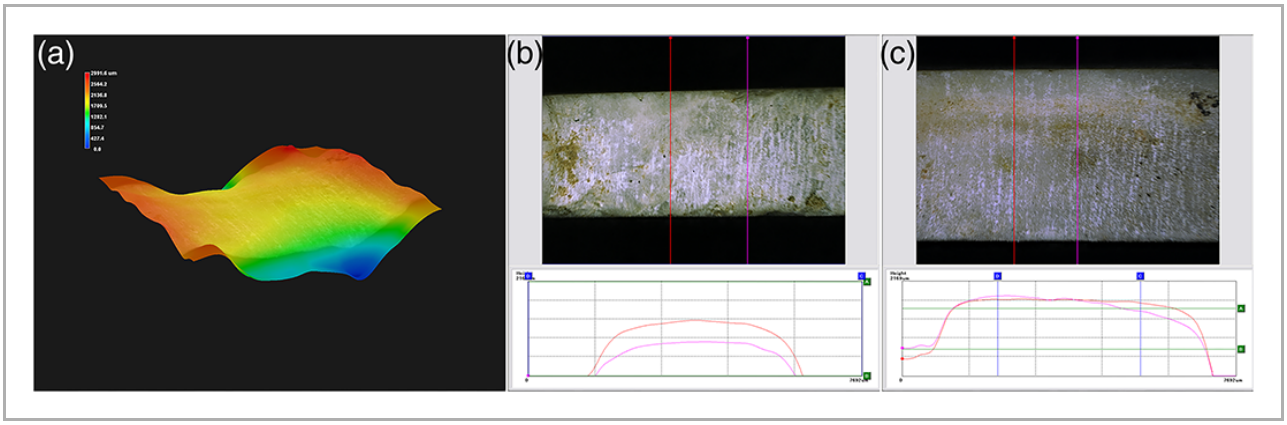

Figure 5.

Open in figure viewer

Micrographs of the handle parts of samples AY1 and AY2. (a) The picture of AY2 under the three-dimensional model. The dark colour shows the highest levels and the light colour shows the deepest levels; thus the mottled colour illustrates the uneven surface. (b) The upper part is the surface of one of the grooves of sample AY1, and the lower part shows the cross-sectional profiles along the two lines. The two cross-sectional profiles are not coincident with each other which further illustrates the uneven surface. (c) Details of a groove in sample AY2. [Colour figure can be viewed at wileyonlinelibrary.com]

Single-side polishing

Traces of jade sand are found on the samples. The particle sizes of the traces on sample AY1 are generally bigger than those on sample AY2 (Fig. 5). The particle sizes of the traces on the two sides of AY1 are different. The criss-crossed lines in Figure 6 (a) reveal the method of primary smooth working, which has not yet been found for the elaborate polishing or wearing. The worker rubbed jade on a flat plane, using an abrasive, or on a rock such as sandstone, without an abrasive, moving crosswise backwards and forwards. For one side, the particle sizes are from 15.28 μm to 22.27 μm, while they are 64.19–77.96 μm for the other side (Fig. 6). This suggests that one side of the handle-shaped artefacts might have been carefully processed after rough shape cutting and edge reforming, and this might be the side to actually be used. This is also verified by the fact that the Chinese characters are only on one side of sample AY2. If only one side of the handle-shaped artefacts was used, they could not be hairpins or handles. This is a simple

deduction, because both sides of hairpins and handles would be used. Taking the archaeological contexts into account, it is highly likely that the handle-shaped artefacts might have been used as sacrificial offerings, in celebrations and funerals.

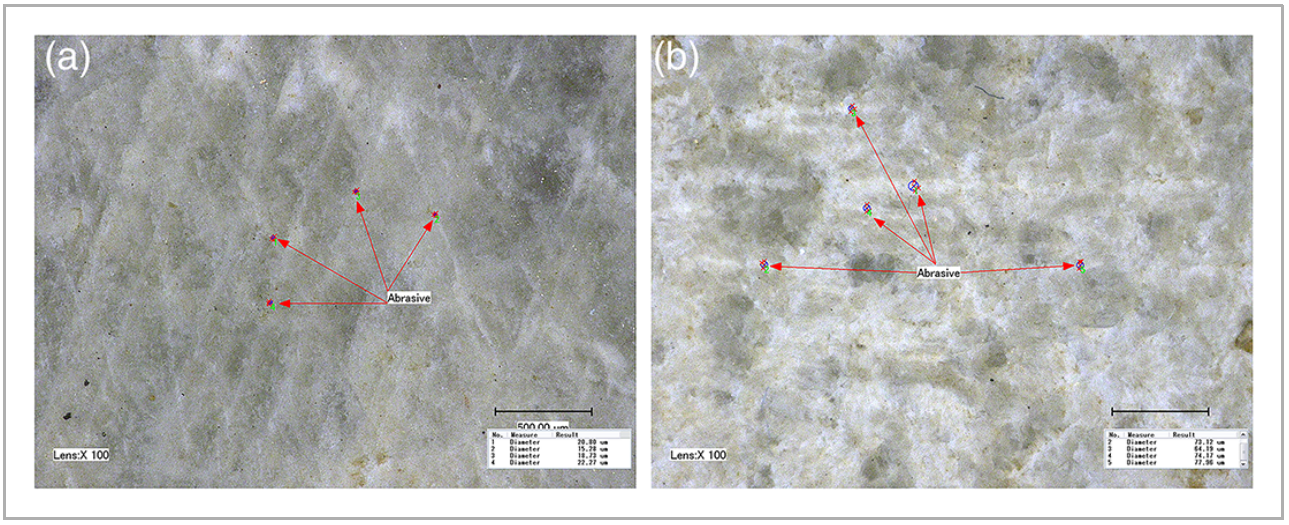

Figure 6.

Open in figure viewer

The traces of jade sand on both sides of sample AY1. The lines on the surface of jades generate by abrasives. So the tool mark line's breadth is approximately equal to the abrasive diameter. The particle sizes are shown in the pictures. [Colour figure can be viewed at wileyonlinelibrary.com]

Conclusions

Two handle-shaped artefacts from the Yinxu site were tested using the digital microscope and the Raman spectrometer. A simulation experiment was conducted, and the scanning electron microscope was used to observe the moulds.

The results showed that the samples might have been made in four steps: (1) rough shape cutting, (2) edge reforming, (3) handle making and (4) single-side polishing. As only one side was used, the handle-shaped artefacts might have been sacrificial offerings in celebrations and funerals.

This study is the first successful attempt to figure out the manufacturing process of one specific jade from the Three Dynasties period, and to explain its function via traces from manufacturing instead of using wear, which shows greater possibilities for the study of the function of archaeological remains. The finding of scientific evidence about primary polishing offers a wider margin of consideration, with more possibilities of interpretation with regard to the jade technology.

Acknowledgements

This research was supported by the National Natural Science Foundation of China (NSFC, Grant no. U1432243) and the fund of the distinguished young scientists on history of sciences by bureau of frontier sciences and education, Chinese Academy of Sciences (Grant no. Y529023EA2). We appreciated the assistance of Professor J. M. Kenoyer and Dr Jingnan Du in the experiments.

Supporting Information

References

Related content