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The technology of jades excavated at the Western Zhou, Jin Marquis cemetery, Tianma-Qucun, Beizhao, Shanxi province: recognition of tools and techniques

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ABSTRACT

This paper is concerned with the technology of a small but representative sample of thirty nephrite jades from the burial assemblages of the Jin Marquisate excavated at Tianma-Qucun, Beizhao, Shanxi province, north-central China. The jades date mainly from two Bronze Age cultures, the Western Zhou dynasty (c. 1050–771 BC) and the previous Shang dynasty (c. 1600–c. 1050 BC). They include unfinished and finished carvings. The carvings were examined at Shanxi Provincial Institute of Archaeology, Houma: following an optical survey of the tool marks, detailed silicone moulds were made from twelve jades bearing evidence of working techniques. The moulds were examined by scanning electron microscopy (SEM) at the British Museum, London. Consideration of several characteristics of the moulded features for comparison with moulded experimental standards provided evidence for the tools employed for several stages of working. Extensive use was made of non-rotary rigid saws and thicker files for shaping many parts of the jades, and pointed tools for incising pieces. Use was also made of rotary solid drills for working narrow perforations for openwork and the suspension of jades, and broader tubular drills. Although no evidence of non-rotary string saws, rotary circular saws or smaller incising wheels was seen on the jades, there was evidence for the use of rotary lathes, on which jades were mounted for shaping.

1. Introduction

The present study is concerned with the technology of a small sample of the two thousand or so nephrite jade mask and pendant sets, ornaments, funerary and ritual pieces, excavated at the Jin Marquis cemetery at Tianma-Qucun, Beizhao, near Houma in Shanxi province, north-central China. Nineteen tombs form nine groups belonging to nine generations of the Marquis of the state of Jin and their consorts (Department of Archaeology, Peking University, and Shanxi Institute of Archaeology, 1993, 1994, 1995 and 2001; Shanxi Institute of Archaeology and Department of Archaeology, Peking University, 1994). They reflect a continuous father to son succession from the second Marquis to the tenth Marquis, and date from about the first half of the tenth century BC in the Western Zhou dynasty (c. 1050–771 BC) to about the mid eight century BC during the Spring and Autumn period of the Eastern Zhou dynasty (770–221 BC). The first Marquis, who does not appear to have been buried at Tianma-Qucun, was the brother of Emperor *He*, and the burial finds of the existing nineteen tombs form an important source of information about the material culture associated with the rise of the Jin, a major power in ancient China during the Eastern Zhou dynasty. The dating of the tombs was based on the style of the grave goods, inscriptions in the bronze finds and the genealogy of Jin Marquisate recorded by Sima Qian in *Shiji* during the Western Han dynasty, 206 BC–AD 9 (Department of Archaeology, Peking University, and Shanxi Institute of Archaeology, 1995). The jades are dated according to the sequence of the tombs and stylistic considerations to the Western Zhou dynasty and also the preceding Shang dynasty (c. 1600–c. 1050 BC) or earlier times.

Nephrite jade, the variety of true jade used almost exclusively in China until the mid eighteenth century, is moderately hard (with a Mohs' hardness, H of 6–6.5). It is marginally softer than quartz (H of 7) but harder than metals such as bronze and iron so that it is not possible to work it with metal tools unless abrasive sand is used. Further difficulties in working are caused by the microstructure of nephrite, which comprises a mass of densely packed and tightly bonded fine fibrous crystals that render the stone extraordinarily tough and very difficult to break. Hence the methods used to shape and decorate nephrite usually rely upon time-consuming abrasive processes rather than methods of flaking/pecking.

Traditional methods of jade working were documented by scholars between the late nineteenth century and the mid

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twentieth century. Hansford (1950, 67–85) described the various loose abrasive sands used in jade workshops in Peking in 1939. The abrasives were all harder than nephrite jade. They were graded from coarse to fine, mixed with water as a lubricant and applied with iron or steel tools to be worked against the jade, the finest abrasives producing the smoothest surfaces. Rotary tools predominated; the tools were mounted in turn on a lathe, traditionally rotated by foot treadles in reciprocal motion. Polishing mixes were particularly fine grained and used with tools of softer materials such as wood, bamboo, dried gourd and leather. Rotary and non-rotary methods of carving, similar to those documented by Hansford, were illustrated by Li Shiquan in 1890 (Bishop et al., 1906).

The accounts of traditional methods of jade carving provide a basis for understanding the technology of earlier periods and its development since Neolithic times, about which considerably less is known. The fine detail preserved in the carved features of jades is however ideal for the investigation of ancient technology and allows the methods of working to be identified. The use of various tools and techniques can usually be recognised from the characteristic morphology of the 'tool marks' in artefacts: detailed moulds of the carved features are prepared, examined and compared with moulded experimental standards, using scanning electron microscopy (SEM). An earlier study of Chinese nephrite jades in the collections of the British Museum, most of which are of unknown context and dated on stylistic grounds by Rawson (1995) from the late fourth millennium BC in the Neolithic period to the present day, provided evidence for a range of non-rotary and rotary methods of working (Sax et al., 2004a).

Following the successful outcome of this investigation, a collaborative study between the School of Archaeology and Museology at Peking University and the Department of Conservation and Scientific Research at the British Museum was set up to apply similar methods of examination to investigate the technology of the jades recovered from the late Bronze Age tombs of the Jin Marquisate at Tianma-Qucun, Beizhao. The method of moulding was originally developed to avoid any risk of damage to artefacts posed by direct observation in the high vacuum of the SEM, and proved to be advantageous for examining deeply carved parts of jades where important evidence for carving technique is often preserved. It is particularly apposite for the present collaborative study between the two locations, allowing the moulded details prepared of jades in China to be examined in the U.K. The focus of the present study is the recognition of the tools and techniques employed for working the jades. The results presented below are based on the initial report prepared for translation by Qin Ling (Department of Archaeology, Peking University) and publication in the university journal, *Ancient Civilization* (in press).

2. Methodology

2.1. Identification of materials

Prior to the present technological study, the mineralogical composition of the stone finds resembling weathered nephrite jade, coloured in shades of green, brown and white, was assessed by Jing Zhichun (University of British Columbia, Canada) using portable Near Infrared spectrometry (PIMA) (Fritsch and Stockton, 1967). This non-destructive method of analysis permits a distinction to be made between artefacts composed of nephrite, one of the two principal varieties of true jade, and jade simulants such as the serpentine minerals, often used in China and referred to collectively by the term *yu*. The simulants are not as tough as nephrite and many are softer; all are more easily worked than nephrite.

2.2. The jades

Thirty nephrite jades (Table 1) in reasonable states of preservation were selected for the study by Professor Boqian Li, Director

Table 1
Nephrite jades selected for study.

Jade (*unfinished carving)	Date	Basic external form
M8:202 ornament in shape of person & three dragons	c. 800 BC, Western Zhou dynasty	Angular slice
M8:203 curved ornament in shape of person & three dragons	Early 8th century BC, Western/ Eastern Zhou dynasty	Longitudinal half of perforated tapered cylinder
M9:115 shaped column with incised spiral design	Late 10th century BC Western Zhou dynasty	Tapered cylinder
M13:185 pendant in shape of dragon*	Shang dynasty, c.1600–1050 BC	Cross-sectional slice of tapered cylinder
M31:60 pendant in shape of person & dragon*	9th century BC, Western Zhou dynasty	Third of perforated circular slice
M31:110 pendant with two dragons incised one side*	c. 800 BC, Western Zhou dynasty	Third of perforated circular slice
M31:111 plaque with two incised dragons	c. 800 BC, Western Zhou dynasty	Angular slice
M62:93 plaque in shape of dragon*	Early 9th century BC, Western Zhou dynasty	Angular slice
M63:4 collared ring with incised circular design	Shang dynasty, c.1600–1050 BC	Perforated cylindrical block
M63:15 shaped column	c. 800 BC, Western Zhou dynasty	Tapered cylinder
M63:20 pendant in shape of three dragons & two persons	c. 800 BC, Western Zhou dynasty	Third of perforated circular slice
M63:62 ceremonial blade	c.1600–800 BC Shang/Western Zhou dynasty	Angular slice
M63:90-9 pendant with incised animal design	Shang dynasty, c.1600–1050 BC	Half of perforated circular slice
M63:90-12 ornament in form of animal head	Shang dynasty, c.1600–1050 BC	Longitudinal half of tapered cylinder
M63:110 ceremonial blade	c.1600–800 BC, Shang & Western Zhou dynasty	Angular slice
M63:111 ceremonial blade	c.1600–800 BC, Shang/Western Zhou dynasty	Angular slice
M63:113 ceremonial blade	c. 800 BC, Western Zhou dynasty	Angular slice
M63:114 ceremonial blade	Shang dynasty, c.1600–1050 BC	Angular slice
M63:159 pendant in shape of bird	c. 800 BC, Western Zhou dynasty	Circular slice
M63:161 curved ornament in shape of two birds	10th century BC, Western Zhou dynasty	Longitudinal section of tapered cylinder
M63:196 shaped tube, possibly hair ornament	c. 800 BC, Western Zhou dynasty	Possibly tapered cylinder
M63:199 pendant in form of fish	Two dates in Shang dynasty, c.1600–1050 BC	Angular slice
M63:209 pendant in form of dragon with fish tail	Shang dynasty, c.1600–1050 BC	Third of perforated circular slice
M74:3 disc with two dragons incised both sides	Early 8th century BC, Western Zhou dynasty	Perforated circular slice
M91:1 ring-shaped hair ornament	Shang dynasty, c.1600–1050 BC, or earlier	Probably angular block
M93:7 ceremonial blade	Shang dynasty, c.1600–1050 BC	Angular slice
M102:34 pendant with incised dragon & two persons	Early 8th century BC, Western Zhou dynasty	Angular slice
M113:71 collared ring	Shang dynasty, c.1600–1050 BC	Perforated cylindrical block
M113:71 handle	c. 2000 BC, re-worked Shang dynasty	Angular slice
M113:130 ornament in form of animal head	Shang dynasty, c.1600–1050 BC	Probably angular block

Key: Jades with **excavation details** in bold were moulded for SEM examination, see Table 2.