

## RESEARCH UPDATE

# Developments in Ceramic Technology in North China in the Sixth Century AD

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## Introduction

Two of China's many outstanding contributions to ceramic technology are represented by Sancai (三彩, three-colour) and white porcelain (Kerr and Wood 2004: 143–163). The Sancai wares of the Tang Dynasty (唐, 618–907 AD) are well-known to the general public in the form of the glazed ceramic horses, camels and human figures which grace the collections of many western art and archaeology museums (Wood 2011: 189–211) (**Fig. 1**). Surprisingly, porcelain is less well-defined. In the Chinese literature, the term can be applied to any high-quality glazed ceramic, while Europeans regard whiteness and translucency as key properties of the material. Our own approach to porcelain is that it should be intended to be white, but is not necessarily translucent, as this is not a condition of the Chinese term.

Productions of Sancai and porcelain appear to have been well established during the seventh century, and became famous in the Tang Dynasty, as recorded in the historical literature in the eighth century. Our project, supported by a Chinese Government PhD scholarship and a Chinese Academy of Social Sciences project grant to Huang Shan, aims to document and understand the changes in



**Figure 1:** Tang Sancai horse in the Shaanxi History Museum (Photo Shan Huang).

the ceramic industry in the preceding sixth century, which led to the development of these iconic ceramics.

## Porcelain Technology

Sancai and porcelain are technologically very different. Sancai typically has a glaze rich in lead and this glaze, fired at low temperatures, allowed the development of greens and yellows based upon the oxides of copper and iron. Porcelain, on the other hand, has a glaze based upon calcium-rich wood ash with no lead, which required firing to much high temperatures. A further ceramic type, of key importance to our research, is celadon, a green-blue ceramic which is technically close

to white porcelain but seems to have been a southern technology transferred to the North (Guo 1987: 3–19).

Although the famous Chinese blue-and-white porcelain was produced from the fourteenth century, in the southern kilns of Jingdezhen, Jiangxi Province, white porcelain was first developed over a thousand kilometres away in the North, in the central plain of China, in Hebei and Henan provinces (Mori 2009: 79–95). The potters took advantage of the natural deposits of kaolinic clay which were low in iron to make a body which fired white. Although Sancai and porcelain are different materials, and were fired to different temperatures with different glaze compositions, their more-or-less contemporaneous development is unlikely to have been coincidental; the social conditions which drove ceramic innovation were applicable to both materials, while both depended upon the successful exploitation of the northern clays to develop a white body which, in the case of Sancai, was needed as a ground to exploit the colours of the glazes to best effect.

Most theories about of the development of white porcelain consider it to have developed from celadon, a similarly high-fired ceramic (The Chinese Ceramic Society 1982: 167; Wang 2005: 1). However, this apparently straightforward answer obscures many of the aspects of the process of innovation – duration, location, social impulse and so on. A detailed assessment of the evidence is needed, particularly in the light of recently excavated material. Our approach to the problem comprises three strands: (1) survey and chronological study of white ceramics in excavation stores and museums in North China (2) provisional characterisation of the ceramics in the field, (3) detailed characterisation in the laboratory.

### Survey and Chronology

We are currently focused on two categories of archaeological material. Funerary assemblages from tombs provide a fine

chronology for the material, as these are frequently dated by inscriptions. Unlike the remarkable amount of burials and kilns post-dating the Sui Dynasty (隋, 589–618 AD), the archaeological evidence of ceramic production predating the seventh century remains obscure. However, recently, sets of whitewares have been unearthed from the Northern Qi Dynasty (北齐, 550–77 AD, one of the last dynasties of the chaotic Northern and Southern Dynasties, predating the Sui Dynasty) tombs in Anyang region. These whitewares are highly similar to those from the Fan Cui tomb (范粹墓, 575 AD) and Li Yun tomb (李云墓, 576 AD), which have been considered candidates for the ‘earliest white porcelain’ for almost 40 years (Henan Museum 1972: 47–57).

Investigation of the evidence from kilns allows us more scope to investigate the production technology of the ceramics and to compare different ceramic types in detail. For example, whiteware sherds similar to those from the tombs have been discovered in a kiln site at Caocun (曹村窑), close to the capital of Northern Qi Dynasty, Yecheng (邺城遗址). Archaeological excavation of this site has been undertaken since 2014 and the assemblage is undergoing detailed analysis in the Wolfson Archaeological Science Laboratories at UCL Institute of Archaeology.

An important aspect of the examination of kiln material is the extent to which the different ceramic types were produced together, or in close proximity. Was understanding passed between different groups of potters, and if so, how?

### Characterisation and Analysis

‘Whiteness’ is a key issue in identifying white porcelain, and the development of a white body and glaze posed a major challenge to the potters. A rapid and non-intrusive field measurement of colour is essential. We are using the *Munsell Rock Color Book* (a colour chart produced by X-Rite company) to record

the colour of the samples, coupled with digital photography using standard colour charts to calibrate white balance and exposure of the sample photos.

As most funerary objects are preserved relatively well, portable X-ray fluorescence (pXRF) is a practical method to determine the key compositional features of the glazes (**Fig. 2**). Furthermore, the presence of lead in the glaze is easy to identify, so the confirmation of lead-rich glaze is straightforward. About one hundred funerary objects kept in museums or storehouses have been analysed *in situ*, to determine whether they have lead- or lime-based glazes.

Detailed laboratory analysis of sampled materials using the scanning electron microscopes in the Institute of Archaeology is providing in-depth understanding of body and glaze compositions, information on firing temperatures, recipes and so on. It allows us to compare in detail the methods used to

make different types of ceramic and how the potters approached the challenge of a white, hard ceramic.

### Conclusion

Surprisingly, given their previous designation as porcelain, the early whitewares made at Caocun and those found in the tombs appear to be exclusively lead-glazed. It seems that there was a desire for whitewares as funerary ceramics which was addressed by adapting the traditional northern lead-glazed earthenware tradition in conjunction with the northern white-firing kaolinitic clays. Given their early dating to the Northern Qi (550–77 AD), the Caocun products appear to be the earliest form of whiteware in North China and it appears likely that they played an important role in demonstrating the potential for whiteware development using the northern raw materials. While the Caocun wares present a range of 'white' shades, closely correlated



**Figure 2:** Analysing ceramic samples with pXRF at Anyang Museum in Henan Province (Photo Lihua Shen).

with the amount of iron impurity in specific batches of clay, the vessels selected for the burials appear to have been chosen on the basis of their closeness to a pure white. Hence, by the time that 'true' porcelain was developed several decades later, there was a recognised desire and established market for white glazed ceramic which would have driven the innovation. This development may have occurred at the Xiangzhou kiln in Anyang (安阳相州窑), situated some 20 km from Caocun, and which has yielded large quantities of slightly later celadon and porcelain, dated to the Sui Dynasty (589–618 AD).

Caocun products also include bichrome and polychrome glazed wares which, in combination with the white-firing kaolinitic body, can be regarded as an early stage in the development of Sancai. Although celadon has been discovered from the Northern Dynasty (北朝, 439–589 CE, comprising five dynasties which could be divided into three periods: Northern Wei, Eastern and Western Wei, Northern Qi and Zhou) tombs, its provenance is still under debate, as the same ceramics of closely similar appearance have been found in southern tombs, and identical sherds unearthed from southern kiln sites. Several sites in Hebei Province have been claimed as Northern Dynasty celadon kilns, for example the Xing kilns at Neiqiu (内丘) and Lincheng (临城), as well as the Linshui (临水) and Jiabi (贾壁) kilns close to Caocun, but the jury is out as to the precise dating, and the exact characteristics of these productions have yet to be determined.

Archaeology is an excellent medium through which innovations in material culture can be recognised. However, a detailed and properly nuanced understanding of the process of innovation requires both a well-defined chronology and careful analysis of the materials and the chaîne opératoire. Recent archaeological discoveries of well-dated funerary assemblages and production sites in North China are allowing a more sophisticated understanding of the

important changes in ceramic production which occurred during the Northern Dynasty. Furthermore, the Northern Dynasty was characterised by strong cultural interactions both within China and between China and other civilisations via the Silk Road. The emergence of white porcelain-like ceramics at the end of the Northern Dynasty, in forms emulating those of metal and glass wares implies that the cultural dynamic and social impulse which drove the technical innovation were complex.

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### Competing Interests

The authors have no competing interests to declare.

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