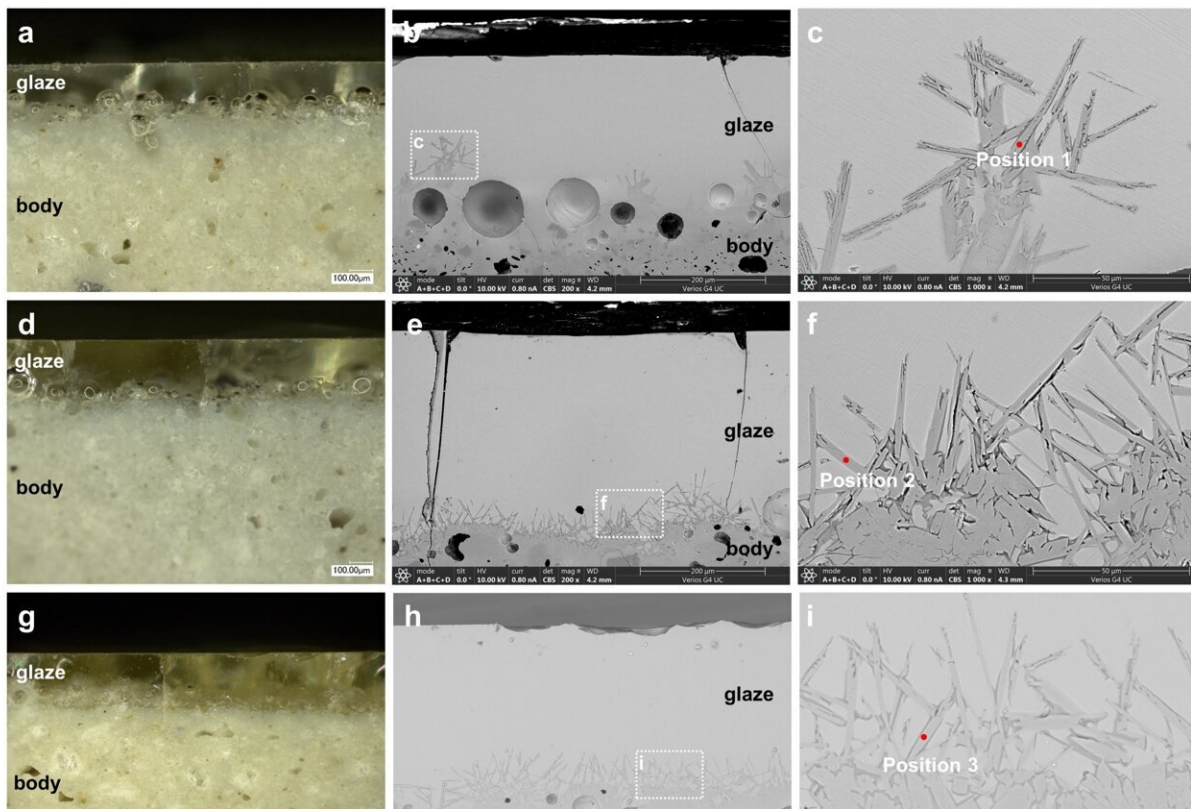


Researchers explore raw materials and firing technology for porcelain from late sixth-century Xing kiln

May 6 2024, by Zhang Nannan



Cross-section microstructure of typical samples in Xing kiln early wares. Credit: Lu Xiaoke

In the process of firing ceramics, the appearance, structure and

properties of ceramics are determined by raw materials and firing technology, so the study of raw materials and firing technology of ancient ceramics has always been a very important archaeological science topic.

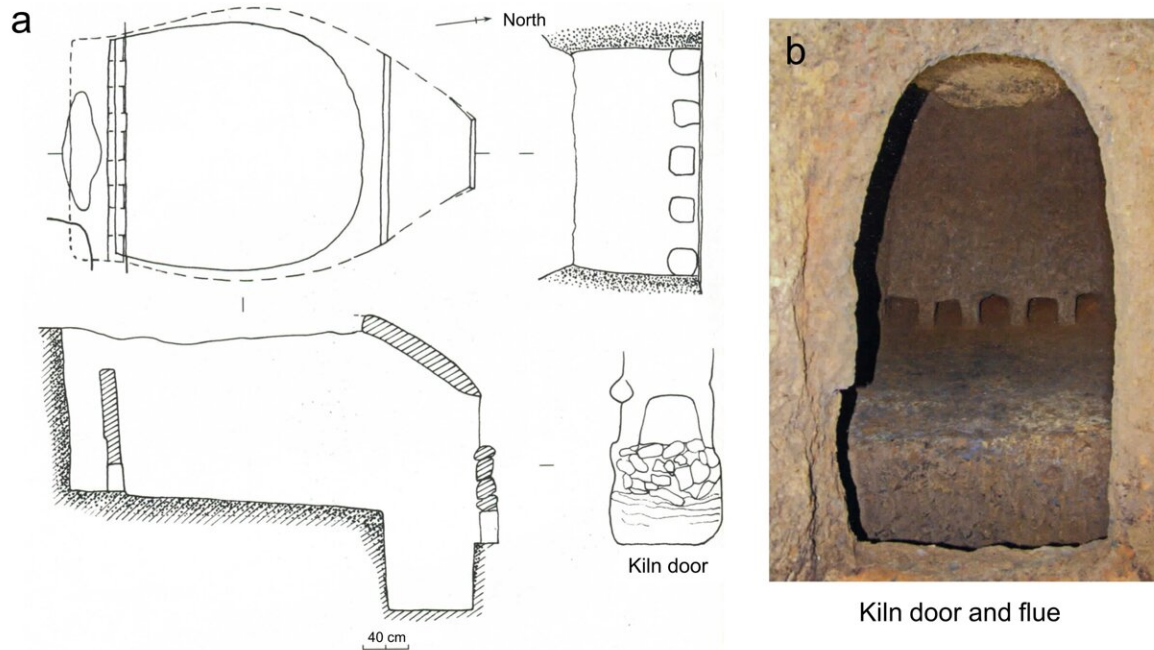
The late sixth century AD was the period when white porcelain was produced and fired in northern China, where the Xing kiln was an important kiln for producing white porcelain. After [archaeological excavations](#), a large number of kilns in the late Northern Dynasty and celadon and early white porcelain were discovered, providing important physical data for studying the origin of white porcelain and porcelain manufacturing technology in northern China.

Researchers led by Lu Xiaoke from the Shanghai Institute of Ceramics of the Chinese Academy of Sciences have systematically studied the early white porcelain and celadon excavated from the Fuwulou kiln site in Neiqiu, Xing kiln. Their [study](#), published in *Archaeometry*, has shed light on the raw materials and firing technology of early porcelain production in Xing kiln.

In this study, plasma inductively coupled [mass spectrometry](#) and thermoelectric ionization mass spectrometry were used to analyze the trace element content and strontium isotope characteristics of the raw materials. The researchers found that the early Xing ware bodies can be divided into two categories based on the trace element pattern, indicating that two types of raw material were used to make porcelain.

The researchers further found that the Xing potters deliberately selected a higher quality raw material, different from that of celadon, for the production of new ware, early white porcelain, which generally contains lower levels of trace elements such as V, Cr, Ni, Nb, Ta, Zr, and Hf, which are closely related to the impurities of zircon and rutile. The analysis of the Sr isotope mixing patterns shows that the early Xing ware

glaze did not generally follow the recipe of mixing wood ash with body clay, but rather mixed with other glaze-making clays.



Kilns in the Late Northern Dynasties of Xing kiln. Credit: Lu Xiaoke

Furthermore, there are discrepancies in Sr isotope compositions between early white porcelain and celadon glaze, suggesting that Xing potters attempted to improve the whiteness by modifying the glazing technology.

The researchers combined thermal expansion instrument, X-ray photoelectron spectroscopy and scanning [electron microscope](#) to reveal the differences in terms of firing technology and technical characteristics between celadon and early white porcelain from the perspectives of firing temperature, firing atmosphere and

microstructure.

The results show that Xing porcelains were fired at high temperatures exceeding 1,200°C and even reaching 1,300°C with a reducing flame, which is consistent with the characteristics of a dome kiln powered by fire wood during the late sixth century.

The high firing temperature causes the glaze to become glassy, with a few bubbles and residual quartz particles, while the body shows the presence of numerous mullite crystals, according to the researchers.

Among the early Xing porcelains, the firing temperature of the early white porcelain is slightly lower than that of celadon, with mean values of 1,242°C and 1,279°C, respectively. This deliberate variation in firing temperature is the result of the ingenious technological advances made by ancient potters to reduce glaze accumulation and improve the whiteness of the products.

The research promotes the emergence of white porcelain in the Xing kiln during the late Sui dynasty, thus establishing a new pattern known as the "southern blue and northern white" in Chinese history, becoming an important milestone in the history of ceramic development in China.

More information: Ruofei Zong et al, Firing technology and physicochemical basis for porcelain from the Xing kiln in the late sixth century, *Archaeometry* (2024). [DOI: 10.1111/arcm.12969](https://doi.org/10.1111/arcm.12969)

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