

# Cobalt – the Bluest of Blues

By Patricia Bjaaland Welch

What makes Chinese blue-and-white ceramics so attractive? It's that spell-binding combination of cobalt blue on porcelain's pure white base.

## What is Cobalt (Co)?

Cobalt is a bluish-white, lustrous metal found in the earth's crust only in chemically combined form. As a result, pure cobalt has to be extracted by smelting. The process is not without its dangers: the name 'cobalt' comes from the German *kobald*, which means goblin, because arsenic is released during the smelting process.

One form of cobalt known as asbolite is indigenous in China but wasn't discovered for some time. The cobalt first experimented with in China was sourced from West Asia, where it was readily obtainable and had been used as early as 4500 BCE by the Egyptians who used cobalt oxide as a substitute for the much rarer lapis lazuli.

## Early Cobalt in China

According to the curator of the Islamic Collections of the British Museum, "evidence of contact between the Islamic lands and East Asia dates back to at least the first century BCE."<sup>1</sup> Archaeological digs show that cobalt was probably brought by overland routes to China by the fifth century BCE when it was, "used for glass [bead-]making during the Warring States (475-221 BCE) period."<sup>2</sup>

Cobalt's next known appearance in China was during the Tang dynasty (618-907 CE), when potters used it very sparingly as a colourant (Fig 1) primarily on ceramics known as 'three-colour' (*sancai*) and tomb wares (*mingqi*). Amongst the potters known for producing *mingqi* were those in Gongxian in Henan province. These potters were simultaneously experimenting with copper oxide to produce the colour green. *Sancai* shards have been found at Mantai in Sri Lanka, Samarra in Iraq and in Fustat (Old Cairo, Egypt).<sup>3</sup>



Fig 1. The famous Tang dynasty phoenix-shaped *sancai* ewer in the Guimet Museum (Paris)

At the same time, the kilns in Gongxian were busy experimenting using coloured pigments (primarily iron oxide) under a transparent glaze. When Chinese potters began experimenting with cobalt, however, the results were disappointing, as you can see for yourself in the ACM's Tang Shipwreck gallery. These pieces are stoneware covered with a slip and decorated with cobalt-blue designs that appear to have melted and run into the clear glaze. Scholars often refer to these early experiments as 'blue-on-white' rather than 'blue-and-white.'

## West Asian attempts to copy Chinese ceramics and vice-versa

The unsuccessful Gongxian potters were probably misled by the samples arriving from West Asia. By the Tang, a significant number of Chinese ceramics (most likely Xing and Ding white stoneware) had arrived in West Asia, primarily as diplomatic gifts, but also in trade, passing through the busy ports of Siraf or Basra. Not possessing the white kaolin or the kiln technology that generated the high temperatures needed for producing stoneware, the local potters of West Asia compensated by creating an opaque white glaze to cover their yellow clay pots, which they then decorated with cobalt blue designs. But while West Asian potters were producing some attractive pieces (Fig 2), potters' attempts back in China, using what they believed was the same methodology as the samples they were shown, were disappointing (Fig 3).<sup>4</sup> It wasn't overnight, but once Chinese potters began to experiment with their raw materials as well as make modifications to their glazing and firing processes, they discovered the successful technique.<sup>5</sup>



Fig 2. A typical ninth century blue-on-an-opaque-white glaze dish, Basra, courtesy of the Kuwait National Museum



Fig 3. Close-up of an early Chinese attempt to imitate West Asian blue-and-white ceramics, salvaged from the Belitung wreck (ca 826 CE)

## The Breakthrough

Until the 1970s, most scholars believed that the breakthrough in China's ability to produce flawless blue-and-white porcelain came in the late Song (960-1279) or early Yuan (1279-1368), but we now know that blue-and-white was made at the Gongxian kiln site in Henan Province as early as the mid-to-late Tang. One successful modification was applying the cobalt *directly onto the unfired porcelain* rather than applying it over the glaze. However, it wasn't until "the early part of the Yuan dynasty that the underglaze blue technique was finally perfected at Jingdezhen ... [when a glaze] that prevented the cobalt from diffusing during firing,

made possible the clear and intricate designs for which early blue-and-white is renowned.”<sup>6</sup>

Both imported and local cobalt were experimented with from the Tang on, but scholars believe “that Yuan blue and white was first made using Chinese cobalt, not imported cobalt.”<sup>7</sup> Imported cobalt had a relatively high percentage of iron-to-manganese and produced a strong brilliant blue, but when accumulated, it produced dark concentrations of specks, an effect known as ‘heaped and piled’ (Fig 4). Local cobalt discovered in Raozhou prefecture in Jiangxi Province<sup>8</sup> not far from Jingdezhen, had a relatively higher percentage of manganese to iron and in comparison, looks “pale and soft”. It is these differentiations that assist archaeologists and collectors to differentiate one from the other.

The flow of West Asian cobalt was interrupted briefly at the end of the Yuan dynasty but was reinstated once the early Ming (1369-1644) had stabilised. During that interim, local cobalt was substituted. It produced paler colours, but the new blue-and-white ceramics were so popular that production continued. When trade resumed under the Ming’s third emperor, Yǒnglè (r 1403-1424) and his grandson the Xuāndé emperor (r 1426-1435), imported cobalt returned to China. The eunuch admiral Zheng He (1405-1433) brought back so much cobalt from his voyages that it kept Jingdezhen well-stocked for several decades, but as that supply began to run out, Chinese potters again began mixing local and imported cobalt in varied proportions dependent on a range of variables, with one reign known for its strong blues and another for its more violet hues. Much depended on the ceramics’ final destination: the imperial court, local consumers or export. However, over time, Chinese potters learned both how to remove their local cobalt’s unwanted impurities to



Giovanni Bellini’s famous painting *Feast of the Gods*, the first western oil painting to feature a Chinese blue-and-white porcelain dish (1514), courtesy of the National Gallery of Art, Washington DC



Fig 4. A Ming dynasty Xuāndé period (1426-1435) blue-and-white vase showing the ‘heaped and piled’ affect when cobalt accumulates in a glaze, courtesy of the British Museum

produce, by the 19<sup>th</sup> century, a relatively manganese and iron-free cobalt, as well as how to replicate the older combinations that produced very convincing fakes.

For those interested in learning more, a good place to start is the British Museum’s tome on *Ming Ceramics* by Jessica Harrison-Hall (2001) and the chapter on ‘Tang blue-and-white’ in *Shipwrecked* (2011), followed by the references used in this article.



The earliest known dated (1351) Chinese blue-and-white ceramics known as the David Vases date to the Yuan dynasty, but earlier shards that can be dated to the Song dynasty (1127-1279) have been found

---

**Patricia Bjaaland Welch** is a former potter and president of the Southeast Asian Ceramic Society ([www.seaceramic.org.sg](http://www.seaceramic.org.sg)), and a long-time ACM docent.

---

Unless otherwise noted, photos by the author

<sup>1</sup> Ladan Akbarnia & others, *The Islamic World: A History in Objects*. London: The British Museum, 2018, p. 147

<sup>2</sup> Christopher F. Kim, “Early Chinese Lead-Barium Glass: In Production and Use from the Warring States to Han Periods (475 BCE-220 CE)”, Brown University, 2012. <https://www.brown.edu/academics/archaeology/sites/academics-archaeology/files/publication/document/Kim2012.pdf> Accessed 12 September 2020

<sup>3</sup> Jessica Rawson, M. Tite and M. J. Hughes, “The Export of Tang Sancai Wares: Some Recent Research” in *Transactions of the Oriental Ceramic Society*, Vol. 52 (1987-88), p. 39.

<sup>4</sup> Laboratory testing confirms that “the transparent glazes of Tang tri-colour ceramics and blue-on-white pottery [were both] low-fired lead glazes.” Weidong Li, et al, “A Landmark in the History of Chinese Ceramics: The Invention of Blue-and-white Porcelain in the Tang Dynasty (618-907 A.D.)”, *STAR: Science & Technology of Archaeological Research*, 3:2, 358-365, DOI: 10.8 0/20548923.2016.1272310

<sup>5</sup> Porcelain stone was originally “the only raw material used for porcelain bodies, [but with the Yuan dynasty] kaolin, with a high aluminium concentration, started to be added.

<sup>6</sup> S. T. Yeo and Jean Martin, *Chinese Blue & White Ceramics*, Singapore: Arts Orientalis, 1978, p. 24

<sup>7</sup> Zhang Pusheng, “New Discoveries from Recent Research into Chinese Blue and White Porcelain” in *Transactions of the Oriental Ceramic Society*, Vol. 56, 1992-92, p. 45.

<sup>8</sup> S J Vainker, *Chinese Pottery and Porcelain*, London: British Museum Press, 1991, p. 191