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Portable X-ray fluorescence analysis of ceramic covered boxes from the 12th/13th-century Java Sea Shipwreck: A preliminary investigation

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ABSTRACT

Forty-one ceramic boxes from the twelfth- or thirteenth-century Java Sea Shipwreck were analyzed at the Elemental Analysis Facility at Chicago's Field Museum using nondestructive portable x-ray fluorescence (PXRF). Twenty-two samples have a *qingbai*-type glaze and nineteen are painted ware with painted black decorations originally covered by a lead-based green glaze. The goals of the analysis were to (1) test whether visually similar ceramics shared similar elemental compositions; (2) identify ceramics that might have been made at different kiln sites (or from different paste recipes); and (3) determine if compositional groups in the ceramic dataset differentiated using PXRF are archaeologically meaningful. Based on this study, although PXRF can be successfully used to some degree to differentiate between different groups of *qingbai*-type ceramics, more research needs to be done on its applicability to painted ware pastes.

1. Introduction and background

1.1. Overview of project

Portable x-ray fluorescence (PXRF) provides researchers with a fast and inexpensive way to determine some of the elements present in archaeological materials at a semi-quantitative level. In addition, the method is typically non-destructive—ideal for working in a museum setting when the conservation of materials is a major concern in research design. Despite being attractive on many levels, PXRF needs to be carefully evaluated as a method of investigation, and the suitability of it for the analysis of certain materials should be assessed. In this paper, I describe the results of a small project in which I used PXRF to analyze the paste material of two main types of ceramic covered boxes from an 800-year-old shipwreck found in the Java Sea in Southeast Asia. The goal of this investigation was to begin to assess the potential for using PXRF for differentiating compositional groups within the collection, especially given the visual similarity of thousands of pieces.

1.2. Historical background

Sometime during the twelfth or thirteenth century, an Indonesian trading vessel set sail from southeastern China, laden with an estimated 100,000 ceramic vessels and approximately 200 tons of iron (Flecker, 2003, 2005-2006). Probably heading for Tuban on the island of Java (Flecker, 2003), the ship may have stopped in southern Thailand, where the merchants aboard traded some of their cargo for fine-paste *kendis*, as well as Sumatra to pick up elephant tusks and resin, which may have been transshipped there from India or East Africa. Before reaching another destination on its trading circuit, perhaps its final one, the ship sank in the Java Sea where its remnants remained on an otherwise featureless sea floor for almost eight centuries (Mathers and Flecker, 1997) (Fig. 1). It was not until the late 1980s that the site of the wreckage was discovered by fishermen and then excavated in 1996 (Mathers and Flecker, 1997). Now known as the Java Sea Shipwreck (JSW), much of the vessel's recovered material is in the Asian Anthropology Collections at Chicago's Field Museum of Natural History.

The Java Sea Shipwreck is evidence of a heightening international trade in the South China Sea, or Nanhai, region during the early to mid-second millennium CE. Often referred to as the “Maritime Silk Road” or “Maritime Porcelain Road,” these exchange networks spanned half the globe and linked places as distant as China and the Middle East not only through economic transactions but also through the establishment of diplomatic relationships, the spread of religious beliefs and practices, the adoption and modification of artistic traditions, and the establishment of migrant communities abroad. There is abundant archaeological evidence that China's participation in maritime trade expanded during the ninth century CE (Flecker, 2001; Guy, 1986; Ho, 1994; Krahl, 2010; Nishino et al., 2014) and flourished during the Song dynasty (960–1279 CE). One of its main export commodities was high-fired ceramics, the majority of which, during the Southern Song dynasty (1127–1279 CE), were made in Fujian province in southeastern China for distribution to

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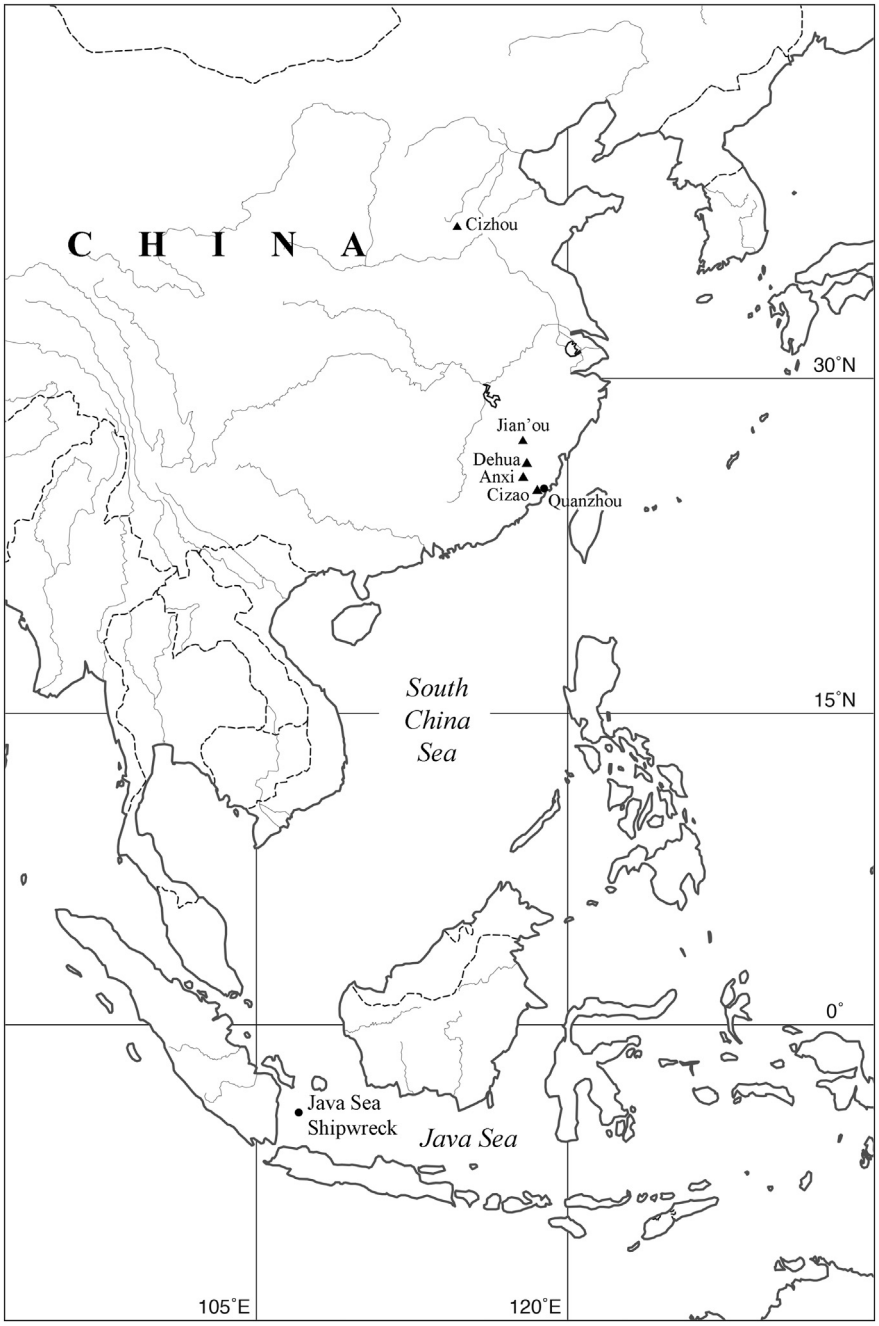

Fig. 1. Map showing location of the Java Sea Shipwreck and Chinese kiln sites mentioned in the text. Illustration by David Quednau and the author.

markets ranging from the Philippines and Sulawesi in Southeast Asia to the Arabian Peninsula and East Africa.

Tens of thousands of ceramics would have been carried by the Java Sea Shipwreck vessel. More than half of the recovered pieces are utilitarian bowls and dishes and there are dozens of varieties of finely-made bowls, dishes, vases, bottles, jars, and covered boxes. Although the production sites (kilns) for these different pieces have been hypothesized (Brown, 1997; Flecker, 2003), analytical technologies, such as portable x-ray fluorescence, are becoming increasingly accessible and are making it easier to differentiate between visually similar pieces and examine questions related to technology, production, and trade. In 2011 and 2012, a small sample of ceramic artifacts from the Field Museum's shipwreck collection, which includes more than 7500 artifacts, was selected for compositional analysis at the Museum's Elemental Analysis Facility (EAF) using portable x-ray fluorescence (PXRF).