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On the origins of tin-opacified ceramic glazes: New evidence from early Islamic Egypt, the Levant, Mesopotamia, Iran, and Central Asia

Moujan Matin[a,b,*], Michael Tite[b], Oliver Watson[c]

[a] Wolfson College, Linton Road, Oxford, OX2 6UD, UK
[b] Research Laboratory for Archaeology and the History of Art, Dyson Perrins Building, South Parks Road, Oxford, OX1 3QY, UK
[c] Khalili Research Centre for the Art and Material Culture of the Middle East, 3 St John Street, Oxford, OX1 2LG, UK

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ABSTRACT

It has been generally accepted that the beginnings of tin-based opacification of ceramic glazes is associated with the white glazed wares excavated in Iraq and western Iran and dated to the ninth century AD (so-called 'Samarra-type' pottery). This paper focuses on an earlier stage in the technological development of tin-opacified glazes, that is, the yellow and white glazed wares produced from the eighth century AD in Egypt and the Levant. In addition, the compositional data was extended for the subsequent spread of tin-opacified glazes into Mesopotamia in the ninth century and Northern Iran and Central Asia in the tenth century. Using SEM-EDS and SR-Micro-XRD, the chemical composition and microstructure of eighty-five samples of opaque yellow and white glazed wares from Egypt (Fustat), the Levant (Madaba, Aqaba, Al-Mina and Raqqa), Mesopotamia (Samarra, Kish, Basra and Susa), Northern Iran (Takht-i Suleiman), and Central Asia (Nishapur, Merv and Samarqand) were investigated. These data confirmed that the yellow and white glazes were opacified by lead-tin-oxide ($PbSnO_3$) and tin oxide (SnO_2) particles respectively. Replication experiments were then conducted to imitate typical compositions of the analysed opaque yellow and opaque white glazes. Overall, the results posited the beginning of tin-based opacification of glazes in the eighth century in Egypt and the Levant, and provided explanations as to how the production of opaque yellow and white glazes in the Levant and Mesopotamia might have been technologically linked.

1. Introduction

The beginning of the Islamic period brought about stylistic and technological revolutions in the production of glazed ceramics. During the preceding Parthian and Sassanian periods in Iraq and Iran, the range of glazing techniques was limited to transparent and semi-opaque monochrome green or turquoise glazes of alkali-lime type (Hedges and Moorey, 1975; McCarthy, 1996; Hill et al. 2004; Pace et al. 2008). Likewise, in the Early Byzantine period in the Eastern Mediterranean, transparent glazes of high lead type, mostly in green, orange/yellow or colourless, were used to cover vessels (Rice, 1930; Armstrong et al. 1997; Vroom, 2004).

Archaeological excavations since the early twentieth century have yielded evidence of the first phase of Islamic glazed ceramics in Egypt, Jordan, Palestine and Syria from as early as the eighth century, namely Coptic Glazed ware (CGW), Hijazi ware and Cream ware (Whitcomb, 1989); and the further developments in the eighth/ninth centuries, known as the Yellow Glaze Family (YGF) (Watson, 1999). Despite their significance, the mention of these wares hardly goes beyond archaeological reports and classifications, and they remain largely unexplored. In fact, these wares have been overshadowed by the results of excavations in Samarra, Iraq, during 1912-13. The Samarra ceramic findings, published by Sarre (1925), had an enlightening, yet somewhat blinding, impact on research in the field of Islamic ceramics. A diverse range of exceptionally fine ceramics covered by opaque white glazes and influenced, in shape and decoration, by imported Chinese Tang porcelain and stoneware were found in the Abbasid capital city of Samarra, all dated to the ninth century AD. As a result, it became widely assumed that Islamic 'fine' glazed pottery was invented first in Iraq or western Iran in the ninth century, under the influence of imported Chinese wares, and from there it was spread to east and west. Although such an assumption brought new interest into the field, an adverse consequence was that it relegated to a peripheral position other types of early Islamic glazed ceramics.

In a critical review, Watson (2014) highlighted the significance of eighth-century glazed ceramic findings from Egypt and the Levant and suggested that these wares, rather than the Samarra pottery, form the first chapter in the history of Islamic glazed ceramics and demonstrate

* Corresponding author. Wolfson College, Linton Road, Oxford, OX2 6UD, UK.
E-mail address: moujan.matin@arch.ox.ac.uk (M. Matin).

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the development of a pre-ninth-century market for fine ceramics in the Near East. Following upon this, Tite et al. (2015) conducted a series of preliminary chemical analysis using SEM-EDS, hand-held XRF, and PIXE on early Islamic opaque yellow glazed wares from Egypt, Syria, Iraq and Iran demonstrating that the yellow glazes were opacified by lead-tin-oxide ($PbSnO_3$) particles. The study also suggested that the origins of tin-based opacification of yellow glazes in the early Islamic period may lie in early Byzantine glass making practices which also used lead-tin-oxide particles to opacify and colour yellow glasses, particularly in the form of mosaic tesserae (see also, Freestone et al. 1990; Mass et al. 1998; Heck and Hoffmann, 2002; Heck et al. 2003; Marii, 2012; Neri et al. 2012).

The first aim of this paper is to provide an extended set of chemical compositional data of both opaque yellow and opaque white Islamic glazed wares from the eastern Mediterranean, across to Mesopotamia, and into Iran and beyond. These data include, for the first time, a comprehensive dataset for glazed ceramics from Egypt (Fustat) and the Levant (Madaba, Aqaba, Raqqa, Al-Mina); an extension of previously published data (Kleinmann, 1986; Mason and Tite, 1997) for glazed ceramics from Mesopotamia (Samarra, Kish, Susa, Basra); and, in an Appendix, data for a small number of ceramics from Northern Iran (Takht-i Suleiman) and Central Asia (Nishapur, Merv, Samarqand) which provide preliminary evidence of the further spread of this opaque glaze technology (Fig. 1). The glazes and bodies of the ceramic were both studied using SEM-EDS, but the bodies were not subjected to either thin-section petrology or trace element analysis (e.g., ICP-MS), in part because the former would have required significantly larger samples, and the latter, would have required samples from many more ceramics from each context for statistical treatment. Therefore, the tentative separation between locally produced and imported ceramics was made on the basis of the major and minor element compositions of the bodies as determined by EDS, and the body textures and distinctive inclusions as observed in the SEM.

The second aim of this paper is to integrate the chemical compositional data for the glazes with primary textual accounts of the glaze production processes, and thus, replicate the opaque yellow and opaque white glazed wares in the laboratory. According to accounts by Abu'l Qasim Kashani in 1301 (Allan, 1973, 113; Afshar, 2006, 342-3) and Isfahani in the nineteenth century (1888, 4, 9), the production of the opaque glazes would take place in two stages. First, a mixture of lead and tin was calcined (oxidised) by heat to produce the 'calx' powder. The ratios of Pb/Sn is stated to be around 16 for opaque yellow glazes (Isfahani, 1888, 9) and between 1.5 and 4 for opaque white glazes (Allan, 1973, 113; Afshar, 2006, 342–343; Isfahani, 1888, 4). In the second stage, to produce the opaque yellow glaze, the calx powder was mixed with a source of silica (e.g., quartz) and heated (Isfahani, 1888, 9). To produce the opaque white glaze, alkaline frit was also added to the mixture of calx and silica and then again heated (Isfahani, 1888, 3–4; Allan, 1973, 113; Afshar, 2006, 342–343).

The combination of the analytical data from the study of Islamic glazed ceramics and from the replicated samples that we present in this paper suggest that there are critical technological links between the production processes of tin-opacified yellow and white glazes. In particular, our study provides evidence that sheds light on the processes of invention and development of these glazing techniques in relation to one another.

2. Archaeological background to the production of Islamic glazed ceramics

2.1. Coptic Glazed Wares (CGW)

Coptic Glazed Wares (CGW) is a term first used by Rodziewicz (1976a, 63-4; 1976b, 209; 1978; 1983) to describe a certain group of ceramics found in Alexandria, Egypt, that occur immediately after the late Roman levels in the archaeological sequence, in layers containing the most ancient Islamic coinage. Rodziewicz suggested Egypt as the original production centre for the CGW given that their shapes and modes of decoration closely imitate those of the local late Roman wares.

CGW is classified into two distinct decorative types: first, a painted type covered with an overall translucent amber glaze, and second, an opaque yellow, green, and/or brown glazed ware. The latter is the focus of this paper. The characteristic of this type is that, rather than an overall decoration, it is covered by glaze in discrete bands with some areas left unglazed (Fig. 2a). Such vessels were recorded also from Fustat (Scanlon, 1998; Gayraud, 2009), Abu Mina (Engeman, 1990), Tod (Joel, 1992), Aqaba (Whitcomb, 1989, 1991, 48–56), Tiberias (Stacey, 1995, 164–166, 286), Pella (Walmsley, 1995, 664, 667-8; Walmsley, 1997, 2–3), Yoqne'am (Avissar, 1996) and Caesarea (Arnon, 2008, 35 and 400).

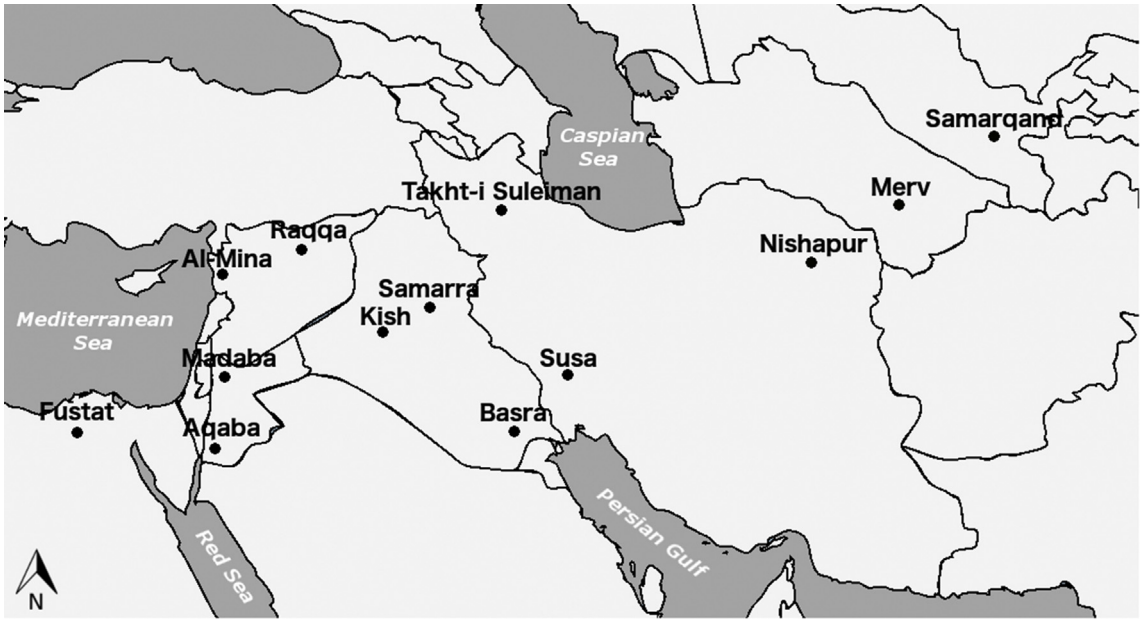

Fig. 1. Map showing location of sites from which ceramic samples were obtained.

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