Hispano-Moresque architectural glazes in the context of medieval glass technology


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Field of interest: technical art history/glazes

Introduction

Hispano-Moresque architectural tiles were extensively used in Portugal and Spain, during the 15th and the first half of the 16th centuries. Their rich patterns comprise mainly five colours – tin white, cobalt blue, copper green, iron amber, and manganese brown – which are all obtained from high-lead glazes with the addition of specific metal oxides (Coenton et al., 2016). These different coloured glazes are physically separated on the tile surface, either by a dark manganese-brown line (believed to contain a greasy substance such as beeswax, which is known as the cuenda seco technique, or by a ridged contour line that acts as “false in the inlay technique (Figure 1)”. From the study of two Portuguese Hispano-Moresque tile collections – the National Palace of Sintra (PNS) and the Monastery of Santa Clara-a-Velha (SCV) – Coimbra – the glaze technology is assessed in the context of coeval glass, glass, and enamel production. Starting with the colour palette and with special emphasis on tin-opacified glazes, the aim of this communication is to present a summary of the process of technological transfer that characterises these glazes.

Fig. 1. Details of a cuenda seco (a) and an inlay technique illustrating the five colours identified in Hispano-Moresque glazes: white, blue, green, amber and brown.

Keywords: Lead glazes, Tin-opacified glazes, Hispano-Moresque, μ-XRF, LA-ICP-MS

Methodology

This work is part of a larger project aiming at characterising and comparing Portuguese and Spanish Hispano-Moresque tile collections. A multi-analytical, minimally invasive methodology was employed, namely the use of two analytical techniques are discussed: micro-X-Ray Fluorescence (micro-XRF) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). The analyses were performed on glass samples (1-3 mm wide) mounted as cross-sections in epoxy resin (Križnik*, 2020) and polished in Micro-Mesh sheets up to 4000. By analysing the glasses in cross-section, it was possible to avoid the corroded surface as well as the glasses-enameled ceramic interface layer.

Results and discussion

High-lead glazes (ca. 40/60 wt% PbO) were identified in all analysed samples and can be divided into two types: “transparent” and “non-transparent”, 45% (SiO2) and lead oxide (PbO) are the major constituents of the glazes making up at least 90 wt% of the total composition. They show an inverse correlation, with higher SiO2/PbO ratios for non-transaparant glazes (mainly white and blue ones). The decrease in PbO is compensated by a higher Na2O content as a fluxing agent in tin-opacified glazes. Potassium, unlike sodium, was found to be present in variable amounts both in transparent and in tin-opacified glazes. This is consistent with a glaze technology that followed the Islamic tradition introduced in the Iberian Peninsula from the 8th century onwards. The use of lead glazes is believed to have started in the Roman Empire or in China, between the 1st century BC and the 1st century AD, and then spread to Europe and the Middle East. Alkali glazes and glasses were also used in Medieval Europe along with lead glasses. However, in the Iberian Peninsula, only lead-glazed ceramics have been unearthed so far, the significant availability of glasses (PNS) in the region being accompanied by one of the major factors for this, that is, the advantages that lead glazes present, such as less sustainability to defects and a higher glaze stability (Irie et al., 1998; Trindade, 2007).

The analyses of these Hispano-Moresque glazes have identified and quantified from 6 wt% and 10 wt% with variable degrees of homogeneity. Use of SnO2 as opacifier represents the most important innovation brought by the Muslim occupation (8th-13th century) to glaze technology, turning the Iberian Peninsula into an important ceramic production centre from at least the 13th century onwards. However, tin-based opacifiers were used since Roman times and tin was found in white enamels and glass mosaics since the 4th century AD. The question remains on why this technology took almost five centuries to be adopted to ceramic glazing, and the earliest evidence of tin-opacified ceramics comes from the 9th century Iberia (Irie et al., 2008).

The pictorial layer is comprised of five colours: white, blue, green, amber and brown. The transition metals identified are those known to be responsible for the colours: cobalt for blue, copper for green, iron for amber and manganese for brown – the very same found in Byzantine glass mosaics, as well as in medieval Limoges enamels, used on metal decoration (Davis-Widmer, 2003; James, 2008). The influence of metal decoration on ceramics is not restricted to the colours and one can see a parallel between cuenda seco and cuerda seca, as well as between champlevé and inlay techniques for separating the different coloured glazes. However, the inlay technique appears as an innovation exclusive to architectural tiles as an evolution from 13th century Gothic lead-glazed monochrome tiles used in France and England (Trindade, 2007).

The blue glaze in cuerda seca and inlay tiles is very characteristic with its light cobalt shade and opacity. The majority of the blue cuerda seca and inlay tiles displays a Fe2O3-NiO association, as determined by μ-XRF and LA-ICP-MS. Copper may be linked to the raw material used for obtaining cobalt, or it could be added intentionally. As an example, a blue enamel recipe from Antonio Ribeiro (1414-1612) includes copper (cinnabar) and tin along with cobalt (cobaltite) (Vázquez & Machado, 2015). During the 15th century, cobalt blue became profusely used by Moorish ceramics, who had the raw materials available. This was one of the most important cobalt deposits in the world. Currently, the known trainers’ blue has been known in the 16th century. In today’s Iran, cobalt blue was believed to have been introduced in the Iberian Peninsula during the 15th century, although its origins are still a matter of discussion. By that, the Middle Eastern and the European (eastern) cobalt mines were known in the Muslim Kingdom (which included part of the Iberian Peninsula), as referred to by Abu al-Williams ceramic treatise (quarter, 1802; Trindade, 2009). A small group of the blue glazes analysed displays a slight content above 1000 ppb of cobalt and similar contents above 500 ppb. The presence of Au is associated with cobalt exported as coffee from the Saxony region (Germany) from the beginning of the 16th century onwards (Guruge et al., 1996). This is consistent with a silverware channel attributed to these tiles, since the group is composed exclusively of metallic samples.

Conclusions

Hispano-Moresque tiles represent a time of great cultural changes. Their technology incorporates Islamic and Christian influences, which is visible in the colours used and glass compositions found as well as in decoration techniques. To better understand the glaze technology and its evolution, one must look at the coeval glass and enamel technologies as well as the colour palette of the same and even the methods for separating the colours are influenced by the metal arts.
Investigating a Byzantine technology: experimental replicas of Ca-phosphate opacified glass

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Field of interest: archaeology/archaeometry

Abstract

The archaearometric examination of mosaic glass tesserae has recently become of great interest, and more attention is given to the textural examination. The glass coloring and opacification techniques so far identified in ancient glass are relatively homogenous from the early glazing until the end of the Roman empire, when a major change occurred. From the 5th century onward, SiO₂-based pigments were substituted by other compounds, such as Ca-phosphate, probably introduced in the form of powder. This compound is found in Byzantine mosaic tesserae and associated to large quantities of gas bubbles. A study aimed at the characterization of the opacifier highlighted the presence of a reaction rim enriched in sodium at the glass/opaque interface, but to date little is known about the technology of production of this specific kind of opacifier.

To understand the production technologies of glass opacified with bone powder, experimental replicas were made under laboratory conditions: using a silica-soda-lime base glass. Bone powders were selected in order to minimize the variables depending on the species or the individual, both cortical and trabecular portions were selected. Different thermal pre-treatments of the bones were tested, and batches were melted with different firing and cooling rates at different temperatures. The experimental samples thus obtained were prepared in polished sections and analyzed by means of optical microscopy (OM), scanning electron microscopy (SEM-EDS) and Raman spectroscopy in order to guarantee the textural, micro-spectroscopic and qualitative chemical analysis of the opacifying phase and the comparison with the archaeological samples.

Keywords: bones; Ca-phosphate; opaque glasses; Byzantine.