Babylonian Blues: Studying the blue and turquoise-green glazes of the Ishtar Gate and the Processional Way

KEYWORDS

Ancient glazes

Polarised light microscopy

Elemental and structural analyses

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Fig. 1–3
Photographs of glazed-brick reliefs from the Processional Way (lion, right) and the Ishtar Gate (dragon and bull, above) that are in the possession of the Ny Carlsberg Glyptotek, NCG (Photos by Riccardo Buccarella).

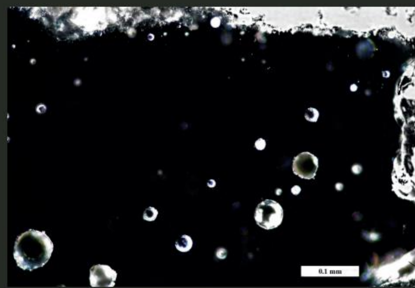

Fig. 4 Micrograph of thin section of a blue glaze, DF, original magnification (20×).

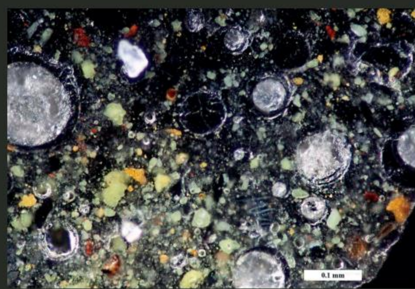

Fig. 5 Micrograph of thin section of a turquoise-green glaze, DF, original magnification (20×).

INTRODUCTION

The Ishtar Gate and Processional Way of Babylon, two glazed-brick structures, were both erected by king Nebuchadnezzar II reigning from 604 to 562 BCE. The Ishtar Gate was adorned with dragons and bulls in relief on a deep-blue background resembling the gemstone lapis lazuli. The gate was reached via the Processional Way which was lined with striding lions in relief on deep-blue and turquoise-green backgrounds. The remains of this monumental structure are among the most impressive and best preserved from antiquity. Yet, remarkably little scholarly attention has been paid to its renowned glazes.[1–3] The Ny Carlsberg Glyptotek (NCG) in Copenhagen is in possession of three glazed-brick reliefs from the Babylonian entrance complex (Fig. 1–3), acquired by the museum in 1930 from the Vorderasiatisches Museum, Berlin. Representing the Ishtar Gate as well as the Processional Way, these reliefs offer a good opportunity to identify the colouring components in the glazes of the architectural structure as a whole.

CONCLUSION AND AVENUES OF FURTHER RESEARCH

- The blue and turquoise-green glazes differ considerably structurally as well as chemically. The blue glazes are rather homogeneous, whereas the greenish ones are highly heterogeneous (Fig. 4–5).
- Cobalt and copper appear to be responsible for the deep-blue hue associated with lapis lazuli.
- Compositionally, the turquoise-green glazes appear more similar to the yellow glazes than the blue ones. Seemingly, the greenish colour has been obtained by mixing a component similar, if not identical, to the yellow glaze with a copper-rich component.

The data and observations reported on here represent the first phase of a larger investigation into the blue and turquoise-green glazes of the Ishtar Gate and Processional Way. In our further research, more samples will be submitted to LA-ICP-MS as well as SEM-EDS analysing for all detectable components including trace markers such as rare earth elements.

METHODS AND MATERIALS

Preliminary elemental analyses of the glazed-brick reliefs of all colours were performed using a handheld Innov-X Alpha XRF analyser. Informed by the preliminary investigation, a total of ten samples measuring 1–2 mm^2 were collected from blue and greenish glazes for further analysis. Thin sections of six samples were examined with polarised light microscopy (Zeiss Axioplan 2, 10×–100×) and LA-ICP-MS (Bruker M90 Aurora, CETAC LS-213). The analytical data are compared to ancient glassmaking texts from Mesopotamia[4] as well as published data on ancient glass and glazes from Mesopotamia and Egypt.[5]

RESULTS

Elemental composition
The preliminary XRF analyses indicate that the blue glazes contain a significant amount of iron, copper and cobalt, all capable of adding a blue tint to the glaze. The turquoise-green glazes contain rather large amounts of lead, copper, tin, iron, arsenic, antimony and zinc but no cobalt. The copper concentrations in the greenish glazes are much higher (×10) than in the blue ones. The elemental composition of the yellow glazes is similar to the turquoise-green ones, except for copper and tin. Iron and zinc levels are similar, whereas the remaining trace elements are significantly more abundant in the greenish compared to the yellow glazes. Qualitative LA-ICP-MS analyses agree with XRF findings and further indicate that copper and cobalt strongly correlate ($r^2=0.99$, $p<0.05$, $n=4$) for blue glazes.

Visual examination
Polarised light microscopy revealed that the blue glazes consist of a transparent, homogenous matrix without distinguishable grains (Fig. 4). However, in one of the samples (IN2811-2) the glass matrix appears to contain clusters of a vitreous material. In contrast to the blue glazes, the greenish glazes are rather opaque and heterogeneous. They contain multiple grains of different colours including green, yellow, and red as well as oblong, greyish grains (Fig. 5).

DISCUSSION

In our investigation into the composition of the blue and turquoise-green glazes, we endeavour to generate as detailed data as possible. We aim to identify the ingredients that went into the melt as well as their sources. We also search for clues testifying to the manufacture of the glazes. In turn, the interpretation of the compiled data will yield information on the trading and costs involved in the embellishment of Nebuchadnezzar II's entrance complex as well as add to our knowledge of ancient glaze production in general.

At this point, it is still uncertain whether iron, copper and cobalt all contribute to the blue colour or not. It is, however, rather clear that all three elements are present in concentrations sufficient to impart a distinct colour to the glazes. The apparent correlation between copper and cobalt levels in the glaze indicates that the two elements were mixed, perhaps fritted, and then added to the melt. In order to produce a blue hue, copper requires oxidising conditions in the kiln, whereas iron requires reducing conditions. Thus, if all three elements were added as blue colorants and, indeed, function as such, it would have had implications for the firing temperatures and times of the final melt. However, this is not supported by the thin sections whose homogeneity indicates rather thorough firing.

The content of cobalt in the blue glazes is not mirrored by the turquoise-green ones suggesting that the two tints are unrelated. Considering the XRF data as well as the thin sections, the greenish hue seems to have been obtained by mixing a component similar, if not identical, to the yellow glaze with a copper-based component containing lead, antimony, arsenic, and tin.

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