INNOVATION OR CONTINUITY? EARLY FIRST MILLENNIUM BCE GLASS IN THE NEAR EAST: THE COBALT BLUE GLASSES FROM ASSYRIAN NIMRUD

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INTRODUCTION

Glassmaking traditions of the early 1st millennium Near East have been little investigated and are therefore poorly understood. However, this is arguably one of the key periods in the development of glassmaking. What little remains of this glass represents an important chronological and geographical link between the Late Bronze Age glassmaking technologies of Egypt and Mesopotamia and the beginning of the long Greco-Roman tradition towards the end of the 1st millennium.

There are several key issues which need to be addressed. Does the early Iron Age Near Eastern assemblage represent a continuity of tradition or do we find the beginnings of the technological innovations that have emerged so clearly by Hellenistic times, such as the use of natron as a flux? Did exploitation of 2nd millennium raw material sources continue, or had new sources of colorants, opacifiers and silica been adopted? Had glassmaking diversified and to what extent?

The glass assemblage from Nimrud, Iraq, a significant proportion of which is housed at The British Museum, offers the possibility to address some of these questions. Nimrud was established in 879 BCE by king Ashurnasirpal II (883–859 BCE) as the new capital of the Neo-Assyrian empire, situated on the east bank of the Tigris river and north of the previous capital at Assur. The capital was later moved to Khorsabad and then Nineveh at the end of the 8th century BCE, and Nimrud declined until it was finally destroyed in 612 BCE by a combined Babylonian and Median army. As a great and relatively short-lived centre with a large corpus of glass principally dating to the 9th–8th centuries, Nimrud provides a fascinating and important piece in the jigsaw of ancient glass research.

The site has been extensively excavated since the mid-19th century, with finds in the British Museum deriving from excavations made by Layard and his successors and those conducted by M.E.L. Mallowan during the 1950s and 1960s on behalf of the British School of Archaeology in Iraq (Mallowan 1966; Reade 1982). The corpus of glass consists of small cobalt blue glass inlays and pieces of a beard from a statuette; translucent turquoise, purple and colourless hemispherical bowls; and turquoise opaque ingots (von Saldern 1966; Barag 1985). More recently, excavations resumed by the British Museum in Fort Shalmaneser in 1989 confirmed the frequency of blue glass inlays at the site (Curtis 1999).

All of these luxury objects are found in royal contexts or contexts associated with senior officials, specifically at Fort Shalmaneser, the North-West Palace and the Burnt Palace. The mechanisms by which these items reached Nimrud presumably included booty, tribute and trade.

Previous analyses of glasses from Nimrud have been published by Turner (1955; 1956), and Bimson and Freestone (in Barag 1985) but these studies were based on a limited number of samples. Brill (1999, vol. 2, 47–9) has published analyses of 24 glasses, covering a range of colours but focusing particularly on red, yellow and blue opaque glasses. Our current work covers a range of glasses, mainly blue and colourless, and adds a further 45 analyses to the Nimrud corpus. In the present paper, however, we focus in particular upon a subset of these glasses, the opaque dark blues. In terms of both their colorant and base glass compositions, the opaque blues are particularly pertinent to the question of continuity versus change in the Late Bronze to Early Iron Age transition.

SAMPLES ANALYSED AND ANALYTICAL METHOD

The 13 cobalt blue glasses analysed here are derived mainly from small inlay plaques, frequently square plaques with central white rosettes. These inlays were set within glass or copper alloy frames which often were attached to ivory inlays set into furniture (von Saldern 1966, 625; Barag 1985, 71–2), but other glass inlays appear to have been hammered onto beds and/or other furniture with bronze tacks (Curtis 1999; Oates 2001, 239–40), and an 8th to 7th-century ‘Phoenician’ glass bowl also excavated at Nimrud was decorated below the rim with plaques of this type (Barag 1985, 65–6, fig. 3, nos 40–40A; cf. also Oates 2001, 240). It has been proposed that these inlay plaques are Phoenician (Mallowan 1978). However, similar square inlays with white rosettes have also been excavated at Arslan Tash and Samaria, and are suggested to have been the products of a south Syrian centre such as Damascus (Winter 1981). Furthermore, glass plaques inlaid into an alabaster cup excavated at Hasanlu in north-west Iran pose further questions over the origin and function of these inlays (de Schauensee 2001). Spaer (this volume) considers these inlays further.

The analyses of the blue glasses are compared with the analyses of other colours from Nimrud, and with those of blue glasses from Egypt and Mesopotamia of the 2nd and early 1st millennia BCE.

Analyses were performed by X-ray microanalysis using an Oxford Instruments ISIS energy-dispersive spectrometer in a JEOL JSM 840 scanning electron microscope. The
Group 3 is a large group of vessels, mainly copper blue with some colourless. Components considered markers of plant ash are generally low, with mean magnesia of 1.7%, mean potash of 0.95%, and mean phosphate of 0.1%. This suggests that the soda came from a natron type evaporitic source. These copper blue glasses have fairly high calcium contents which, if not plant ash, probably reflect a limestone source, added either separately or in conjunction with quartz sand.

Cobalt blue glasses comprise 13 cobalt-coloured glasses which have particularly low potash, averaging only 0.5%, strongly suggesting that these are natron-based glasses. The low lime contents of these glasses (averaging 2.9% and as low as 1%) support this view, as lime is a major constituent of plant ash and the use of plant ash soda alone would typically yield a glass with 5% lime or more. Low P₂O₅ contents, at around 0.1% also appear to preclude plant ash as a source of the soda. These cobalt blue glasses are mainly inlay pieces opacified with calcium antimonate.

The Nimrud glasses therefore are not all typical Mesopotamian plant ash glasses as might have been expected. Plant ash glass is present but the compositions of two, possibly three, of the four main groups have low potash contents, closer to glasses made with mineral soda, this being particularly so for the cobalt blue glasses. The importance of this is that natron-based, non-cobalt glasses occur here somewhat earlier than has generally been documented, although Schlick-Nolte and Werthmann (2003) have recently reported natron-based glasses not coloured with cobalt dating to the 10th century BCE from the tomb of Nesikhons in Egypt.

The nature of the cobalt colorant

The lime–alumina plot (Fig. 2) emphasizes the distinctive character of the cobalt blue glasses. Not only are the lime contents particularly low, but alumina is consistently high, ranging from 4 to 7.7%. The high alumina contents associated with the cobalt blue colorants immediately bring to mind the cobalt blue glazes of New Kingdom Egypt, which Kaczmarczyk (1986) argued were coloured by cobalt-bearing alum obtained from the Kharga and Dakhla Oases of the Egyptian Western Desert, a view which has come to be widely accepted (e.g. Nicholson 1993; Henderson 2000; Shortland and Tite 2000; Tite et al. 2002).

**Table 1: Average compositions of Nimrud and Egyptian glasses in wt%**

<table>
<thead>
<tr>
<th>Nimrud</th>
<th>Na₂O</th>
<th>MgO</th>
<th>Al₂O₃</th>
<th>SiO₂</th>
<th>P₂O₅</th>
<th>SO₃</th>
<th>K₂O</th>
<th>CaO</th>
<th>TiO₂</th>
<th>MnO</th>
<th>FeO</th>
<th>CuO</th>
<th>ZnO</th>
<th>SnO₂</th>
<th>Sb₂O₃</th>
<th>NiO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>13.90</td>
<td>3.07</td>
<td>1.00</td>
<td>69.69</td>
<td>0.15</td>
<td>0.53</td>
<td>1.46</td>
<td>8.66</td>
<td>0.14</td>
<td>0.43</td>
<td>0.48</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Group 2</td>
<td>15.08</td>
<td>5.18</td>
<td>1.01</td>
<td>60.84</td>
<td>0.18</td>
<td>0.52</td>
<td>3.40</td>
<td>6.32</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>0.57</td>
<td>0.14</td>
<td>2.97</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Group 3</td>
<td>16.96</td>
<td>1.70</td>
<td>0.55</td>
<td>69.85</td>
<td>0.10</td>
<td>0.54</td>
<td>0.95</td>
<td>6.15</td>
<td>&lt;0.1</td>
<td>0.10</td>
<td>0.28</td>
<td>&lt;0.1</td>
<td>1.74</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Group 4</td>
<td>18.12</td>
<td>2.72</td>
<td>5.50</td>
<td>66.28</td>
<td>&lt;0.1</td>
<td>0.56</td>
<td>0.45</td>
<td>2.88</td>
<td>&lt;0.1</td>
<td>0.38</td>
<td>0.85</td>
<td>0.16</td>
<td>&lt;0.1</td>
<td>0.13</td>
<td>&lt;0.1</td>
<td>1.71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Egyptian Cobalt Glass</th>
<th>Fe₂O₃</th>
<th>Sb₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Malkata¹</td>
<td>0.12</td>
<td>1.47</td>
</tr>
<tr>
<td>Malkata²</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Amarna³</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

¹ calculated from Lillqvist and Brilli 1999
² calculated from Lillqvist and Brilli 1995, 41
³ calculated from Brilli 1999, 27–30
**FIG. 2 Scatter-plot of lime versus alumina for Nimrud and Egyptian New Kingdom cobalt blue glasses**

Other characteristics of glasses coloured with this cobalt alum include high concentrations of magnesium, manganese, iron, nickel and zinc. According to Kaczmarczyk, these elements are invariably associated in New Kingdom cobalt blues, and are therefore considered to provide a reliable indicator of the alum source. As is observed from Table 1, the Nimrud blues are elevated in the same suite of elements, and a similar cobalt alum source is therefore likely. However, the positive correlation between manganese and cobalt in 2nd-millennium Egyptian cobalt coloured glasses found by Kaczmarczyk and Hedges (1983) does not appear to occur in the 1st-millennium Nimrud cobalt glasses.

A further similarity between the New Kingdom and the Nimrud cobalt blues is the low potash contents of both groups. Shortland and Tite (2000) argued for the Egyptian glasses that this low potash indicates that the soda in the blue glasses was derived from natron, as plant ash generally imparts a potash concentration well in excess of 1.5%. They considered the high magnesium content of the glasses to be the result of the presence of magnesium in cobalt alum. This view was challenged, however, by Rehren (2001) who prefers a plant ash source for the soda in the New Kingdom glasses. Tite and Shortland (2003) later modified their position, suggesting that Egyptian cobalt blue glass contained both natron and plant ash. In the case of the Nimrud glasses, it seems probable that the soda is derived largely from natron, as their lime contents are generally much lower than those expected in glasses where the alkali is added in the form of plant ash. Of course, this still leaves open the question of the soda source in the New Kingdom cobalt blues, as these glasses contain high lime.

The cobalt alum imparts high magnesium to the glass, so a low magnesium natron-based glass was preferred in order to avoid resultant devitrification. This also resulted in a low lime glass, but its stability was not compromised due to the relatively high level of aluminium imparted by the cobalt alum. The low aluminium, low calcium natron glasses of Nesikhons on the other hand, are very unstable (Schlick-Nolte and Werthmann 2003).

**DISCUSSION**

The use of cobalt alum as a colorant in Iron Age Nimrud was not expected. Cobalt alum began to be used as an intentional colorant for dark blue glasses and faience in Egypt from the mid 2nd millennium BCE. However, the investigation of Egyptian faience glazes by Kaczmarczyk and Hedges (1983) indicated that no cobalt was used in Egypt after the New Kingdom, from the 11th to the 7th centuries BCE, during the unsettled Third Intermediate Period. Cobalt was again used as a colorant in Egypt from the beginning of the Late Period, in the mid 7th century, but cobalt-coloured glasses at this time do not exhibit the elevated levels of manganese, nickel or zinc observed in cobalt glasses of the earlier period. Kaczmarczyk (1986) inferred that this indicates a cobalt source outside Egypt.

While most Mesopotamian blue glasses appear to be coloured with copper from the 3rd to 1st millennium BCE, a mere handful of cobalt-coloured glasses, faience and glazes have been reported from Eridu, Nippur and Ur (Garner 1956; Neumann 1927). These were found to be coloured with a non-Egyptian, non-alum cobalt source (Kaczmarczyk 1986, 374). Kaczmarczyk concluded that while the Great Western Oases were the most likely source of cobalt alum to the 2nd-millennium Egyptian craftsmen, the cobalt source for Mesopotamian glasses of all periods, and Egyptian glasses and glazes of the 1st millennium BCE, was Iran. This picture, however, was clearly an oversimplification.

The Nimrud cobalt-coloured glasses are therefore found in the middle of a period of over 400 years when cobalt is not reported as a colorant in Egyptian glass, and furthermore in a region not generally associated with the production of cobalt blue glass. Were it not for these chronological and geographical gaps, it would be logical to assume that the cobalt alum in the Nimrud glass represented a continuation of the use of the Egyptian source from the Bronze Age, but such a proposal clearly needs careful consideration.

There is little evidence for the production of the cobalt blue glass in Mesopotamia itself. However, it should be noted that the use of red alum (note that cobalt-bearing alum is pink in colour) as an additive in the manufacture of ‘lapis lazuli’ coloured glass is mentioned in the famous cuneiform glassmaking texts from Ashurbanipal’s (668–627 BCE) library at Nineveh (Oppenheim et al. 1970, 41). This suggests that the use of alum as a colorant was known to Mesopotamian glass makers.

The Nimrud cobalt blue glass plaques seem likely to have originated from Syro-Palestine, and were probably not made by local expatriate craftsmen imported by Ashurnasirpal II. There are similarities in base and colorant composition of the cobalt blue glasses from Nimrud to those analysed from early 1st millennium BCE France by Gratuze and Picon (in press) who attributed them to a Syro-Palestinian origin. If the glass arrived from the west, there is the possibility that Egyptian cobalt alum was used by Levantine glassmakers, or by glassmakers in Egypt itself, although the failure to detect alum-derived cobalt in Egyptian faience glazes of this period (Kaczmarczyk and Hedges 1983) renders the latter possibility unlikely.

Circumstantial evidence for an Egyptian source of cobalt lies in the apparently precocious use of natron as an alkali
alumina and magnesia in the cobalt colorant. Robert Brill's analyses (1999, 48) show that opaque yellow glasses from Nimrud are also very low in lime, and opaque red glasses are moderately low; these colours are likely to have been preserved due to the presence of divalent lead and copper added to colour them. Thus it is very likely that a substantial number of glasses from this period, which were not coloured with large amounts of stabilizing compounds, or preserved in the extreme dry conditions such as those encountered in the tomb of Nesikhons, have simply weathered away, and that much of the evidence for Late Bronze Age to Early Iron Age use of natron-based glass has been lost completely.

CONCLUSIONS

Cobalt blue glasses from Nimrud were coloured using a pigment derived from cobaltiferous alum, similar to that used in New Kingdom Egypt. These glasses also share the characteristic that both are low in potash. Coupled with exceptionally low lime content, this characteristic indicates that the alkali in the Nimrud glasses was added mainly in the form of natron, with minor or no plant ash, although the relative amounts of natron and plant ash in the New Kingdom glasses remain uncertain. Other glasses from Nimrud are also low in potash and magnesia and appear to be natron-based. These technological characteristics hint both at continuity, in the form of the use of cobalt alum, and change, with a shift from plant ash to natron as the prime glass flux, during the LBA-IA transition. However, further work is needed to understand the intricacies of the glassmaking technology at this time. It is hoped that trace element analyses, now in progress, will help to answer these questions.

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