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Between Egypt, Mesopotamia and Scandinavia: Late Bronze Age glass beads found in Denmark

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ABSTRACT

New research results from glass beads found in Denmark reveal surprising evidence for contact in the 14th–12th centuries BC between Egypt, Mesopotamia and Denmark, indicating a complex and far-reaching trade network. 290 annular glass beads ranging from dark blue to green, white and yellow, along with four polychrome beads, have been found in 14th–12th century burials from Denmark and Schleswig-Holstein in North Germany. Coming from well dated contexts, twenty-three well-preserved Danish glass beads were chosen for analysis.

1. Introduction

Glass is a synthetic material obtained by fusing rocks high in silica (quartz or sand) with fluxing agents (soda or potash from natural deposits or plant ash) in order to lower the melting temperature. Glass obtained in this manner may be colored light blue, yellow or green by natural impurities such as iron oxides. In order to produce colorless or colored glass, glassmakers added decolorants or colorants in the form of metal oxides. The chemical compositions of ancient glasses (raw materials and coloring recipes) vary with the place where the glass was made, but also with the historical period of its production (Turner, 1956; Sayre, 1965). Although the beginning of glass production dates back to the middle of the 3rd millennium BC, most likely in Mesopotamia, the manufacture on a larger scale started during Middle/Late Bronze Age transition in the mid-2nd millennium BC, in both Mesopotamia and Egypt (Peltenburg, 1987; Shortland and Tite, 1998).

Early glass was a rare and expensive luxury traded along the coasts of the Mediterranean between Egypt, the Near East and Mycenaean Greece in ships like the Uluburun shipwreck off the coast of Turkey, dating to the late 13th Century BC (Bass, 1986). Here we present evidence for both Egyptian and Mesopotamian glass beads in Danish graves from the second half of the 2nd millennium BC, more than 5000 km from the initial glass workshops. As a result, Denmark can be proposed as the most distant area that received such beads, revealing links with the trade systems of the Mediterranean.

2. The Scandinavian glass beads

It has long been known that the burial mounds of South Scandinavia, particularly Denmark, contained glass beads (Müller, 1882; Kersten, 1935). Those reported here belong to the second half of period II and period III of the Nordic Bronze Age, c. 1400–1100 BC. In one of the earliest works on Bronze Age glass in Denmark, Egypt was mentioned as a possible place of production (Müller, 1882). Later, this idea was dismissed because of the lack of similar finds in Central Europe. There were seemingly no signs of trade connections between Scandinavia and the eastern Mediterranean (Haevernick, 1978; Harding, 1971). The find of a

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European glass workshop in Northern Italy at Frattesina in the Po Valley, although from a slightly later period, raised the possibility that the glass beads could have had a European origin (Biavati and Verità, 1989).

2.1. The chemical analyses

Twenty-three glass beads recovered from different Danish Bronze Age sites and ten fragments of glass working debris from Amarna (Denmark National Museum collections) were analyzed by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The ablation system used here consists of a Neodyme:YAG laser working at 266 nm (quadrupled frequency) coupled with the Thermo Electron Finnigan ELEMENT XR mass spectrometer. The technique requires no special preparation of the samples and is virtually non-destructive (Gratuze, 2013).

With the exception of one polychrome bead (B7328) composed of a turquoise blue spherical body decorated with the colors of amber, white and yellow glass eyes, the twenty-two other beads are monochrome and range from light to dark blue. The Amarna glass working debris are composed of eight amber (7411 9), black (7411 1), dark blue (7411 2–4) and translucent or opaque turquoise blue (7411 5–7) glass rods and two glass chunks (7410 1 dark blue and 7410 2 turquoise blue).

Chemical compositional results are shown in Table 1. All samples are soda glass, with soda (Na_2O, 14 to 21.5 wt%) as the primary flux, and high magnesia and potash indicating a plant ash source for the soda (MgO, 3 to 7 wt%; K_20, 0.5 to 4.1 wt%, only two cobalt blue samples exhibit potash content below 1 wt %). Their alumina, lime and iron contents present a large variability (Al_2O_3, 0.6 to 2.6 wt%; CaO, 4 to 11 wt%; Fe_2O_3, 0.26 to 1.1 wt%) as might be expected from the use of different source of silica (SiO_2). These compositions show that the glass used to make the Danish beads and the Amarna glass working debris was fused from powdered quartz or siliceous sands containing various amounts of alumina and lime, mixed with the ashes of plants high in soda, such as Salicornia sp. or Salsola kali. The presence of a large amount of unmelted quartz grains is observed in the Danish bead B17106.

For the Danish glass objects, five beads are colored dark blue by cobalt oxide (D115, B2209, B13707, B15853, B17106) and eighteen turquoise blue by copper oxide, although one of these contains an unusually high level of cobalt oxide (80 ppm for B15205). Among the five Danish glass beads colored by cobalt, two (B2209 and D115) exhibit high zinc and nickel contents correlated with cobalt, while for the three others, nickel and zinc concentrations are much lower and are not correlated with those of cobalt. The copper contents of these five beads is fairly low (CuO 0.007 to 0.14 wt %). For the eighteen turquoise blue Danish glass beads, the low tin concentrations measured for sixteen beads suggests the addition of relatively pure copper, while in two cases (B3289 b and c), the high tin levels indicate the use of bronze scrap containing from 6 to 8 % tin. The amber, white and yellow glasses which compose the eyes of the polychrome bead are respectively colored by iron (probably iron polysulfides), calcium antimonate and lead antimonate.

For Amarna, the black (7411 1) and the amber (7411 9) glass rods are colored with iron (probably also as iron polysulfides). The three dark blue glass rods (7411 2–4) and one of the chunks (7410 1) are colored with cobalt and various amount of copper. The high variability of copper concentrations in Egyptian cobalt blue glasses has recently been shown by Smirniou and Rehren (Smirniou and Rehren, 2013). As expected for Egyptian Bronze Age glasses colored by cobalt, these four glasses are characterized by high nickel and zinc concentrations correlated with those of cobalt (Kaczmarczyk, 1986; Shortland et al., 2007). Copper is the main coloring agent for the second chunk (7410 2) and the three other rods (7411 5–7, turquoise blue translucent and opaque). The glass of the turquoise blue opaque rod (7411 6) contains 1.6% antimony, probably in the form of calcium antimonate. Among the seven Amarna glass rods and chunks which contains more than 0.2% of copper (only the amber and black rods and one cobalt blue rod contain less than 0.03% copper), the tin contents show the use of bronze scrap containing from 5 to 8 % tin.

While the major element compositions of the Danish glass beads and the Amarna glass working debris are characteristic of Late Bronze Age Near Eastern glass, their trace element patterns could allow us to distinguish between Mesopotamian and Egyptian productions. Since 2007, several studies have proposed models using chromium, lanthanum, zirconium and titanium contents to distinguish between early Egyptian and Mesopotamian glass (Shortland et al., 2007; Rehren and Pusch, 2005; Shortland and Eremin, 2006; Walton et al., 2009; Jackson and Nicholson, 2010) while others focus on the copper- and cobalt-blue colorants (Walton et al., 2012; Smirniou and Rehren, 2013).

If we apply these criteria to the Danish glass beads and the Amarna glass working debris we observe that two of the Danish glass beads (made with glass colored by cobalt oxide: B2209 and D115) and all the Amarna glass working debris are characterized by low chromium/lanthanum and variable zirconium/titanium ratios. The twenty one remaining Danish glass beads exhibit higher chromium/lanthanum and lower zirconium/titanium ratios.

By comparing our data with those published by Shortland, Rehren, Walton and Jackson, we observed that the two Danish cobalt blue glass beads and the ten Amarna rods and chunks fall within the Egyptian glass group defined by these authors while the twenty one remaining Danish glass beads fall within their Mesopotamian glass group (Fig. 1).

According to their boron and lithium concentrations the Danish glass beads made with Mesopotamian glass could be further divided into two groups: twelve beads are characterized by medium to high boron (0.12–0.32 % B_2O_3) and lithium (>0.005% Li_2O) contents while nine have far lower boron (<0.055% B_2O_3) and lithium (<0.005% Li_2O) concentrations. One of the Mesopotamian cobalt blue glass beads (B13707) belongs to the high boron lithium group while the two others belong to the low boron and lithium group (Fig. 2).

High boron glass beads have already been described on the Mesopotamian sites of Hasanlu, Iran, (Brill, 1999) and Tell Brak, Syria (Shortland et al., 2007).

The two other Danish beads, which matched the Egyptian glass group, and Amarna glass working debris, are all made with low boron glass.

The Egyptian origin of the two Danish glass beads (B2209 and D115) is confirmed by their colorant composition: in both beads, cobalt correlates with nickel, zinc, and manganese. This correlation has been shown to be typical of the cobalt colorant extracted from Egyptian alum deposits such as those at the Kharga and Dakhla oases (Kaczmarczyk, 1986; Shortland et al., 2006, 2007). The overall composition of these glasses appears also very similar to the one of the Egyptian glass found at Uluburun (Jackson and Nicholson, 2010; Smirniou and Rehren, 2013) in New Kingdom workshops at Malkata and Amarna.

As observed previously, the nickel, zinc and manganese contents of the three cobalt glass beads (B13707, B15853 and B17106), which belong to the Mesopotamian glass groups, are lower than those found in the two Danish beads with Egyptian origin, while their copper contents are higher. A fourth bead (B15205) which present