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Cover: Examples of large glass beads of leech fibulae from Iron Age necropoli in northern Italy (see the lead article by Leonie C. Koch).
Inside back cover: Information for Authors.

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KARLIS KARKLINS, editor

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THE LARGE GLASS BEADS OF LEECH FIBULAE FROM IRON AGE NECROPOLI IN NORTHERN ITALY

Leonie C. Koch

During the Iron Age, around 700 BC, artisans in northern Italy produced bronze bow fibulae decorated with large, elongated, leech-shaped glass beads. These extraordinary brooches, known only from women's tombs, required special technical knowledge and skill to create. This article provides an overview of these adornments as well as insights into their production technology, chemical composition, and origin. The wide variety of these objects suggests the existence of several local glass workshops.

HISTORICAL BACKGROUND

Different kinds of fibulae, or brooches, for decorating and fastening clothes were popular in the northern part of the Italian peninsula during the late 8th to 7th centuries BC. Most of the fibulae are of bronze and often characteristic of ancient regional cultures. In Etruscan places like Tarquinia or in the Emilia-Romagna (the Etruscan zone in the region of Bologna, north of its core area in Tuscany), simple bow-shaped fibulae made of a bronze wire with small glass or fine bone beads on the bow were already in use in the 9th century BC. A bronze type with a broad bow resembling the form of a leech became common in the 8th century.¹ Some of these have a large leech-shaped glass bead on the bow (called *Glasbügelfibeln* in German). They occur in various Etruscan and neighboring necropoli utilized from the last third of the 8th century onwards, the beginning of the so-called Orientalizing period.² Often elements of bone and amber complete the leech shape at either end.

The glassy leech fibulae are mainly concentrated in cremation necropoli between Bologna and Verucchio (Emilia-Romagna) (Figure 1). They are occasionally found in Tuscan tombs such as at Chiusi, Marsiliana, and Vetulonia, and elsewhere, e.g., Falerii (the ancient Faliscan area), Belmonte (Picenum, present-day Marche), and Este in Veneto. Isolated finds are known from Magdalenska gora (Slovenia), Frög (Austria), and Gorszewice (Poland), all probable imports from northern Italy. Some museum collections hold specimens of these glass-bow fibulae,

usually without any provenience information, so this jewelry item has not lost its attraction even in modern times.

MANUFACTURING TECHNIQUES

The glassy fibula beads in leech form (“sliders”) are relatively large and can be over 8 cm long. They have a longitudinal perforation and thus “slide” onto the brooch’s bow-shaped bronze wire. The generally dark body is decorated with a zigzag pattern of applied yellow and/or white glass threads (Figures 2-3). Other decorative patterns include wavy lines, dots, and circles. A rare type with “horns” (Figure 4) is found mainly in Emilia-Romagna (von Eles 2015: type 84, Plate 195; Koch 2010:66, 70-73, Figures 16, 87, 90). This distinctive form, with its spiral and wavy decoration, has parallels in certain triangular beads from the Balkan area, especially Croatia and Slovenia (Bakarić, Križ, and Šoufek 2006:64, 165 f., nos. 151-152, 155-156). These and other large spherical “Kompolje beads” (so called after the place of discovery in Croatia) have a partially vitrified sandy quartz core coated with dark glass onto which the decoration is applied.³ The same technique is evident in the large fibula bow beads, in both the horned and the leech forms, and it also appears in glassy spindle whorls from Emilia-Romagna. It seems that an exchange of glass-working techniques took place around the Upper Adriatic in the late 8th and 7th centuries BC.

Eroded and broken leech beads clearly show that the core consists of a bright yellow mass, mostly with a rough crystalline texture (Figure 5) (Koch 2010:52-55; Purowski, Syta, and Wagner 2016; Towle and Henderson 2007:58, Figure 6). This sandy mass has been sintered (partially fused or vitrified), as revealed by internal gas bubbles that also indicate the addition of a flux during production. The individual steps of preparing the core are unknown, e.g., was it sintered before or during the application of the glass surface? In order to obtain the massive leech form, the artisans probably used some kind of two-part mold.

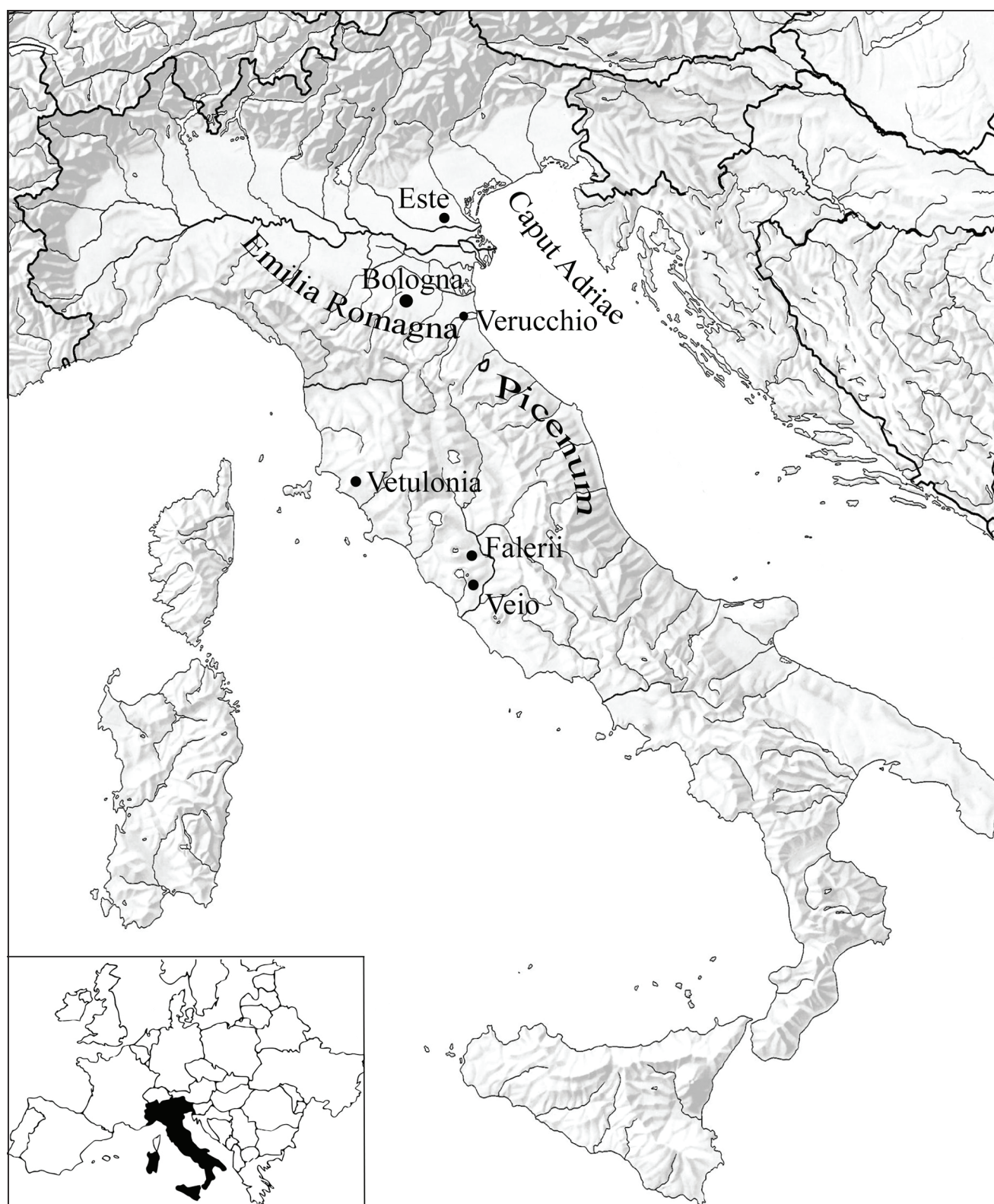


Figure 1. Map of Italy showing the most important find sites and regions mentioned in text (no further reproduction without renewed permission of the proper regional authorities is allowed) (all images by the author).



Figure 2. A pair of fibula bow beads from Verucchio (Lippi tomb 13/1972). The typical herringbone pattern consists of alternating white and yellow lines though the latter have mostly disintegrated (courtesy of the Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).

This is obvious considering the very similar shape and dimensions of the beads where pairs of fibulae have been discovered (Figures 2 and 11). It is highly unlikely that the



Figure 3. Large fibula bow bead from Bologna (Benacci, without tomb context). The decoration consists of groups of yellow and white lines (courtesy of Museo Civico Archeologico Bologna).

cores were produced by coiling molten glass on a mandrel as proposed by T. Purowski (2012:103, Figure 30). It is,

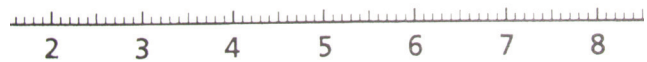


Figure 4. Rare horned fibula bow beads with spiral decoration on the horns; some of the yellow glass is missing (Verucchio, Lippi tomb 13/1972) (courtesy of Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).



Figure 5. An eroded bow bead showing the light-colored sandy quartz core beneath the dark glass layer; the decoration is gone (tomb Strada Provinciale 1970, Verucchio) (courtesy of Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).

however, plausible that the exterior glass coat was applied in this way.

Most fibula sliders have a blackish glass coating, though there are rare hints of a yellow one (Koch 2010:79). After the coating was applied and smoothed by heating, the decorative threads were wound around the body – a difficult moment in the manufacturing process that required the artisan to understand the properties and workability of the glass that they used. Their expertise is manifest, since only in rare cases do we see faults in the application of the decorative threads which consist of monochrome yellow or white glass, or bichrome using both colors. In the case of bichrome decoration, the change from one color to the other generally occurs on the lower side and is not visible when the brooch is in use (Figure 3). Yellow and white lines may alternate (Figure 2) or constitute alternating groups of several threads of each color. This “group decoration” is found on relatively large bow beads from Bologna (Figure 3), and the example from Gorszewice in Poland also seems to be of this kind.⁴

The final production step was to comb the white and yellow lines into a zigzag or herringbone pattern with a pointed tool. This step produced deep longitudinal grooves in the glass coating which we can also see as a decorative element. The surfaces of cores that have lost their glass coating exhibit traces of these grooves (Koch 2010: Plate 2, no. 1), revealing that the core was hot and soft at this stage.

Some bow beads from the Bologna region were made using a different technique. Here, the whole body is colored but it contains a large portion of unfused quartz or sand granules that are visible to the naked eye (Figure 6). It may be that a pre-produced colored glass was ground to a powder and mixed with common sand or crushed quartz. There is no



Figure 6. A broken bow bead from Bologna (Malvasia Tortorelli, formerly tomb 2). The entire body consists of a colored glassy mass (courtesy of Museo Civico Archeologico Bologna).

evidence of an extra layer of glass on the surface so it seems that enough glass (powder?) was soft during the sintering and/or decoration process to allow the applied white or yellow glass threads to sink into the surface. Possibly, the artisans added a liquid to the glass powder and sand/quartz mix to obtain a workable mass that could be pressed into a mold, as for the cores described above. This is reminiscent of the process used to make faience beads. In both cases it was necessary to form the bead around a rod for further working and decorating – and to leave an opening for the fibula bow. Usually, the hole is much larger than actually needed, and sometimes small pieces of wood were slipped into the hole to fix the bead on the thin bronze wire of the fibula (e.g., Koch 2010: nos. 122 and 123).

There is also a third production technique. In a few cases, smaller leech-shaped beads, 4-5 cm long and made of pure translucent blue or dark brown glass (Koch 2010:

nos. 164 and 165), seem to have been formed on a bronze wire that was then shaped into a fibula. Other beads have a large round hole and were worked like a common bow bead on a rod that was coated with a parting agent (Figure 7). To achieve the bowed leech form, these beads, while in a hot and workable state, were bent over a narrow curved form or some tool. This procedure is rather tricky and the glass must have the right temperature. In the case of beads produced on a fine fibula wire, there would have been no problem in removing the working rod. For the other examples, we may hypothesize a slightly curved rod. The smooth bottom side that is formed like a segment of a circle provides unambiguous evidence that the beads were shaped in a hot state (Figure 7). On the blue examples, wrinkles are present on the underside where the glass was pushed together and cooled on the surface of the form. These wrinkles indicate that the beads were shaped after they had been decorated. Thus these objects, in all their variants, reveal the high technical ability of their makers over 2500 years ago.

RESULTS OF CHEMICAL STUDIES

The Early Iron Age glasses in Italy differ from those of the Late Bronze Age mainly in the use of different flux materials. The glass of the Final Bronze Age (12th-10th centuries BC) that was worked and maybe also produced

in well-known Frattesina and other nearby workshops (e.g., Bellintani 2014) is a mixed-alkali glass containing both soda and potash. In contrast, Iron Age glasses have a different and more variable chemical composition. Due to their soda content of ca. 14-20% NaO, they are considered to be natron glasses with soda as the only flux (Angelini, Gratuze, and Artioli 2019). When this soda content is combined with very low amounts of magnesia (MgO) and potash (K₂O), it seems feasible to argue that a mineral soda source, namely natron, was used (Purowski, Syta, and Wagner 2020; *see also* Koch n.d.). This is not the place to discuss European Early Iron Age glass chemistry in greater detail, so we will highlight only some interesting results regarding the leech-shaped beads.

Recently, T. Purowski (2012) and co-workers (Purowski, Syta, and Wagner 2016) carried out new chemical analyses on a fibula bow bead found in Poland. They analyzed the oxides of the basic glass ingredients as well as trace elements in the vitrified portion of the quartz core and in the superficial dark glass coat. Purowski, Syta, and Wagner (2016:113) suggest that a plant-ash flux was used because of the relatively high levels of MgO and K₂O in both the glasses. Due to the proportion of zirconium and strontium, the authors believe that the sand came from an inland source and not from the seacoast (Purowski, Syta, and Wagner 2016:113). They emphasize that the glasses



Figure 7. A pair of fibula bow beads made of translucent glass from Veio (Vaccareccia tomb 24). Note the smooth underside that was probably formed while the glass was viscid; the ends are ground flat (courtesy of Museo delle Civiltà – Museo Preistorico Etnografico “Luigi Pigorini” and the Ministero per i Beni e le Attività Culturali).

of the core and the colored layer are of the same type and similar in composition, differing only in the amounts of trace metal oxides thought to stem from the coloring agents used (Purowski, Syta, and Wagner 2016:113, Table 2, 116, Figure 7). This important finding implies that the quartz-rich mass of the leech bead's core was mixed in the same workshop and using the same basic materials as the colored glass. As previously mentioned, we know the core technique was only used in a few geographical areas and only to produce certain glass artifacts. If further research can confirm this finding for other fibula beads, it would be good evidence to argue that local workshops produced their own glass in Italy around 700 BC.

The researchers also detected a rather high concentration of cobalt oxide (0.88%). This is in line with the dark glasses of other fibula sliders, although it is among the highest cobalt content noted to date. Other results currently available for CoO are in the range of 0.16-0.93%, namely 0.16% for a leech bead without context (Braun 1983: Table 21), 0.23% for a sample from Este discussed below (Casa di Ricovero 235; Towle 2002:315, Table 5.43), 0.25% for another bead without context (Bomford collection, Bristol; Towle 2002:315, Table 5.43; Towle and Henderson 2007: Table 5), 0.31% (Este, Rebato 100; Towle 2002:279, Table 5.24), and up to 0.93% on an example said to come from Slovenia.⁵ These levels are remarkably high considering that cobalt is a strong coloring agent that can impart a dark blue color at a concentration of only 0.02% (see e.g., Henderson 1985:278-281, 1988:438). For this reason, Purowski, Syta, and Wagner (2016:116) suggest that “the coloring process was apparently out of control of the artisans.” This does not take into account, however, that the artisans may have deliberately added a high concentration of cobalt in order to create a blackish color. Most fibula bow beads with a preserved surface are of a very dark color, occasionally altered (by the funeral pyre?) to reddish brown, but sometimes clearly identifiable as dark blue when held up to a strong light (e.g., Figures 2 and 5). Black glasses are among the very first glasses in the Early Iron Age, from the 10th-9th centuries BC onwards, and were colored by adding different elements, primarily iron, in various amounts.⁶ With the availability of cobalt toward the end of the Early Iron Age, this efficient colorant seems to have been preferred.

The dark glass of the Gorszewice bead also contains higher amounts of nickel, copper, lead, and iron oxides (2.77% FeO) that may in part have been introduced to the glass batch with the cobalt mineral. This finding correlates with the analysis of other sliders that have iron oxides in concentrations from 1.03% Fe₂O₃ to 5.55% FeO. This is much less than in the earliest Iron Age black beads, but high enough to have an effect on the glass batch. So I think that a

black glass matrix was desired – and successfully obtained by all available means.

Somewhat problematic is a bead from Este (Towle 2002:315, Table 5.43, sample 370) which has the “usual” high amounts of cobalt (0.23%) and iron oxide (1.83%), but also a significant content of lead (8.33% PbO) and antimony (1.21% Sb₂O₅). Towle (2002:270), who analyzed a large sample of artifacts from the Italian Iron Age, describes the glass material as “green and opaque,” as one would also expect from the detected coloring agents such as cobalt and lead antimonate yellow. To my knowledge there is no green opaque glass during this period, and the bead appears to be covered with a dark layer of unknown material that could give the impression of being green. From Tomb Ricovero 235 (Koch 2010: no. 132), this bead is broken, weathered, and probably also suffered from the heat of a funeral pyre. From the broken section, it is clear that the quartz core is not covered by a dark glass layer but by a yellow one, and the yellow glass is confirmed by chemical analysis. Only in a few other cases from Este and Bologna are there indications of a yellow coating, though it may not be as durable as the dark glass. The yellow glass matrix has been noted in combination with a white decoration, thereby creating very bright trinkets (Koch 2010:79). Based on the chemical analysis, it may be that a dark cobalt-colored glass thread was wrapped around the yellow body to create the herringbone decoration. The instrument readings may have been taken at a spot where traces of the blue/black glass remained or cobalt molecules had diffused into the yellow matrix.

LOCAL WORKSHOPS?

Glass workshops are difficult to identify archaeologically because the tools used are not very specific (like tongs or tweezers) and a small oven or even a small forced fire would be sufficient to obtain the temperatures required to work the glass (Koch 2011:28-31 with literature). The only positive evidence of glass workshops in European prehistory so far available comes from the region of Frattesina di Fratta Polesine (Rovigo) in the Italian Veneto. It dates to the local Final Bronze Age (12th-10th centuries BC) and includes technical ceramics like crucibles and earthen working platforms together with glass waste and dark colored cullet (Angelini 2019; Bellintani and Stefan 2009; Towle et al. 2001). It is not known, however, if the raw glass was produced here or if there were other glass workshops in existence during this period, though both seem likely. Without any archaeological information regarding glass workshops in the Italian Iron Age, one has to look for evidence elsewhere.

The shape of the leech fibulae is very specific to Italy in the advanced Early Iron Age, so the occurrence of a

glass variant is the best evidence for the existence of local glass workshops. Chemical investigations may offer new arguments for local manufacture and raw glass production as discussed above. The artifacts themselves – their style and occurrence – also undergird some arguments. For example, sliders of “true” translucent glass (Figure 7) have been found in Veio and the adjacent area of the Faliscan territory (Koch 2010: nos. 154-161). A few other variations are known, e.g., from Chiusi or the Picenian territory. Excavations in the latter region have produced a bead fragment made of a translucent bottle-green glass (probably colored by iron oxides) and decorated extraordinarily with opaque red glass (Figure 8). There may even be two examples of this type.⁷



Figure 8. A fragment of a glassy slider made of green and red glass from the Picenean area (courtesy of the Museo Archeologico Nazionale delle Marche Ancona and the Ministero per i Beni e le Attività Culturali e per il Turismo – Direzione Regionale Musei Marche; no further reproduction without renewed permission is allowed).

The beads with colored bodies (Figure 6) have different textures and colors ranging from blue to dark reddish brown or nearly black. A pair from Bologna has hammered spiral bronze wires inside the glass mass, probably for technical reasons (Koch 2010: nos. 10-11, Plate 2, no. 4). So it is obvious that the same technology was used in different workshops over time and some examples exhibit characteristics that may indicate local experimentation and development of glass working technology.

A comparison of a fibula bow bead from Verucchio (Lippi, grave 38/2006) and a pair from Veji (Quattro Fontanili, grave EE 7-8B) reveals that these beads – with dots and circular decoration at the middle and alternating straight and wavy lines instead of a herringbone pattern at the ends – are of the same ornamental tradition (Figures 9-10). They are, however, obviously made of different kinds of glass materials, and were found at sites about 350 km apart, separated by the Apennine Mountains: one near the Adriatic coast, the other close to Rome.

Large bow beads with bicolor decoration that may have originated in the same workshops are known from Bologna as well as Verucchio (Koch 2010:79-81) (Figure 3). To my knowledge, however, sliders with only yellow herringbone



Figure 9. A bow bead with circular and wavy lines (Veji, Quattro Fontanili tomb EE 7-8B) (courtesy of Direzione Regionale Musei Lazio – Civita Castellana [VT], Museo Archeologico dell’Agro Falisco Forte Sangallo).

decoration come solely from Bologna and environs (the pair from Vetulonia [Figure 11] is of another type), while examples with only white decoration come from Verucchio. The white trailed decoration on a dark matrix is common on distinctive beads and pendants from Verucchio and seems to have been a local specialty (Koch 2015: type 12 or 15). It could, therefore, be concluded that in Verucchio, in the Rimini hinterland on the Adriatic coast, glass workshops produced their own trinkets based on local demand and tastes, supplemented by imports from Bologna.

Some distinctive beads from Este in the Veneto deserve mention as well. Three of the rare fibula bow beads with a yellow coating come from Este (Koch 2010: nos. 132, 133, 136), as does a huge, somewhat distorted bow bead with a unique decoration of yellow and white threads from an unknown context (Koch 2010: no. 135). In the decades that followed, the glass workers of Este produced objects based on local glass making traditions. They exhibit an opaque, porous glass often formed into objects with spikes or knobs, including spindle whorls and even fibula sliders (Koch 2010: nos. 137-139). Local diversity in style and glass type is obvious here.

“Unusual” types of glassy bow beads are also known from the main Etruscan area, such as the brownish and



Figure 10. A small slider decorated with circular and wavy lines (Verucchio, Lippi tomb 38/2006) (courtesy of Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).



Figure 11. A pair of leech-shaped fibulae with glassy bow beads from Vetulonia (Secondo Circolo delle Pellicce). The decoration of the upper bead is missing and may have been of a different glassy material (white glass?) than the lower bead (courtesy of Museo Archeologico e d'Arte della Maremma Grosseto).

hot-formed example from Cetona (the only one from the Chiusi area) and the unique example with two lateral lobes and a yellow zigzag pattern (Figure 12) from Vetulonia (Koch 2010: nos. 153, 147). Other regionally specific glass objects like “simple” beads also raise the possibility of local glass workshops. Research on Early Iron Age glass, be it archaeometric or archaeological, is still in its infancy (Koch 2011, 2015, n.d.). One must reckon concurrently with imports of raw glass and beads from other workshops, on a regional and inter-regional scale, from the Aegean or the Balkans.



Figure 12. A uniquely shaped glass bow bead from Vetulonia (Primo Circolo delle Pellicce, pit 4) (courtesy of Museo Archeologico e d'Arte della Maremma Grosseto).

These special ornaments expressed a particular esthetic and, as part of costume, they formed an element of women's identity. Furthermore, they were used in certain local funerary rituals and excluded from others. A good example is the glassy fibula pair from the tomb of a ca. four-year-old girl in the Veji necropolis which is the only example among several hundred tombs in the necropolis of Quattro Fontanili (Figure 9). In the cremation burials of the Emilia-Romagna they adorned dead women and were incinerated with them (Figure 13). Their role in decorating funerary urns, probably during a process of anthropomorphizing the vessel, is also well known from the necropoli of Verucchio.



Figure 13. A pair of glassy fibula sliders from Verucchio (Lippi tomb 31/1972). They are partly deformed from the heat of the funeral pyre and covered with melted bronze from other costume elements (courtesy of the Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).

The items draped around the vessels were mainly pairs of various bronze fibulae, some decorated with a glass slider or amber, together with clothes or scarves, necklaces of glass and amber beads, girdles, pendants, and ear-rings (Bentini et al. 2015; Koch 2008). Over three to four generations, extravagance increased and by the middle of the 7th century, very large and elaborate bronze-and-amber brooches, in part with figural decorations, were produced (von Eles 2013; von Eles and Trocchi 2015; Scarnecchi, Siboni, and Zanardi 2015). Among the 48 fibulae around the urn in Lippi tomb 40bis/2006 at Verucchio – which is among the richest and the latest (phase V) tombs in the Lippi necropolis – was a pair with glassy bows that had been reduced to quartz sand (von Eles 2015: Plate 197, nos. 1788 and 1789). Similarly, only fragments of the core remained of a massive pair measuring ca. 17 cm in length (Figure 14) (Manzoli and Poli 2015). Apparently the intention to make the largest glass bow fibulae resulted in products that were huge, and maybe splendid at the moment of burial, but not durable. Considering their high weight, it is possible that they were produced only for the funeral and not for use during life. Thus knowledge of this extraordinary glassy jewelry, as well as the less-impressive smaller beads, allows us to understand



Figure 14. Leech-shaped fibula with two amber elements and remnants of the core of a huge glass bow bead that adorned an urn in Lippi tomb 40bis/2006, Verucchio (courtesy of the Ministero per i Beni e le Attività Culturali e per il Turismo, Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini. Museo Civico Archeologico Verucchio).

much more about it than just production techniques and distribution.

CONCLUSION

Regarding archaeological glass objects and the glass itself, one of the most important questions is whether the beads or pendants were made locally or imported. Glass workshops can rarely be identified and studied archaeologically. A lucky exception and rare prehistoric example is Late Bronze Age Frattessina in Veneto. Glass beads are also known in Italy from the Earliest Iron Age, but only in the subsequent Orientalizing period are local workshops suggested in the excavated finds. A few glass items in specific shapes are the first hints of local workshops. One of these items is the leech-shaped fibula with a glassy slider bead. Examination of nearly 200 of these beads reveals regional differences in manufacturing technique, shape, ornamentation, and the kinds of glass used (Koch 2010). While many are single finds, regional characteristics nevertheless become apparent and may indicate local workshops. Some technically unique cases can be interpreted as evidence for a much larger production of glassy bow beads from northern Latium to the Veneto than is apparent at first sight. Consequently, it can be supposed that in the decades around 700 BC, several glass artisans or workshops found specific solutions for the production of these glassy leech-shaped beads which are difficult to form, and produced various types under locally specific conditions and possibilities – and for different tastes and demand. Chemical analyses, only rarely performed until recently, can provide further clues regarding the existence of local workshops or even the local production of raw glass.

The use of these beads and fibulae in local burial rites differs. While the glass-bow fibulae often occur in

rich female tombs until the middle of the 7th century BC in Emilia-Romagna, in Etruria and other regions, these ornaments were only exceptionally worn by deceased females or placed in their graves.

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ENDNOTES

1. For details and distribution, see Koch (2010) (in German with an Italian summary).
2. First mentioned in the literature by Dehn (1951) and Haevernick (1959). New finds not dealt with in Koch (2010) are from Bologna, Via Belle Arti (von Eles 2019) and Imola, Ponte Santo, tomb 7, with maybe six pairs (Esposito 2019:23, types C 16, and C 22, 104, Plates 62-63; 65-66).
3. In general, the structure of the fibula sliders looks like that of frit-core beads of the 16th-17th centuries (Karklins 2019: Figure 1).
4. In new photos published by T. Purowski (2016: Figure 1), it can be seen that the grooves that once held the decoration are of different sizes. On other examples of this type it was observed that the different glass colors leave different traces in the matrix glass. In dimensions it conforms with other large examples (see Koch 2010:79-81, Figure 25, Plate 1, no. 2). It is therefore very likely that the imported glassy leech-fibula bead from Gorszewice is of the massive type with group decoration (nine groups of two to six lines) that finds direct parallels in Bologna (Figure 3).
5. The bead with three “horns” is held by the Römisch-Germanisches Zentralmuseum, Mainz, Germany (Koch 2010:196, Figure 87, no. 180). Six measurements at

different points were taken by S. Greiff, member of the museum staff; the results are unpublished. Together with high levels of FeO, PbO, CuO, MnO, and NiO, the glass contained between 0.40-0.93% CoO.

6. FeO was found in very high concentrations (up to 20%), e.g., Conte et al. (2018); summary in Koch (n.d.).
7. Beinhauer (1985:801, Plate 187, no. 2182) records fragments of a fibula bow slider made of “green glass” from the Novilara necropolis, Fondo ex-Servici, grave II. We have not been able to verify the object, but another fragment with inv. no. 18726b lacking context information (but surely not the same as the one from Novilara) is held by the National Museum at Ancona (Figure 8).

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ANCIENT EGYPTIAN SULFUR BEADS¹

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The Ancient Egyptian and Near Eastern Collection at Tokai University (AENET), Japan, contains two unique necklaces made of an opaque yellow substance identified as sulfur through XRF and XRD analysis. Sulfur beads are rare and have not been adequately studied. We therefore undertook a study of the AENET beads and estimate that they date to the Ptolemaic and early Roman periods in Egypt. A digital-image comparison between the AENET beads and similar beads in another museum collection shows a strong correlation, suggesting that they share a single mold. An isotopic analysis also provides a specific fingerprint of the sulfur. Experiments to replicate the beads indicated that they were made by pouring molten sulfur into a greased mold. The process is simple, revealing that a small-scale cottage industry was sufficient to make them. The beads were used for funerary purposes (likely incorporated into broad collars) rather than in daily life because oxidized sulfur emits an unpleasant odor, discouraging people from wearing them every day.

INTRODUCTION

The Tokai University collection of ancient Egyptian artifacts includes two necklaces composed of opaque yellow beads (Figure 1). They are somewhat porous with visible crystalline structures. In that a previous paper (Yamahana and Akiyama 2017) provides a detailed description of each bead and discusses the dating, only a summary discussion is presented here. This article combines archaeological and scientific methods to determine the date, composition, and method of manufacture of the beads.

DESCRIPTION OF THE BEADS

The AENET collection contains approximately 6000 books, 15,000 images, and 6000 artifacts of archaeological value. They were donated to Tokai University in 2010 by the family of the late Professor Emeritus Hachishi Suzuki, who lived in Egypt from 1958 to 1968. Most of the artifacts were purchased from antique dealers in Cairo, and the two strings of yellow beads (reg. nos. SK 10 and SK 176) also appear to be purchased items.

One might speculate that the yellow beads unearthed in Egypt were made of glass because yellow glass beads were not uncommon to ancient Egypt. The beads do not appear to be glass, however, but are made of an opaque yellow porous substance with a matte texture and a peculiar needle-like crystalline structure on the reverse. They smell faintly of rotten eggs, suggesting the presence of a sulfur compound.

Common materials for ancient Egyptian beads are bone/tusk, stone, clay, glass, and faience. Beads made of sulfur rarely occur in an archaeological context. A few sulfur bits of irregular shape were found at two ancient sites, Defenneh and Badari (Lucas and Harris 1962; Petrie 1888), but not in the form of beads. Comparable beads can, however, be found in the Louvre Museum in Paris (Keimer 1938:208), the Egyptian Museum in Cairo (reg. nos. JE71593a-c), and the Hirayama Ikuo Silk Road Museum (reg. no. NR103112) and the Kobe Lampwork Glass Museum (Habara 2015:7) in Japan. The beads in the first two museums were accessioned at the beginning of the 20th century, while the beads in the latter two were purchased from antique dealers and registered later. The AENET beads were most probably acquired between 1958 and 1968, when the late Professor Suzuki lived in Cairo. All of them, unfortunately, lack the original provenience.

SK 10 and SK 176 are the two strings of opaque yellow beads that are discussed in this paper. SK 10 has 18 bucranium (“ox head”) and 50 12-petal floral beads, while SK 176 has 26 bucranium and 45 12-petal floral beads, for a total of 139 beads with 44 bucranium and 95 floral shapes. The beads are strung on modern blue cotton thread, indicating that the beads were recently formed into two necklaces and do not reflect their original context.

Radial grooves emanate from the center of the floral beads to represent petals (Figure 2, left). The back is flat and plain, though many beads exhibit a peculiar crystalline structure. The average diameter is a consistent 12 mm, but the thickness varies from 2 mm to 4 mm; even a single bead exhibits an uneven thickness. There is almost always a dark-colored disk bead about 2 mm in diameter in the center of



Figure 1. String SK 176 of yellow sulfur beads (photo: S. Miyahara; subsequent images are by the authors).

the bead, as if to represent the disk floret of a flower. A hole passes through the center of each bead perpendicular to the short axis.

The bucranium bead represents an ox head with two horns and small bumps between them (Figure 2, right). Two ears, eyes, and nostrils are indicated. The maximum width is 18 mm, with a thickness that varies from 3 mm to 6 mm. The perforation extends horizontally between the horns and ears. The average perforation diameter of both bead forms is approximately 1.2 mm.



Figure 2. A 12-petal floral bead and a bucranium bead.

DATING THE SULFUR BEADS

Dating the floral beads is difficult since that form was in use in ancient Egypt since the beginning of the pharaonic period. Conversely, the bucranium beads have unusual bumps between the horns that may allow us to determine a specific date.

The decorative row of bumps between the bucranium's horns has no parallel in dynastic Egypt. There are, however, instances of bucrania crowned with floral garlands during the Ptolemaic and Roman periods. The bucranium most likely represents the goddess Hathor since she is one of the few deities depicted by a bucranium/human frontal view. In contrast, most gods and goddesses are represented by their profiles in ancient Egypt.

Hathor takes the form of a human, a bucranium, or a human with cow ears and horns. She is one of the most popular deities in the ancient Egyptian pantheon. Since she was the goddess of motherhood, worshiping her became popular, especially during the latter part of ancient Egyptian history. Thus, the bucranium beads most probably date to the period between the Ptolemaic (304-30 BCE) and early

Roman (30 BCE to probably the end of the 2nd century AD) periods.

Nearly identical beads are held by the Egyptian Museum in Cairo, the Louvre, the Hirayama Ikuo Silk Road Museum (Kamakura, Japan), and the Kobe Lampwork Glass Museum (Kobe, Japan). All museums, including the AENET, share the 12-petal and bucranium beads. In the Hirayama Ikuo Silk Road Museum collection, however, the beads are in the form of Bes, an ancient Egyptian protective deity who gained popularity throughout the Mediterranean coastal areas from the Late period to the early Roman period (from approximately the 7th century BCE until the 2nd century CE). The Egyptian Museum in Cairo also has 15-petal beads made of the same yellow material. In all, four variations – 12 floral petals, 15 floral petals, bucranium, and the Bes figure – are known, for a total of 342 beads (Table 1).

The photographic measurements taken of both the 12-petal and bucranium beads are identical. The beads in other collections were also photographed and compared with the AENET specimens. The measurements of beads in other Japanese collections are almost identical to the AENET beads. Although the beads in Cairo and Paris were inaccessible for study, the approximate measurements obtained from their photographs also show a close similarity to the AENET beads. The uniformity of shape and size, together with the rarity of the material, suggest that the beads were produced at one time in the same locality.

ARCHAEOLOGICAL ANALYSIS

Elemental XRF Analysis

As noted above, the two strings of yellow beads (SK 10 and SK 176) emit a distinctive sulfurous odor. The beads were analyzed using non-destructive X-ray spectroscopy

(XGT-2700 HORIBA). The analyzed points were yellow-based materials of the floral and bucranium beads and a purple bead embedded in the center of the floral beads. The XRF setting was Rh as a target, 30kV, 0.8mA, 150 seconds, and a measured diameter of 100 μ m. The bead samples were analyzed in a vacuum chamber.

Analysis revealed that both bead forms have identical compositions. The material shows a strong sulfur peak around 2320 eV (Figure 3, left). Quantitative analysis indicates that the yellow base is 95 wt% of sulfur. The purple-black disk bead, on the other hand, is composed of 63 wt% of silica, 9 wt% of calcium, and 8 wt% of iron, with the remaining 20% consisting of manganese and other minor elements (Figure 3, right). This is most likely a sodium-silicate vitreous material with a dark purple colorant. The use of manganese-iron black is an indication of the authenticity of the beads since this particular colorant was widely used in ancient Egyptian vitreous materials such as faience and glass, especially during the Late period to the early Roman period (ca. 7th century BCE to the 2nd century CE).

The use of sulfur is rarely mentioned in ancient Egyptian texts, only appearing in a medical text on treating eye diseases such as pterygium (Bryan 1930). Archaeologically, a sulfur nugget was found in a pot together with an organic spice at Defenneh (Petrie 1888). Several nuggets were also found near Badari, but their chronology and function remain undetermined (Keimer 1938).

Structural Analysis by XRD

An X-ray diffraction analysis (Bruker, D8 Discover) of the beads was also conducted to examine their crystalline structure. The purple-black disk bead was cut to expose a fresh section to eliminate contamination. The XRD setting

Table 1. Quantities of Sulfur Beads in Known Museum Collections.

Beads	Museums					Total	Ratio
	AENET (SK 10-1)	AENET (SK 176)	Egyptian Museum	Hirayama Ikuo Silk Road Museum	Kobe Lamp- work Glass Museum		
12-petal floral	50	45	72	28	33	228	66.6%
15-petal floral	0	0	2(?)	0	0	2(?)	0.5(?)
Bucranium	18	26	46	2	15	107	31.2%
Bes	0	0	4	1	0	5	1.5%
Total	68	71	124(?)	31	48	342	100%

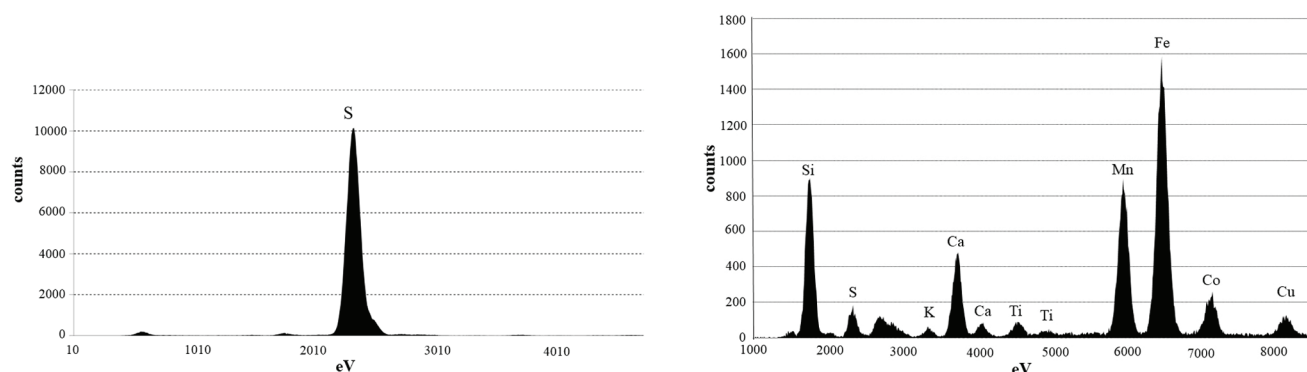


Figure 3. XRF spectrum of a bucranium bead (left) and a purple-black disk bead in the center of a floral bead (right).

was Cu K α as X-ray source, 30kV, 15mA, collimator diameter 0.1 mm. Figure 4 compares the XRD pattern of a bucranium bead to that of orthorhombic sulfur. The intense X-ray diffraction around 23.1 degrees (2θ) indicates that the crystal is polycrystalline orthorhombic sulfur. The presence of a halo reveals that the material also contains amorphous features.

A comparison of the XRD result of a small purple-black disk bead and that of quartz is provided in Figure 5. A prominent silica peak and a slight indication of the amorphous phase are its principal characteristics. A distinctive amount of calcium is present in the disk bead (Figure 3), indicating that the material is not ceramic (unglazed and glazed pottery or porcelain). Although it has a smooth vitreous surface and looks like glass, it is actually faience, a precursor of glass. Faience first appeared in Mesopotamia and Egypt around 4500 BCE and spread throughout the ancient Near East and Mediterranean. Its production died out after the Roman conquest of Egypt and it was no longer being made by the beginning of the 2nd century CE. We can, therefore, assume that the sulfur beads embedded with the faience disks were made before this time.

Isotopic Analysis

Some fragments of beads of strand SK 10 were also examined using stable isotope analysis ($^{34}\text{S}/^{32}\text{S}$ ratios) to determine the provenience of the sulfur, which provides clear evidence of the origin. The investigation was conducted by Professor Mizota of Iwate University and Dr. Yamanaka of Tokyo University of Marine Science and Technology (Mizota, Yamanaka, and Yamahana 2018).

$\delta^{34}\text{S}/\delta^{32}\text{S}$ ratios for native sulfur were measured online using a continuous flow mass spectrometer coupled with an elemental analyzer (Isoprime EA: GV Instruments, Cheshire, UK). The result is summarized in Table 2. The isotopic composition has a narrow range from +3.3 to +4.0‰, with an average value of +3.7‰, while the standard deviation of the measurement is 0.2‰. The tested specimens proved to be reasonably homogeneous in nature.

Ras Jemsa, Bir Ranga, and Ras Benas are historically known sources of sulfur, all of which are located on the coast of the Red Sea. There is also a small sulfur deposit called “sulfur springs” at Helwan (Lucas and Harris 1962). Unfortunately, the isotopic composition of the sulfur from

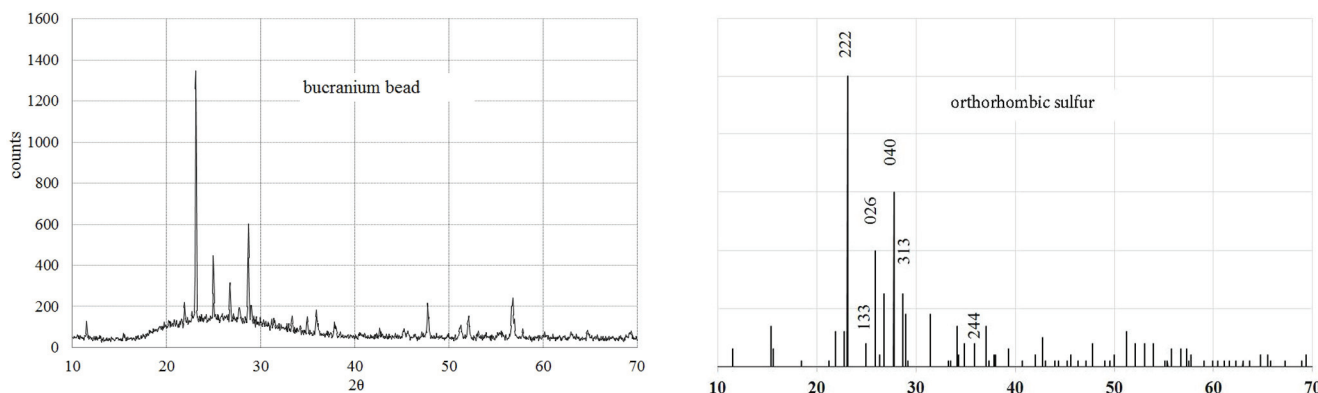


Figure 4. XRD patterns of a bucranium bead (left) and orthorhombic sulfur (right).

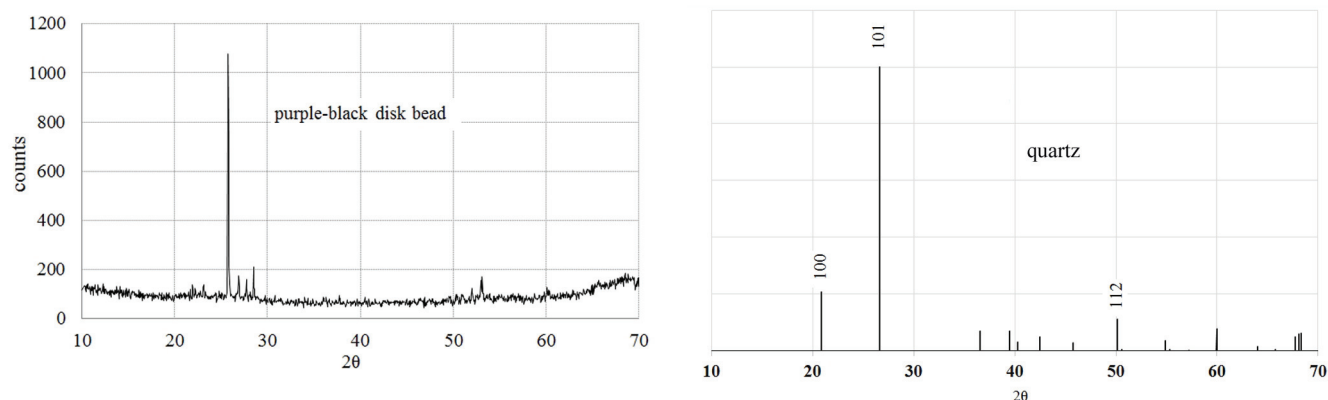


Figure 5. XRD patterns of a purple-black disk bead in the center of a flower bead (left) and quartz (right).

these Egyptian sites has not been investigated. Thus, it is impossible to perform a comparative study to determine the provenience of the AENET beads. Relatively pure sulfur is obtainable by heating a sulfur-containing mineral to a temperature high enough (140 °C) for the sulfur to melt.

BEAD PRODUCTION TECHNOLOGY

The sulfur beads must have been produced by either molding or carving. The former method consists of either filling a mold with powdered sulfur and compressing it into a solid mass or pouring liquid sulfur into a mold. Carving involves shaping crystalline sulfur with a sharp tool. There are some archaeological finds of sand molds for metal production, terra cotta molds for making faience objects, and gypsum molds for an unknown purpose. We made terra cotta and gypsum molds to test the feasibility of these methods. In the first experiment, we filled a mold with sulfur powder and then pressed the mold to solidify it. The results demonstrated that neither mold could withstand the pressure. The second possibility, pouring liquid sulfur into a mold, will be discussed below.

Carving a bead from solid sulfur was another possible manufacturing method. The XRD analysis indicates that

the ancient beads are made of polycrystalline sulfur. It is, however, possible that the sulfur was once a crystal and later assumed a polycrystalline structure. Crystal sulfur has a translucent yellow color and looks like a semi-precious stone, making it attractive enough for ornamental jewelry. It is as soft as gypsum, rating a hardness of 2 on the Mohs scale. In a second experiment we made a glassy crystal of sulfur from carbon sulfide. Carving it was challenging due to cleavage. It was also fragile under pressure and shattered easily, revealing that carving beads from crystallized sulfur was not a realistic choice (Yamahana and Akiyama 2017).

The last possibility involves pouring molten sulfur into a mold. Figure 2 shows macro images of a floral and a bucranium bead. Both exhibit untrimmed excess material (flashing) along the edges clearly resulting from casting. Moreover, the backs of the beads are concave, and needle-like crystal structures are present on almost all of them (Figure 6). Monocrystalline sulfur is stable at high temperatures but becomes orthorhombic under 95.6 °C and



Figure 6. The back of a floral bead.

Table 2. Isotopic Composition of Three Bead Fragments from String SK 10-1.

Sample no.	$\delta^{34}\text{S}_{\text{vs. V-CDT}}$ values (‰)
1. Small	+3.7; +4.0
2. Medium	+3.3; +3.7
3. Large	+3.6; +3.8
Average standard deviation	+3.7 $\pm$ 0.2

volume contraction occurs. This causes a slight depression in the back of the beads. The needle-like structures formed when the monocrystal transformed into an orthorhombic crystal. The evidence indicates that the beads were made by pouring molten sulfur into a mold.

There are 44 bucranium beads in the AENET collection and they are all similar. Their apparent similarity was tested using digital pattern matching (Figure 7). Horizontal lines were drawn on samples A and B, and every fifth line of A was replaced with the same line of B. The joint image (Figure 7, right) clearly retains the bucranium's facial traits, and shows distinctive, almost identical, facial features with uneven right and left eyes, eyebrows, and ears. The bucranium beads in the Ikuo Hirayama Silk Road Museum were also examined using pattern matching and are virtually identical to those at AENET. It is therefore reasonable to assume that the bucranium beads were all made in the same mold or molds made using the same master model.

On the other hand, the floral beads seem to have been made in several molds. Although the beads are all 12-petal floral, the reference lines do not always share the same pattern. Some are quite similar, but others appear slightly different. Digital pattern matching was difficult due to the rounded shape of the beads with no distinct cardinal point for comparison. In that floral beads comprise 66% of the entire sulfur bead collection, it seems likely that several floral molds were used to create the more than 200 beads.

The next step in our experiment was to make molds which could be used to replicate sulfur beads. To do this, we 3D-scanned the floral and bucranium beads with the cooperation of Abist Ltd. (Meshlab, v.32bit, 1.3.3.) (Figure 8). This is an effective way of examining valuable archaeological objects in detail without handling them. The images show the excess material along the edges of the

floral beads and behind the ears of the bucranium beads. The molds were, therefore, relatively shallow but deep enough to accommodate the string hole. This is round and was likely made by putting a reed or twig in the mold. In this way, the artisans could mass produce the beads.

REPLICATING SULFUR BEADS

There is no archaeological evidence to suggest that molds were used to make the sulfur beads. There is, however, some material evidence that gypsum, terra cotta, and sand molds were used during the New Kingdom period (1550-1070 BCE). Sand molds can be excluded as potential candidates since the casting surface is not smooth enough to retain fine details, such as the eyes and nose, leaving gypsum and terra cotta as the probable candidates. Resin replicas of the beads were printed from the 3D-scan data. These were used as master models to make the molds (Figures 9-10). The depth of the molds was adjusted according to the measurements of the actual beads.

Since the melting point of orthorhombic sulfur (α -sulfur) is 112.8 °C and that of monocrystalline sulfur (β -sulfur) is 119.6 °C, we heated the molds filled with sulfur powder to 130 °C. The sulfur liquified as expected, but it stuck to the molds, making it impossible to extract the beads without breaking them. A parting agent, which will be discussed later, was subsequently applied to the molds, but it fused with the sulfur powder during heating, failing its intended purpose.

We then undertook to pour liquid sulfur into the molds. The sulfur was heated to 140 °C using an alcohol lamp. This temperature is above the boiling point of water but low enough so that a reed or twig could be used to form the perforation. A blackish glass bead was placed in the center



Figure 7. Pattern-matching of bucranium beads. Sample A (left), sample B (center), and a digitally combined image of samples A and B (right).

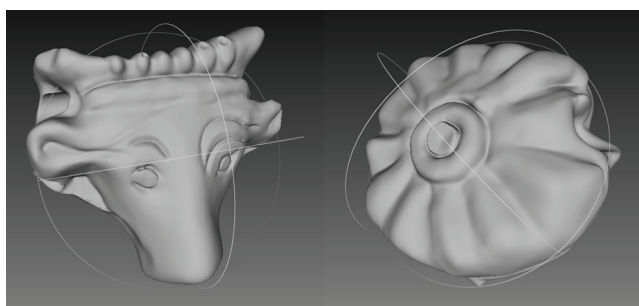


Figure 8. 3D images of a bucranium bead and a floral bead.

of the floral bead mold and a plastic stick was set to make the string hole. Liquid sulfur was then poured into the molds of the two bead forms. Separating the solidified beads from the molds was more manageable than in the former experiment, but it was still challenging. It was also difficult to achieve the delicate impressions of the eyes and ears of the bucranium beads. Regarding the first problem, we realized the mold should be warm so that the liquid sulfur would not harden before the fine details could be copied. As for the second, we found that a parting agent definitely facilitated the removal of beads from the molds. In ancient Egypt, they used oils of such plants as castor, *Tribulus*, safflower, moringa, linseed, olive, almond, rapeseed, and sesame. Animal fat – such as beef tallow, lard, and sheep and goat fat – was also used for cooking and other purposes (Serpico and White 2000). Vegetable oil would have been more easily accessible to commoners than animal fat since the latter was often used in palaces and temples where numerous sacrifices were made daily. Any of the aforementioned oils could have been used as parting agents, though olive oil seems to have been the most common, being used since the beginning of the dynastic period. We therefore chose olive oil for our experiment.

After applying olive oil to the gypsum and terra cotta molds, we put a purple-black glass disk bead in the center of

the floral molds and heated them to 100 °C. We then poured molten sulfur heated to 140 °C into the molds and left them at room temperature for 20 minutes. For the terra cotta mold, the use of olive oil as a parting agent was successful and all the beads could be removed intact (Figure 11). The delicate impression of the eyes and ears of a bucranium were copied effectively, and the replicated beads also exhibited needle-like sulfur crystals. On the other hand, the olive oil was absorbed by the gypsum mold before the liquid sulfur could be poured and failed as a parting agent. Terra cotta is, therefore, the most plausible mold material for making sulfur beads.

CRYSTAL STRUCTURE OF THE REPLICATED BEADS

Liquid sulfur has a transparent yellow-green color. After pouring it into a mold, the fresh color gradually fades and turns into an opaque creamy yellow. As this happens, the needle-like crystal structure grows on the exposed side. The color change and the crystal growth indicate that the sulfur transforms into monocrystalline sulfur (β -sulfur) right after it is poured. The sudden shrinkage of volume causes the crystals to grow. The sulfur stabilizes into orthorhombic sulfur (α -sulfur) after being left below 95.6 °C (i.e., room temperature), causing the sulfur to turn opaque yellow.

Unique morphological transformation occurs when the hot sulfur cools. The change from monocrystalline to orthorhombic sulfur begins right after solidification. Figure 12 (left) shows the XRD pattern of a replicated bead an hour after it was made, while Figure 12 (right) is the pattern after three days. The intense X-ray diffraction, around 26 degrees (2θ), indicates the crystal preferentially oriented on a {026} plane. The broad halo in Figure 12 (left), which shows the amorphous phase, vanished after three days and the material became orthorhombic sulfur (Figure 12, right). The

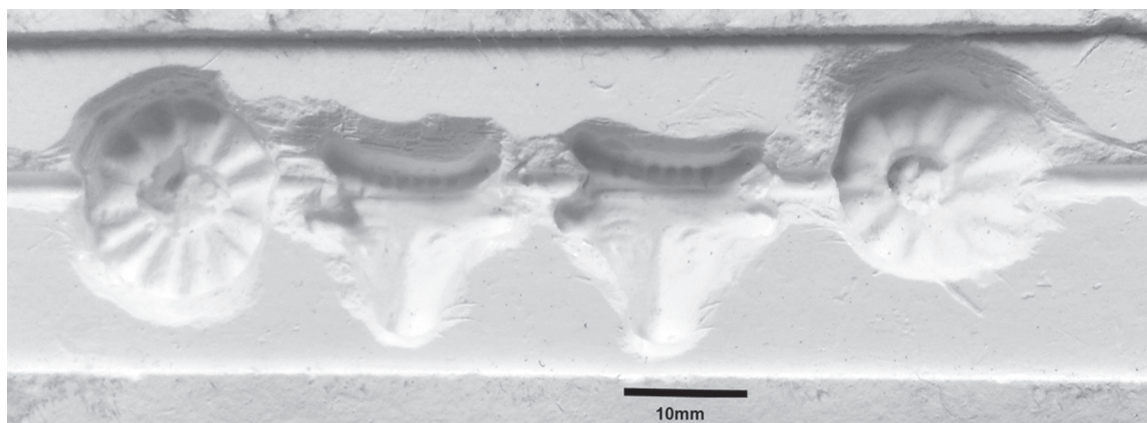


Figure 9. Reproduction gypsum mold.



Figure 10. Reproduction terra cotta mold.

crystalline structure of both the AENET bead (Figure 4) and the laboratory reproduction (Figure 12, left) are very similar; only the latter shows the presence of a broad halo. The high signal-to-noise ratio of the X-ray diffraction profile indicates that the crystal has a good crystallinity. Sulfur is, however, vulnerable to air, hot water, and bacteria, and contact with them easily oxidizes it, changing its chemical structure. Hence, the amorphous phase of the AENET beads (Figure 4) may have resulted from oxidization and degradation. The AENET beads emit a distinctive odor due to the presence of sulfur dioxide and hydrogen sulfide, chemical compounds formed when sulfur oxidizes.

THE FUNCTION OF THE BEADS

It is widely known that craftsmanship was highly developed in ancient Egypt, especially after the Ptolemaic

period, when the AENET sulfur beads are thought to have been produced. Sophisticated products were made by the skilled craftsmen using the high-tech production methods and equipment of the time. They made high-quality objects using precious or semi-precious materials such as gold and silver, which have high melting points. Their customers were usually from the upper social class.

Conversely, the AENET beads did not require sophisticated technology to produce. Sulfur is easily melted and does not require special knowledge to manipulate. All that was needed was a mold, a small lamp, a parting agent, a reed or a stick to make the hole, and sulfur. The production of sulfur beads was likely more a small-scale cottage industry than a major operation. Given that there are fewer than 350 sulfur beads in collections worldwide, we may assume that the AENET beads were part of a one-time production in a local workshop.

The sulfur beads were definitely intended for ornamental purposes, but sulfur emits an unpleasant odor during oxidation, something the AENET beads still exhibit, even after more than two thousand years. It would, therefore, have been unpleasant for people to use sulfur beads in their daily lives.

In ancient Egypt, yellow pigments such as ocher or orpiment were used extensively in funerary contexts – such as tomb murals and coffin decoration – as a substitute for gold. The story, “Shipwrecked Sailor,” written during the 12th Dynasty (ca. 1976-1794 BCE), mentions that god’s skin is made of gold (Lichtheim 1985). We, therefore, assume that the sulfur beads were funerary ornaments, perhaps to adorn the dead.

There are two possible ornamental configurations for the beads: a single-string necklace or a broad collar (for details, see Yamahana and Akiyama 2017). If the former, several strands could have been produced, based on the number of beads in the collection. It is, however, more likely that they comprised a broad collar (*wesek*) which was worn by the gods and goddesses of ancient Egypt, and was essential funerary attire for the dead, the deceased being considered gods in the afterlife. Reconstructions of both forms were created using beads of yellow-dyed silicone made in the reproduction terra cotta molds (Figure 13).

Further support for the supposition that the sulfur beads were not made for everyday use is in the form of the suspension hole. Each bead has a single perforation that causes the bead to flip over when threaded. At least two holes are needed to keep the faces of the beads in position. If worn by the living, it would have been an annoyance to constantly flip them back to the proper position.

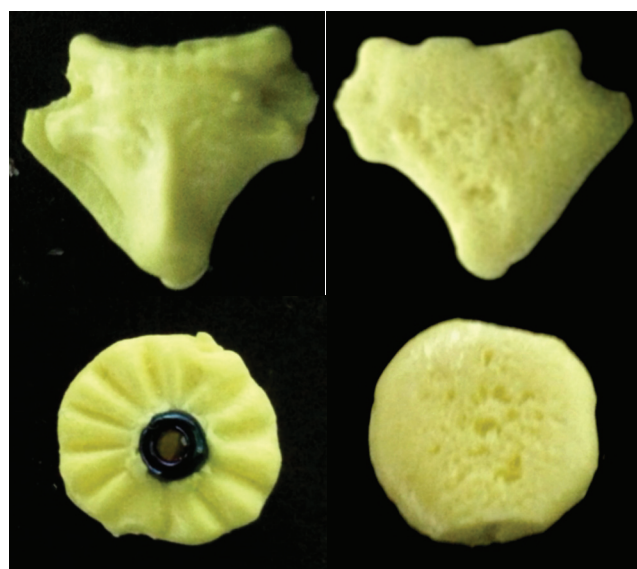


Figure 11. Replicated bucranium and floral beads, front and back.

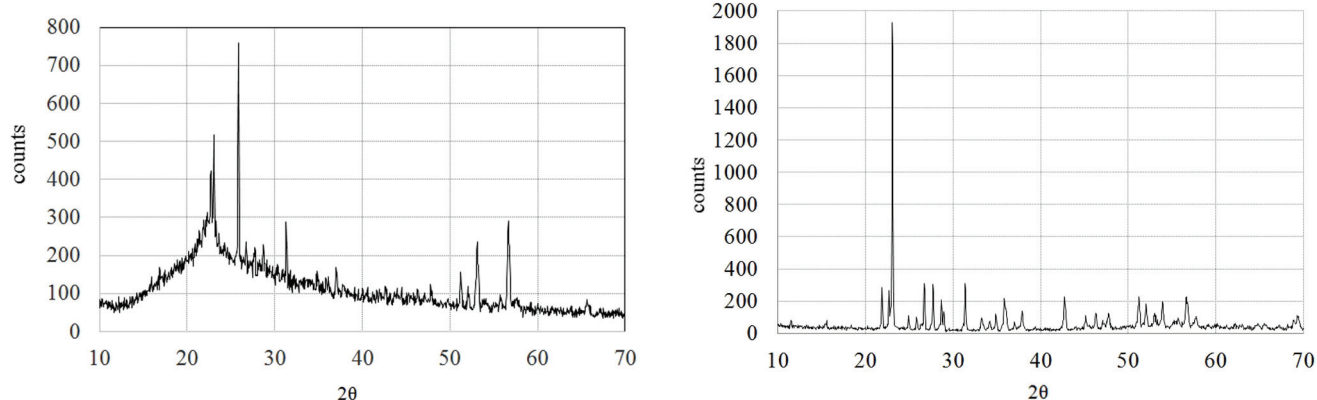


Figure 12. XRD patterns of replicated sulfur beads: one hour after synthesis (left) and three days after synthesis (right).

CONCLUSION

Our research has shown that the yellow beads were made of almost pure sulfur. The opaque yellow color with the needle-like crystal formation resulted from the transformation of monocrystalline to orthorhombic sulfur. The beads were mold-made at relatively low temperatures using simple techniques and tools. They indicate the presence of a beadmaking cottage industry during the later period of ancient Egyptian history, most probably from the Ptolemaic to the early Roman period. Although we are not sure how many sulfur beads were actually made and how

their different forms were arranged when strung, they were most likely made for funerary use, as a broad collar, which usually comprises more than 300 beads.

The use of sulfur in ancient Egypt is little known because of insufficient archaeological and textual finds. Furthermore, except of the AENET specimens, no isotopic study of sulfur beads has so far been undertaken elsewhere. We hope to provide more insights into ancient Egyptian sulfur beads when the opportunity arises to find additional parallels.



Figure 13. Two possible reconstructions of the sulfur bead necklace: a single string and a broad collar.

ENDNOTES

1. This paper is based on two articles published in Japanese: Yamahana and Akiyama (2017) and Yokoyama et al. (2019).

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BARIKOT BEADS AND GANDHARAN ART ORNAMENTS: A CRITICAL STUDY OF ADORNMENT PRACTICES DURING THE KUSHANA PERIOD OF PAKISTAN

Mubariz Ahmed Rabbani

To reconstruct and understand adornment practices during the Kushana period of Gandhara (1st-3rd centuries CE), this article compares selected examples of beads recovered from the stratigraphically excavated site of Barikot (Swat Valley, Pakistan) with the forms of beads carved into regional iconography, i.e., sculptures of Bodhisattva (Buddhist divine beings) deriving from the Gandharan world. This article evaluates bead shape, size, and style to determine if the carved depictions represent actual ornaments or if they are simply symbolic or imaginative. This analysis can provide new insight into how ornaments were worn in the early historic period of South Asia and into the accuracy of iconographic depictions.

INTRODUCTION

Ornaments, including beads, form important parts in the reconstruction of adornment practices existing in the past. Although numerous archaeological sites have yielded a great range of beads in the northwestern part of the Indo-Pakistani subcontinent over the past 100 years, research on Gandharan bead ornaments is relatively limited. The key sites of Bhir Mound and Sirkap in Taxila (Marshall 1951), for example, have revealed a large variety of beads and were the basis for some of the earliest systematic studies of stone beads carried out by Horace Beck (1928, 1941). Recent attempts to restudy beads from Dharmarajika Stupa in Taxila have provided important new data on raw material identification and drilling (Uesugi and Rienjang 2018), but stylistic comparisons with sculptures were not carried out. A clear chronology is also still lacking for the occupation phases of both Bhir Mound and Sirkap (Allchin 1993; Petrie 2013). As Khan et al. (2000:58) argue, “difficult to date even roughly, beads from sites in the northwest are almost always out of archaeological context... and may represent periods from the beginning of the occupation of a site to the present.” Another key site for understanding stone beads and bead production for this general period is

Arikamedu, a trading post and seaport site in South India (Francis 1991). Unfortunately, because the excavation was not stratigraphically controlled and investigators failed to recognize the accumulation of disturbed deposits, all the recovered artifacts were assigned to one period (mid-1st century BCE) (Ravitchandirane 2007:207). Such chronological limitations hinder an accurate reconstruction of the diachronic development of beads, and make it difficult to understand the chronological and cultural context of any bead.

Several Kushana-period coins and seals depict human figures and/or deities adorned with bead ornaments of various materials, shapes, and sizes (Baumer 2014:46; Callieri 1997). The number of bead depictions is limited, however, and their precise rendering may be affected by interpretative biases. The depictions may be exaggerated, fictionally created, or reflect omissions. Drawing simplistic deductions about bead materials and forms from any artistic depiction may also prove hazardous considering the well-documented coexistence of precious ornaments and cheap replicas in low-cost materials in South Asian contexts such as in the Indus traditions (Kenoyer 1991, 2001; Vidale and Miller 2000). Art figurines, sculptures, and iconographic depictions on coins or seals that depict bead ornaments are often produced smaller or larger than actual size, making it a challenge to extrapolate the probable material and/or shape of any portrayed bead. The size of the Gandharan sculptures, for instance, is not consistent or standardized. Also, the portrayed ornaments may include representations of organic materials such as leather, silk, wood, and vegetal fibers that do not survive in the archaeological record. Furthermore, with regard to seals, despite incorporating specific physiognomic features, some of the engraved figures may represent generalized/idealized human images rather than specific individuals as Lerner (2010) has argued regarding the portraits on the seals from Bactria and the Indo-Iranian borderlands. Hence, any portrayed jewelry on

any particular seal, coin, or sculpture may similarly reflect generalized images of beads rather than specific real objects.

Although several studies have proven that Gandharan artists reproduced ornaments as they truly appeared (Fabrègues 1991; Schmidt 1995, 1997; Tissot 1999) – especially a seminal article on the ear plugs from Barikot (Micheli 2007) – the problem of chronology remains. With the exception of the excavated material from Swat, no precise dates can be proposed for the Gandharan sculptures, although their chronological bracket cannot exceed the 1st-3rd centuries CE (Olivieri and Filigenzi 2018). As Tissot (1999:402) comments, “we cannot tell when the carvers of the statues copied the real jewels, and if these jewels were new in fashion, or ancient princely belongings, treasured for centuries by their families.” Nevertheless, the studies carried out by scholars such as Tissot, Schmidt, Fabrègues, and Micheli have shown that at least some of the ornaments depicted on the Gandharan sculptures were based on real prototypes, which is why this article aims to carry out an additional comparison between the beads from Barikot and the forms of beads decorating Gandharan Bodhisattva religious statues. As Morphy (2010:266) states: “art production is too important to be neglected because it reflects emotional and experimental dimensions of being in the world.”

While it is likely that the elaborately adorned images reflect ideals of adornment in ancient Gandhara, some scholars have proposed that the native nobility and aristocracy of Gandhara may have used images of Bodhisattva as a model to create their own appearance (Baumer 2014; Rosenfield 1967; Tissot 1999). This proposal is difficult to test as few ornaments have been recovered from well-dated sites. The many available representations of Kushan aristocratic types in statues, coins, and seals show no resemblance to the attire found on the different types of Bodhisattva images (Callieri 1997:256; Rowland 1961), suggesting that the Bodhisattva ornaments are indeed highly stylized. Nevertheless, it is useful to compare the archaeologically recovered beads and ornaments with those on these sculptures.

The latest stratigraphically controlled excavations at Barikot conducted by the ISMEO Italian Archaeological Mission in Pakistan revealed a great range of bead ornaments from contexts dated by a substantial series of radiocarbon analyses that provide a detailed chrono-cultural framework for the social evolution of ancient Swat (Olivieri and Iori 2020; Olivieri et al. 2019). Hence, Barikot is one of the few archaeological sites from this period that has a chronology supported by numerous radiocarbon dates. It provides an exceptional opportunity to attempt a critical comparison with the regional iconographic record of Gandharan Bodhisattva sculptures. In addition to the beads of Barikot,

this study will include relevant beads from the excavations of other contemporaneous sites as potential matches with the sculptural evidence.

BARIKOT

Located in northwestern Pakistan ($34^{\circ}40'51''\text{N}$, $72^{\circ}12'46''\text{E}$; ca. 799 m amsl) (Figure 1), the site of Barikot (Bir-Kot-Ghwandai) has been excavated systematically since 1984 under the direction of the Italian Archaeological Mission in Pakistan (now ISMEO) and currently by Professor Luca M. Olivieri. The site occupies an area of 12 ha and is bound to the north by a crescent-shaped hill and the Swat River. The urban settlement is located in a strategic position and the site has an impressive stratigraphic sequence that shows an astonishing occupational continuity divided into cultural phases or “macrophases” (Table 1) from the Bronze Age (1700 BCE) until the Medieval period (1500 CE). The site is identified as the city of Bazira that was conquered, according to classical historians, by Alexander the Great in 327 BCE (Baums 2019:169; Tribulato and Olivieri 2017). It has, however, a much earlier occupation extending back to the protohistoric period (Stacul 1987).

Macrophase 1 marks the second cultural phase of Barikot (1300-800 BCE) which corresponds to periods V-VIII of the Ghalegai sequence. The beginning of the



Figure 1. The Indian subcontinent showing the location of Barikot and historical sites mentioned in the text (all images by author).

Table 1. Barikot Chronology and Cultural Periods.

Macrophase	Chronology	Cultural Period
9a-9b	11th-15th centuries CE	Ghaznavid, Dardic, Timurid
8a-8b	ca. 7th-11th centuries CE	Turki-Shahi, Hindu-Shahi
7	ca. 5th-7th centuries CE	Post-urban phase
6	4th century CE	Kushano-Sasanian
5b	2nd half of the 3rd century CE	Kushano-Sasanian
5a	1st half of the 3rd century CE	Late Kushan
4b	2nd century CE	Mature Kushan
4a	1st-2nd centuries CE	Early Kushan
3b	1st century BCE to 1st century CE	Saka-Parthian
3a2-3a4	end of the 2nd century BCE	Indo-Greek
3a1	mid-3rd to early 2nd century BCE	Greco-Bactrian
2b	late 4th to mid-3rd century BCE	Mauryan
2a2	5th to mid-4th century BCE	Achaemenid
2a1	6th-5th centuries BCE	Pre-Achaemenid
1a-1b-1c	1300-800 BCE	Late Bronze & Early Iron ages

historical city dates to around 500 BCE (Macrophase 2a1), followed by the Achaemenid acculturation phase (Macrophase 2a2). The Macedonian siege of Barikot (autumn 327 BCE) and the succeeding Mauryan rule of the site occurred during Macrophase 2b. During the Indo-Greek phase (post-150 BCE) (Tribulato and Olivieri 2017; Zellman-Rohrer and Olivieri 2019), the lower city and its acropolis were refortified with the construction of a massive defensive wall (Macrophase 3a3). Eventually, Swat was annexed and maintained as a military stronghold by the invading Saka and Parthian dynasties between 50 BCE and 80 CE (Macrophase 3b) but lost its military significance during the Kushana phases (Macrophases 4a-5a: 80-250 CE).

It was during the Kushana period that the ancient city reached the pinnacle of its development, and became part of the “metropolitan” territory of a larger Kushan empire (Olivieri 1996). Barikot grew into a large, thriving settlement whose economy was largely based on agriculture and long-distance trade. Workshops and storage rooms were built around large well-constructed mansions along with Buddhist urban sanctuaries. A high level of veneration prevailed for the Buddha, the Bodhisattvas, and various local “deities” as evidenced by the recovery of numerous small stone stelae and narrative art panels in the excavated parts of the city. The

city was probably under the political control of local Kushan vassal chiefs who were also the patrons of the Buddhist monasteries in the countryside (Olivieri 2014, 2016). After the Kushan political system fragmented, resulting from the emerging Sasanian power (Macrophase 5b: 250-270 CE), the lower city was abandoned (Macrophase 6; 300 CE) and the settlement was reduced to a fortified complex covering the whole hill (Macrophases 7 and 8: 400-1000 CE and Macrophase 9: 1000-1500 CE) (Olivieri 2015; Olivieri and Iori 2020; Olivieri et al. 2019).

GANDHARAN ART SCULPTURES

The iconographic assemblage of the Gandharan region is preserved in the form of stone and stucco sculptures in various narrative or static panels that depict the Buddha (without any ornaments), as well as elaborately ornamented images of male and female elites who worshiped or interacted with the Buddha. Among the most highly ornamented images in Mahayana Buddhist iconography are the Bodhisattvas, beings who have delayed their passage to *nirvana* or enlightenment (Fogelin 2015:151-152) in order to help the world and generally depicted as princely male figures. The Maitreya Bodhisattva is considered to be a divine being who will come in the future. Images of this

being are often among the most highly ornamented in the Gandharan repertoire. Another type of Bodhisattva who was part of the Mahayana Buddhist pantheon is Avalokiteshvara, a Bodhisattva of compassion and protection (Behrendt 2007; Rhi 2006).

Although many of the Gandharan sculptures found in the major museums today derive from disturbed contexts or have an uncertain provenience (Behrendt 2004:112; Rienjang and Stewart 2018), they form the richest available repertoire to study features of adornment during the Kushana phases of Gandhara. They include intricately carved ornamental objects that we can use to draw inferences about idealized and possibly actual ornament traditions between the 1st and the 3rd century CE. Any distinctive patterns and findings can provide new perspectives on their function, possible meanings, raw materials, craft organization, and trade connections with other geographical regions.

METHODOLOGY

A high-resolution photographic protocol was adopted to document the most relevant Gandharan art collections that depict ornamentation on display in five museums: the Guimet Museum (Musée national des arts asiatiques) in Paris, and the Taxila Museum, Lahore Museum, Swat Museum, and Peshawar Museum in Pakistan. The Barikot beads were documented with photographs and measurements using a digital caliper, and the raw materials were initially identified with the expertise of Professor Massimo Vidale and Professor Ivana Angelini (University of Padova and ISMEO, Italy) using a stereomicroscope equipped with a digital camera. The final raw material identifications of the stone beads of Barikot and the forms of beads produced on the sculptures were confirmed with the assistance of Professor J.M. Kenoyer, University of Wisconsin, Madison. The beads of Barikot were analyzed and classified according to the systems developed by H.C. Beck (1928) and J.M. Kenoyer (2017), supplemented by the author's own observations.

In order to make a reliable correlation between an archaeological bead from Barikot and the carved image of a bead in a stone sculpture, the main variables considered were the shape, size, style, and chronology of the two. It was also possible to address the challenging concept of "value" as viewed in the past (Kenoyer 2000; Miller 2008; Moffett and Chirikure 2016; Papadopoulos and Urton 2012). Several factors increased the value of an object in the past, including the availability or rarity of raw materials, elite control, and the technological skills required for its manufacture. These aspects clearly mattered in the ancient world as, for

example, research on the Indus Valley Civilization by J.M. Kenoyer has exemplified (Glover and Kenoyer 2019:182; Kenoyer 2000:91; Miller 2008; Vidale and Miller 2000). It is unlikely that materials of low value were included in the richly adorned Bodhisattva sculptures alongside high-value stones and metals. Gandharan artisans appear to have adorned the Bodhisattva statues with depictions of beads of both "exotic" materials such as carnelian, as well as locally available materials such as garnet and rock crystal, probably because of their physical and symbolic properties. Furthermore, artisans used locally available materials such as rock crystal, garnet, beryl/aquamarine, and amethyst for the first time during the Saka-Parthian and early Kushan phases (Macro-phases 3b-4a), possibly exerting some ritual or cultic function. This function may be another factor that made these materials valuable in the eyes of the Gandharan patrons and artisans associated with the Bodhisattva sculptural tradition.

CASE STUDIES

The following seven case studies compare specific bead types with ornaments carved on stone sculptures, giving rise to new ideas and discussions.

Case Study 1

We begin with the vase- or *ghata*-shaped beads seen on Maitreya Bodhisattva sculptures (Figures 2-3). At Barikot, we first see these beads in terra cotta during the Indo-Greek period (Macro-phases 3a2-3a4: end of the 2nd century BCE) while those made of stones such as garnet (Figure 4) arise during the Kushana phases (Macro-phases 4a-b: 1st-2nd centuries CE). These beads usually have a globular shape with a distinct collar or rim at one end, defined by Beck (1941:33) as resembling a globular vase or pot. They are now called *ghata* or *ghara*, the Hindi word for a traditional terra cotta water pot (Dikshit 1952:52-63; Gosh 1947-1948: Plates 43-46). Several of the Bodhisattva sculptures wear various sizes of *ghata*-shaped beads (e.g., Bodhisattva Maitreya and Avalokiteshvara from Sahri Bahlol, Peshawar Museum). On the sculptures, we usually see this bead suspended as a pendant along with other amulets worn together on a long cord that drapes across the torso from the left shoulder to the right hip (Figure 2). The archaeologically recovered stone beads of this type are usually made of garnet, rock crystal, beryl, or carnelian. The *ghata* may have represented a container of sacred water or some other offering, but its precise significance will remain uncertain until a reference is found in one of the Buddhist texts.



Figure 2. Carved *ghata*-shaped bead (delineated) on a Bodhisattva Maitreya (Dhamani, ca. 2.43 m high) (courtesy of Department of Archaeology, Lahore Museum, Government of Punjab).

Case Study 2

Another Bodhisattva appears to exhibit a bead with circular motifs or depressions (Figures 5-6) that resemble glass eye beads which are found widely distributed across the region (Beck 1941). Eye beads made of faience and agate, probably imbued with apotropaic power to avert the evil eye, come from Indus Tradition sites such as Harappa, Sanauli, and Mohenjo-daro (Kenoyer 2014; Prabhakar 2014; Vidale 1987). The carved bead on the Bodhisattva is clearly visible on the chest of the figure, possibly to ward off evil rather than to display prestige and wealth. Although the carved object is without doubt an eye bead, we cannot directly



Figure 3. Detail of the *ghata*-shaped bead in Figure 2.

link it with eye beads made of glass. There are depressions on the surface of the engraved bead, which were probably inlaid with stones to form the eye design. Excavation has uncovered similar inlaid eye beads at Sirkap and other parts of Taxila, but not at Barikot. Beck (1941: Plate I, no. 8 and Plate II, nos. 36, 38-39, 43-45) defines them as cemented stone eye beads while Marshall (1951:746) details that they are stone to which pieces of differently colored stone are cemented in order to form the eyes. The inlaid stones were probably also high-quality materials such as carnelian, agate,

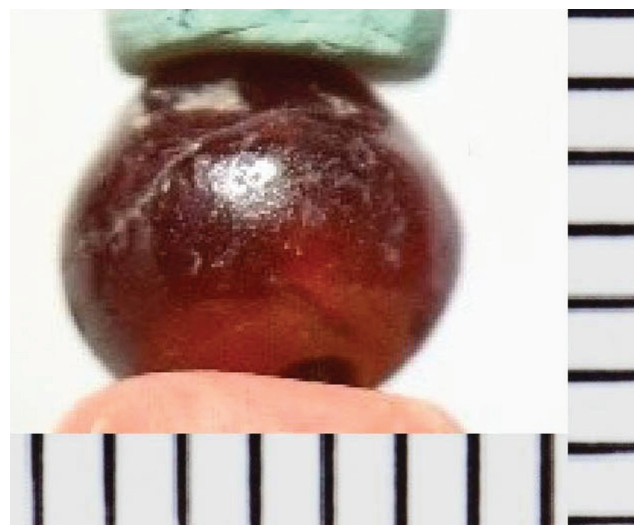


Figure 4. *Ghata*-shaped garnet bead from Barikot, BKG 4175 (Macrophase 4b: 2nd century CE).



Figure 5. Carved eye bead (delineated) on a Bodhisattva Avalokiteshvara (2nd-3rd centuries CE; Sahri Bahlol, ca. 1.02 m high) (courtesy of Directorate of Archaeology, Peshawar Museum, Khyber Pakhtunkhwa).

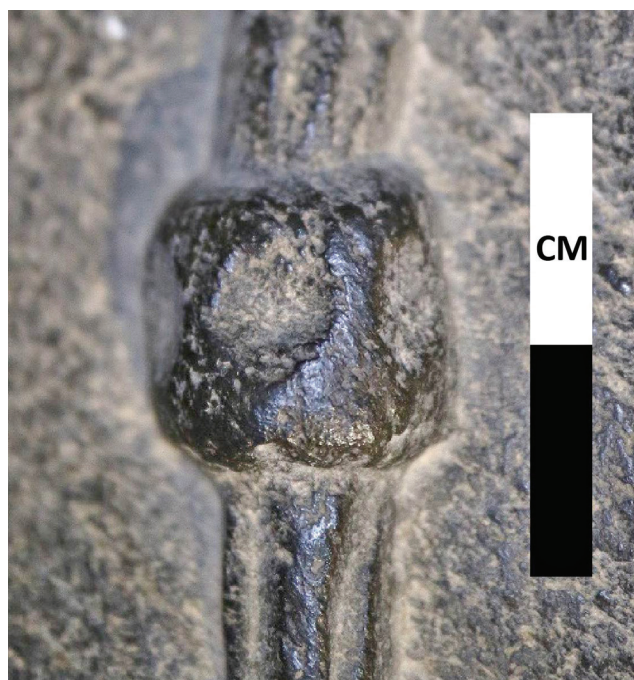


Figure 6. Detail of the carved eye bead in Figure 5.

or chalcedony, if we may judge by the recovered cemented stone beads from Taxila. Hence, we cannot identify the bead on the sculpture as representing a glass bead.

Case Study 3

Beads carved on a Bodhisattva Avalokiteshvara may be representations of long, hexagonal, barrel beads (Figures 7-8). A similar bead (Figure 9) found at Barikot (BKG 2453) was made of carnelian, a high-value material. Although this bead belongs to the later Kushano-Sasanian phase (Macrophase 5b: second half of the 3rd century CE), such bead types could reasonably derive from the Kushan phases as well, which the example discussed in case study 6 shows. The carnelian bead from Barikot is the only known specimen of this type, supporting the idea that there was a demand for rare types of wealth items to display prestige and high status. Hexagonal barrel beads were also made of other stones such as rock crystal and amethyst, as seen in many examples from sites at Taxila (Beck 1941: Plate VI, no. 53) and Vaisali (Sinha and Roy 1969: Plate LXIIA, nos. 172-173).

Examination of the carved beads shows that the exterior facets have a slightly concave section (Figure 8). So far, we have no archaeological examples of concave faceted surfaces on beads and this feature may reflect specific stone-carving styles rather than copies of actual beads. Although their precise meaning remains unclear, faceted beads were certainly manufactured to reflect light, possibly with the intention to create a symbolic effect as outlined in Buddhist



Figure 7. Carved hexagonal barrel beads (delineated) adorning a Bodhisattva Avalokiteshvara (2nd-3rd centuries CE; Sahri Bahlol, 1.53 m high) (courtesy of Directorate of Archaeology, Peshawar Museum, Khyber Pakhtunkhwa)

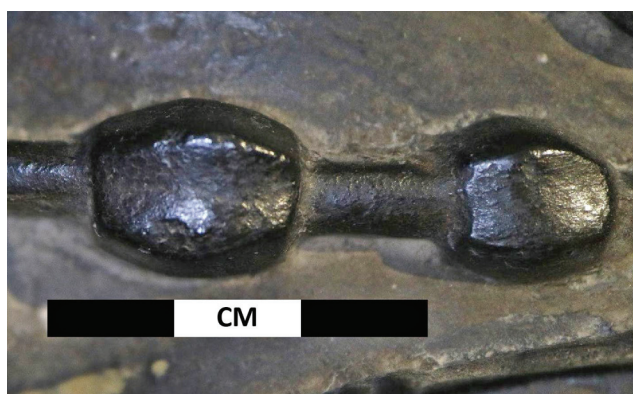


Figure 8. Detail of the carved hexagonal barrel beads in Figure 7.

literary traditions (Granoff 1998). The popularity of creating six facets may have a significance that the vast body of Buddhist literature might illuminate.

Case Study 4

A unique type of bead carved on a Bodhisattva Maitreya sculpture clearly represents another faceted stone bead, probably carnelian or rock crystal. It is biconical rather than barrel shaped (Figures 10-11). Although the Kushana period at Barikot has revealed no long hexagonal bicones, archaeologists have recovered similar beads made of carnelian at other contemporaneous sites such as Vaisali (Sinha and Roy 1969: Figure 57B, no. 11). Thus far, only six carnelian and four agate beads have been recovered from Kushana-phase contexts in different parts of Barikot (Macrophases 4a-b and 5a: between the 1st century and the first half of the 3rd century CE), probably reflecting their status as prestige objects in Kushan society. In fact, a variety of faceted beads, probably representing originals made of carnelian or rock crystal, are common not only on Bodhisattva statues but also on other Gandharan sculptures such as those of Hariti (Sikri) and Panchika (Tahkal, Lahore Museum).

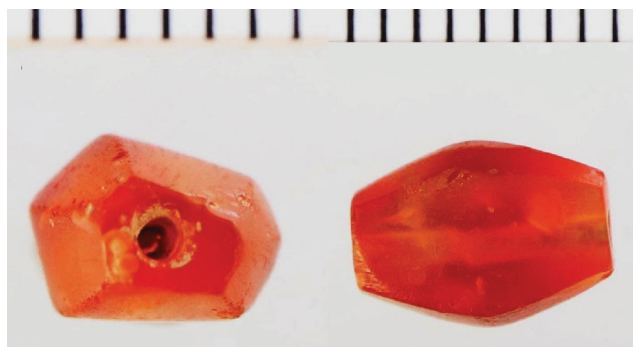


Figure 9. Faceted barrel bead of carnelian from Barikot, BKG 2453 (Macrophase 5b: second half of 3rd century CE).



Figure 10. Long hexagonal bicone bead (delineated) adorning a Bodhisattva Maitreya (2nd-3rd centuries CE; Mohra Moradu, ca. 1.02 m high) (courtesy of Department of Archaeology, Taxila Museum, Government of Punjab).

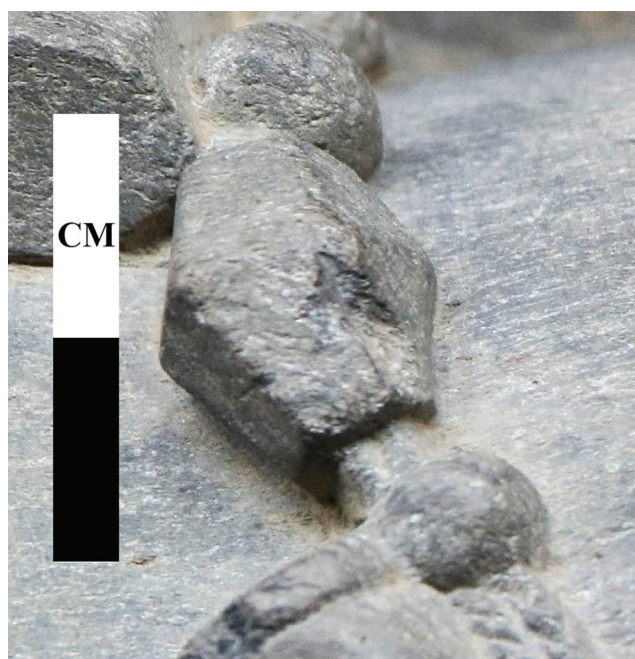


Figure 11. Detail of the carved hexagonal bicone bead in Figure 10.

Case Study 5

The adornments on a Bodhisattva Maitreya sculpture include at least one collar bead. Made in various forms, these beads all have a “collar” around each end. Although artisans of the Indus Tradition already produced them, such beads only became common during the early historic period (Francis 1986:117, 2002:42). A single collar bead of shell was found in the Saka-Parthian levels at Barikot, but no example has come to light from the Kushana period. Archaeologists have found greater quantities of collar beads of stone and glass in South India compared to other locations, while Arikamedu has yielded evidence of their production (Francis 2002:42).

There are two major types of collar beads: flat and barrel. The former have a flat section, a round or lozenge-shaped body, and protruding collars at the ends (Francis 1986:117), as do some glass collar beads from Sirkap, Ahichchhatra, Sonkh, and Alagankulam (Beck 1941: Plate IX, no. 14; Dikshit 1952: Figure 5, no. 112; Gunasena 2018:315; Härtel 1993:302, no. 33). Wheeler, Ghosh, and Krishna Deva (1946:97) define them as “lug-collared.”

Barrel collar beads have a round cross section, a barrel-shaped body, and collars which are little more than incised lines around the ends (Beck 1941: Plate VI, no. 20; Francis 1986:117). Wheeler, Ghosh, and Krishna Deva (1946:97) call them “groove-collared.” The example which appears in the center of the chest of the Bodhisattva sculpture is gadrooned (Figures 12-13). A similar bead made of glass was found at Sirkap in Taxila (Beck 1941: Plate IX, no. 15).



Figure 12. Gadrooned collar bead (delineated) on a Bodhisattva Maitreya (2nd-3rd centuries CE; Sahri Bahlol, ca. 1.28 m high) (courtesy of Directorate of Archaeology, Peshawar Museum, Khyber Pakhtunkhwa).



Figure 13. Detail of the gadrooned collar bead in Figure 12.

A possible collar bead is situated over the sculpture's right armpit (Figures 14-15). Its collars are not aligned, but point upwards at an angle. An apparent parallel is a unique carnelian bead from Taxila (Figure 16) called a "collared ball" by Beck (1941: Pl. IV, no. 11). The carver may thus have copied in stone a real collared ball bead, possibly made of a high-value stone such as carnelian or garnet. Various types of collar beads adorn numerous figures in Gandharan art, for example, the right-hand-side "guard" figure in narrative relief from the Shotorak monastery in the Musée Guimet. Alternatively, the possible "collared ball" may be a globular bead flanked by short barrel-shaped beads, as its configuration is reminiscent of the natural curve of beads strung together. The best interpretation will depend on the finding of a collared ball bead at Barikot.

Case Study 6

From the 3rd-2nd centuries BCE onwards, the Buddhist Sangha began favoring new symbolic associations with natural forms, possibly in reaction to preexisting "orthodox" ideological associations stressing the dominance of artificial, abstract bead forms (Vidale 2005:324). We see this archaeologically in evidence coming from the Kushana period at Barikot, in the form of beads made from coral, pearls, and marine and cowrie shells. Interestingly, Bodhisattva statuary may also show unmodified or

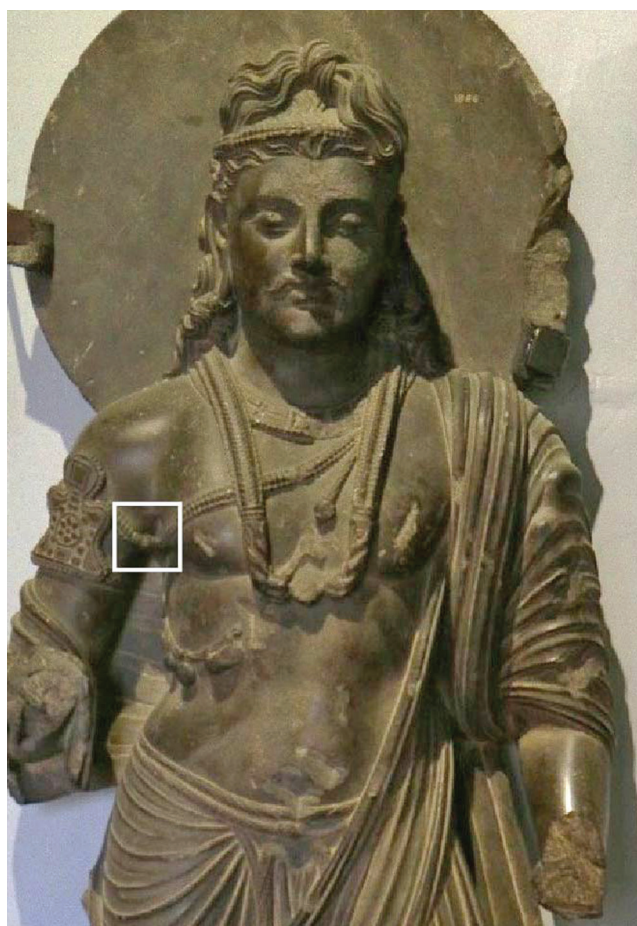


Figure 14. Possible collar bead (delineated) on the Bodhisattva Maitreya.

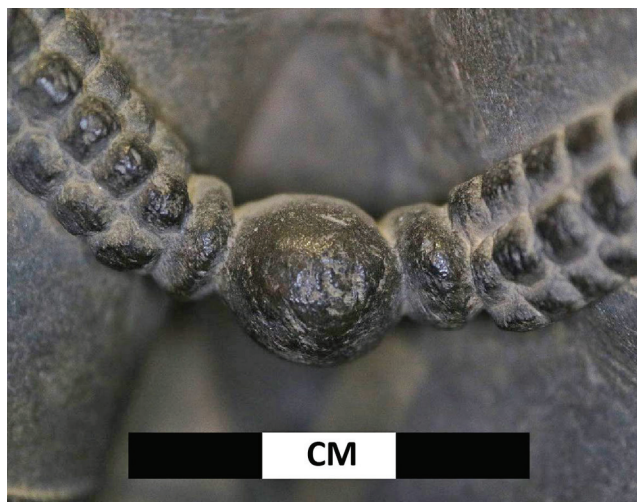


Figure 15. Detail of the possible collar bead in Figure 14.

minimally modified forms of materials. Figures 17-18 show a carved, long, hexagonal, cylinder flanked by short barrel-

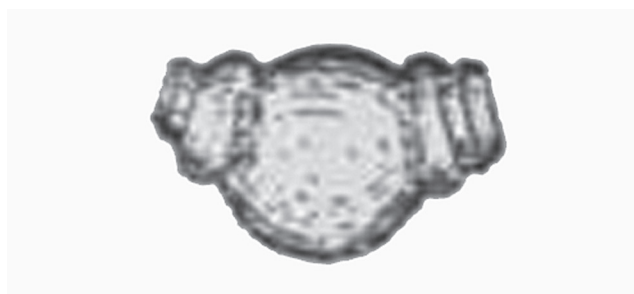


Figure 16. Collared ball of carnelian, Bhir Mound, Taxila (Beck 1941: Plate IV, no. 11).

shaped beads. The material of the beads on which the carving is based was probably not emerald, judging from the relatively smaller crystals produced in the emerald mines of Swat that are still in operation. Rather, the carved depictions may represent aquamarine, a color variant of beryl. Aquamarine is commonly found in many areas of the Karakorum Range and occurs in relatively large crystals in the Gilgit-Baltistan region, as represented on the sculptures (Grande and Augustyn 2009:125-126; Wenk and Bulakh 2004: Plate 15, c). Beryl crystals would have required little modification to transform them into beads, supporting the carvers' taste for natural forms. Excavations at Barikot have revealed what appears to be a long, hexagonal, barrel bead, made of beryl/aquamarine with a slightly bluish-purple color (Figure 19). Likely, the beryl/aquamarine was acquired from other regions and not from Swat, as this material is common in the stupa deposits of Bimaran and Hadda in Afghanistan, as well as Dharmarajika in Taxila (Rienjang, Kenoyer, and Sax 2017; Uesugi and Rienjang 2018). A distant source may explain the apparent rarity of beryl/aquamarine beads at Barikot.

Case Study 7

The hairnet of another Bodhisattva image is loaded with repeated sequences of what appear to be short, faceted, biconical and/or barrel-shaped beads (Figures 20-21). The models for these beads were most likely faceted rock crystal, amethyst, carnelian, or agate, examples of which exist at Taxila and other contemporaneous sites (Beck 1941: Plate III, no. 32; Sinha and Roy 1969: Figure 50, nos. 6, 8; Uesugi and Rienjang 2018). These types of beads are also found in Southeast Asia and Korea during this time period (Carter 2013; Glover and Kenoyer 2019; Heo 2018). Due to the sheer variability in bead shapes, we must carefully ground our comparison between the short faceted forms excavated at the various archaeological sites and the beads decorating the hairnet. Long, faceted, barrel-shaped beads of rock crystal are associated with the Kushana period at Barikot but they do not match the short, faceted, biconical and/or barrel-shaped beads depicted on the Bodhisattva



Figure 17. Carved, long, hexagonal, bead (delineated) on a Bodhisattva Maitreya (2nd-3rd centuries CE; Mohra Muradu, ca. 1.02 m high) (courtesy of Department of Archaeology, Taxila Museum, Government of Punjab).



Figure 18. Detail of the hexagonal bead in Figure 17.

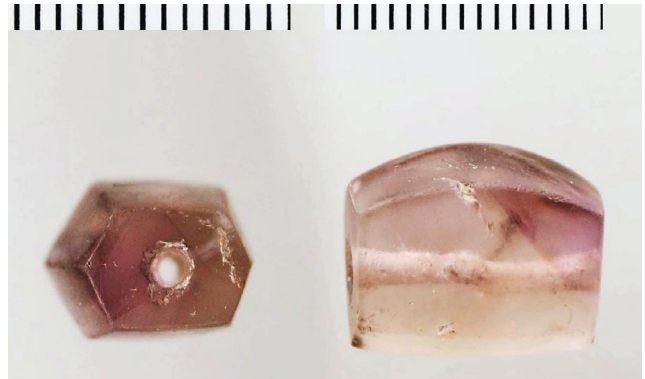


Figure 19. Long, hexagonal, barrel bead from Barikot, probably beryl/aquamarine, BKG 3181 (Macrophase 4a: 1st-2nd centuries CE).

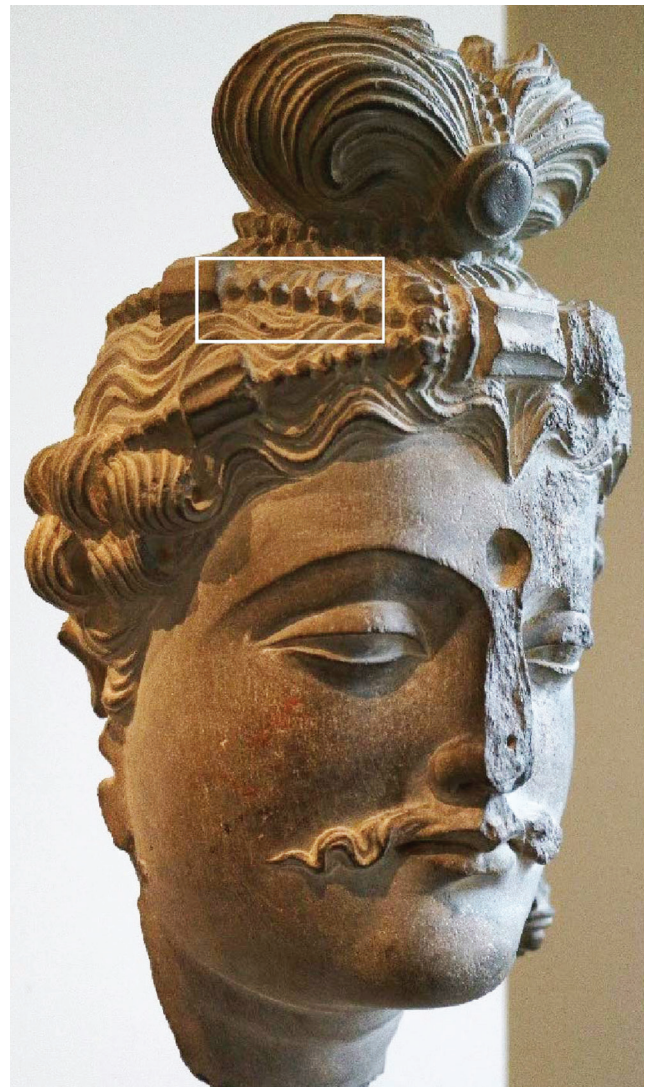


Figure 20. Short faceted beads (delineated) on a Bodhisattva Maitreya (1st-3rd centuries CE; Buner Valley, ca. 0.33 m high) (courtesy of Musée national des arts asiatiques, Paris).



Figure 21. Detail of the faceted beads in Figure 20.

image. Possibly, future excavations at Barikot will reveal such beads of rock crystal or other materials. Black or deep red garnet crystals, found in the schist deposits of Swat, may constitute a match especially since the use of garnet by the Great Kushans is well attested by garnet seals and an eight-sided gold amulet case decorated with several inset garnet stones (Adams 2011:20; Schmidt 1995:33). Nonetheless, although the use of garnet is well documented during the Kushana period, beads were never made from the naturally faceted garnets that come from schist deposits. Further, the few faceted garnet beads are usually extremely small and not the size that is depicted on the Bodhisattva headdress.

CONCLUSION

There is no doubt that at least some of the beads depicted on the Bodhisattva images represent real-life prototypes. From a visual perspective, there are several strong parallels between the two sources of evidence with only minor differences reflecting the sheer variability among the bead types as well as the weathered condition of the carved ornaments. It is highly likely that all of the proposed beads were highly valued and well-polished to create not only a reflective effect but also to symbolize purity, luminous qualities, and divine properties. Further, the identification of the portrayed beads has shed light on the long-distance trade network that operated at the time with carnelian, for example, imported from either the Sistan region in Iran to the west or Gujarat to the southeast (Law 2011; Tosi 1969:374). Since the Bodhisattva sculptures represent the male gender, representations of women, children, and animals are excluded from this analysis. Consequently, only a limited selection of bead types appear on the Bodhisattva sculptures, resulting in few correlations. From the richly decorated narrative panels and female sculptures, however, we do know that females wore bead ornaments at Gandhara as they did in other parts of the subcontinent during the same time range (Fabrègues 1991).

In fact, several additional beads from Barikot show positive correlations with ornaments carved on various art sculptures of Gandhara including short biconical and short spherical beads of carnelian, perforated cowrie shells, and pearls. Several perforated cowrie shells, for example, come from the Kushana phases of Barikot (Macro-phases 4a-b and 5a: between the 1st century and the first half of the 3rd century CE), while a necklace of perforated cowries adorns a female sculpture discovered in the sacred stupa area of Butkara I at Swat (Faccenna 1964: Plate CDXXXII, no. 3969). Although it is difficult to assign a precise date to it, the sculpture does not belong to the earliest stylistic group, but to a production that is certainly later than the early 1st century CE. In fact, a great variety of bead materials with both geometric and figurative forms derive from the Kushana layers of Barikot (Figure 22) signifying a period of sustained growth and prosperity. Deeper study should be conducted on the bead assemblages from Taxila, a key metropolitan site of greater archaeological significance, taking its chronological limitations into account. At the same time, there is a need for more stratigraphically controlled excavations of historical sites across the subcontinent to obtain reliable information on the chronology of each new bead.

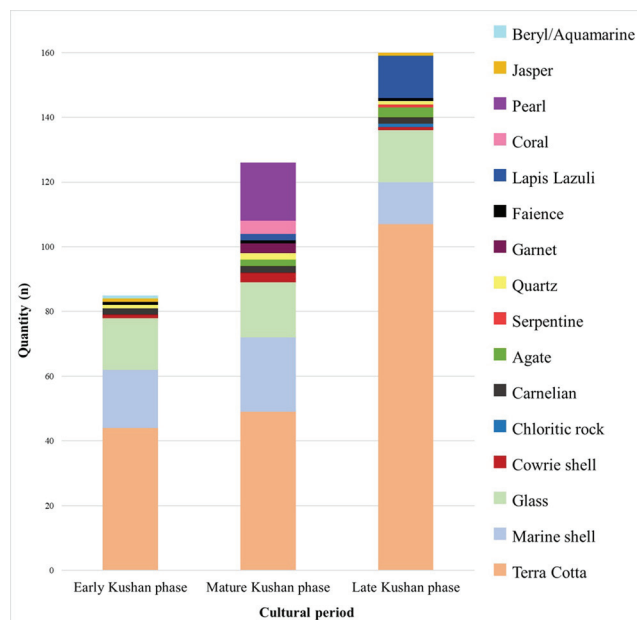


Figure 22. Distribution of raw materials during the Early, Mature, and Late Kushan phases of Barikot (Macro-phases 4a-4b and 5a: between the 1st century and the first half of the 3rd century CE).

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THE BLUE BEADS OF ST. EUSTATIUS: NEW PERSPECTIVES FROM ARCHAEOLOGY AND ORAL HISTORY

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The blue beads of St. Eustatius are a famous symbol of the island's heritage, evoking both positive and negative emotional responses in local stakeholders. Archaeologists often encounter oral historical accounts to explain the functions of the blue beads in colonial society. Until now, these accounts have not been thoroughly recorded, investigated, or integrated with other sources of data. Oral historical interviews conducted in 2016 provide information on the role of the blue beads in enslaved and free communities. We discuss these findings and their relation to archaeological evidence on the island as well as elsewhere in the Americas and West Africa. Such involvement of local people in the interpretation of their own heritage encourages the decolonization of archaeology, and we hope that this approach will become standard throughout the Caribbean region.

“Well the main thing about, with slavery, that I hold close to my heart also is the blue beads... this is one artifact I treasure it like gold” (Interviewee EUX-OH-01).

INTRODUCTION

Researchers have studied the beads of St. Eustatius (also known as Statia), an island in the Caribbean Netherlands (Figure 1), since the 1970s (Burger 2019; Hartog 1976:54; Karklins and Barka 1989; Stelten 2019). Archaeologists have often referred tangentially to oral historical accounts about blue beads by local people, but have often seen them as mythological. We would like to suggest that oral historical accounts of the blue beads have value on the same level as the archaeological evidence. This is because the legacy of enslaved people in the Caribbean is oral and material, and they seldom had a documentary voice.

Today the blue beads play an important role in the Statian economy, as tourists are attracted by the prospect of diving for them at archaeological dive sites such as Blue Bead Hole (Scubaqua Dive Center 2020). Unfortunately, chronic and well-established looting damages archaeological sites and it is imperative to thoroughly research the beads before more evidence is destroyed.

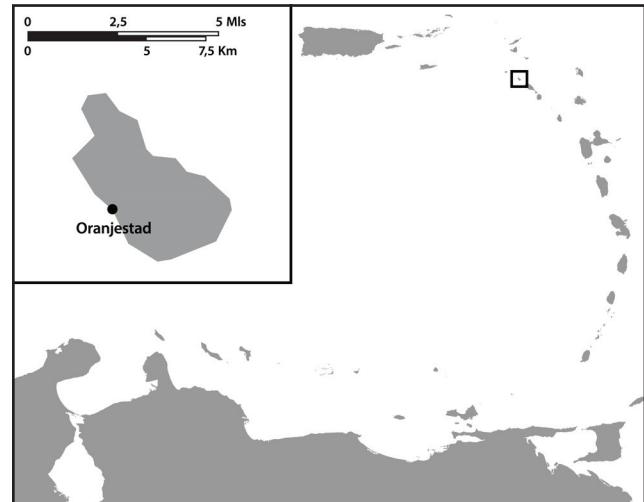


Figure 1. The eastern Caribbean showing the location of St. Eustatius (drawing: Felicia Fricke and Pepijn van der Linden).

In this article, we will discuss the provenience and archaeological record of these beads, as well as using oral historical narratives as a primary data source. We conducted the oral history interviews in 2016, and participants demonstrated detailed knowledge about the importance of the blue beads in enslaved Statian communities. Many of their stories can be triangulated with data from elsewhere in the Americas and West Africa and align well with the work of other scholars.

HISTORICAL CONTEXT OF THE ISLAND

The ubiquity of blue beads on St. Eustatius characterizes the island's global and regional significance during the 17th to 19th centuries. The island, although relatively obscure within the modern context of the Caribbean and North America, was once an international epicenter for trade and commerce (Barka 2001:104). No other port in Europe or the Americas was as busy as St. Eustatius' Oranje Bay during

the latter half of the 18th century (Gilmore and Dijkshoorn 2005:201).

When the Dutch settled St. Eustatius in 1636, they followed a practiced and successful colonial model focused on agriculture. By the early 18th century, however, the Dutch understood that the lack of fresh water and the island's propensity for drought limited its agricultural prospects (Attema 1981). Its gentle Caribbean-facing coast offered a natural harbor and its proximity to French, Danish, English, Spanish, and other Dutch islands presented an opportunity for trade (Jordaan and Wilson 2014). The steadily developing economy boomed through the first half of the 18th century and in 1756 the island was designated a free trade port (i.e., with no customs duty). St. Eustatius' moniker, "the Golden Rock," branded the island as a prosperous hub of economic activity. Warehouses lined the harbor of the island's "Lower Town," a bustling and lively commercial district. An account by Janet Schaw, a Scottish woman traveling through the Caribbean between 1774 and 1776, illustrates the scale of the island's multinational influences:

From one end of the town... to the other is a continued mart, where goods of the most different uses and qualities are displayed before the shop doors. Here hang rich embroideries, painted silks, flowered Muslins, with all the Manufactures of the Indies. Next stall contains most exquisite silver plate, the most beautiful indeed I ever saw, and close by these iron-pots, kettles, and shovels. Perhaps the next presents you with French and English Millinery-wares. But it were endless to enumerate the variety of merchandize in such a place, for in every store you find everything, be their qualities ever so opposite (Schaw 1939:137).

In addition to its trade of a diverse array of merchandise, St. Eustatius was also a hub for slave trading. While some enslaved individuals arrived directly from West Africa, many were also sold between Caribbean islands via the inter-colonial slave trade (Klooster 1998). The first enslaved individuals came to St. Eustatius in the mid-1600s, and slavery was widely practiced on the island until abolition on 1 July 1863. There were slave depots at Fort Amsterdam and Crook's Castle, at the northern and southern ends of the island's commercial district, Oranje Bay (Dethlefsen et al. 1982; Gilmore 2013:43). Historically, a majority of African and Afro-Caribbean enslaved people inhabited the island, along with a minority of free Europeans (Oostindie and Klinkers 2003:58). By the late 18th century, however, a growing population of free Afro-Caribbean people resided in an area today referred to as the "free black village" (Goslinga 1985:152).

Free residents of St. Eustatius enjoyed unhindered economic prosperity resulting from free-trade status until 3 February 1781 when the British, angered by St. Eustatius' support of the rebelling American colonies, captured the island and ransacked it for nine months (Hartog 1976). The French stole onto the island and took control in November of 1781, and by 1784 had handed it back to the Dutch, with whom they were allies (Attema 1981:43).

Despite the significant loss of wealth resulting from the British sack, the island's economy recovered, reaching its peak in 1790. Between 1794 and 1816, the island changed hands several times between the French, English, and Dutch (Attema 1981:61). After 1816 it became "permanently" Dutch. While trade activities were long past their peak, slavery continued to support a small agricultural economy on the island (Attema 1981:47). Over the next two centuries, the warehouses that lined the bay, relics of the island's former heyday, slowly fell into disrepair and washed into the sea.

HISTORY OF THE ST. EUSTATIUS BEADS

Today St. Eustatius is famous for its glass beads, cultural markers of the island's economic "golden age." While stories about the beads live on among tourists and locals alike, oral narratives have yet to be thoroughly studied and critically evaluated. Narratives about the beads, both written and oral, share common elements as well as differing in their finer details. In order to understand beads within the context of St. Eustatius, we shall first place the beads within the wider context of the colonial era.

The bead trade in Europe can be traced back thousands of years, although the colonial period saw a more nuanced and calculated practice of bead exchange. The production of glass beads in Venice and other European centers boomed after Europeans realized that beads had aesthetic and symbolic value for people in areas they sought to colonize (Stine, Cabak, and Groover 1996). Archaeological evidence indicates that glass bead production existed in West Africa well before the European colonial period (Babalola et al. 2017; Gott 2014; Lankton, Akin Ige, and Rehren 2006; van der Sleen 1958). Beads were used as decoration and amulets, and could convey cultural meanings such as marital status, wealth, age, and other social and political affiliations (Babalola et al. 2017; LaRoche 1994; Stine, Cabak, and Groover 1996). European traders in Africa during the 15th to 19th centuries noted that blue beads were significant to many West African ethnic groups, e.g., among the Ashanti who used them in divination and religious offerings (Stine, Cabak, and Groover 1996). The tradition of bead production

and usage in Yoruban culture was also symbolically meaningful, rather than purely aesthetic in nature, with various shades of blue representing political status, celestial bodies, or water, and white beads representing seniority and elite status (Mason 1998:29; Ogundiran 2002:455).

Consequently, when Europeans arrived in Africa seeking trade opportunities, they found a receptive market and well-established bead economy on the western coast (Russell 1997; Stine, Cabak, and Groover 1996). Beads may then have come to the Caribbean in a variety of ways. Merchant and slave ships from Europe likely included beads as part of their cargo, but it is also possible that enslaved people brought some of these beads with them from their homelands (LaRoche 1994:16; Stine, Cabak, and Groover 1996). Primary accounts describe men and women aboard slaving ships wearing beads around their necks, arms, and waists (Handler and Lange 1978:147; LaRoche 1994:16).

During the 17th century, when the Dutch took part in colonial activities in Africa and elsewhere, various factories in the Netherlands produced glass beads, including in Amsterdam, Haarlem, Middelburg, Rotterdam, and Zutphen (Baart 1988; Karklins 1974). Their products were drawn beads, however, not the blue beads which are furnace-wound. Archaeological evidence reveals that the blue beads found on St. Eustatius are the products of cottage industries centered in the Bavarian/Bohemian forest region which encompasses Upper Austria, southern Bohemia, and the adjacent section of southeastern Bavaria (Karklins 2019; Tarcsay and Klimesch 2018). They were also made in the Fichtelgebirge region of northeastern Bavaria (Karklins et al. 2016:29). The beads were exported through various ports, including Amsterdam, where they have been found in material dredged from the city's canals (van der Sleen 1963).

Curiously, while the Dutch traded a variety of glass beads internationally, beads found on St. Eustatius fall into a specific color spectrum that is discussed in more detail below. Given the multi-national trade legacy of St. Eustatius and its transient population of travelers, merchants, and traders, the limited variety of beads, with relatively few outliers, suggests that merchants catered to a specific market. Indeed, the typological specificity of St. Eustatius' beads warrants further investigation.

BLUE BEADS FOUND ON ST. EUSTATIUS

Attributes

The most common glass bead found on St. Eustatius, and most frequently associated with the enslaved, is a five-

sided cobalt-blue type. Locally called "Statia" beads, they are furnace-wound and typically 8-25 mm long and 8-15 mm in diameter (Figure 2). They are typically found in mid-18th to 19th-century contexts (Cook and Stelten 2014; Karklins and Barka 1989; Morsink 2013; Soffers and Zahedi 2013). In the past, scholars working on St. Eustatius have often used the term "blue bead" to refer to only this type (Burger 2019; Gilmore 2013). Local people, however, apply the term to a variety of beads of different shapes (including round, oblate, oblong, donut, flattened, pentagonal faceted, and five sided) and colors (many different shades of blue, but also white) (Figure 3).

The second most common type of blue bead is also furnace wound, nearly spherical, and ranges between 10 mm and 30 mm in diameter (Karklins and Barka 1989). Regardless of shape and color, all of the beads depicted in Figures 2-3 are locally called "blue beads." This linguistic disparity brings to mind that postcolonial approaches to archaeology stress the need for archaeologists not to impose colonial viewpoints onto local cultural practices. It is important to utilize phrases which have meaning for stakeholder groups (Atalay 2012; Gonzalez-Tennant 2014). With this in mind, we use the term "blue beads" to refer to this diverse array of glass beads found on St. Eustatius throughout the article.

Many of the beads found on St. Eustatius also commonly occur elsewhere, including the Netherlands, West Africa, the United States, and other Caribbean islands. The "Statia bead," however, is found in an unusually high concentration on St. Eustatius. An island-wide survey of archaeological sites conducted by the College of William and Mary between 1981 and 1987 uncovered 325 blue beads, 25% of which were "Statia beads" (Karklins and Barka 1989).

Geographical Distribution

Both archaeological excavations and looting have revealed four main zones of blue beads on St. Eustatius: Upper Town, Lower Town, the agricultural plain, and the Maritime Archaeological Zone on the western side of the island. This is consistent with historical settlement patterns on the island, with beads seldom found in areas that were unpopulated.

The historic commercial district of the island, Lower Town, has revealed dense hoards of beads across the Oranje Bay area. Although much information has been lost due to looting, test excavations at the Crook's Castle site, a former sugar refinery and slave depot, revealed a wide variety of beads (Dethlefsen et al. 1982; Karklins and Barka 1989). Blue beads were also found at other sites including a trash deposit (n=28), a domestic structure (n=47), and several



Figure 2. Five-sided “Statia Beads” are not uniform in size or color, and are the most common type of blue bead found on St. Eustatius (photos: St. Eustatius Centre for Archaeological Research and the SMH Collection).

warehouses (Karklins and Barka 1989; Soffers and Zahedi 2013). A commercial project at the Oranje Bay Hotel site uncovered one bead, although it was later discovered that local residents sifting through back dirt found at least four additional specimens. Residents and tourists strolling along the beach at the Scubaqua Dive Center occasionally find beads in the sand.

In Upper Town, a diverse range of sites has revealed blue beads including an unmarked grave, the synagogue ($n=1$), Simon Doncker House ($n=46$), Government Guest House ($n=171$), and Princess Estate ($n=4$) (Karklins and Barka 1989). Blue beads have also come to light in the gutters of Upper Town, having been washed out of the soil during rainstorms, although this occurrence has reportedly decreased in recent years. On the agricultural plain, archaeologists have found beads at the Battery Bouille site, Fair Play Plantation, and English Quarter (Cook and Stelten 2014; Karklins and Barka 1989; Morsink 2013).

Perhaps the highest concentration of blue beads lies at Blue Bead Hole, located in the Maritime Archaeological Zone on the western side of the island (Figure 4). Long-established and encouraged looting has eliminated the possibility of knowing the exact number of beads found at the site, although it is estimated in the thousands (Stelten

2019:77). The explanation commonly given for the high number of beads at Blue Bead Hole refers to the oral history of formerly enslaved individuals throwing blue beads (symbolic of their bondage) off the cliffs at Crook’s Castle on Emancipation Day (1 July 1863). This interpretation of the site is problematic for several reasons. The nearby presence of ballast stones and other historical artifacts such as ceramics, clay pipes, and glass suggests that Blue Bead Hole is a shipwreck site. The sandy sea floor has no distinct topographic features that would encourage the beads to collect at the site naturally. Additionally, Blue Bead Hole is too far from Crook’s Castle to throw beads from this location to the site (Stelten 2019:77). It is unlikely that the bead deposit at Blue Bead Hole resulted from this celebration of freedom.

Yet the collective memory of symbolically throwing beads from the cliffs persists. Indeed, historical accounts, archaeological research, and anecdotal evidence have noted an abundance of beads at Crook’s Castle, perhaps supporting the oral historical narrative. Both the material and the oral narrative may be true. It is possible that the blue beads at Blue Bead Hole came from a wrecked ship, and that formerly enslaved people also threw beads from the cliffs at abolition.

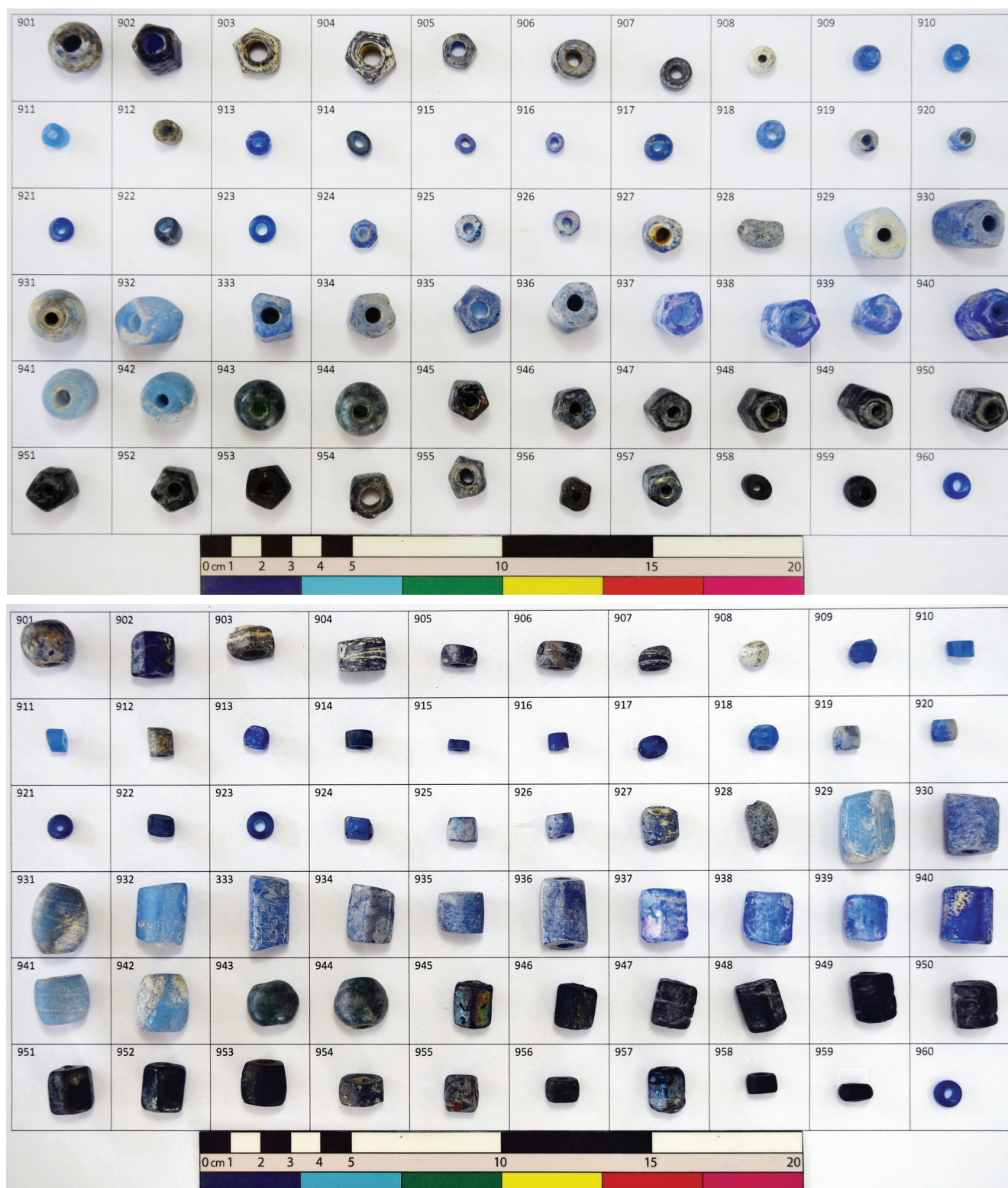


Figure 3. “Blue beads” come in a wide range of colors, ranging from opaque white to almost black (photo: St. Eustatius Centre for Archaeological Research and the SMH Collection).

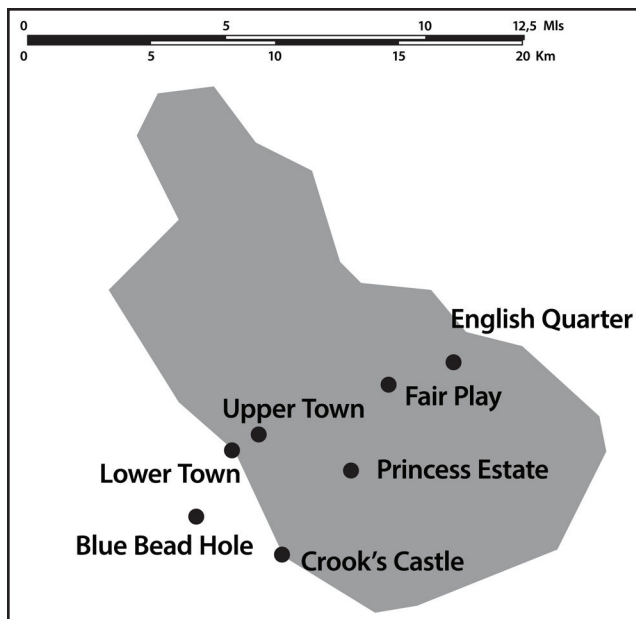


Figure 4. Blue bead find sites on St. Eustatius (drawing: Felicia Fricke and Pepijn van der Linden).

Archaeological research therefore reveals a wide distribution of blue beads across the island, both at terrestrial and marine sites. Yet, evidence is missing at sites with a direct and exclusive link to enslaved people. Archaeologists found no glass beads in the excavations of the Schotsenhoek or Fair Play enslaved villages, although they found shell beads at the latter. The one blue bead from the Fair Play Plantation lay in a building identified as the “big house” (Cook and Stelten 2014). This inconsistency between oral historical and archaeological evidence is thought-provoking; as for historical accounts, they seldom mention blue beads at all.

There might be a number of explanations for this, not least the shortfall of additional research into the lives and experiences of the enslaved on St. Eustatius, and an overemphasis on the economic and material systems of slavery and plantation society. In recent years there has been increasing attention to the decolonization of archaeological research (Agbe-Davies 2010; Battle-Baptiste 2011; Singleton 2010). Utilizing new strategies such as community input and collaboration on archaeological research, interpretation, and information dissemination will inform better practice that is more relevant to communities that are the ultimate stakeholders in heritage research. An interpretative focus on oral history in this setting can contribute to the democratization of knowledge, which can be a powerful agent for social change and overcoming persistent systemic oppression in the Caribbean.

ORAL HISTORY AND THE BLUE BEADS

Once considered merely a methodology, oral history has emerged as a discipline in its own right (Shopes 2014). The collective memories that it allows us to access can be accurate at considerable time depth (Boeyens and Hall 2009; Fahlander 2004). Antiquarians and early archaeologists were more likely to use oral history at greater time depths, but with the adoption of scientific methods, archaeologists questioned the reliability of such information. In the last two decades the pendulum has swung back, with the influence of post-structuralism and post-modernism on archaeology (Jones and Russell 2012). Researchers learned that memory functions differently at different time depths. Recent or linear time (within three or four generations) can provide detailed historical accounts, while middle or cyclical time (over the past four centuries) can provide more general information such as palimpsests of historical events and qualitative information about lifeways (Boeyens and Hall 2009; Fahlander 2004; Mason 2012; Spear 1981). More distant time periods may include mainly mythical information which, while not necessarily factual, can help to understand a cultural group (Spear 1981). Some researchers do argue for the usefulness of oral history at a mythical time depth, for example almost a thousand years in Ethiopia (Finneran 2009).

In Africa, postcolonial archaeology has long relied on oral historical data in tandem with data from the archaeological record and colonial documentation (DeCorse 2014; Miller 2003; Schmidt 2013; Schmidt and Munene 2010). Such studies are successful in their deconstruction of colonial narratives and their construction of the subaltern (Schmidt and Munene 2010). Oral history as a discipline has therefore proven its ability to be helpful in contexts like colonial Statia where one group of people is systematically oppressed by another.

With this in mind, oral historical data collected during interviews in 2016 provides us with a more nuanced view of the blue beads and their importance in the enslaved communities of the island. The interviews were semi-structured, lasted approximately one hour each, and were part of a wider project looking at the lifeways of enslaved people in the Dutch Caribbean. We recruited interviewees using the snowballing technique (Braun and Clarke 2013:57). Transcripts (*see* Appendix) are referenced by their individual codes such as EUX-OH-01. This anonymization was necessary in order to protect the identities of participants and is standard practice in oral history projects examining sensitive topics such as slavery and operating in small communities.

Blue Beads as Exchange Vectors

Several interview participants mentioned the use of blue beads as a type of “currency” (EUX-OH-01, EUX-OH-03). In the past archaeologists have treated such information with skepticism, wondering how the use of blue beads as currency would have functioned in practice. There are two reasons why we believe that oral historical accounts of such usage should be taken seriously. Firstly, the use of the word “currency” may be misleading, as it implies the use of a commonly upheld system within which all participants know the monetary “value” of a bead in a given context. The existence of such a complex system within such a small community may be unlikely. Instead, we suggest that the beads should be seen less as a true currency and more as part of an extended barter system like that used in West Africa during the same time period, where items like cowrie shells, blue beads, and fabric were exchanged for captives (Law and Mann 2003; Liberato 2009). We also know that barter systems existed in other communities of enslaved people in the Caribbean during this period (Tomich 1991). Secondly, it seems that the use of blue beads in this way reinforced enslaved status. Acquiring blue beads from their enslavers instead of money paid for services rendered may have made it more difficult for enslaved people to participate in the wider economy, for example by buying their own freedom. One interviewee (EUX-OH-02) mentioned that this “currency” may actually have been a form of “disrespect” for the labor of enslaved people.

In a North American context, Russell (1997) does not consider it likely that slave owners provided enslaved people with the beads that they used at The Hermitage, Tennessee. Yet, given what we know of the ways in which enslavers psychologically manipulated enslaved people – e.g., the technique of “divide and conquer” (Akbar 1996:16-19; Lewis 1983) – the provision of blue beads to the enslaved people of St. Eustatius seems a credible part of a system whereby maximum profit can be made with minimum risk. If enslaved persons with a specialization such as blacksmithing or sailing received blue beads for their labor, then the enslavers could keep the money they earned. The system was complex in that there were “ranks” of blue beads, with the large, round marble beads being “worth” more in the system of exchange and therefore more frequently given to those with a higher social position in the enslaved community, especially men (EUX-OH-01). As Chan (2007:141) notes, the use of beads as items of personal adornment in West Africa is sometimes linked to notions of status and prestige.

Blue Beads as Cultural Commodities

The blue beads also came to perform important social roles. Several interviewees mentioned their use in marriage.

Enslaved men had to earn the right to marry enslaved women by acquiring enough blue beads to go around their waist (EUX-OH-06, EUX-OH-10). Chan (2007:140-141) and Karklins and Barka (1989) note that the wearing of beads (including around the waist) might be associated with women and with ideas of womanhood in African-American contexts. In fact, at the New York African Burial Ground, an adult woman was buried with a string of mostly blue beads around her waist (Russell 1997). Adorning the waist may relate to cultural values of thinness, plumpness, and obesity in women. Cross-culturally, plump but not obese individuals are often seen as healthier and more attractive (Madrigal 2006:42-44). This might have been particularly so in marginalized communities such as the enslaved. Food scarcity in enslaved communities is indicated by the prevalence of deficiency diseases in buried populations (Handler 2009; Khudabux 1991:39-48), but also by ongoing traditions of carbohydrate-heavy diets which are cheap and filling. Interviewees indicated that the traditional diet of St. Eustatius includes johnny (or journey) cakes, dumplings, sweet potatoes, and yams (EUX-OH-02).

Although other bead types are found on Statia and elsewhere in the Americas in association with enslaved people, the vast majority of beads found here are blue (Karklins and Barka 1989). The preference for blue echoes patterns at other sites in the Americas, e.g., Rich Neck in Virginia (Franklin 2004:127). There may be some cultural significance to this. Stine, Cabak, and Groover (1996) have suggested that beads may function as protective or healing charms as well as decorative items in the areas of West and Central Africa where enslaved people in the Americas originally came from, and the association of this color with protection from spirits and witches continued in the Americas (Stine, Cabak, and Groover 1996). For example, a blue bead was found in a 19th-century context at the Slayton House workrooms, Annapolis, in a door sill cache also containing nine pins and a crab claw (Leone and Fry 1999). Use of amulets and caches like these provided ways for enslaved people to cope with their enslavement and exert their agency (Chan 2007:163; Frey and Wood 2003; Lima, Souza, and Malerba Sene 2014; Wilkie 1997). The color blue is thought to have protective properties in other areas of the Caribbean, such as in Curaçao (Fricke 2019:222).

At Newton Plantation in Barbados, a man was buried with a string of blue beads around his neck. Archaeologists have suggested that he may have been an Obeah man for the local enslaved community (Handler and Norman 2007). Obeah is an African-influenced belief system existing on the English-speaking Caribbean islands, including St. Eustatius (Fernandez Olmos and Paravisini-Gebert 2011:155-156). The word Obeah probably derived from the Ashanti

obayifo (wizard) and *obeye* (witch) (Fernandez Olmos and Paravisini-Gebert 2011:155; Sypkens-Smit 1981:81). Its traditions, however, are influenced by many different West African beliefs about witches, ancestors, and spirits (Frey and Wood 2003; Wilkie and Farnsworth 2005:198). It is similar to Vodou, Myal, Quimbois, Brua, and Montamentu, which are all African-influenced belief systems in the Americas (Allen 2010; Fernandez Olmos and Paravisini-Gebert 2011:155-171; Havisser 2006, 2010). Blue beads have also been interpreted as apotropaic adornments (to ward off evil, to bring luck) on enslaved sites in the United States (Stine, Cabak, and Groover 1996). It is therefore possible that the multiple meanings of blue beads in St. Eustatius are linked with Obeah, although such interpretations of material culture in the Americas are tentative because of the large, diverse, and changing region of West Africa potentially contributing cultural elements (DeCorse 1999).

STATIA'S ENDANGERED CULTURAL HERITAGE

The blue beads of St. Eustatius have a range of historical values and meanings. To the Dutch, they evoke imperial nostalgia, embodying the former glory of the Dutch colonial empire; to enslaved people, they had a range of symbolic and practical attributes associated with trade, marriage, status, and religion; to the inhabitants of St. Eustatius today, blue beads have taken on a mythological quality and play a role in island identity. While some people hold the blue beads "close to their hearts" (EUX-OH-02; *see also* EUX-OH-01 and EUX-OH-10), gifting them to loved ones and wearing them as ornaments, others avoid them because of their association with slavery and oppression. It is clear from any viewpoint that the blue beads are extremely valuable both as historical and contemporary objects.

Despite consensus on the cultural value of the blue beads, they are still threatened by persistent looting. Local dive shops in particular have engaged in active removal of cultural materials from archaeological sites such as Blue Bead Hole. (We note that the two dive shops on the island are not owned by people from St. Eustatius.) Finding a blue bead is marketed as "lucky" for tourists as indicated on the Scubaqua dive shop website:

According to the legend you don't find blue beads but the beads find you, and if you're found, you will return to St. Eustatius again and again. Blue beads are the only artifacts that are allowed to leave the island (Scubaqua Dive Center 2020).

Articles such as "Treasure-hunting in the Caribbean" (Dean 2016) and "Blue Bead Fever" (Harterink 2013), among many others, brand St. Eustatius as a tourism destination

where treasure hunting is allowed, and even encouraged. Through a postcolonial lens, the use and destruction of local heritage for the purpose of economic benefit by white and usually non-local people is at best inconsiderate and at worst cultural exploitation and appropriation. With so many unanswered questions about blue beads at hand, the ultimate risk posed by bead looting is that we will never truly know the stories of the beads and the people to whom they belonged.

Both looting and archaeological excavation have demonstrated a geographically wide distribution of blue beads at categorically diverse sites (i.e., domestic, commercial, military), yet their absence in enslaved contexts is puzzling. Exposing this research gap are oral histories that consistently and unequivocally describe blue beads as symbolically important to enslaved people, consistent with archaeological evidence from elsewhere in the Americas (Dillian 2011; LaRoche 1994; Russell 1997; Stine, Cabak, and Groover 1996). As archaeologists know, absence of evidence is not evidence of absence (Altman and Bland 1995). Rather, apparent inconsistency between oral histories and archaeological evidence should inspire further inquiry and reaffirm the need for more substantial research. This issue, moreover, recalls the importance of combining traditional archaeological methods with the study of oral history, especially in contexts where diverse perspectives have been understudied and underexplored.

To understand this inconsistency more thoroughly, we may consider the nature and context of past archaeological research conducted on St. Eustatius. Cultural resource management projects required by commercial development in parts of the island such as Lower Town have provided insight and context to the island's rich mercantile history, while historical documentation has provided a wealth of information on the ways in which the system of slavery was administered at elite levels. This research has prioritized colonialist history, embedded in a European perspective, partly because the information is readily available. While it has been commonly assumed that Lower Town was occupied almost exclusively by free people during the slaving era, a 1781 document listing merchants of Lower Town includes census information on their enslaved people, who made up approximately 52% of the population. Although the document does not indicate where these enslaved people resided, it is possible that they lived alongside, or at least worked closely with, slave owners in the Lower Town district. In the context of St. Eustatius, an island where enslaved individuals outnumbered their enslavers (Barka 1996), it is probable that objects belonging to the enslaved would appear in a range of contexts not restricted only to plantation villages. On the other hand, oral historical

accounts referring to the blue beads as highly prized may make it unsurprising that enslaved villages are not littered with them. Blue beads had great value for enslaved people but less value to slave owners who might have stored them or discarded them with less care.

A wider scope is now essential for strong, more nuanced interpretations. The challenge for 21st-century archaeologists lies in developing a progressive research model that fosters an understanding of diverse perspectives, facilitates sustainable relationships between researchers and local communities, and empowers marginalized groups. In the context of St. Eustatius, providing opportunities for descendent populations to celebrate and study their own history will ensure that archaeological investigations on the island not only continue in the future, but also provide better research with deeper context and greater nuance. The value of local involvement in scientific research cannot be understated as archaeologists and other scientists move away from a colonial and “global-north” perspective. With this in mind, it is pertinent for researchers to reflect on the value of oral history narratives, which can diversify and enhance the benefits of archaeological research.

Legally speaking, the unauthorized excavation of artifacts (including beads) from protected archaeological sites is punishable by up to one year in prison or a fine (Overheid Nederland 2010). There are over 100 protected archaeological sites on St. Eustatius, including some which are very popular with blue bead hunters, such as Crook’s Castle. Unfortunately, Blue Bead Hole is not on the protected list, allowing tourists to vandalize a site that has great importance for local heritage narratives. In the future, increased protection for underwater sites should be a priority, as should improved education for island visitors, who in many cases do not understand that they are damaging the beautiful island to which they return again and again. Local organizations such as the St. Eustatius Centre for Archaeological Research (SECAR), St. Eustatius National Parks (STENAPA), the St. Eustatius Historical Foundation, and the St. Eustatius Monuments Foundation can be instrumental in this regard. Indeed, some progress has already been made: the dive shops on St. Eustatius are selling reproduction beads produced by a glass artist on the neighboring island of Saba which are an ethical substitute for authentic beads. Dive shops have also reportedly begun recording beads recovered at dive sites, although their continuing encouragement of the removal of historical artifacts from the site and the island remains problematic.

Looting undertaken by locals may be more difficult to halt. The economic circumstances of the island do not offer a wide variety of jobs and, as on many Caribbean islands, the

cost of living is high. Greater financial and social investment is needed by the Dutch government to make St. Eustatius a “Golden Rock” for all those who live there, and not only for the tourists who come there to enjoy the beautiful scenery both above and below the waves.

CONCLUSION

Statia’s blue beads are widely regarded as important objects to both past and contemporary communities on the island. This study has shown that the integration of archaeology and oral accounts can provide new perspectives on their history and social significance. It has also demonstrated that in seeking knowledge and nuanced interpretations about people of the past, it is essential that we involve people of the present. Indeed, for non-Caribbean researchers, working in the Caribbean is a privilege. We therefore have a social responsibility to include local stakeholders in our research and to listen to perspectives that may sometimes be very different from our own. In this way, our archaeological endeavors become better integrated, more sustainable, and more relevant to stakeholder communities. It is our hope that by honestly evaluating the way in which we engage with cultural materials and the people to whom they belong, we will be able to have a positive and meaningful impact both inside and outside academia.

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APPENDIX. ORAL HISTORY TRANSCRIPTS

These transcript excerpts come from semi-structured anonymous interviews conducted by Felicia J. Fricke (FJF below) on St. Eustatius in 2016. They pertain directly to the blue beads. Full interview transcripts relating to the lifeways of enslaved people on the island can be accessed on submission of a suitable research proposal on the archiving website DANS Easy (www.easy.dans.knaw.nl).

Interviewee EUX-OH-01

EUX-OH-01. And they used to call them trade beads, some – I grew up knowing them called trade beads, Indian beads and later on in between, well, people say, well, slave beads, you know, but these were used as pay to the slaves so... when they worked, this is what they were paid with, they wasn't really paid with currency, it's the beads. And then they trade among themselves. [...] Well the main thing about, with slavery, that I hold close to my heart also is the blue beads. You know, even though they were used as pay to the slaves it, it is something about the bead, it's – I don't know if it feels like a connection or the excitement about it, just finding one or having one. I have some and I tend to have it every time just making sure that I feel them to make sure they're there [unintelligible] stuff like that. And it's something that you think back and say well, in those times these was used as pay to slaves. And the story behind of them that they came here in large quantities. They were stored and then these was paid to the slaves. So every time I go out and look for them, 'cause they are very hard to find now. And I heard, you know, like stories that they were in the past they were found here a lot. And up until the 1900s kids – because maybe people knew that they was from the olden days, they were paid to the slaves, but since slavery was abolished there wasn't – the demand for them wasn't much and it seemed that there wasn't value anymore, so nobody never really focused on them. But kids still used to collect them and string them and strangely this is the tradition that people still feel connected and want to look to find one, you have tourists coming in and they want to find one so, this is one artefact I treasure it like gold. [...] Oh, [you find them] anywhere on the island once you go walking. I always the same, I am walk with the head down, it can be a little dangerous. Because I am for sure experience a little incidence without paying attention, so focused in looking for the beads, but once you find one the feeling is – you feel so excited, you feel so happy that it's like a big exam you finally – you find a test and you win the test. You know we have them in different shapes and color. One of the main ones I want to really find is the marble, the marble bead. We call them marble. Those are the big blue ones. And the slaves that got those, they got them based on their position. And mostly men slaves used to get those kind of round ones. So imagine finding the big round one, it's like you hit the jackpot [laughs] you know? [...] I remember one time a tourist told me that she found about five in her back yard when she was doing gardening in New York. Five of the same five-sided beads. And she told me that she found them in her back yard and I was like excited to know that, you know, because she said it was – I know for sure they different shapes like I mentioned sizes and colors, but she said no they were just the same like the ones that you have.

And she said it was in perfect shape, in perfect order. So here we go looking for them when the weather is rainy. Especially when we have a rough sea, you see a lot of people walking the beach or the coast area looking for these, these beads. [...] The beads – because the beads I do know, OK, to each his own, I don't know – the main thing I know that from hearing what people say when they find their bead it brings the excitement and then you hear some oh, I looking for years, I never find any, I want to find one, and some just be like I don't care how much it costs, I will pay for one, you know, and I know for sure they have tales from the olden times that the blue beads, they don't, you don't find it sometimes, it finds you. And I know for sure that people for over the years and [unintelligible] trace back through the centuries that persons dreaming about beads, you know, dreaming about beads in a certain area they were buried, some of the beads were also hidden, some slaves used to bury them and hide them, if they have – some of them have the barrels with the beads in the store rooms in the cellars from warehouses. Some of them will try steal some and hide it. So they find different areas. And it was said too that when it had Emancipation Day, that most – I don't know if it, to say it was a myth – but they say that they would go to the cliffs and throw it over the cliffs as a symbol that they were free.

Interviewee EUX-OH-02

EUX-OH-02. I think they said the slaves were paid here with the blue beads, that they will call money, and what can you with that if you can't trade it anywhere else? You understand....

FJE. What's your opinion on the blue beads as payment thing?

EUX-OH-02. I think that was horrible, 'cause how – what is the value? Who determines the value? How do you know how much money you had? Or... you know, I think it was unfair 'cause if they had real money, they should have been paying them, if they wanted to pay them then pay them in real money, but I think that was still sort of a disrespect towards them because you're giving them a bead that - that's why they say on emancipation, you know the word Emancipation Day, they took all the blue beads and they throw them out over the cliff because they are like, now we don't have to use these any more as payment. Now we get the real money.

FJE. Oh OK. I have heard that story but I don't know which cliff it is. Is it....

EUX-OH-02. That's what they call Crook's Castle, I don't know if you heard of Crook's Castle, that's why they

said when you go over there you find a lot of blue beads, that's where, because that's where they went by that area, and they threw them over there. Yeah. That's the story. And it's true 'cause a lot of people find a lot of blue beads over that way. I've never found one, but hey [laughs].

FJF. Are you looking?

EUX-OH-02. Ah well, I stopped. When I was younger we did. When I was younger we used to go look. But yeah.

FJF. They say it finds you.

EUX-OH-02. Yeah, that's what they said. So I'm still waiting! [laughs]. Waiting for it to find me. I guess I'm unfindable [laughs].

FJF. [laughs] Apparently it's good to go out and look after it rains.

EUX-OH-02. Yeah, that's what they said. Yeah. See I don't have patience. [...]

Interviewee EUX-OH-03

EUX-OH-03. Oh, the blue beads. Although slave and it's so long ago you still would come across these blue beads and they actually called to slave beads, they cost a lot of money now. You can get one for oh, around – they are very expensive now, because, and I am going to give an example. A tourist from Venezuela was up here, and he wanted a slave bead. [...] And I say excuse me mister, it's not the glass you're buying, it's the history behind it. When he called back to get the slave bead it was gone already because he didn't realize. You see, so you're not buying the bead, it's the history behind it that you're – that's what it's all about, that's what you're, you know. And up to today you still when it rain a lot you can find them. I have never found one, but... But many people they have tourists came here and found them. You see, but I have never found any! 'Cause some people walk looking. But I don't look so I have never found any. [...]

Oh, the slave beads. Yeah. They paid for them – in fact, there's a saying that Manhattan was bought with 30 slave beads, 30 beads. The Indians gave it because they were interested in things like that. And that's what they – they bought them, they took the slave beads so the Indian took that for them and – you know it's interesting... because the Dutch had it at first. Yeah, it's interesting. Like when you go down Greenwich Village and so you see the same type of buildings. [...] What they do is they exchange, they

exchange stuff, they – the provisions and so. You see. Like long time ago money was hardly ever used. They – you came with your product and you exchange. You had potatoes, I had yams, and you gave that person and then you exchange. [...] Well, they were actually made in Holland. And that's where they were made in Holland and then they brought them down here. [...] And this is interesting, Queen Juliana, well now called Princess, she got a necklace with blue beads and silver. [Name of company] made them for her. So that's another thing that many people mightn't realize but she got the – they presented her with a necklace. And the prince, each prince had a bead. That's another thing. Each one of them, they had given them so – when they came with her, they had – so each one's supposed to have a slave bead. [laughs] Well now they came, I don't know if he still has it, but each of them had a – was given a slave bead.

Interviewee EUX-OH-06

EUX-OH-06. And what we also learned in the history book that Holland made some slave beads, they are blue. And they used them in different parts of Europe, also in Africa and Asia and other parts of the world. And so the slaves – in order for me as a slave to get married to you, I have to work for as much blue beads so that they can tie around your waist. Then I can have the opportunity to get married to you. So if you are fat, I work harder. If you are slim as you are, it was easier. [laughs]. You know? So that was one of the things that – Manhattan, New York was bought by the Dutch for 30 blue beads, and these blue beads were all here for also they used as payment to the slaves and so. And for business. And were used quite a few places around the world. They were made in Holland. Glass beads. So that's what we learn about the slave beads.

FJF. Did they use them to trade amongst themselves?

EUX-OH-06. Yes, and amongst other – business colonies and so. Yeah. They were very important.

Interviewee EUX-OH-10

EUX-OH-10. By the way there are many people on Statia who have that mind-set. They think slavery is over and done with, let's not get stuck in it, and we're free, we've been free since 1863, let's focus on the future, and all that slavery stuff, you know, let's forget about it, let's move on. And there are other people on Statia who think the opposite – no no no, we must not forget because then we ignore, then we, yeah, we ignore, the suffering of our forefathers and so forth. So those two currents, if you like, tendencies, trends,

exist on Statia. [...] So I don't know how many stories you've heard already. One of them is that a man could only take a – a slave could only take a woman as his companion, you know, I can't say wife because they were not officially married, if he had enough blue beads to string around her waist.

FJF. Yes, I did hear that and I wanted to discuss that as well because it seems in that case if you have to do that, it's easier to marry a thin woman than it is to marry a fat woman. So does that imply that having a bit of extra weight on you was desirable? Do you think that that's where that comes from?

EUX-OH-10. Yeah? Logic would dictate that, yeah. The – the, yeah, the wider your circumference, if I may put it that way, the richer your suitor had to be.

FJF. Yeah. And I guess if there's a shortage of food, then if you can be fat then it's – yeah, you're showing that you can get food.

EUX-OH-10. Yeah. Correct. So that's another story is that when abolition happened and the slaves got their freedom, they symbolically threw their blue beads over the cliff. Which would then explain why you find so many of them along the beach. Maybe you've heard that story as well? Yeah. So – but you know, so I told you I travel. And of course I went to Ghana as well because there, you know, the Dutch were there, built forts and had – Elmina was their capital and so forth, and of course a lot of the enslaved Africans that came to Statia were shipped from the Gold Coast, from Ghana, what is now Ghana. And lo and behold, when I was in Ghana, what do they sell on the market? Blue beads! They are still a normal item of everyday use in West Africa, at least in Ghana where I was and where I saw them for sale on the market. So there is a very very strong tradition of using these blue beads connected with the West African culture. Of course originally they were introduced as an import item and a guy did research into their chemical composition and found that they were, that they correspond with a glass factory in Amsterdam, of Mr Soop. And yeah, they, the Dutch did use the beads as items of trade and barter in West Africa. Which means that they were considered valuable items, and so the West Africans were used to looking at the blue beads as valuable items that you can buy things with, barter things with. So yeah, that continued here on Statia. Of course the remarkable thing is that you do find them on other places, but not in the same quantities as here on Statia. So that's a bit peculiar. What does – why is that? On other islands and also in North America, you know, in the east coast you find them, but not as many as here. So one of the explanations is that a ship carrying barrels with these beads

on – was here, at Statia, and either in a storm or something, either the ship got wrecked or maybe in a storm the barrels rolled out of the ship or – but anyway, that – because of that, a ship losing its load, either because it went down itself or it lost its load in a storm, and the load consisted amongst other things of these barrels with blue beads, here in Statia maybe that is an explanation. It is possible. It's not documented but it's an explanation. [...]

FJF. Yeah, that's really interesting. I was wondering about the blue beads in West Africa. What – what are they used for there?

EUX-OH-10. Right now?

FJF. Mm, yeah.

EUX-OH-10. Yeah, I think as decoration.

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FURNACE-WOUND GLASS BEAD PRODUCTION AT SCHWARZENBERG AM BÖHMERWALD, UPPER AUSTRIA

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Translated by Karlis Karklins

Exploratory excavations carried out in Schwarzenberg am Böhmerwald, Upper Austria, uncovered the remains of an unrecorded glassworks. Part of a furnace was exposed, along with glass beads and buttons, as well as holloware and flat glass fragments from the 17th and early 18th centuries. This article describes the finds and their relationship to the nearby Sonnenschlag glassworks where similar beads and glassware fragments have been collected. Both sites are related to the beadmaking industry in the nearby Bavarian and Bohemian forests, which experienced a veritable bead boom around 1700.

INTRODUCTION

The village of Schwarzenberg am Böhmerwald is located in northern Upper Austria which is in the Bohemian Forest and thus part of a large historical glassworks landscape that includes the Bohemian Forest (Šumava), the Bavarian Forest, the northern Waldviertel in Lower Austria, and the northern Mühlviertel in Upper Austria (Figure 1). The finding of large quantities of glass beads (Figure 2) south of the property at Schwarzenberg 93 (now Zinngießerweg 3) led to the archaeological investigation of the site in 2017, on the initiative of local researcher Franz Haudum. This revealed the remains of an early modern glassworks not recorded in the archives. Now known as “Glashütte Gegenbach” (the Gegenbach glasshouse), the site is problematic as it corresponds formally and chronologically to the Sonnenschlag glassworks which is located only about a kilometer away on the same manor (Ort Schwarzenberg). The archival documents concerning the Schwarzenberg glassworks were, therefore, subjected to a renewed, precise examination, to determine the relationship. This work was coupled with a systematic recording of the extensive finds and the chemical analysis of selected glass items. While a detailed report on the site has already been published (Haudum and Tarcsay 2019), this article presents explicit new information regarding the recovered glass beads and their production.



Figure 1. The location of Schwarzenberg am Böhmerwald in Upper Austria (drawing: Kinga Tarcsay).

HISTORY OF THE SCHWARZENBERG GLASSWORKS

The village of Schwarzenberg was under the dominion of Schlägl Abbey where glasshouses are known to have been present since the 16th century. Franz Haudum (2019:204-233) reviewed, evaluated, and discussed the documentation on the huts in detail as part of the project. Archival material provides the following sequence of glassworks in the vicinity of Schlägl Abbey:

Schlägl (ca. 1525)

- a) “Glashütte auf der Glaserin” on the Glashüttenteich, ca. 1525.

Schwarzenberg (1638-1861)

- a) “Landgrafhütte” on the Sonnenschlag, 1638 to ca. 1700 (Figure 3, A).
- b) The excavated glassworks “Gegenbachhütte” or “Paterlhütte,” pre-1700 to 1716 (Figure 3, B).
- c) “Schläglerhütte am Schwarzenberg,” 1719-1749 (Figure 3, C).



Figure 2. Beads collected at the Gegenbach glassworks site (property of the landowner) (photo: Kinga Tarcsay).

- d) The non-existent “Obere Hütte” in Oberschwarzenberg. According to Haudum (2019), this glasshouse, which appears in older publications, never existed and its inclusion in lists of regional glassworks is the result of misinterpretation of location information by earlier researchers (Figure 3, D).
- e) “Rosenbergerhütte” or “Fieglmüllerhütte” in Oberschwarzenberg, 1821-1861 (Figure 3, E).

Sonnenwald (1750-1900)

- a) “Kloster Schlägliche Glashütte” in Sonnenwald, 1750-1816.
- b) “Wagendorfferhütte” in Sonnenwald, 1832-1900.

The earliest glassworks in the vicinity of what is now Schwarzenberg was built in 1638 for the Schlägl Abbey by the well-known glassmaker Hans Waltguny (Weilguni) from Harmanschlag, Lower Austria. He had previously been commissioned to construct several other notable glasshouses in Lower Austria and southern Bohemia whose products are well known archaeologically: Glashütte Harmanschlag (Tarcsay 2003), Glashütte Reichenau im Freiwald (Tarcsay 2008a), and Glashütte Wilhelmsberg (Fröhlich 1994).

Just a year later, Christoph Reichenberger took over what is now known as the Sonnenschlag glasshouse. He was followed by his stepson Georg Landgraf in 1654, and later by his son Johann Anton Landgraf who, in 1691, married Rosina Müllner, daughter of the well-known glass master Michael Müllner of the Helmbach glassworks from 1695 to 1716 (Haudum 1980:18; Krinzing 1921:212-213). Before Georg Landgraf was able to hand over the glassworks to his son Johann Anton in 1692, the abbot of Schlägl Abbey

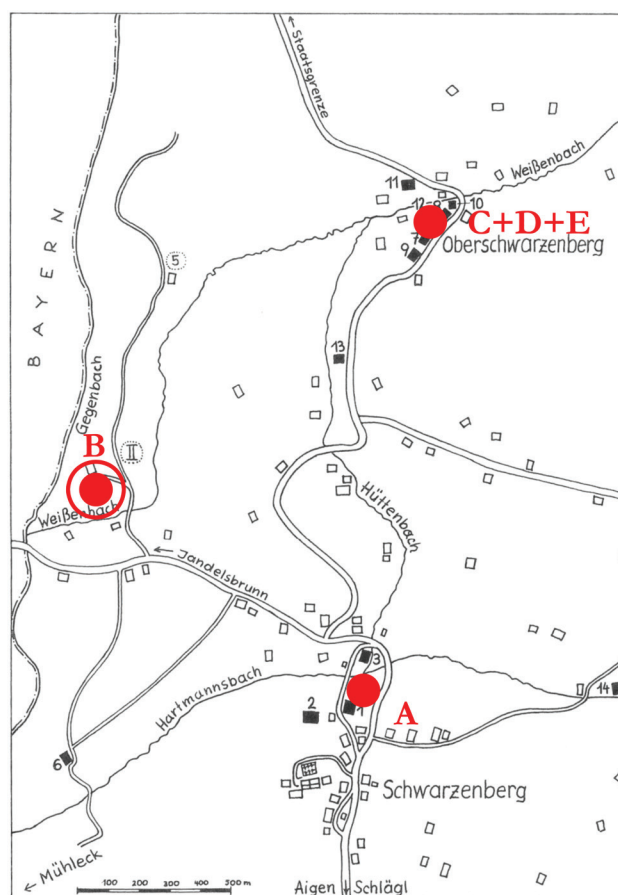


Figure 3. Historical glassworks in the vicinity of Schwarzenberg am Böhmerwald (refer to the list of glassworks for their identity) (drawing: Franz Haudum and Kinga Tarcsay).

visited and conducted an investigation which unearthed all kinds of negligence and unauthorized excesses so that the transfer was delayed until 1695 (Haudum 2019:218-219).

While the inherited estate had considerable livestock, the glass furnace was in a rather poor state, as Michael Müllner, the father-in-law, portrayed in letters. Nevertheless, Johann Anton was apparently able to make the glassworks function well. In 1701, for example, the abbot of Engelszell ordered 8000 disc window panes from the Schlägl abbot, and in 1702 Johann Antoni Landgraf had the great honor of delivering a large chandelier to the imperial hall built by Carlo Antonio Carlone between 1693 and 1695 in the Kremsmünster Benedictine monastery (Haudum 2019:209).

Archival documents from the 1660s and 1670s reveal some of the items produced earlier at the Sonnenschlag glassworks. These include beer, lidded, and vinegar glasses, wine bottles, offering ewers or jugs, urine glasses, and various types of flat glass (Haudum 1980:19, 1986:15; Krinzing 1921:213-214). Also, from at least 1701 onwards, numerous beadmakers (*Betlmacher*) employed at

Schwarzenberg are named in the parish registers (Haudum 2019:225-226).

The list of the products made under Johann Anton Landgraf's leadership from 1704 to 1709 includes large quantities of window panes, glasses decorated with cut coats of arms, gold and ruby stems, and "cut French foliage" or blue appliques, as well as "*Stangenglas*" (tall, narrow beakers), lidded glasses, confectionery bowls, jugs, and polished bottles, but there is no mention of beads (Haudum 2019:219- 220).

In 1711, Landgraf complained that he urgently needed good ash to make lime and crystal glass, glass beads and window panes, and hoped to be able to continue making the coveted beads (Haudum 2019: 220-221). Unfortunately, economic problems ultimately forced him to sell all of his properties in Sonnenschlag and he moved to southwestern Upper Austria where he founded the Freudenthal glassworks at Weißenkirchen im Attergau (Haudum 2019:229-232). In the "*Schläglerhütte am Schwarzenberg*" that followed, only one beadmaker (*Petlmacher*) appears in the first production listing from 1720-1721; possibly no more beads were produced thereafter (Haudum 2019:225-226).

The reason for the construction of the Gegenbach glassworks and the date it occurred remains unclear, but new observations by F. Haudum (2019:218-222) indicate that the two glasswork sites in Schwarzenberg may be sequential. This inference is based on a letter from the abbot of Schlägl Abbey to Landgraf in 1711 which mentions two glassworks, a "previous" glasshouse and the "current" one. Although this testifies to the existence of a new glasshouse in 1711, it does not provide any information regarding the location, date, or reason for the relocation of the furnace which, according to Haudum (2019:218-222), is probably the Gegenbachhütte.

The location of the Sonnenschlag glasshouse is clearly identifiable from the historical documentation and surface finds. Numerous glass artifacts in various collections are said to come from the site, where more recent investigations have also been carried out. In addition to various hollowware and flat glass fragments, the assemblage also includes a large quantity of beads (Figure 4) and production waste which largely correspond in shape and color to the material recovered from the Gegenbach glassworks (Tarcsay 2003:89, Figure 5, 2019:260-262).

THE ARCHAEOLOGICAL INVESTIGATION OF THE GEGENBACH GLASSWORKS

Two small test units were excavated at the site in 2017 under the direction of Wolfgang Klimesch (Archeonova) to verify the postulated glassworks location, following geomagnetic surveys (Figure 5).



Figure 4. Beads from the Sonnenschlag glassworks (Ulrichsberg Culture House, Upper Austria) (photo: Kinga Tarcsay).

Test trench 1 revealed part of the base of a furnace which abutted a huge boulder over 3 m in diameter. The furnace had a semicircular end, the exposed portion of which was 3.8 m long and about 4.5 m wide. The masonry, of which only the lowest layer remained, consisted of unaltered granite boulders and cobbles set without mortar. The walls were well defined and 70 cm thick (Klimesch 2019) (Figure 6). Associated with them were fragmentary and strongly secondarily-fired bricks which generally served as components of cooling furnaces. Standardized and grooved glass furnace bricks, made of melting-crucible clay and known from other sites, are not present (Tarcsay 2008a:76-80, R-O3 to R-O7).

As the structure was not completely excavated, it was not possible to clearly differentiate between collapsed and intact building structure in the interior, though a transverse wall running almost north-south was noted and may have served as a partition in the firebox. A stone slab in the west end is likely part of the adjacent work platform. The majority of the finds came from the destruction horizon of the furnace and the thin layer of humus above it.

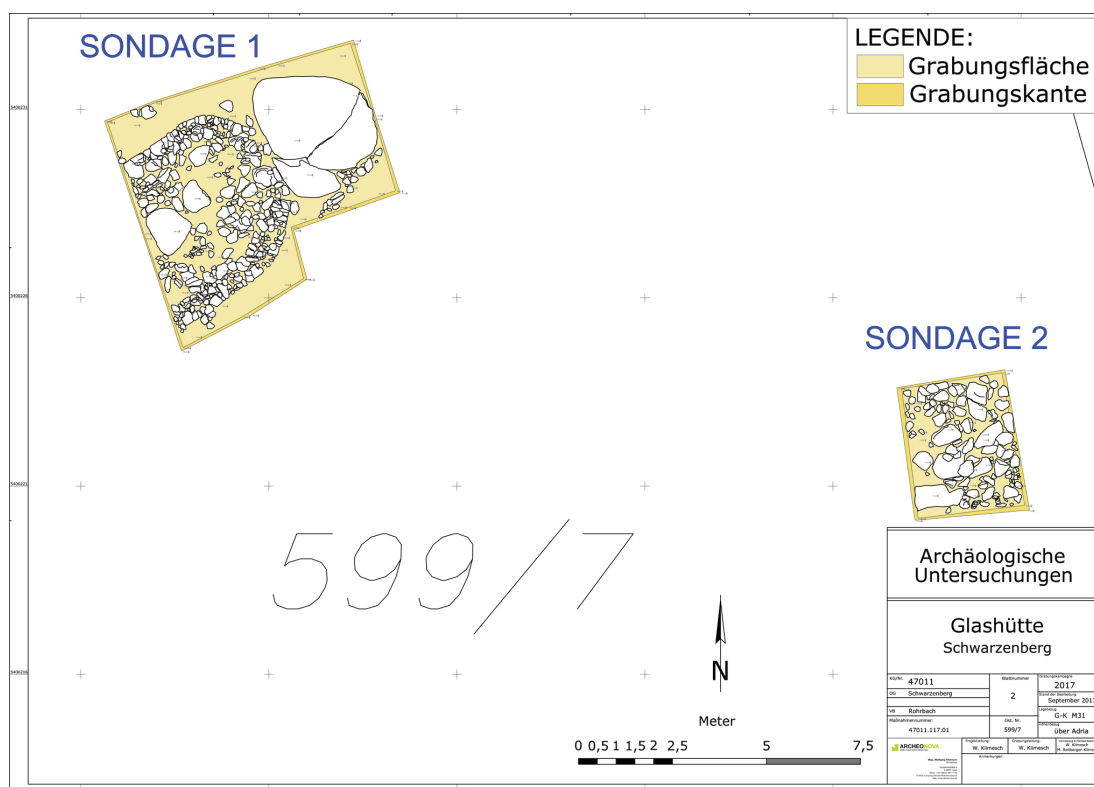


Figure 5. Ground plan of the excavation units at the Gegenbach glassworks site (drawing: Wolfgang Klimesch, Archeonova).

Trench 2, about 15 m to the southeast, uncovered a burned layer under the humus which overlay hewn and unhewn granite stones. A thin layer of ash covering the stony subsoil may be interpreted as a forecourt with fire residues from another furnace that is likely located under an adjacent stone mound. Numerous finds were recovered from the unit, particularly glass slag (Klimesch 2019).

Conclusions regarding the function of the furnace or the reconstruction of individual work processes cannot be

drawn at present due to the limited scope of the excavation, which did not fully uncover either structure. Possibly there was a half-round glass furnace separated from an attached furnace component by the north-south transverse wall. Such a structure is characteristic of the “Bohemian glass furnace type,” at least during the 17th century (Tarcsey 2008a:50-56). To clarify this, it will be necessary to completely uncover the entire structural complex, or at least the furnace.

Unfortunately, there are no analogous excavated bead furnaces that correspond in time and space to the Gegenbach remains to allow them to be identified as an actual beadmaking oven. At Nová Ves in the Bohemian-Moravian Highlands, for example, where the son of Michael Müllner (the brother-in-law of Johann Anton Landgraf) was a glass master from 1703 to 1720, and where similar beads were made, large areas of the glassmaker’s settlement were exposed but not the actual glassworks area with the furnaces (Hrubý et al. 2009). Similarly, while a 3 x 3 m glass furnace was uncovered at the Ochsenkopf in the Fichtelgebirge region of northeastern Bavaria where beads, buttons, and spindle whorls were made from Proterobas around 1640 (Karklins et al. 2016:23, Figure 6; Steppuhn 2008), the structure differs from that at Schwarzenberg in that it has a rectangular floor plan.



Figure 6. The foundations of the Gegenbach furnace (photo: Wolfgang Klimesch, Archeonova).

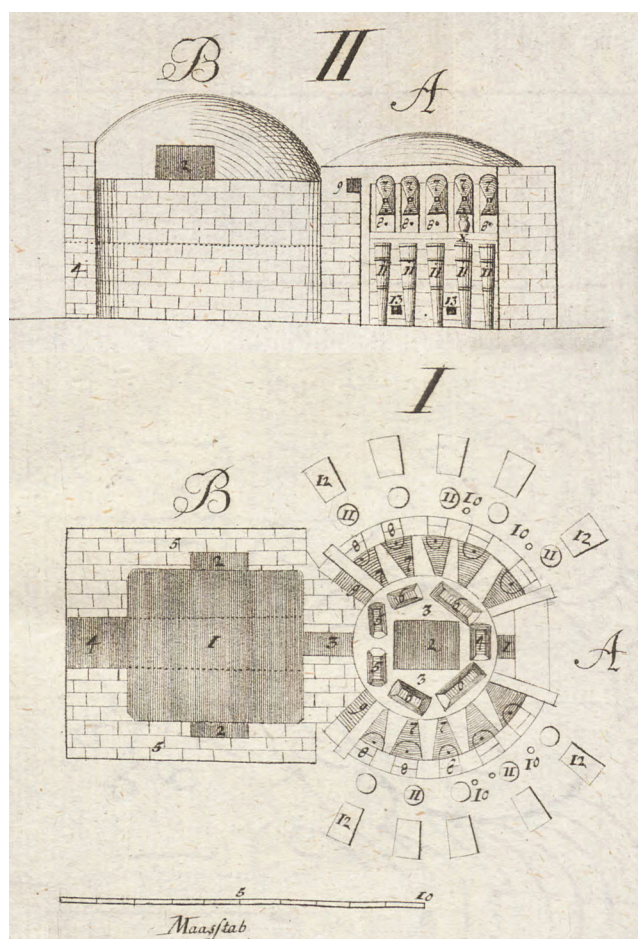


Figure 7. Floor plan and elevation of a *Paterlofen* (Flurl 1792; Bayerische Staatsbibliothek München, BHS II C 8 a, Tafel III, urn:nbn:de:bvb:12-bsb10706849-7).

The oldest known image of a beadmaking furnace (*Paterlofen*) dates from the late 18th century and shows the “button oven” (*Knopfofen*) at the “Paterlhütte” Warmensteinach, also located in the Fichtelgebirge (Figure 7) (Flurl 1792: Plate III). The combined type of glass furnace has an arrangement similar to the above-mentioned “Bohemian furnace.”

THE GEGENBACH GLASSWORKS FINDS

Despite the relatively small size of the two test excavations, they yielded a large number of finds, with hollowware and flat glass represented by very small fragments. In that this material is only a small, non-quantifiable sample, only a few conclusions may be drawn regarding the furnace’s production spectrum.

For the initial evaluation, which was largely carried out by the author, the artifacts were sorted and recorded

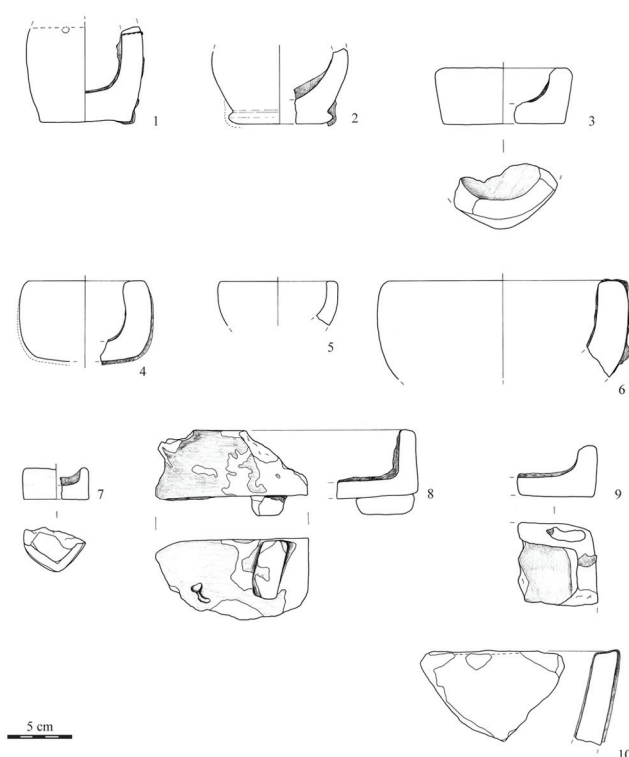


Figure 8. Glass melting crucibles: 1-6) small with curved walls and a round cross section; 7) very small with spout; 8-9) small rectangular with flat base; 10) rim fragment of a large, conical crucible with a round cross section (drawing: Ines Ruttner).

according to form groups. The detailed cataloging of the finds is a desideratum for a possible follow-up project. This also applies to the recovered ceramics, since only artifacts relevant to glass technology have been recorded so far. The few metal finds were processed by Christina Schmid (2019) of the Upper Austrian State Museum. There are no objects specific to the furnace, such as glass processing tools.

Glass Melting Crucibles

The recovered glass melting crucible fragments primarily represent small handmade vessels with round cross-sections that are hard-fired like stoneware. There are also small short pots (rim diameter: 8-14 cm, height: 6-6.5 cm) (Figure 8, nos. 1-6) and half of a miniature vessel with vertical walls and an extended spout (height: 2.5 cm) (Figure 8, no. 7). Other fragments belong to small, rectangular melting pots with flat bottoms, straight walls (height: 4-5 cm), and small stubby feet (Figure 8, nos. 8-9). These small melting pots may be related to bead production, but are also documented at glassworks where only hollowware was produced. They were probably used for trial melting or for melting small amounts of glass. Only a few rim fragments

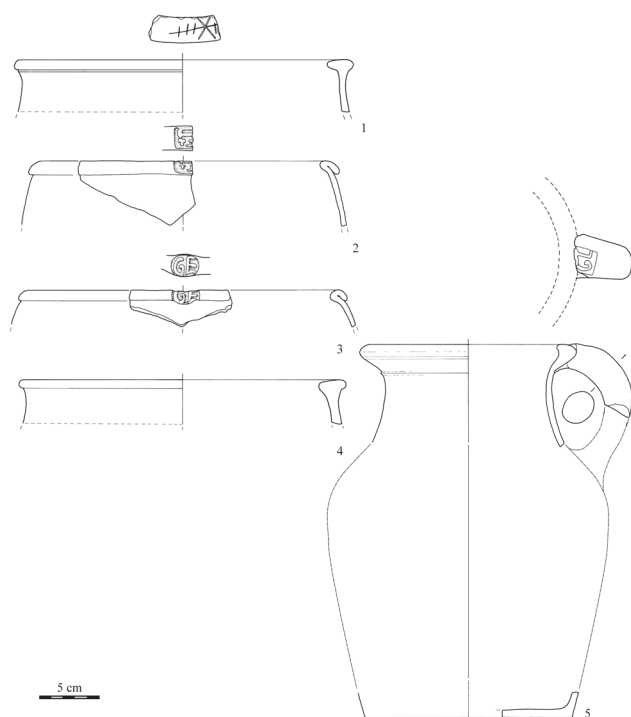


Figure 9. 1-4) pot-shaped cooling vessels; 5) possible jug-shaped cooling vessel (drawing: Ines Ruttner).

come from larger conical crucibles with a straight rim (rim diameter: ca. 32-34 cm) (Figure 8, no. 10). The raw glass remnants in the pots are colorless, blue, amber, and opaque pink (Tarcsay 2019:240).

Cooling Vessels

For easier handling, finished glassware was placed in ceramic vessels with perforated walls and then placed in the cooling furnace to ensure gradual cooling (Frey 2015:85-183; Tarcsay 2008a:236-246). Pot-shaped forms predominate and are made of oxidation-fired, quartz-tempered clay. They generally have incurved, club-shaped rims (Figure 9, nos. 1, 4) or rims folded over onto the exterior face (Figure 9, nos. 2, 3) (average rim diameter: ca. 27-30 cm); only individual wall fragments are perforated.

A large jug can also be assigned to the cooling vessel category based on its composition and manufacturing technique (rim diameter: 18 cm) (Figure 9, no. 5). This previously unrecorded shape could have been used specifically in bead production.

A representation of such a cooling vessel can be seen in the engraved image of the Warmensteinach bead/button furnace (Figure 10). The accompanying text reads: an “X”

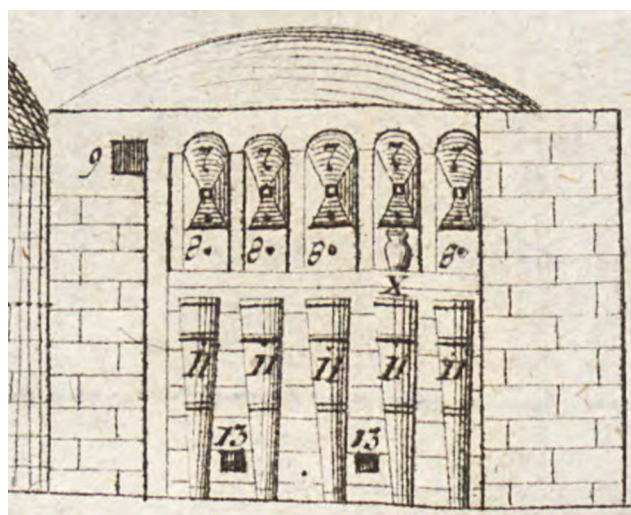


Figure 10. Detail of the Flurl elevation plan of a cooling furnace with a cooling vessel under the fourth working hole (X).

on the floor plan marks “a small earthen vessel” into which the workers dropped the finished buttons through small holes (“8”) “where these buttons must slowly cool” (Flurl 1792: Plate 3.II.A). The contour of the depicted vessel with a constricted neck corresponds to that of the jug described above, but the vessel in the engraving has no handle. These vessels were inset in the furnace wall beneath the work ports. Photographs of the furnace of the last beadmaking works in Warmensteinach from the 1930s show jugs to the left and right of the work ports, but they apparently had a different function (Herrmann 2008; Karklins et al. 2016:20-22, Figures 3-5).

The rims of the cooling vessels from Schwarzenberg are stamped with the mark of Hafner of Passau which dates to the last third of the 17th century and the beginning of the 18th century (Figure 9). Thus, the purchase of ceramic cooling vessels from this well-known production location is verified (Tarcsay 2019:240-242).

Production Wasters

The glass wasters are colorless to opal white, bluish, greenish, dark green, emerald green, amber, blue, and purple chunks of raw glass. Moils (the unwanted tops of blown objects) of green, opaline, and amber glass indicate that the blowpipes had an average diameter of 12 mm. Their presence indicates the manufacture of hollow glass in the enumerated colors.

The waste products of glass processing include teardrop-shaped remnants, threads, twisted rods, cuttings, tubes, and distinctive three-lobed segments, as well as the

remains of bead production (*see below*). Among the twisted rods and segments is a colorless piece with a fine ruby-red thread inside. This find reveals the processing of ruby-red glass rods at the Gegenbach glassworks, but their actual production here remains uncertain due to the absence of ruby-red raw glass among the wasters. Ruby-red cuttings and rods, as well as ruby-flashed glass fragments, were also recovered from the neighboring Sonnenschlag glassworks.

Hollowware

The recovered hollowware is primarily represented by very small fragments. Nevertheless, with a few exceptions, they can be assigned to clear shape groups on the basis of their characteristics (Tarcsey 2019:244-245). The older group consists of colorless glasses *à la façon de Venise*, simpler vessels made of light green and blue glasses, all with thin walls and exhibiting slight iridescence. These are Renaissance-era glasses, for which very good equivalents can be found at the glassworks of southern Bohemia and the Waldviertel, for example, at least until the 3rd quarter of the 17th century (Tarcsey 2008a:294-295).

The more recent shape groups include clear colorless glass, the development of which between 1670 and 1700 marked a change in glass technology. These characteristic Baroque glasses comprise thick-walled, conical beakers and goblets, sometimes adorned with various cut designs such as wreaths, of clear glass with internal ruby decoration, opaque white glass with blue, combed, or marbled patterns, as well as thick-walled mass-produced goods made of green glass. This hollowware group corresponds very well with the products of the South Bohemian glassmakers that were primarily associated with the Müllner family (Tarcsey 2019:263-264).

Since the hollowware finds are mostly represented by very small fragments and often only represent individual pieces, it is difficult to make a reliable distinction between local production and imported cullet, especially since the multiple occurrence of identical shapes is a decisive criterion when determining the products made on site. Due to the limited quantity of the recovered material, it cannot be ruled out that the older glass is cullet, possibly brought in from the neighboring Sonnenschlag glassworks.

Flat Glass

The glass finds include a large number of fragments of different types of flat glass. Among them are many bull's-eye pane remnants that may not be local products but were also

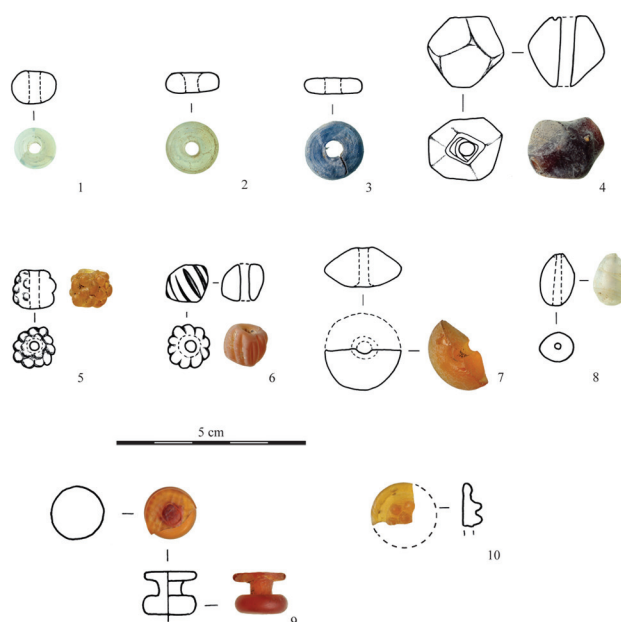


Figure 11. The bead (nos. 1-8) and button (nos. 9-10) types recovered from the Gegenbach glassworks (drawing: Ines Ruttner; photo: Alexandra Bruckböck, Upper Austrian State Museum).

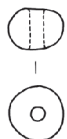
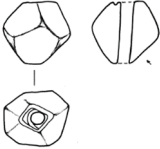
brought in as cullet. Of local origin are plate glass wasters: round, high-quality glass panes which – in contrast to the bull's-eye panes – do not have an annoying pontil mark in the center thanks to a special manufacturing technique (Tarcsey 2008a:193-195, 2008b).

Beads

The Gegenbach glassworks production spectrum is characterized by wound beads made of colorless, opalescent white, yellow to orange/amber, blue, or emerald green glass. Round, oblate, oval, disk, pentagonal-faceted, mulberry/raspberry, ribbed, and biconical types have been recorded so far (Table 1; Figures 11-12). The round/oblate and faceted types predominate with more than 300 examples each, while the disk, biconical, and oval specimens are represented by only one or two specimens. Identical beads were also collected at the Sonnenschlag glassworks (Figure 4).

Production waste includes tapered glass segments (Figure 13) as well as malformed beads with “tails” (Figure 14), revealing that the beads were made by winding them on a mandrel directly from the crucible (for a detailed description of the production process, *see* Karklins et al. 2016). While still in a viscid state, the newly formed beads could be shaped by pressing them with a small paddle. In the case of the mulberry beads, it may be that the knobbed patterns (Figure 15) were imparted through the use of a

Table 1. Characteristics of the Glass Beads from the Gegenbach Glassworks Excavations.

Form	Quantity*	Color	Dimensions	Kidd Type**
 Round to oblate	341	Colorless to opal, emerald green, amber, blue	Diameter: 7-10 mm, also 13-14 mm	WIb
 Donut	12	Colorless to opal, amber	Diameter: 8-14 mm, Length: 5-7.5 mm	WId
 Disk	1	Blue	Diameter: 15.5 mm	flatter than WId
 Pentagonal faceted	300	Colorless to opal, emerald green, amber, blue	Length: 6.5-12 mm, also 15-20 mm	WIic
 Mulberry/ raspberry	52	Colorless to opal, emerald green, amber, blue	Diameter: 8-13 mm	WIId
 Ribbed	27	Colorless to opal, emerald green, amber,	Diameter: 8-12 mm	WIIE
 Bicone	1.5	Amber	Diameter: 12-21 mm, Length: 6-10 mm	WIik
 Oval	2	Amber, opal	Length: 12 mm, Diameter: 7-9 mm	WIc
* Two bead halves were counted as a single bead. ** Kidd and Kidd (1970).				

small ceramic stamp (Figure 16). Such a stamp, with which berry nubs were stamped on vessel walls, was found at the

Reichenau glassworks (1601-1686?) in Freiwald, Lower Austria (Tarcsey 2008a: R-K1, 235-236, Figure 184).



Figure 12. Color varieties of the Gegenbach beads (photo: Alexandra Bruckböck, Upper Austrian State Museum).

In addition to the general production waste from bead production were beads that were likely discarded due to certain quality criteria. Numerous beads have the finest hairline cracks from which they break easily and sometimes even fall apart in storage. This damage could have been caused by conditions in the ground, but more likely it was caused by their being cooled too quickly after production (Figure 17).

Buttons

Like other beadmakers, Gegenbach also produced buttons. Two varieties have been recorded. One, made of amber-colored glass, has a waffle pattern on the flat disk face (Figure 11, no. 9). These have also been recovered from the Sonnenschlag glassworks and from Bohemian sites (Fröhlich 1989: Plate 7, no. 12). The second, also amber-colored, has several berry knobs on the broken flat disk face (Figure 11, no. 10) (Fröhlich (1989: Plate 7, no. 7). The shank is missing.

THE CHEMICAL COMPOSITION OF THE GEGENBACH PRODUCTS

Based on purely macroscopic criteria, the Gegenbach glass clearly reflects the change from Renaissance

glass to Baroque clear glass, which appeared during the 1670s and 1680s. This assessment is confirmed by the chemical analysis of 22 glass samples carried out by Dana Rohanová (Department of Glass and Ceramics,



Figure 13. Production waste from beadmaking, Gegenbach glassworks (photo: Kinga Tarcsay).



Figure 14. Malformed beads from the Gegenbach glassworks (inv. no. B 73451/41) (photo: Alexandra Bruckböck, Upper Austrian State Museum).

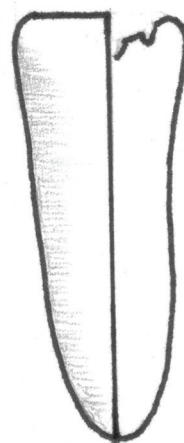
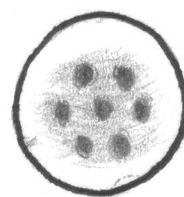
University of Chemistry and Technology, Prague) using a scanning electron microscope equipped with an energy dispersive spectrometer (SEM/EDS) and X-ray fluorescent spectrometry (XRF) (Rohanová 2019:251-256).

Two glass groups are represented. The first was produced using non-purified beech ash as a flux and the composition is close to that of Renaissance glass. Nearly colorless and light green glasses were decolorized by the high MnO content of the beech ash during the melting process. Green glass was colored using copper, blue glass was colored with iron and manganese under specific melting conditions, and brown glass was probably colored the same way as the brown and yellow glass in the following group.

The second glass group, refined with arsenic (As_2O_3), was produced beginning in the 4th quarter of the 17th century and is typical Baroque glass. A subgroup comprising colorless glass was melted using pure raw materials (sand,



Figure 15. Mulberry/raspberry bead showing the recognizable imprint of a knobbed-berry stamp, Gegenbach glassworks (Photo: Kinga Tarcsay).



1 cm



Figure 16. Ceramic knobbed-berry stamp, Glashütte Reichenau am Freiwald (M216/41) (photo: Kinga Tarcsay; drawing: Eva Saidi).

potash or tartar, and limestone) with the addition of arsenic. It could be characterized as “crystal” glass. A subgroup of opaque glasses employed ash derived from sheep bones as an opacifier; Flurl (1792:72) describes how transparent, apparently colorless, buttons made of glass mixed with bone ash were rendered opaque milk-white by subjecting



Figure 17. Spherical beads of opal glass, many of them broken, Gegenbach glassworks (photo: Kinga Tarcsay).

them to a secondary firing. Dark green glass was colored intentionally with a higher content of iron together with copper oxide. Yellow and brown glasses – well known as “amber glass” – were likely colored with a tetrahedral complex compound containing Fe^{3+} and S^{2-} , under reduction conditions during the melting process.

INTERPRETATION OF THE GEGENBACH GLASSWORKS

Due to the wide range of recovered glass products, the original idea that there was only a small bead furnace (*Paterlofen*) at the Gegenbach glassworks – based on the presence of many beadmakers (*Bettmakers*) at the site from 1701 to 1714 – had to be abandoned in favor of a larger glassworks with more varied production.

The similarity of finds at both the Gegenbach and Sonnenschlag glassworks raises the question of why the two glassworks, which are only about one kilometer apart, apparently existed at about the same time. A plausible explanation for this could be the “stationary forest glassworks” and associated “succession places” postulated by Kirsche (2005:128-137) for the early modern glassworks in the Ore Mountains of Saxony. The stationary glassworks were built in remote forest regions and existed for longer periods of time. Part of the “heritage” of the glassworks were additional glass ovens, the so-called succession places, so that production could be relocated if necessary. Kirsche (2005:128-137) states that this type of situation existed from the middle of the 16th century to around 1720. A similar situation is evidenced by the four former furnaces at the Reichenau glassworks in Freiwald, Lower Austria, which operated concurrently in the 16th century a short distance from each other (Tarcsay 2008a:293). The chronologically appropriate analogies as well as the similar archaeological finds suggest that the

Gegenbach hut may be interpreted as the succession place of the Sonnenschlag glassworks, thus explaining the lack of another hut name in the historical sources.

While the finds from both sites tend to suggest that the two glassworks are coeval, Franz Haudum’s renewed critical review of the historical sources reveals that there was obviously a chronological sequence of the “former” Sonnenschlag works and the “present” Gegenbach furnace. Ultimately, only further historical and archaeological research will clarify this situation.

CONCLUSION

Bead production at Schwarzenberg am Böhmerwald is documented from the 17th century until the closing of the Gegenbach glassworks in 1716, and at least until 1720/1721 at the Schlägler am Schwarzenberg glasshouse. Due to the apparently significant production of beads, the Schwarzenberg glassworks belong to the so-called *Paterlhütten* (“bead huts”) whose typical products since the Middle Ages were beads for jewelry and rosaries (*Pat[t]erln*). The production of wound glass beads is likely to have been largely the same here from the Middle Ages to the 18th century. Only a single person with a few tools and a small furnace port was required to wind beads, but he could produce several thousand in a day.

The bead huts – which can be identified through archival material, place names, or archaeological investigations – operated in the southern Bohemian Forest, the Upper Palatinate Forest, the Bavarian Forest, the Grätzen Mountains, the Bohemian-Moravian Highlands, and the northernmost Mühlviertel (Fröhlich 2015; Haller and Schopf 2018). Among the huts are those that produced only beads (and buttons), but also those at which, as apparently at Schwarzenberg, they were only one of several product lines (Fröhlich 2015; Lněničková 1996:30-31). Mauritius Vogt (1712:141) noted increased attention to the production of glass beads in southern Bohemia, including the Bohemian Forest, around 1700 (Haudum 2019:224-225). From 1704/1705 on, large quantities of beads were also produced further south, near the border with Upper Austria, in Aich near St. Gilgen am Wolfgangsee in Salzburg (Wintersteiger 2007:26-28).

Glass beads corresponding to those from Schwarzenberg were also produced in southern Bohemia (Figure 18) at the Alte Schlemmerhütte/Tomášova glassworks in Winterberg/Vimperk (1689-1722) (Blau 1956:215; Fröhlich 1989:9-10, 2015:434) and the Stegerhütte/Štegarova hut near Wallern/Volary (end of the 17th century) (Fröhlich 1989:16-17, 2015:434), as well as at the somewhat secluded hut at Nová



Figure 18. Location of the beadmaking glassworks in the Bohemian Forest with a similar production spectrum, 17th-18th centuries (drawing: Kinga Tarcsay).

Ves in the Bohemian-Moravian Highlands (1691-1721) (Hrubý et al. 2009). As previously mentioned, Johann Anton Landgraf's brother-in-law worked at the latter glassworks, as well as at the Bodenmaiser glassworks, and finally took over the Helmbachhütte from his father (Haudum and Tarcsay 2019:225; Hrubý et al. 2009:482), so that similar bead production can also be assumed at the latter works.

According to F. Haudum (2019:222-226), glass bead production in the Bavarian-Bohemian region experienced a boom around 1700. The beads were exported in large quantities to Passau and Vienna, as well as to Holland, Spain, and Portugal, from where they were exported overseas, especially to the Americas and India. That few of these beads have so far been found in domestic and burial contexts in Austria suggests that they were mainly produced for export.

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THE BEADS FROM AN 18TH-CENTURY ACADIAN SITE, PRINCE EDWARD ISLAND, CANADA

Helen Kristmanson, Erin Montgomery, Karlis Karklins, and Adelphine Bonneau

Excavation of the Pointe aux Vieux site, an 18th-century Acadian house located on western Prince Edward Island, Canada, yielded a significant assortment of beads. Among the glass and bone specimens are ten black beads decorated with undulating yellow lines around the middle. Commonly called “rattlesnake” beads by collectors, this stylistic form has been found at many sites in North America as well as elsewhere in the world. Unlike the other beads, however, the ones from Pointe aux Vieux are not glass but formed by melting an igneous rock called “proterobas” to form a totally opaque black glass. The only known source of beads made from this material is the Fichtelgebirge region of northeastern Bavaria. While black ball buttons made of proterobas have been encountered at various sites in the eastern United States and Western Europe, this is the first recorded instance of proterobas beads in North America. It is hoped that this article will lead to more such beads being identified in archaeological collections so that their distribution and temporal range may be determined.

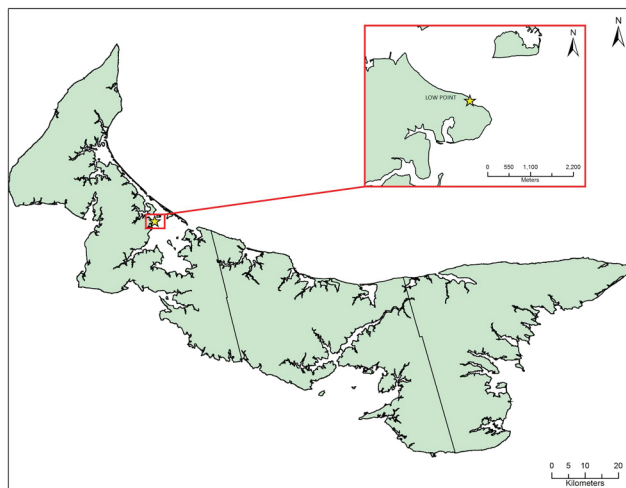


Figure 1. Prince Edward Island showing the location of the Pointe aux Vieux site (CdCx-5) in Low Point (graphic: Erin Montgomery).

INTRODUCTION

The Pointe aux Vieux site (CdCx-5) is located at Low Point on the western shore of Malpeque Bay on northwestern Prince Edward Island (Figure 1). Known as the Garden of the Gulf, Prince Edward Island is Canada's smallest province, encompassing 5620 square kilometers. Surrounded by over 1100 kilometers of shoreline, the island sits at minimum about 13 km from the mainland and consists mostly of agricultural lands, forest, and rolling hills.

Prince Edward Island's long history of human occupation began about 13,000 years ago, long before it became an island, when the warming climate melted the Laurentide ice sheets and made way for the arrival of plants, animals, and people. Today the Mi'kmaq, who call the island Epekwitk, are recognized as the Island's Indigenous population and their history is documented orally, archaeologically, linguistically, textually, and ethnographically. By comparison, Europeans were relative newcomers to the island, permanently settling there in 1720.

HISTORICAL CONTEXT

The Pointe aux Vieux site represents the remains of an Acadian house built and inhabited for 30 years, or parts thereof, between 1728 and 1758, as part of the first non-Indigenous settlement in western Prince Edward Island. Though archaeological evidence points to a comfortable existence at this picturesque location, ongoing political upheaval shaped life during the 17th and 18th centuries as Britain and France vied for territorial control of Atlantic Canada and the lucrative cod fisheries off their coasts. In 1713, the Treaty of Utrecht awarded the French territories of Newfoundland and Acadia (present-day Nova Scotia) to the British, but allowed the French to retain most of New Brunswick, Île Royale (present-day Cape Breton), and Île Saint Jean (present-day Prince Edward Island). In an attempt to secure their loyalty, British authorities pressured Acadians to take an oath of allegiance to the British Crown and move to territory under the French regime, such as Île Saint Jean (Arsenault 2009). Few chose to immediately leave Acadia, however, adhering to the policy of neutrality they

had maintained for generations. The Acadian community continued to prosper and by the 1740s, the population had grown to 10,000.

Beaubassin was a major Acadian settlement during this time. Established between 1671 and 1672, it was a prized site for its strategic location at the Isthmus of Chignecto between French and British territories. Here, the Acadians were constantly exposed to recurring hostilities and political pressures. This, in combination with the pressures associated with a growing population, may have played a role in the decision to relocate to other areas such as Île Saint Jean.

The Acadian Settlement at Malpeque

Although the Mi'kmaq had regular contact with European fishers and traders in the 17th century, permanent European settlement on Île Saint Jean did not take place until 1720, beginning with the French settlement, Port-la-Joye (now Skmaqn–Port-la-Joye–Fort Amherst National Historic Site), and followed by numerous Acadian settlements across the Island. One such settlement, known as Malpec or Malpeque, was founded by the families of Pierre Arsenault II and his wife Marie-Anne Boudrot, their son, Charles, and his wife, Cécile Breau, and Jean Lambert (spouse unidentified), who in 1728, said goodbye to their homes in Beaubassin, Nova Scotia.

Malpeque was the first non-Indigenous settlement in western Prince Edward Island and the new settlers appear to have respected the Mi'kmaq name for the place, *Maqpa'q*, meaning “a large body of water.” The Acadians who settled there were likely drawn by the forests, wild game, and fertile soil. Several accounts of the period praise the quality and accessibility of the land, sea, and resources. But while the settlement at Malpeque had access to a bountiful harbor, the settlers were ordered to focus on agricultural production to supply the Fortress of Louisbourg. Only the settlements of Havre Saint Pierre and Tracadie were permitted to engage in commercial fishing, though archaeological evidence confirms that the settlers at Malpeque Bay supplemented their diet with a variety of fish, bird, and wild game species (Kristmanson 2015a, b). Overall the archaeological record points to a fairly comfortable existence, but the settlement at Malpeque periodically endured agricultural hardships including three consecutive years of poor crop yields from infestations of field mice, grasshoppers, and scald.

The French government at Louisbourg commissioned the first Island census in 1728. At this time, the settlement at Malpeque, populated only by the Arsenaults and Lamberts, was the smallest of the six enumerated communities on the

island, comprising only 17 men, women, and children (La Roque 1906). Over the next three decades, the settlement expanded approximately 15 km along the shoreline between Green Park and Grand River. Most of the settlers were Acadians from the Beaubassin region, but there were others who hailed from the Acadian settlements of Port-Royal, Grand-Pre, Pisiquid, and Cobequid, as well as Île Royale (Cape Breton), Brittany, Normandy, and Île d'Orleans.

By the time Joseph de la Roque conducted the last Island census under the French regime in 1752, the settlement at Malpeque consisted of at least 201 people in 32 households. The community was supported by infrastructure including farmsteads, grist mills, a windmill, church, and cemetery. While historical records provide no information for the settlement's evolution between 1752 and 1758, the population continued to increase, especially during 1755–1756, when the British began to deport Acadians from the present-day Maritime Provinces. Under this plan, the British military forcibly removed the Acadians, sequestering men from their families, escorting families out of their homes before they could gather their belongings, and often setting fire to their houses and barns to prevent them from resettling. Many Acadians ended up in the British colonies, were put in jail, or died at sea while being transported to France. Others escaped to Île Saint Jean, which provided a relatively safe haven until 1758, when the British captured the Fortress of Louisbourg for the second time.

Shortly after the siege at Fortress Louisbourg, British Lieutenant-Colonel Lord Andrew Rollo brought troops to Île Saint Jean, but his objective of mobilizing a mass deportation plan was diverted by unforeseen factors. For example, their plan to march the Acadians roughly 65 km across land to waiting ships at the colonial capital, Port la Joye, was abandoned due to the poor health of the settlers at Malpeque Bay (Lockerby 1999). Moreover, the British had underestimated the size of the Island Acadian population, arriving with a fleet capable of transporting only those within reach of Port la Joye. This was compounded by changing priorities within the British military which resulted in inaction, giving the Malpeque Acadians time to systematically pack their belongings and escape by sea. The Mi'kmaq came to the aid of the Acadians during this time of upheaval, helping some to find shelter in the woods and others to load their livestock onto boats. Most Acadians moved several times before resettling in the Maritime Provinces, Gaspé Peninsula, Magdalen Islands, Miquelon, Louisiana, or France. While some Acadians returned to settle on Prince Edward Island, the house at Pointe aux Vieux, and the settlement at Malpeque, were never restored (Arsenault 2009; Kristmanson 2015a, b; Lockerby 1999, 2003).

THE ARCHAEOLOGICAL STUDY OF POINTE AUX VIEUX

Telltale signs of the Acadian settlement at Malpeque Bay have long been reported in the Low Point area. In 1846, physician and geologist Abraham Gesner (1847) reported encountering “the site of an old French village and a large chapel” along this shoreline during his geological survey of Prince Edward Island. Here he also mentioned seeing a number of human bones scattered along the base of a low cliff where “the sea has advanced rapidly upon the shore, and has intruded upon the cemetery” (Gesner 1847). Similar observations were made in an Island newspaper, *L’Impartial* (1893:2), by an anonymous person who had visited the site and, guided by the current landowner, noted several vestiges of the past including depressions associated with cellars, a perfectly preserved well, and skeletal remains peeking out of the erosional face at Low Point. Historical maps, such as those produced by Captain Samuel Holland (1765) and Charles Morris (1768), show what remained of the Acadian settlement at Malpeque Bay as much as a decade after the Deportation. In these maps, the Pointe aux Vieux site appears to be situated behind a larger building nearer the shore and represented by Morris as a “Chapelle” (Figure 2).

A brief archaeological assessment was conducted in the area in 2001 because bones were found extruding from the bank. These remains were faunal and found in association with other artifacts consistent with 18th-century Acadian sites, including Saintonge pottery, square nails, and pipe stem fragments (Buchanan 2001). Though two archaeological features were identified during this assessment (a domestic refuse pit and a cellar), the Pointe

aux Vieux site was not archaeologically studied until 2007, when it was rediscovered during a shoreline survey by Dr. Helen Kristmanson (Government of Prince Edward Island) and Jesse Francis (Parks Canada/Mi’kmaq Confederacy of Prince Edward Island). The aim of the survey was to retrace the steps of William Wintemberg, National Geological Survey archaeologist, who surveyed and tested numerous locations along the Island’s north coast between Malpeque Bay and Cable Head in 1913. The research objective was to locate and consider the effects of coastal erosion on the 18 precontact sites he identified in Malpeque Bay (Kristmanson 2008; Wintemberg 1914). If he noticed it, Wintemberg did not identify or record the Pointe aux Vieux site, his main purpose being the discovery of Indigenous sites.

At this location, Kristmanson (2008) and her team encountered a cellar feature perched at the water’s edge. This evidence, combined with 19th-century accounts of bones showing in the exposed soil profile, suggests that the church and cemetery associated with the settlement at Malpeque have been lost to erosion, leaving only the subsurface house remains partly exposed in the shoreline bank.

We do not know who owned the house at Pointe aux Vieux nor whether it was home to a single family or successive occupants. Given the circumstances under which the site was evacuated, the inhabitants were likely able to pack their belongings, leaving behind only fragmentary detritus. Archaeological evidence points to an original build and a later renovation by a single or extended family (Kristmanson 2015a, b). The census records of 1752 (La Roque 1906) offer no architectural information but provide a glimpse of the Acadian families at Malpeque Bay including the names and ages of all family members and residents of each home, their country of origin, years as an Île Saint-Jean resident, types of crops in cultivation, types and number of livestock, and, occasionally, whether they owned a boat. There are few details describing when Acadian families were granted parcels of land or by what mechanism. On occasion La Roque notes that some parcels were granted through verbal permission. Neither census records nor historical maps (e.g., Holland 1765 or Morris 1768) associate particular plots of land with named Acadian owners.

Methodology

Archaeological excavations at Pointe aux Vieux were conducted between 2008 and 2011 (Kristmanson 2009, 2015a, b). Preliminary investigations began with a geophysical survey of the area using a Bartington

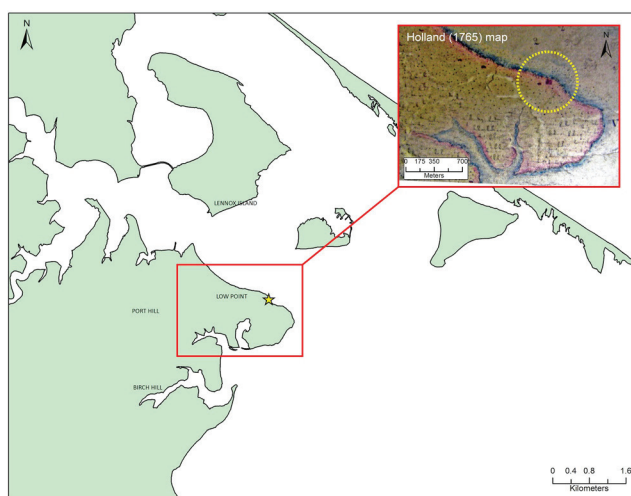


Figure 2. The location of the Pointe aux Vieux site. The inset shows the disposition of the church and house in 1765 (graphic: Erin Montgomery).

601Grad fluxgate gradiometer magnetometer. The geophysical survey results were inconclusive and offered little information regarding remnant structural features at the site (Gendron 2008). Shovel testing produced a small number of non-diagnostic artifacts but, encouraged by the presence of Saintonge coarse earthenware which is found on archaeological sites in the Maritime Provinces dating from the late 17th to mid-18th centuries, archaeological investigations proceeded (Kristmanson 2008).

A 5-cm elevation map gave a clear view of the cellar depression and basic site topography, but indicated no other cultural features. Further testing by 50cm² shovel tests and 1m² units helped determine the most productive location for excavations. Using a grid system of 1m² squares tied to a fixed datum, 26 units were hand troweled. Back dirt was screened through a quarter-inch mesh and soil samples were removed for water screening and flotation.

Architectural evidence

Little is left of the Acadian house at Pointe aux Vieux, which has been quietly disappearing for 250 years. Nonetheless, the collapsed foundation and other features came into view as the archaeologists removed the overburden (Figure 3). Although the foundation was not intact, a pattern could be seen to suggest a footprint of roughly 7 x 6 m oriented on a NW-SE axis, similar to the foundations at the coeval Belleisle sites in Nova Scotia (Christianson 1984; Kristmanson 2015). Eighteenth-century accounts of Acadian homes by Hale (1731) and MacDonald (1795) suggest the house was likely a one-and-a-half-story dwelling with one main room where the occupants slept, cooked, and ate. Archaeobotanical evidence suggests that the structure sat in a clearing and had a thatched steep-pitched roof made from locally available rush grasses (Faucher 2012). The presence of two decomposed hewn planks, an excavated cellar, foundation stones, hand-wrought nails, and a very small amount of what may be mortar or plaster, suggests that the house was wood-framed with a stone foundation. A few pane glass fragments indicate the presence of at least one window.

A depression approximately 1.25 m below ground surface is indicative of a root cellar with a natural sandstone floor underneath part of the house. An outdoor bake oven conjoined to an indoor fireplace is at the eastern end of the dwelling. All that remains of the oven are field stones about the size of a football set into a horseshoe-shaped clay base, while two stonework footings indicate where the fireplace stood. In the cellar, a layer of highly organic soil containing thousands of fragmentary artifacts and ecofacts – including



Figure 3. The foundation of the house at Pointe aux Vieux (photo: Helen Kristmanson).

bird, fish, and animal bones, ceramics, smoking pipes, glass, gun shot, and charcoal fragments – was found under 40-50 cm of clay and rock. This suggests that waste was thrown or fell into the cellar, at least for a time, and was sealed with a thick and precisely laid layer of clay and rock in a subsequent episode of construction. There is no evidence to suggest that the site was used before or after the Acadian period (1728-1758) (Kristmanson 2015b).

THE POINTE AUX VIEUX ARTIFACTS

The Non-Bead Material

Approximately 22,000 artifacts and ecofacts were excavated from Pointe aux Vieux with an additional 5000 artifacts surface collected from the shoreline in front of the site. Faunal remains dominate the assemblage with over 11,000 mainly fragmentary elements representing more than 50 species (Stewart 2010, 2012, 2013). These included a variety of wild game, such as terrestrial and sea mammals,

birds, and fish, in addition to a variety of domesticated livestock (chickens, cows, pigs, and sheep). The assemblage contains a high volume of mollusks, mostly oysters. The preservation of faunal remains and bone cutlery handles may be explained in part by the presence of shell in the acidic soil.

A high volume of small (2-6 mm diameter) lead shot was recovered, including a cache of several thousand on the beach. Their small size suggests use in a fowler flintlock which would have been effective for hunting birds or fox-sized game. A lead pistol patch, sprue, and several gunflint fragments are further evidence of firearms at the site. A distinctive escutcheon in the form of an owl with the face of the goddess Athena on its chest was found in the cellar feature. A similar item was uncovered at Fort Michilimackinac in northern Michigan and is interpreted to be of English origin (Kristmanson 2015b).

The assemblage includes an array of cutlery, tableware, and glassware imported from Europe. Over 150 fragments of Saintonge coarse earthenware vessels are in the collection. Dating ca. 1700-1800, this ceramic comes from southwestern France and is indicative of French colonial and Acadian sites. Other ceramics include fragments of tin-glazed earthenware (faience), yellow Staffordshire slipware (ca. 1670-1795), a decorated Delftware chamber pot handle, and a grape vine jar (Kristmanson 2015b). Grape vine jars were used to transport live grape vines to North America from Biot in southwestern France, and have been found at Fortress Louisbourg in the context of wealthy residents (Jonah and Vechambre 2012). It is not clear how this luxury item came into the hands of the people at Pointe aux Vieux or how it was used. Other dining materials recovered from the site include stemmed wine glasses, dark-olive wine bottles, and a bone-handled serving fork and knife set.

A range of personal items hint at the individual identities and activities of the people at Pointe aux Vieux. An ornate copper-alloy shoe buckle, buckle chape, two metal buttons, a fragmentary hook and eye closure, and over 150 straight pins are among the clothing-related artifacts. In addition to their use as clothing fasteners, straight pins were also used for lace making and sewing. Historically, they also served as talismans (Beaudry 2006; Longman and Loch 1911). Direct evidence for sewing is in the form of a small copper-alloy thimble, and several lead bale seals attests to the bolts of fabric to which they were once affixed.

Two items from Pointe aux Vieux may be related to personal adornment. The first consists of six small “gooseberry” beads mounted on a straight pin, the pointed end of which has been bent into a loop, apparently so that the object could be suspended (Figure 4). It is unknown whether this item – which is 19.5 mm long – served as an ornament



Figure 4. Six “gooseberry” beads mounted on a straight pin (photo: Claude Arsenault).

or had some other purpose. The second object is a perforated metal disk which may have functioned as a pendant. There is no evidence that the object is a modified coin.

One of the most fragile and rarest artifacts is a small religious pendant or reliquary (Figure 5). The circular object, which measures 19 mm in length and 12 mm in width, has a copper-alloy frame enclosing a textile disc on which is printed IHS between two red dots. This is variously interpreted as a Christogram or abbreviation of the first three letters of the Greek name of Jesus, Iota-Eta-Sigma (ΙΗΣΟΥΣ), or as *Iesus Hominum Salvator*, meaning “Jesus Savior of Mankind.”

A large suspension eye is situated at the top of the reliquary with a smaller one at the bottom. A small emerald green glass bead (IIa27) serves as a buffer between the medallion and the lower eye. The pendant may once have been affixed to a rosary. A few bone rosary beads and a



Figure 5. A reliquary incorporating an emerald green bead (photo: Claude Arsenault).

perforated lead cross may be associated with this object and are a reminder of the Acadians' religious faith.

The Bead Collection

A total of 125 whole and fragmentary beads representing 32 varieties (Figure 6) was recovered from the Pointe aux Vieux site. Most of these are conventional glass, of both drawn (n=97) and wound (n=14) construction, but ten of the wound beads are made of proterobas, an igneous rock (a greenish lamprophyre) that melts readily to form an opaque black glass. Another three beads are made of bone. In addition to the 114 beads described below are 11 glass specimens that were either too fragmentary to be classified or not available for study.

The glass beads are classified using the taxonomic system developed by Kenneth E. Kidd and Martha A. Kidd (2012) as expanded by Karklins (2012). Varieties that do not appear in the Kidds' lists are marked by an asterisk (*) followed by a sequential letter for ease of reference. The color names generally correspond to those used by the Kidds. Diaphaneity is described using the terms opaque (op.), translucent (tsl.), and transparent (tsp.). Regarding measurements, D=diameter; L=length.

Drawn Glass Beads

Drawn beads predominate (n=97) and comprise 24 varieties. Tubular beads (n=32) are represented by 16 varieties while circular seed beads (n=65) are of 8 varieties. All the tubular beads are decorated with stripes, primarily spiral, while the seed beads – with the exception of six “gooseberry” beads – are all plain.

Ib*(a). Tubular; op. white; four (?) op. red stripes; n=1. D: 6.4+ mm; L: 7.0+ mm.

Ib*(b). Tubular; op. white; four (?) op. blue stripes; n=1. D: 4.4 mm; L: 7.3 mm.

Ib'*(a). Tubular; op. red; three op. white slightly spiral stripes; n=1. D: 5.4 mm; L: 38.1 mm.

Ib'*(b). Tubular; op. white; four op. red spiral stripes; n=1. D: 40.8 mm; L: 5.8 mm.

Ib'*(c). Tubular; op. white; eight narrow op. red spiral stripes; n=2. D: 20.9 mm; L: 6.1 mm.

Ibb'*(a). Tubular; op. red; indeterminate number of red-on-white spiral stripes; n=2. D: 6.0 mm; L: 11-27 mm.

Ibb'*(b). Tubular; op. white; three (?) op. red/yellow/blue spiral stripes; n=2. D: 6.2+ mm; L: 10.1+ mm.

Ila7. Circular; op. black; n=10. D: 2.9-3.2 mm; L: 1.6-2.1 mm.

Ila14. Circular; op. white; n=22. D: 2.2-3.3 mm; L: 1.7-2.7 mm.

Ila17. Circular; op. light gold; n=1. D: 2.6 mm; L: 1.9 mm.

Ila27. Circular; tsl. emerald green; n=1. D: ca. 2.0 mm; L: ca. 1.0 mm. Part of a religious medallion.

Ila47. Circular; op. shadow blue; n=2. D: 2.5 mm; L: 1.5-1.8 mm.

Ila56. Circular; tsp. bright navy; n=20. D: 2.7-3.7 mm; L: 1.7-2.6 mm.

Ilb18. Circular; tsl. light gray “gooseberry” beads with 12 op. white internal stripes; n= 6. D: 3.0 mm; L: 2.0-3.5 mm.

IIIb'*(a). Tubular; op. red outer layer; tsp. green core; four op. white, slightly spiral stripes; cased in clear glass; n=1. D: 7.0+ mm; L: 16.8+ mm. The stripes are ridged, apparently representing glass rods laid side by side on the original glass gather.

IIIbb1. Tubular; op. red outer layer; op. green core; three black-on-white stripes; n=1. D: 7.1 mm; L: 17.9 mm.

IIIbb5. Tubular; op. red outer layer; op. black core; three blue-on-white stripes; n=2. D: 6.0+ mm; L: 11.8+ mm.

IIIbb'*(a). Tubular; op. red outer layer; op. black core; decorated with three black-on-white slightly spiral stripes; n=3. D: 5.7-6.8 mm; L: 11.8-25.5 mm.

IIIbb'*(b). Tubular; op. red outer layer; tsl. light gray core; three black-on-white slightly spiral stripes; n=3. D: 4.9-5.8 mm; L: 13.5-23.2 mm.

IIIbb'*(c). Tubular; thin op. white outer layer; tsl. light gray core; three blue-on-red spiral stripes; n=8. D: 4.7-6.1 mm; L: 15.1-37.3 mm.

IIIbb'*(d). Tubular; thin op. white outer layer; tsl. light gray core; three spiral compound spiral stripes of which only a red component remains; n=1. D: 4.3 mm; L: 25.6 mm.

IIIbb'*(e). Tubular; thin op. bluish white outer layer; tsl. light gray core; three broad blue/red spiral stripes; n=1. D: 5.6 mm; L: 24.0 mm. The stripes are ridged, apparently representing glass rods laid side by side on the original glass gather.

III[e](a).** Tubular-ribbed; op. red outer layer (12 ribs); tsl. light gray core; three (?) op. white stripes; n=2. D: 3.9-6.5 mm; L: 17.9-20.0 mm.

IVa3. Circular; op. red outer layer; tsp. light gray core; n=3. D: 2.9-3.6 mm; L: 1.8-3.1 mm.

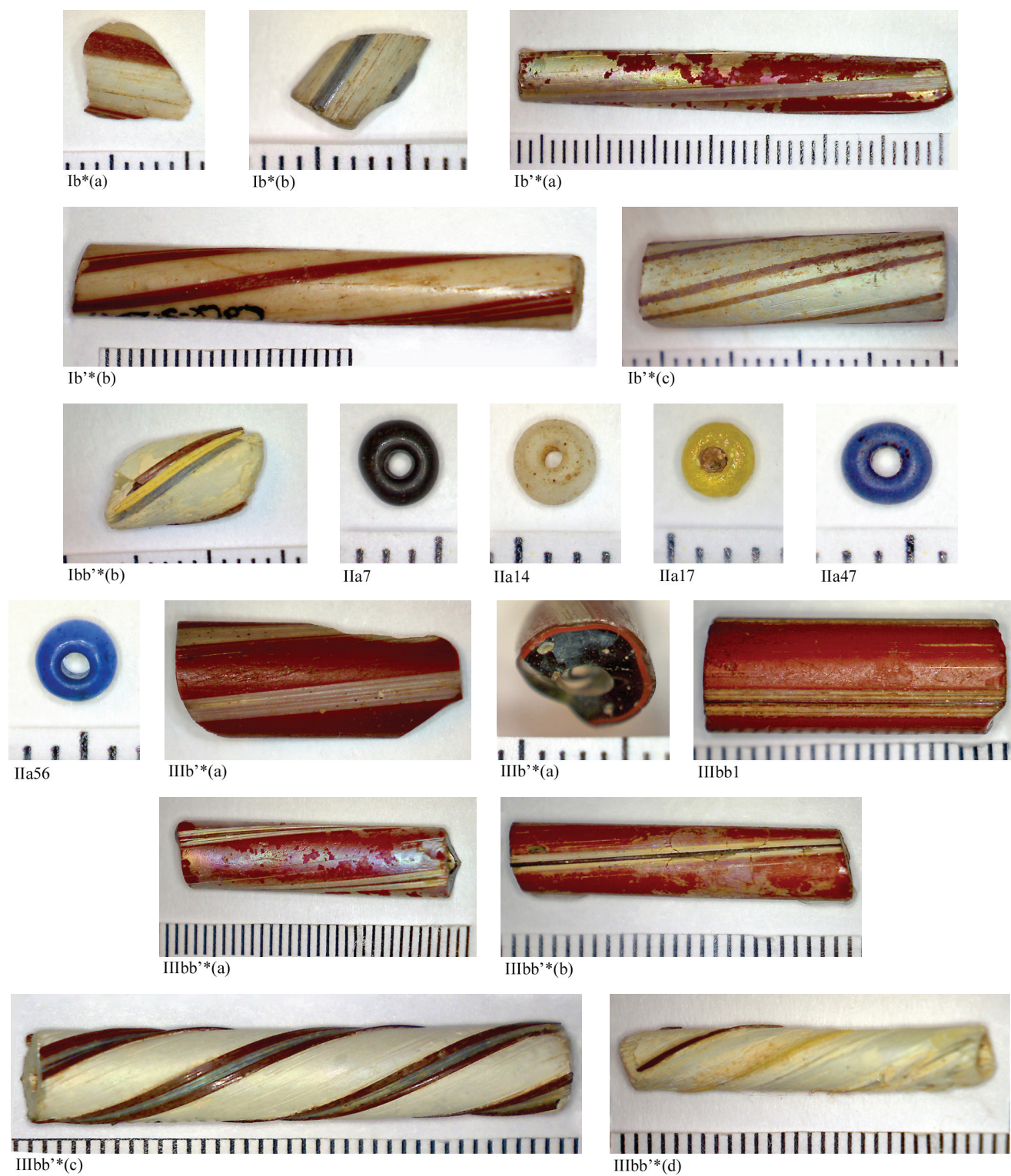


Figure 6. The Pointe aux Vieux bead varieties (not all varieties are illustrated) (photos: Claude Arsenault).

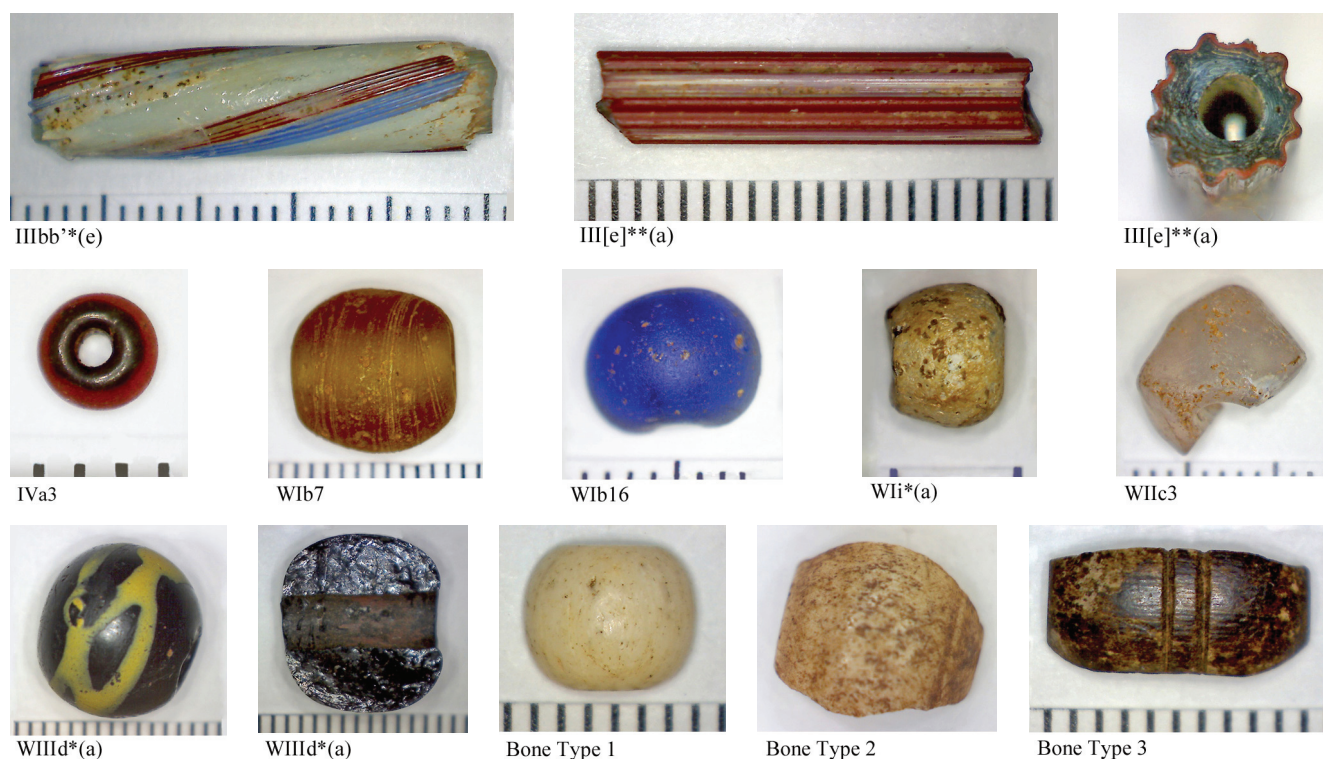


Figure 6, continued. The Pointe aux Vieux bead varieties (photos: Claude Arsenault).

Wound Glass Beads

Wound beads, represented by five varieties, are in a minority (n=14). While it cannot definitely be said of all the beads, the pentagonal-faceted and decorated black beads are furnace wound. The others could have been produced at the lamp.

Wlb7. Round; tsl. amber; n=1. D: 9.4 mm; L: 9.6 mm.

Wlb16. Round; tsl. bright navy; n=1. D: 7.7 mm; L: 5.8 mm.

Wli*(a). Truncated teardrop; tsl. maple; thick patina; n=1. D: 5.4 mm; L: 4.5 mm. One end appears to be broken.

WIic3. Pentagonal-faceted; tsl. pale blue with golden cast when held up to the light; n=1. D: 9.2 mm; L: 7.7 mm.

WIId*(a).¹ Round; op. black; op. yellow meandering lines around the middle; n=10. D: 9.4-11.4 mm; L: 9.3-10.8 mm. One specimen has lost its decoration. Made of proterobas.

Bone Beads

The three bone beads all appear to be lathe turned and most likely represent rosary components.

Type 1. Round; n=1. D: 5.9 mm; L: 5.0.

Type 2. Round; groove around one end; flat ends; n=1. D: 4.5 mm; L: 5.0.

Type 3. Oblong; two medial grooves; flat ends; n=1. D: 4.6 mm; L: 9.6.

ARCHAEOMETRIC ANALYSIS OF SELECT GLASS BEADS

Close examination of the broken surfaces of the fragmentary WIId*(a) beads revealed that they were rough (Figure 6), unlike the smooth conchoidal fractures exhibited by most glasses. This roughness has also been noted on some broken ball buttons made of proterobas in the Fichtelgebirge region of northeastern Bavaria during the 17th century (Karklins 2014: pers. obs.). Proterobas is an igneous rock, a greenish lamprophyre, that melts readily to form a totally opaque black glass without the need of additives; traditional black glass is either deep purple, green, or blue when held up to a strong light. In that proterobas can be readily identified due to its distinct composition, a sample of the WIId beads was sent to Adelphine Bonneau at Laval University, Quebec City, for analysis. Also submitted were two proterobas samples recovered from the early-17th-century Wolfslohe glasshouse site near Fichtelberg, Bavaria (Karklins et al. 2016:22-24), and several other Pointe aux Vieux beads for comparison.

Table 1. Semi-Quantitative Analysis (SEM-EDS) of a Sample of Pointe aux Vieux Beads.

Cat. No.	Kidd Code / Color	SiO ₂	CaO	Na ₂ O	K ₂ O	PbO	MgO	Al ₂ O ₃
Proterobas Waster 1	Black	43.61 ± 2.35	9.44 ± 0.89	2.98 ± 0.23	2.28 ± 0.28	n/a	6.62 ± 0.3	13.58 ± 0.7
Proterobas Waster 2	Black	59.97 ± 0.85	1.76 ± 0.43	5.75 ± 0.64	7.65 ± 0.13	n/a	2.49 ± 0.49	17.43 ± 0.4
1988	WIIId* Black	41.60 ± 2.92	8.24 ± 0.5	2.73 ± 0.32	1.91 ± 0.45	0.33 ± 0.25	5.92 ± 0.37	13.75 ± 0.36
9352	WIIId* Black	47.66 ± 0.99	4.28 ± 0.49	2.17 ± 0.18	9.84 ± 0.14	n/a	6.93 ± 0.07	15.80 ± 0.23
17598	WIIId* Black	47.38 ± 1.68	9.43 ± 0.75	2.97 ± 0.39	1.90 ± 0.1	n/a	6.78 ± 0.21	17.06 ± 0.44
17597	WIIId* Black	37.57 ± 1.32	9.96 ± 0.74	3.11 ± 0.72	2.18 ± 0.12	2.23 ± 0.18	5.77 ± 0.68	11.84 ± 0.79
17617	IIa7 Black	52.30 ± 0.46	11.77 ± 0.75	10.27 ± 0.64	1.83 ± 0.08	n/a	2.56 ± 0.18	5.33 ± 0.27
2048	IIIbb1 Red	63.79 ± 0.42	10.97 ± 0.37	10.66 ± 0.12	1.95 ± 0.04	n/a	3.25 ± 0.20	4.08 ± 0.28
17644	WIIc3 Opal	80.05 ± 1.53	5.84 ± 1.01	1.29 ± 0.19	7.45 ± 1.22	n/a	1.06 ± 0.08	3.45 ± 0.32

The study was conducted in two stages: microscopic observation, and scanning electron microscopy coupled with X-ray energy dispersive spectroscopy (SEM-EDS). LA-ICP-MS analysis would have been the ideal analytical method as many beads have been studied using it including the proterobas products of the Fichtelgebirge workshop in Bavaria (Karklins et al. 2016). Unfortunately, it was not available. X-ray fluorescence was considered but rejected due to its weak capacity to detect and quantify sodium and aluminum which are important elements in glass composition. SEM-EDS was selected for its ease of access at the Lux Laboratory in the Earth and Atmospheric Sciences

Department at the University of Quebec in Montreal (UQAM), and because it would provide both images and the chemical composition of the beads without having to sample them. Nine beads representative of the Pointe aux Vieux collection were analyzed. The two proterobas wasters from the Fichtelgebirge workshop were used as references (Table 1).

SEM examination revealed that the drawn glass beads (e.g., IIIbb1) have a honeycomb texture (Figure 7, a), while the WIIId*(a) beads and the two proterobas wasters have a smooth surface texture with small crystals in the form of

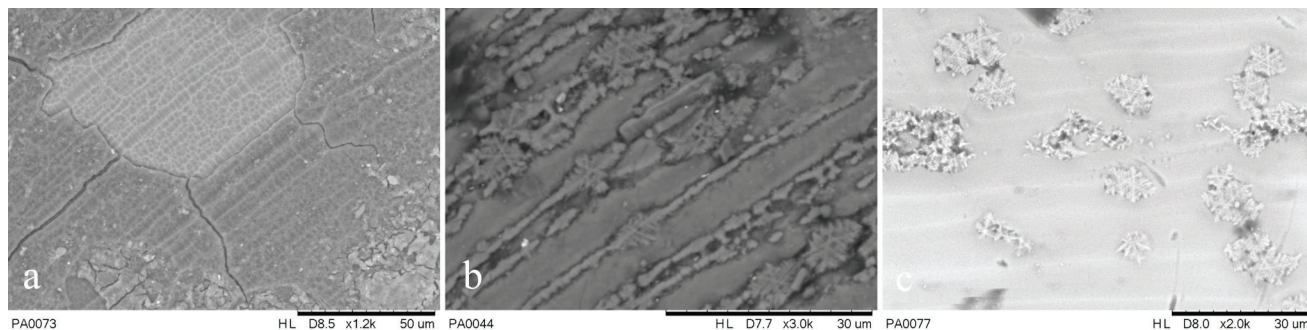


Figure 7. Backscattered SEM images of three specimens: a) honeycomb texture of a glass bead (IIIbb1); b) “snowflake” crystals on a proterobas bead; c) “snowflake” crystals on a proterobas waster (photos: Adelphine Bonneau).

Table 1. Continued.

Cat. No.	Kidd Code / Color	Fe ₂ O ₃	ClO ₂	SO ₂	MnO	P ₂ O ₃	CuO	TiO ₂
Proterobas Waster 1	Black	19.05 ± 2.82	n/a	n/a	n/a	0.12 ± 0.05	n/a	2.32 ± 0.14
Proterobas Waster 2	Black	3.21 ± 0.62	n/a	n/a	n/a	0.22 ± 0.11	n/a	1.51 ± 0.29
1988	WIIId* Black	21.80 ± 4.64	n/a	n/a	n/a	0.49 ± 0.12	n/a	3.23 ± 0.4
9352	WIIId* Black	10.31 ± 0.59	0.16 ± 0.08	n/a	n/a	0.66 ± 0.02	n/a	2.20 ± 0.19
17598	WIIId* Black	11.64 ± 1.24	n/a	n/a	n/a	0.35 ± 0.17	n/a	2.49 ± 0.20
17597	WIIId* Black	23.17 ± 2.26	n/a	n/a	n/a	0.44 ± 0.09	n/a	3.73 ± 0.44
17617	IIa7 Black	3.04 ± 0.19	1.42 ± 0.01	0.16 ± 0.08	10.75 ± 0.67	0.37 ± 0.15	n/a	0.20 ± 0.1
2048	IIIbb1 Red	1.98 ± 0.07	1.17 ± 0.01	0.24 ± 0.12	n/a	0.11 ± 0.05	1.80 ± 0.09	n/a
17644	WIIc3 Opal	n/a	0.87 ± 0.1	n/a	n/a	n/a	n/a	n/a

“snowflakes” (Figure 7, b-c). They resemble similar features called spherulites on obsidians and rhyolites. They are “rounded or spherical masses of one or more acicular minerals that radiate out from a central point” and are “commonly composed of alkali feldspar and quartz polymorphs that are only a few microns in diameter” (Hanson 2020). In that proterobas is an igneous rock, similar crystallization on the surface of the beads is to be expected. Two samples exhibit yellow decoration which is composed of small yellow crystals (Figure 8), and appears to be some kind of paint or glaze rather than glass. The decoration rests on the black glass and can be easily removed by scraping, leaving no trace.

Beads previously analyzed with LA-ICP-MS were used to determine if SEM-EDS semi-quantification results can be directly compared to those obtained using LA-ICP-MS. The results were negative; sodium, magnesium, and calcium were underestimated with SEM-EDS and aluminum and potassium overestimated. This is because SEM-EDS is a surface analysis, whereas LA-ICP-MS makes a microscopic hole in the sample, and obtains readings from the interior (about 100 to 200µm in depth). Even if the glass seems unaltered, ions migrate to its surface and form a layer that has a different chemical composition than the core. We took this phenomenon into account in our interpretation.

In order to determine if the decorated black beads were proterobas, they were compared to the two proterobas wasters and their major and minor compositions match perfectly. Proterobas has a distinct composition: low soda and potash but high concentrations of alumina, lime, magnesia, and iron (Karklins et al. 2016:27). It is very different from that of the drawn black bead (IIa7) which is

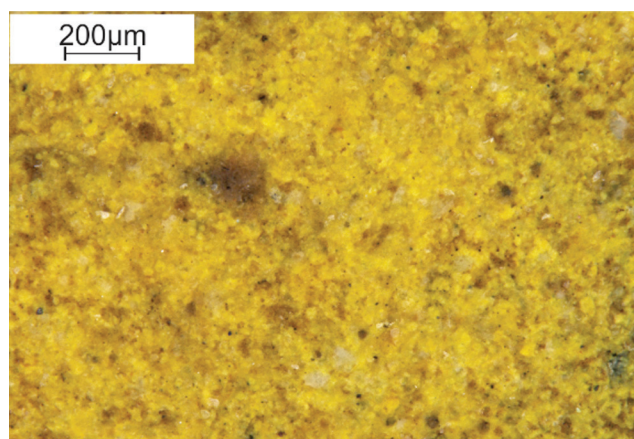


Figure 8. Microscope image of the yellow decoration on the proterobas beads showing its crystalline structure (photo: Adelphine Bonneau).

composed of a soda-lime glass. The yellow decoration is composed of lead and antimony, pointing to the use of the pigment, Naples Yellow ($\text{Pb}_2\text{Sb}_2\text{O}_7$). The exact composition and structure of the yellow material remain undetermined. Further investigation is needed to determine if it is a paint, a glaze, or something else.

Of the other three beads that were analyzed, the pentagonal-faceted specimen (WIIc3) is composed of a high-potash glass, whereas the tubular red bead (IIIbb1) and the black seed bead (IIa7) are soda-lime glass. This suggests two different sources for these beads.

DISCUSSION

Beads of European manufacture have been found at numerous archaeological sites throughout eastern North America, but few beads have been reported from 18th-century Acadian sites in Canada's Maritime Provinces. Two comparable sites from the region are the Belleisle and Melanson settlements in Nova Scotia, each of which was settled in the pre-Deportation era and characterized by similar archaeological features and artifact assemblages that include glass beads. At the Melanson settlement, an unspecified number of spherical glass beads were identified as jewelry to be threaded on a ribbon to form a choker as was the fashion in 18th-century France (Crépeau and Dunn 1986; Dunn 1999). At Belleisle, only two beads were recovered, both glass. The first is a white seed bead found on the surface above a house feature. The second is a blue "raspberry" bead associated with a house feature. The bead has "smooth ends, was presumably tumbled, and is translucent" (Christianson 1984:54).

Considering the dearth of beads elsewhere, the Pointe aux Vieux assemblage provides major insight into what varieties were available to the Acadians during the second quarter of the 18th century. While the diversified nature of the recovered beads hints at possible trade with the local Indigenous population, there is no evidence for this. In fact, excavations conducted at Pitaweikek (Kristmanson 2019) and Nikani-ika'taqank, two nearby sites occupied by the Mi'kmaq between 1728 and 1758, yielded no beads, suggesting that the Pointe aux Vieux beads were not intended for trade.

The Pointe aux Vieux assemblage is dominated by small seed beads, primarily white and blue in color. Tubular beads are less common but quite varied, being represented by 16 varieties, either white or red in color and all decorated with stripes. Not a single monochrome tube is present.

Of special interest are the wound black beads with yellow decoration (WIIId*) as these represent the first proterobas beads to be recorded in North America. While wound "black" beads with the same kind of decoration have been found at numerous sites in the United States and elsewhere (e.g., Brain 1979; Good 1972; van der Sleen 1967), they have all been identified as "glass" and in some cases, they are specifically described as being a translucent burgundy glass when held up to a strong light (e.g., Pluckhahn 1996-1997:52). There is, however, the possibility that some of the beads, especially if truly opaque, are actually proterobas.

The production of proterobas beads was restricted to the Fichtelgebirge region of northeastern Bavaria where an 8-km-long dike of this material cut through the Ochsenkopf, a granite mountain situated between the towns of Bischofsgrün and Fichtelberg (Karklins et al. 2016:16). While glass beads were already being made in the region by 1450, when exactly proterobas began to be used for this purpose remains to be determined. The earliest date recorded so far comes from the archaeological excavations at the Wolfslohe glassworks site which operated on the Ochsenkopf ca. 1640 (Steppuhn 2008). The last mention of proterobas beads in the literature is in 1811 (Schaller 1989). Consequently, archaeologists with these beads in their collections, especially if from well-dated contexts, are encouraged to have them analyzed. If their specimens turn out to be made of proterobas, this will greatly assist in determining their exact temporal range as well as their geographical distribution.

The fragmented pentagonal-faceted bead (WIIc3) is also noteworthy as it may have been produced in the Fichtelgebirge as well, the same form, but in amber glass, having been surface-collected near Bischofsgrün (Karklins et al. 2016:25). If not there, it likely originated in the Bavarian/Bohemian Forest region ca. 150 km to the southeast where an extensive furnace-wound bead industry produced these and other related forms during the 17th to early 19th centuries (Fröhlich 2015; Karklins 2019; Tarcsay and Klimesch 2018). That this bead is composed of high-potash glass further supports a Bavarian or Bohemian origin as it is typical of the *Waldglas* (forest glass) produced in the general region (Karklins 2019:27).

It should be pointed out that these beads, as well as the decorated black beads and other distinctive furnace-wound forms (e.g., raspberry, pigeon egg, five sided), were originally thought to have been produced in Amsterdam, examples having been recovered – along with wasters of drawn bead manufacture – from material dredged from its canals and used to fertilize gardens outside the city during the 17th century (Karklins 1974; van der Sleen 1967).

Subsequent research has revealed no evidence, either archaeological or archival, for the manufacture of wound beads there and it is now clear that Amsterdam only served as a transshipment point for them, along with other glass products of the Fichtelgebirge glasshouses.

Based on the composition of the analyzed tubular beads (soda-lime glass), they were likely made in Venice or another beadmaking center that utilized this type of glass. The bone beads could have originated in any of a number of countries including Germany or Spain (Moreno-García 2010; Spitzers 2013).

CONCLUSION

Overall the artifact assemblage at the Pointe aux Vieux site points to a fairly comfortable life in which the Acadians were well adapted to their environment and connected to an international economy. Among the items are glass, proterobas, and bone beads which originated in several European production centers. How the inhabitants utilized these items is not clear since only seven of them were found in functional contexts: the six “gooseberry” beads mounted on a straight pin which may have served as an ornament, and the emerald green bead that was incorporated into a reliquary. The three bone beads most likely represent rosary components, and the decorated black beads and the pentagonal-faceted example may have served a similar purpose. The small seed beads may have been used in beadwork. How the numerous tubular beads were utilized remains to be determined.

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ENDNOTE

1. The wound, “opaque” black beads with yellow or white meandering lines are generally assigned to the WIIIb group in that the decorative elements are glass and marvered into the surface to some degree. In the case of the proterobas examples, the decoration is a paint or glaze that rests on the surface and can be easily scraped off. They therefore belong in the WIIId group.

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A NEW WAY TO STUDY ANCIENT BEAD WORKSHOP TRADITIONS: SHAPE ANALYSIS USING ELLIPTICAL FOURIER TRANSFORMS

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A new analytical methodology using trigonometric functions of Elliptical Fourier transforms (EFTs) is presented for studying morphometric proportions of stone beads. The methodology was tested using ethnographically produced bead types from a single workshop compared to a discrete assemblage of stylistically similar archaeological beads from the Levant. The two-dimensional outlines of the shapes of both sets of beads were analyzed using the same methodology and EFTs were used to classify beads by their stylistic types and calculate their average morphometric values. These data defined the variation present within a techno-stylistic workshop tradition. EFT data from the modern bead groups were compared to the archaeological samples and both shared the quantitative characteristic of a single workshop tradition. The archaeological samples can be interpreted as reflecting a distinctive workshop tradition. This pilot study suggests that EFT analysis provides meaningful, empirical demonstrations of shared group membership, in terms of style and metrics.

INTRODUCTION

One of the most basic objectives of archaeological research is to identify discrete groups of artifacts (beads, in the context of this article) that share a common origin. The demonstration that certain beads closely share styles, materials, and technical procedures has long been taken as plausible evidence for their origin in the same or similar cultural traditions and their production during a specific chronological time period (Beck 1928; Xia 2014). With the emergence of early complex societies throughout the world, some communities began to specialize in the production of specific types of stone beads, first as a part of household production for personal use and eventually as a specialized craft that catered to consumers outside the household (Bar-Yosef Mayer and Porat 2008; Kenoyer 2005). Studies of bead production in South and West Asia have demonstrated that distinctive aspects of bead production, such as drilling (Kenoyer and Vidale 1992) or combinations of drilling and bead shape (Kenoyer 2008; Ludvik, Kenoyer, and Pieniążek

2014; Ludvik et al. 2015), can be used to link beads to a specific region or cultural tradition and time period. These arguments rest on the assumption that groups of similar beads were produced according to similar idiosyncratic, learned processes shared by artisans operating in the same workshops, trained by the same master artisans, and using the same or similar toolkits (Kenoyer, Vidale, and Bhan 1994). Beads that might have similar shapes, but different proportions of length-to-width measurements, drill hole diameters, or were produced using different chipping, grinding, polishing, or drilling technologies, could have been made by differently trained artisans, possibly in different workshops and during different time periods (Kenoyer 2017a).

A considerable body of research has been published on different aspects of early bead technology, production, and trade in South and West Asia, and summarized by various scholars (Kenoyer 2003; Ludvik 2018; Roux 2000). In this literature, applications of multiple archaeometric and quantitative methods have provided concrete data for defining specific suites of attributes that can identify the products of distinct workshops, which in turn can be associated with different cultural traditions (Kenoyer 2017a-c; Law 2011; Ludvik 2018). An example that is particularly relevant to this study is the identification of long carnelian beads at sites such as Ur (Woolley 1934; Zettler 1998) and Kish (Mackay 1929) in Mesopotamia that appear to have been made using raw materials and technologies that are distinctive of the Indus Valley region of what is now Pakistan and western India (Kenoyer 2014). These beads date to around 2500-1900 BCE and their presence in Mesopotamia has long been thought to reflect the trade of beads made in workshops within the Indus Valley region (Chakrabarti 1990; Ratnagar 1981). Some scholars, however, have proposed that it is possible that Mesopotamian artisans were also making similar beads (Reade 1979, 2008). A study by Kenoyer (1997:272, 2008:21-26) confirms that some of the beads from the royal cemetery at Ur appear to have been made in non-Indus shapes, but using Indus drilling

technology and possibly even Indus carnelian raw materials. This suggests that Indus artisans, or local artisans trained in the use of Indus technology, were producing the beads locally using Indus raw materials as well as Indus shaping and drilling technology. It is also possible that these artisans were making beads of Indus shapes for local use, but it has not been possible to distinguish them from beads made in the Indus workshops since the raw materials, shapes, and technologies are identical. As will be discussed below, we do now have a methodology for potentially addressing this issue and refining the ways in which to distinguish actual Indus workshops in the Indus Valley itself, and workshops outside the Indus Valley that are using Indus raw materials and technology to produce similar or almost identical objects.

In his recent study of beads from the Levant dating to the mid-3rd millennium BC and later, Ludvik (2018) was able to identify a large number of Indus-style stone beads that were made from carnelian as well as some other types of agate.¹ By comparing these beads with those found in the Indus, he has developed a more precise concept of the “workshop tradition” to aid in defining and tracking artifacts with common origins, particularly in the context of stone beads. The term “workshop tradition” refers to “a community of similarly trained artisans using the same methods of production, or *chaîne opératoire*, to produce a single coherent group of artifacts sharing stylistic, metric, and technological characteristics” (Ludvik 2018:23). Workshop traditions can thus be identified by using multiple attributes, including stylistic, morphometric, technological, and elemental characteristics. Together, beads empirically shown to share specific quantifiable aspects of these key traits are proposed to represent the idiosyncratic products of a group of similarly trained and equipped artisans operating in a specific region and cultural milieu, with their technical knowledge and the associated artifact forms and sizes passed down from master to apprentice.

In order to develop a methodology to try and distinguish Indus-style beads made in Mesopotamia, it is necessary to go beyond the study of drilling and raw material and carefully assess the entire *chaîne opératoire*. This includes the raw material, and the shaping, drilling, and polishing processes. In this article we focus on the methodology to assess the specific shapes of the beads produced in a well-established workshop tradition. Specifically, we propose a method to quantitatively assess whether or not artisans trained in what we call a single workshop tradition actually did produce beads of a certain shape (i.e., elliptical barrel) within a definable range of morphometric variation. This method can also be used to examine whether or not the proportions associated with one techno-stylistic group can be differentiated from those of beads made in other styles and thus theoretically

coming from other workshops traditions. In order to do so, Elliptical Fourier transforms (EFTs) were used to quantify morphological, metric, and stylistic difference/similarity between and among three groups of modern beads from Khambhat, India, known to have been made in what we consider a paradigmatic single workshop tradition. One group of ancient beads and one group of archaeological beads were also analyzed and compared to the modern beads. Based on the close correlation between the modern and ancient samples, it is clear that EFT analysis can be used to identify ancient workshops that were intentionally producing specific styles of stone beads for specific groups of consumers.

THE BEAD COLLECTIONS

To examine the range of variation in the products of a proposed single workshop tradition, the authors first studied three groups of modern beads that were intended to replicate ancient beads found at the site of Harappa and dating to the Harappa Phase of the Indus Civilization, ca. 2600-1900 BCE (Kenoyer 1987) (Figure 1, a-c). All of the modern replica beads were produced by bead master craftsman Inayat Hussain and his assistants in Khambhat, India, commissioned by Kenoyer as part of his ethnoarchaeological study of traditional beadmaking in Pakistan and India (Kenoyer, Vidale, and Bhan 1994:281; Vidale, Kenoyer,

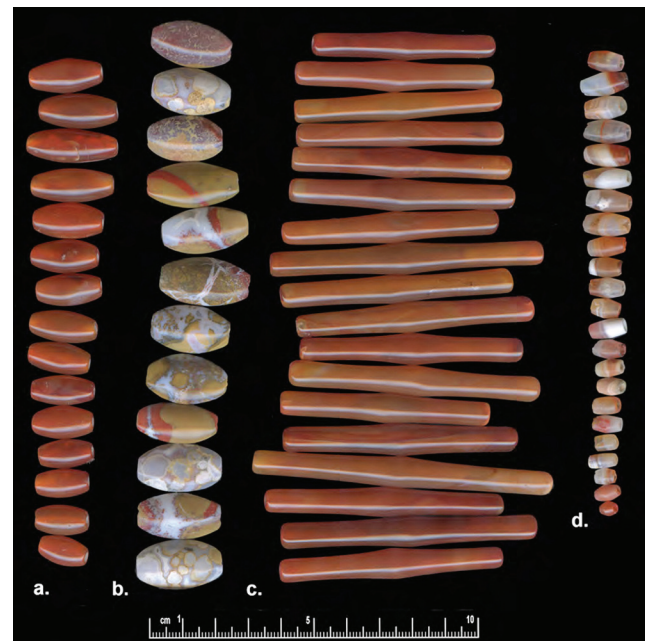


Figure 1. Modern and ancient beads utilized in the study: a) carnelian, long barrels; b) jasper, elliptical long barrels; c) carnelian, very long bicones; d) banded carnelian, long barrels and long bicones (Afghanistan) (photo: J. Mark Kenoyer).

and Bhan 1992:1). The same types of tools were used in all stages of chipping, grinding, and polishing. Each bead was also hand drilled with a bow drill and double diamond drills by master bead driller Pratap Bhai. These beads were not made specifically for this study but were being produced in order to develop replicas of ancient Indus style ornaments. Hussain was requested to produce three different types: very long biconical carnelian, long elliptical barrel agate, and long barrel carnelian.

Although hundreds of beads were made of each type, Kenoyer selected just 88 beads for analysis: two handfuls of the very long biconical beads (n=29) taken from a large bag of finished beads, and one strand each of the long elliptical barrel beads (n=34) and the long barrel carnelian beads (n=25) that had been prepared by the beadmakers. The strands were part of larger bunches intended for shipment. Each strand reflects choices the beadmakers made in selecting beads that they considered to be typical of the same style as requested by the customer.

In the production process for the very long carnelian beads, Inayat Hussain was asked to optimize raw material length to produce the longest beads possible given the natural size of the carnelian nodules. For the other two bead types, the artisans focused on the production of a certain size and shape (i.e., long elliptical barrel and long barrel). Hussain chipped all of the bead blanks and both he and his assistants were involved in the grinding and polishing of the beads. This way he could oversee all stages of bead production. If at any point a bead did not meet Hussain's expectations, he made sure that it was modified to ensure both quality and conformity with the type being produced. The beads were all produced by one individual master bead maker and his assistants according to three formal technostylistic templates. Each type was defined by the practice of what the authors term Hussain's own workshop tradition of manufacture. This collection of ethnographically produced beads provides an excellent sample with which to empirically test the workshop tradition model, since each group of beads from Hussain's workshop matched the proposed criteria of a single bead workshop tradition. These beads provide three examples of types made by the same group of craftsmen trained by the same master, using the same tools, and producing products within a strictly defined morphometric and stylistic template. Using these artifacts of known provenance, it is possible to test the model to determine if single-workshop tradition types do share quantifiable characteristics that can be used to identify and differentiate them.

In addition to the modern beads, two groups of ancient beads were selected for comparative purposes. One set of beads (n=37) came from a necklace of banded carnelian

long barrel and long biconical beads (Figure 1, d) purchased from an Afghan bead dealer in Istanbul. These had been restrung by the seller and grouped together on a single string because of their similar shapes and raw material, but it is not known if they all came from the same region or time period. Examination of the drill holes indicates that they all were drilled with tapered cylindrical or constricted cylindrical stone drills (probably 3rd millennium to 2nd millennium BCE) and all were made of relatively similar types of banded carnelian. Overall the beads appear to have been made in similar but not identical ways and may not have come from a single workshop, but would serve as a test to determine if they fit within what we would call a single workshop tradition.

The second archaeological sample of long barrel carnelian beads (n=16) comes from three different sites located in modern Israel/Palestine, the ancient Southern Levant: Bet Dagan, Tell el-Ajjul, and Holon (Figure 2). All 16 are technically Indus-style beads, displaying the use of constricted cylindrical stone drills and other characteristics consistent with Indus-associated beads. These artifacts are part of a collection documented by Ludvik for his doctoral dissertation and come from secure burial contexts dated to the late 3rd millennium BCE (Ludvik 2018). They were selected because their close similarities in shape, raw material, drilling technology, and overall production processes highly suggest an origin in a common workshop tradition. Elliptical fourier analysis would serve to test this hypothesis.

PRELIMINARY ANALYSES

Each bead was first measured using a digital caliper to record overall morphology and drill hole diameters, following the measurement protocol used to document stone beads (Kenoyer 2017; Ludvik 2018; Ludvik et al. 2015). The measurements taken from each modern bead confirmed that Hussain's craftsmen did in fact produce beads of a given type within a set range of variation; the measurements of their products were very tightly clustered in terms of metric proportions, especially a relatively narrow range of length-to-width ratios (Figure 3). Based on these initial measurement studies, it was concluded that the best metrics for illustrating the differences between the three bead groups were the length-to-width ratios compared with average drill hole diameters. The spread of values for these two parameters was therefore preliminarily taken to indicate the expected signatures for beads made in the same style by the same workshop tradition (indeed, by the same individuals) and for the signatures of beads made optimizing the length of raw material.

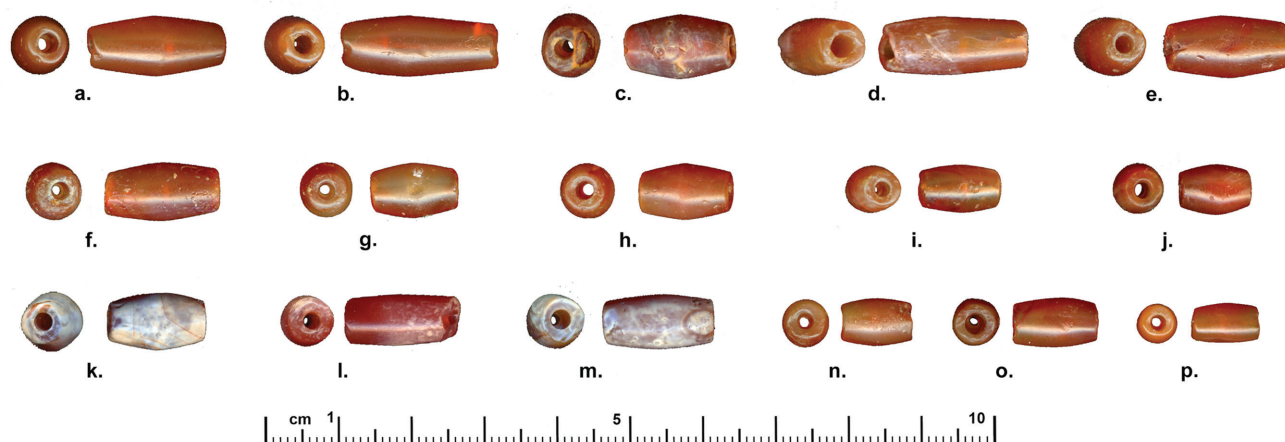


Figure 2. Ancient beads from the Levant: a-j) Bet Dagan; k-m) Tell el-Ajjul; n-p) Holon (photo: Geoffrey Ludvik and J. Mark Kenoyer).

In order to test the statistical significance of these differences, one-way analysis of variance (ANOVA) tests were performed, alongside post hoc pairwise t-tests. The three assumptions for ANOVA (normality, homogeneity of variance, and independence of observations) were first tested to see if this statistical method was appropriate. The bead groups met the third assumption of independence based on study design (i.e., groups were assigned in such a way that no one bead was counted in two groups). The other two assumptions required formal testing for normalcy and homogeneity of variance in each group, both in terms of length-to-width ratio and average drill hole diameter metrics. A standard normalcy test (Shapiro-Wilks) was employed in the statistical program R first. To test the homogeneity of differences at an inter-group level, a Levenes test in R was also employed (Ludvik 2018: chapter 6). All three modern bead groups as well as the two ancient groups (Afghan and Southern Levantine) were determined to be suitable for ANOVA testing. The results of ANOVA, followed by pairwise t-tests with Bonferroni corrections in R, indicate that the differences observed between the groups of beads are significant in some but not all cases, even for the three groups of beads known to have been produced in different styles. This suggests that, while the use of length-to-width ratios and average drill hole diameters functioned well to demonstrate coarse distinctions between bead types, a more refined method was necessary to conclusively and significantly identify the products of distinct workshop tradition types; the two metrics alone were insufficient to demonstrate statistically significant differences.

After being introduced to the use of Elliptical Fourier transforms in the study of animal tooth morphology during a lecture by Dr. Juliet Brophy of Louisiana State University and in collaboration with co-author Dr. T. Dobbins, a new way of studying bead shapes was pursued. In order to more

clearly differentiate the modern bead groups and assess the range of variation within single workshop tradition types, Elliptical Fourier transforms were utilized to describe bead shapes as trigonometric functions (ellipses of known sine/cosine functions). The following section outlines Elliptical Fourier transform analysis and describes how it demonstrates that the workshop tradition model does accurately reflect an archaeological reality: beads made by similarly trained artisans in similar styles with similar tools are indeed similar in metric proportions and can be differentiated in practice.

ELLIPTICAL FOURIER TRANSFORMS METHODOLOGY

As a first step in EFT analysis, flatbed digital scans are made of the beads on a group-by-group basis, with each bead labeled sequentially and identified by sample name. The scans are then examined to obtain solely bead outlines by means of the edge-finding program in MATLAB®, a commonly utilized programming language and numerical computation system in engineering. The outline coordinates are then determined and analyzed using Elliptical Fourier transforms, also in MATLAB®. The resulting information is ultimately used to find the range of morphometric variation of a type of bead and employed to group the beads by type. After using this methodology to test the three groups of modern beads, the two groups of ancient beads were analyzed for comparison.

More generally, this method of employing MATLAB® computation enables the study of an artifact's size and shape in a thorough, multidimensional manner. This allows the entire shape of the artifact to be studied and statistically analyzed. The technique is well suited to the study of

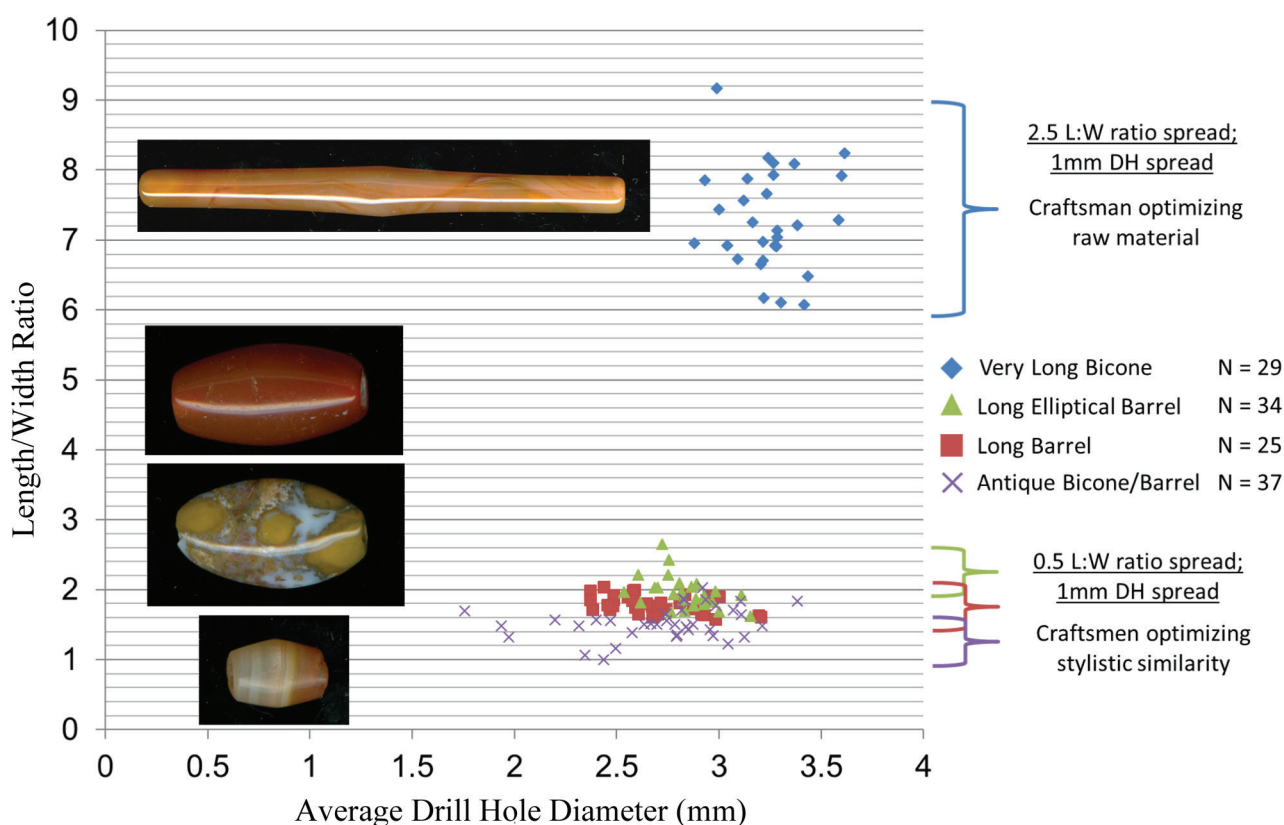


Figure 3. Length-to-width ratio vs. average drill hole diameter (mm) (graphic: Geoffrey Ludvik).

symmetrical bead shapes and can also be used to study other kinds of artifacts that can be classified and seriated by shape. Therefore the approach we outline here has the potential for wide methodological application. A researcher would simply need to take high-quality scans or pictures of the artifacts in question and upload them into the program for analysis in consultation with a colleague familiar with the system. Care should be taken to ensure that these images show the profile of interest (side, top view, etc.) and not a skewed angle that would artificially warp the image. In addition, if the absolute size of the artifact is going to be analyzed for this work, some reference will be needed to scale the pixel sizes in the image to real space coordinates (centimeters, inches, etc.). After the images are acquired, someone familiar with MATLAB® analytical procedures can employ software to find the edges of the artifact. The position of the edge of the artifact can then be used to find the Elliptical Fourier coefficients of the outline of the artifact, quantitative values that can be statistically analyzed in a variety of ways. We employed MATLAB®, but similar studies could easily be replicated in other programming languages like Python™, which are free to use. Both MATLAB® and Python™ have publically available packages to automatically find the edges of an image and calculate the elliptical coefficients.

Bead Shape Analysis

All beads involved in this study were scanned against the same black background by an HP Scanjet G4050 digital photo scanner with a resolution of 600 dpi. Each image was cataloged and an outlined bead shape was found using a series of analysis routines written in MATLAB® and using MATLAB®'s Image Processing Toolbox. The contrast between the bead brightness and the background was used to determine the bead edges. The images were converted to black and white by defining any brightness above a certain level as "white" in code and everything else as "black;" the pixels where the black to white transition occurred identified the edge of each bead. The results of this process can be seen in Figure 4. The output of this analysis was x and y coordinates describing each point along the edge of a given bead and controlled for bead size with a millimeter scale. This method allowed for a very precise outline of each bead to be created in a matter of minutes for all 141 beads considered here along with a list of x/y coordinates that were later used to assess morphometric similarities and differences (*see below*).

An example of each bead type is plotted in Figure 5 for visual comparison of types, both in their true shape/



Figure 4. Very long biconical carnelian bead with outline from analysis code (photo: Thomas Dobbins and Geoffrey Ludvik).

size and when normalized to the overall bead size. The very long bicone beads are quite distinct in size and shape, but the elliptical long barrel, and historical beads from the Afghanistan group are more similar in shape, accounting for the difficulties in assessing statistically significant differences. Nevertheless, using the EFT method, these types are still readily distinguishable. The variation in the shape of the very long bicone beads is plotted in Figure 6. Note that while there is great variation in bead lengths, widths are quite consistent.

Elliptical Fourier Transforms

In order to analyze and compare the shapes of the beads in a more complete way, Elliptical Fourier transforms were used. The idea of a Fourier transform is to describe a set of data in x space as a summation of sines and cosines. Elliptical Fourier transforms allow one to apply this analysis technique to a closed contour (a shape that loops back on itself) by performing a Fourier transform on the x and y coordinates of the pixels found by the image analysis routine mentioned earlier. This essentially generates a mathematical description of a given closed-contour shape in terms of a series of concentric ellipses that fit together to define its border coordinates. The formulation is:

$$x_N(t) = A_0 + \sum_{n=1}^N a_n \cos(2n\pi t/T) + b_n \sin(2n\pi t/T)$$

$$y_N(t) = C_0 + \sum_{n=1}^N c_n \cos(2n\pi t/T) + d_n \sin(2n\pi t/T)$$

where t is the parameterization in which the unit is the amount of time to move one pixel, T is the basic period of the data (the amount of time to make it all the way around the contour), N is the number of harmonics used in the expansion, and a_n , b_n , c_n , and d_n are the coefficients of the expansion of order n . In order to find the values of the EFT coefficients for use in subsequent analyses, we used the following equations where t_p is the number of steps required to reach the point p :

$$a_n = \frac{T}{2n^2\pi^2} \sum_{p=1}^K \frac{\Delta x_p}{\Delta t_p} [\cos(2n\pi t_p/T) - \cos(2n\pi t_{p-1}/T)]$$

$$a_n = \frac{T}{2n^2\pi^2} \sum_{p=1}^K \frac{\Delta x_p}{\Delta t_p} [\sin(2n\pi t_p/T) - \sin(2n\pi t_{p-1}/T)]$$

$$c_n = \frac{T}{2n^2\pi^2} \sum_{p=1}^K \frac{\Delta y_p}{\Delta t_p} [\cos(2n\pi t_p/T) - \cos(2n\pi t_{p-1}/T)]$$

$$c_n = \frac{T}{2n^2\pi^2} \sum_{p=1}^K \frac{\Delta y_p}{\Delta t_p} [\sin(2n\pi t_p/T) - \sin(2n\pi t_{p-1}/T)]$$

There are several features of these transforms that are significant for this analysis. First, by increasing the number of harmonics used in the fitting, the accuracy of the fit improves (up to a point related to the number of points in the

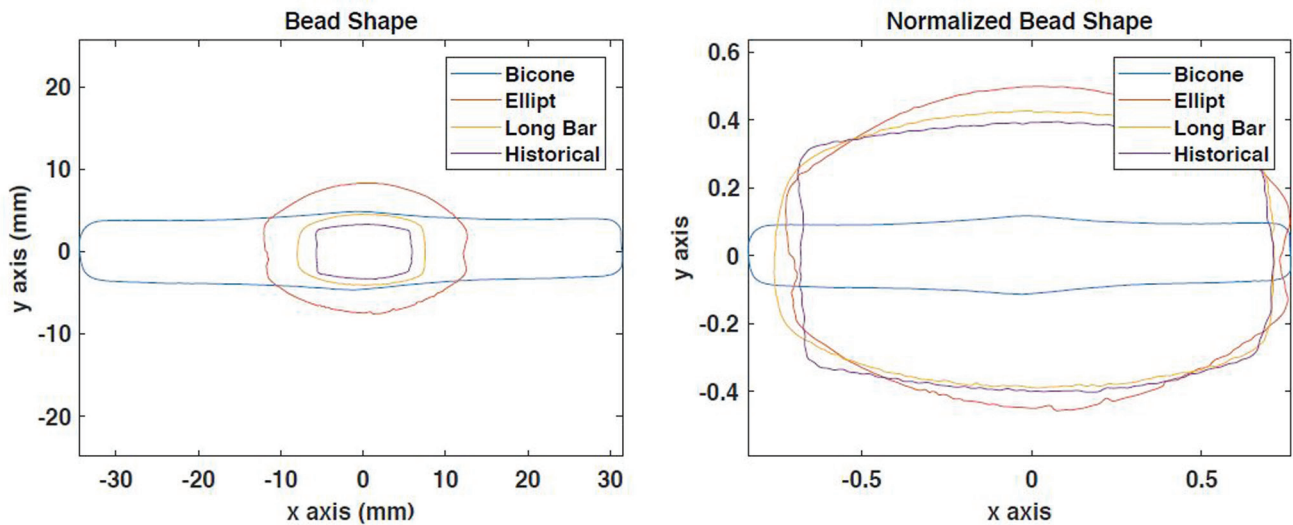


Figure 5. Example beads compared. Actual size (left) and normalized (right) (this and all subsequent graphs by Thomas Dobbins and Geoffrey Ludvik).

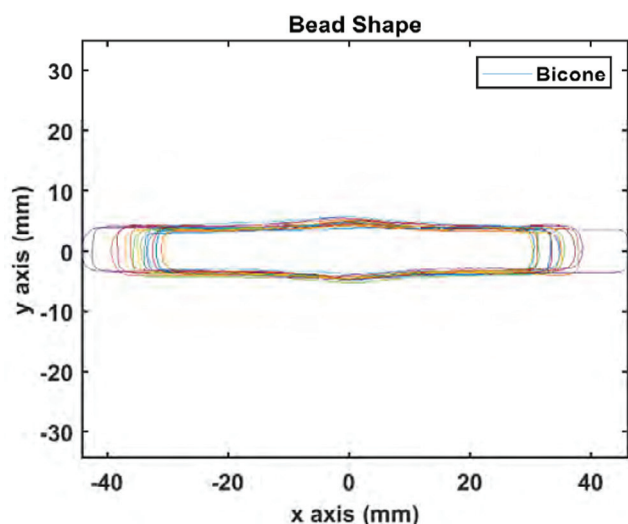


Figure 6. Very long biconical beads group morphometric variation.

contour). That being said, the first few terms tend to be the most important in order to find the overall shape of the bead, while the higher order modes “fill in” the outline (Figure 7). As such, this work will focus primarily on the lower order modes in EFT analysis.

Additionally, a procedure was undertaken for rotation and normalization of the EFT coefficients to ensure proper comparisons between beads. This is important for several reasons. For example, the rotation is necessary so that all the beads are aligned in the same direction (e.g., the bead in Figure 7 has a slight axis tilt prior to rotation based on its position on the flatbed scanner during initial imaging). In this case, the semi-major axis (the longer dimension of the bead) is rotated such that it falls in the x direction (*see* equation below). This allows comparison of bead shape despite the fact that the images were not initially aligned in precisely the same direction.

$$\theta_1 = \frac{1}{2} \arctan\left[\frac{2(a_1b_1 + c_1d_1)}{a_1^2 + b_1^2 + c_1^2 + d_1^2}\right]$$

The second step after rotation is to normalize each bead by its size for one round of testing. This can be useful in that it allows comparison of solely the stylistic shape of the beads of varying size while ignoring the overall size of the beads in question; absolute differences in size are an important feature in techno-stylistic type to be sure, but also considering morphology independently of length and width provides an additional test of bead similarity/difference. Normalization can be done in one of two ways: 1) by normalizing the beads by the length of the first harmonic

(roughly the length of the bead) or 2) by normalizing them by the average radius of the first harmonic (roughly the average of the length and height of the bead). In this study, normalization by length was used, though the conclusions drawn were not dependent on the choice of normalization. Non-normalized beads were then analyzed in a second round of testing, since bead size is an important element of their classification. The rotated reconstructions of the beads used in this analysis were plotted in Figure 5 to show the different shapes of the three modern bead types and the ancient Afghan beads, while Figure 6 shows the spread of the very long biconical bead by way of example.

SPREAD IN BEAD SHAPE

In order to classify the variation within a single bead type and between bead types, two calculations were made using the EFT coefficients. The two calculations were the sum of absolute differences and mean squared methods for calculating error:

$$\sigma^2 = \sum_{n=1}^N (x_n - \bar{x})^2$$

$$E = \sum_{n=1}^N |x_n - \bar{x}|$$

The two methods for calculating error have differing dependence on deviations from the mean. Sum of squares more heavily weighs large outliers than the sum of the absolute values. As such, they give different information on the spread of the beads from the average and therefore both will be examined in this work. The spread of each type of bead from its mean EFT coefficient value is plotted in Figure 8. The degree of spread of the beads from their mean bead shape is comparable in all cases, but the largest morphometric deviation is seen in the very long bicone beads due to a few exceptional outliers.

It is significant that the ancient beads, both those from the Afghan bead group and the distinctive long barrel group found in the Southern Levant, have a consistent spread in deviation from their mean EFT coefficient values, comparable to the behavior of the three modern bead types in this same test. Thus, these two ancient groups seem to match the expected variability in morphometric proportions of groups known to have been produced in single workshop tradition types, suggesting that they may also have each been products of single traditions of manufacture.

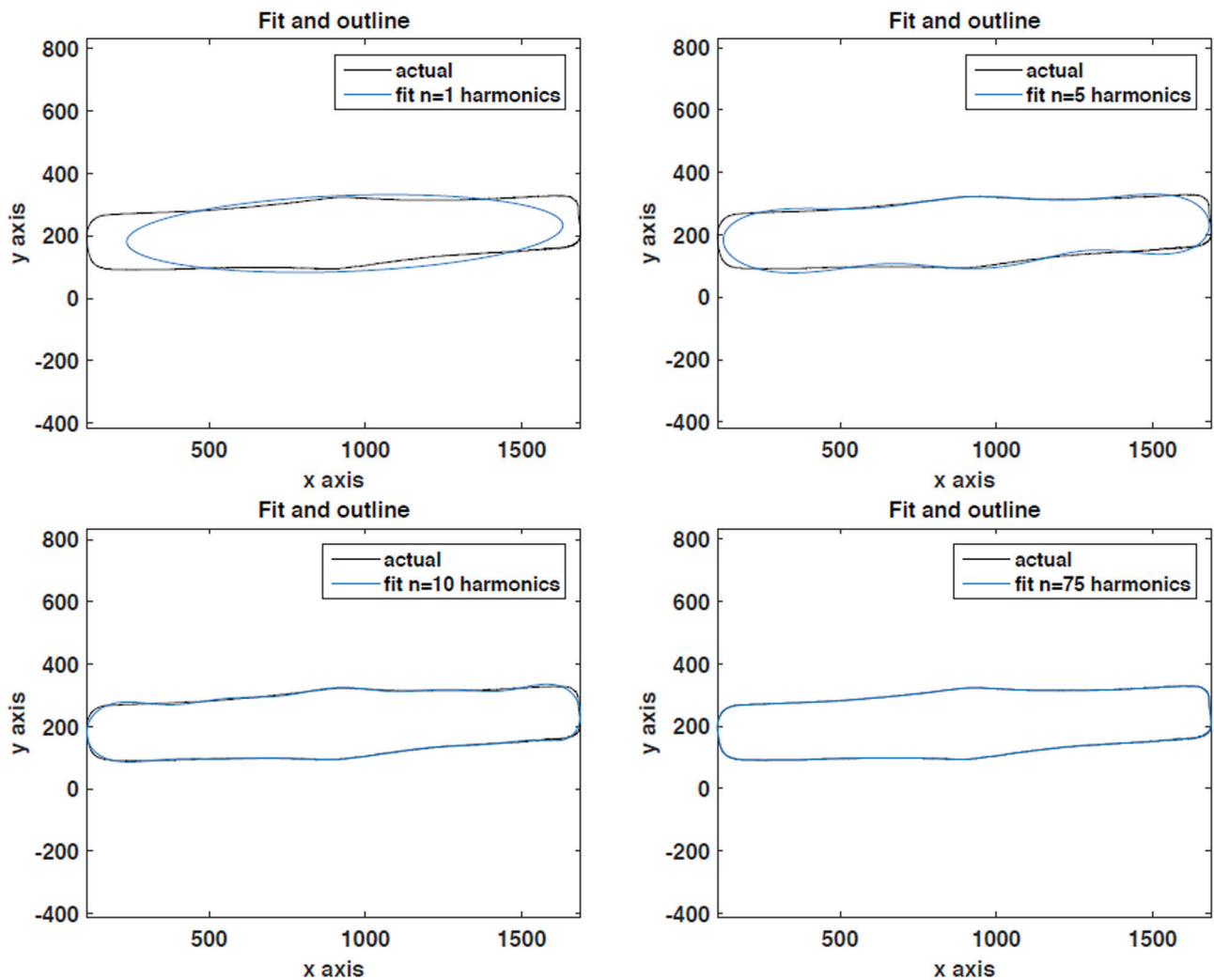


Figure 7. Bead outline plotted with fits of varying mode numbers.

DIFFERENTIATING BEAD SHAPES

With the description of the spread of morphometric proportions from their mean values complete, EFT coefficients were then used to differentiate between bead types. This is important because the ancient Afghan beads, the ancient long barrel beads from the Southern Levant, the modern long elliptical beads, and the modern long barrel beads are relatively close to each other in size and shape, but are nevertheless known to be truly distinct bead types.

As such, a method was developed to differentiate between bead types using the ETF data. A simple first step, following the methodology described above, was to calculate each bead's deviation from the average EFT coefficient values of another bead type rather than its own. If the beads are in fact different, one would expect the comparison to the means of other bead types to yield a larger deviation than

when the beads are compared to their own group mean. The results of this simple analysis are shown in Figure 9. They demonstrate that the spread from mean values within each group is less than the spread of each of those beads from the mean values of other bead groups. This indicates, for these collections of known group membership, that the bead types as defined are differentiable and coherent. This method can also be used to identify which bead types are most similar to each other in shape.

There are several issues with the simple analysis, however. For example, it depends on the use of preexisting group identities, assuming the groups have been accurately defined (in this case, a good assumption given the control groups and the distinct beads from Afghanistan and the Levant). Additionally, it only takes the magnitude of deviation into account, not the direction of deviation. A bead that was shorter by a set amount from the average would

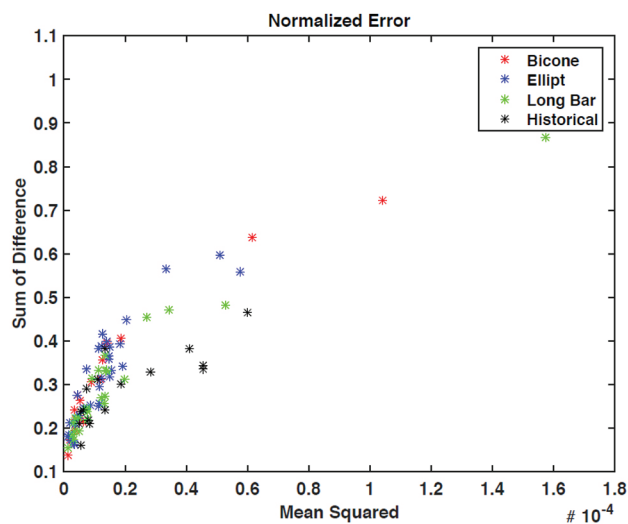


Figure 8. Normalized error of each bead from its average.

have the same deviation as a bead that was longer by the same amount and would be grouped together, despite having different shapes. Therefore, a better analysis technique, in this case canonical discriminant analysis, was also used.

Canonical discriminant analysis, a type of machine learning, can be used to find the linear combinations of the EFT coefficients that most effectively differentiate various types beads. This method allows one to find what terms in the ETF spectrum are the most different between the various bead types, and could, with careful analysis, allow for improved insight into the important features that differentiate beads by type. This analysis was done using SAS® software and the results are shown in Figure 10. They indicate that the three groups of modern beads produced in different styles are easily differentiable when considered using canonical discriminant analysis. Using the combination of EFT and canonical discriminant analysis it is potentially possible to classify a new bead of unknown identity into one of the types already analyzed and documented.

CONCLUSION

It has been demonstrated that EFT has great potential in the study of the archaeology of craft production, especially stone beads. With its reliance on quantitative trigonometric analysis, EFT provides a more objective mechanism for determining beads that belong to coherent stylistic, morphometric, and technological groups. The preliminary examinations of length-to-width ratios and average drill hole diameters, but especially the application of EFT analysis of bead shape, have been shown to provide empirical support for the assumption of idiosyncrasy in bead production.

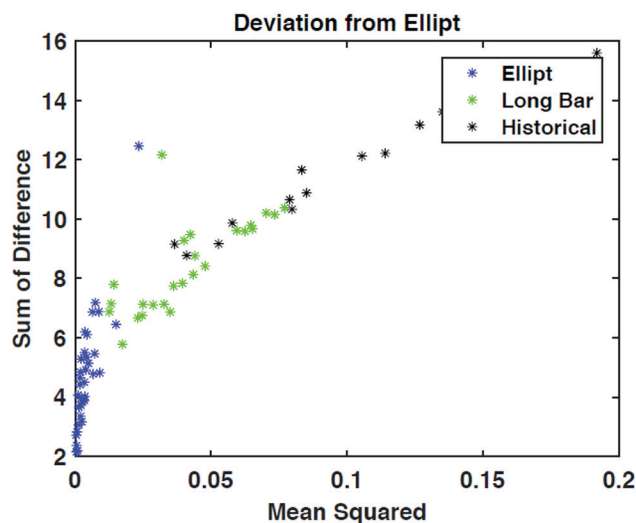


Figure 9. Deviation of each bead from the average long elliptical bead.

Using EFT, we have been able to document and quantify the range of variation indicative of beads produced in the same workshop traditions. It has been shown that craft persons operating within the same workshop tradition do, in fact, make beads similarly. The three groups of beads from Hussain's workshop in Khambhat provide an excellent case study. Through the examination of their EFT coefficients, it is clear that each single techno-stylistic group deviates from its mean shape and size within a clustered, definable, and differentiable range.

Conversely, it has been shown that artisans operating in different workshop traditions do, in fact, make beads differently. The two archaeological groups of beads were easily differentiated by EFT coefficients from the modern products of Hussain's workers. Additionally, the three

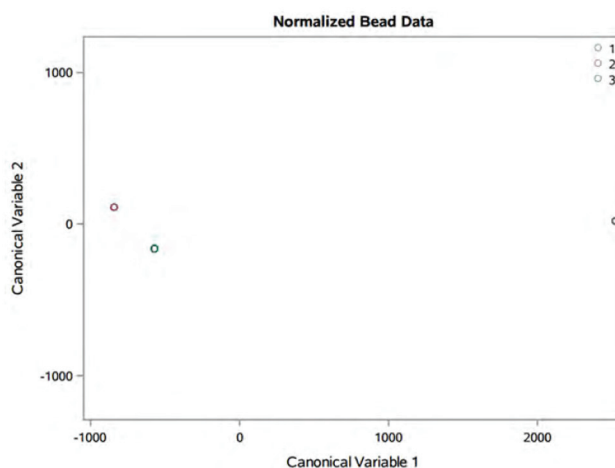


Figure 10. Results of canonical discriminant analysis on the three modern bead groups.

distinct techno-stylistic types produced in Hussain's workshop were also differentiable, suggesting that EFT coefficients provide a reliable method to examine group membership.

Lastly, we have demonstrated that, by analogy to the behavior of modern control groups, ancient beads made with similar styles, proportions, and technologies can plausibly be linked together as potential single workshop tradition types. Like the groups of modern beads produced in single workshop traditions, the two archaeological samples examined here display a similar spread from their mean EFT values. This provides support for their possible identification as groups of products made in the same workshop traditions in antiquity. For the Indus-style beads from the Southern Levant (late 3rd millennium BCE), this suggests the common origin in a single workshop tradition of manufacture for 16 beads from different necklaces buried with four different individuals. This does not mean that they were made in a single workshop but that they were made by groups of artisans who were working with similar sets of raw materials and tools, producing closely matching bead shapes.

At present Kenoyer and his colleagues are in the process of studying a larger sample of beads from sites in the Indus Valley, such as Mohenjodaro, Harappa, and Dholavira, to determine if it is possible to identify a distinctive workshop tradition that reflects the entire Indus region or perhaps regional varieties based on major sites. Similar studies need to be carried out in other regions, specifically at the sites of Ur and Kish. Once these data have been collected it will be possible to compare what has been identified in the Levant with the workshop traditions of the Indus and Mesopotamia to determine if the beads from the Levant derive from actual Indus workshops or workshops of Indus-style bead production in Mesopotamia.

It is possible that there is a single, relatively homogenous tradition of Indus-style bead production in the 3rd millennium BCE in the Near Eastern world, likely associated with a small number of workshops of similarly trained artisans but dispersed to many regional sites. As discussed earlier, this has already been proposed based on technical and qualitative stylistic considerations, but with EFT analysis, a quantitative demonstration of group similarity can now be tested. In all, EFT has the potential to greatly assist archaeologists and other researchers in documenting the workshop traditions of origin for stone beads. This method has demonstrated great quantitative accuracy in defining the range of variation between and within single workshop tradition types. This, in turn, has produced an expected range of EFT coefficient values indicative of single workshop tradition styles that can now be used as a starting point to empirically identify new

beads that share key morphometric similarities and plausibly common origin in a coherent group. The application of EFT is poised to advance the study of the idiosyncratic, learned processes responsible for the production of different groups of artifacts in the archaeological record. This pilot study has shown that it is indeed possible.

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ENDNOTE

1. Such beads were identified as "Indus-style" primarily because they were perforated with constricted cylindrical stone drills, a diagnostic technology developed and used by artisans of the Indus Valley Civilization. Additional features corresponding to Indus-associated manufacture include: 1) they exhibit highly polished surfaces and fine shaping, evidencing skilled craftsmanship, 2) there is a variety of barrel/biconical forms reminiscent of documented Indus types, marking them as distinct from other beads in the regional archaeological record, 3) they have morphometric proportions consistent with other beads known to have derived from the Indus craft repertoire, and 4) they are often made from similar varieties of high-quality raw material, i.e., slightly translucent, deep-red orange carnelian.

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FRIT-CORE BEADS: AN UPDATE

Karlis Karklins

This article reports a new style type of frit-core bead from a South American context and summarizes the nine types recorded to date. It also discusses modern African copies of one of the types.

THE NEW TYPE

The inventory of frit-core bead types continues to grow. The latest addition, designated Type 9, was found on a strand of faceted seven-layer chevron beads obtained from a geologist working in Colombia in 1995 (Marie-José Oppé 2020: pers. comm.). It is oblong, 10 mm in length, and represented by two specimens. Unlike the other frit-core types, the outer layer is black instead of deep blue, possibly from weathering. Four rounded ridges run the length of the bead. The areas between these bow out slightly and have a raised white stripe running along them (Figure 1).

SUMMARY OF THE FRIT-CORE BEAD TYPES

Since descriptions of the various types are now dispersed over four articles including Karklins (2016, 2019) and Karklins and Bonneau (2018), a summary is provided here. The body of the beads is generally a dark navy blue color, though that of Type 9 is black. All the decorative elements are white with the exception of those on Types 6 and 8. There are, however, scarce variants where the body and raised decoration are dark blue with the low areas covered with off-white glaze. These beads are identified by the letter A appended to the type number (e.g., Type 4A). All have ovoid shapes except for Type 6 which is round (Figure 2).

Type 1. A loop with six dots around a single dot in its center is situated on opposite sides of the bead. The space between the two loops contains a longitudinal row of four to five dots on either side.

Type 2. This type exhibits three, four, or six longitudinal stripes between each pair of which is a row of three to five dots.



Figure 1. The Type 9 frit-core beads from South America (photos: Marie-José Oppé).

Type 3. No decoration.

Type 4. A configuration of six “petals” encircles either end of the perforation; a line encircles the middle. There are examples where the surface is covered with white glaze and the design elements are blue (Type 4A).

Type 5. There are three or more longitudinal stripes, between each pair of which is a configuration of five to six dots around a single dot with a short stripe at either opening of the perforation. As with the previous type, there are examples where the color scheme is reversed (Type 5A).

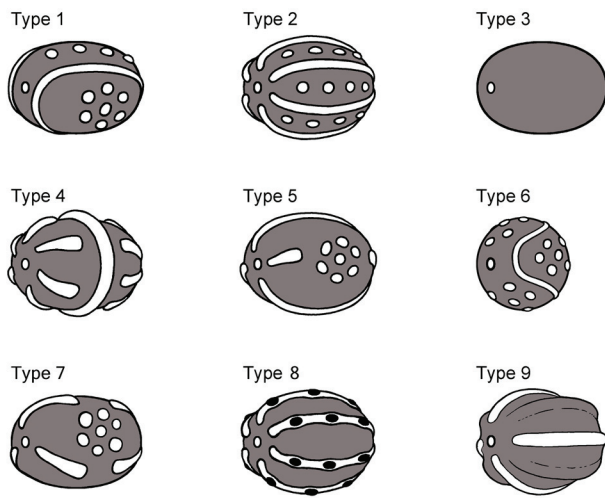


Figure 2. The frit-core bead types (drawing: Dorothea Larsen).

Type 6. An undulating white line encircles the bead. In each of the four undulations is a floral design composed of six light blue dots around a yellow dot.

Type 7. This type exhibits three or five short, longitudinal, petal-like stripes around either end. Three rosettes composed of six dots around a central dot encircle the middle.

Type 8. There are two variations. One, with a unique indigo hue, exhibits six longitudinal, slightly raised white stripes, each of which is decorated with three blue dots. On the other, the six stripes are represented by raised ridges which exhibit four white dots.

Type 9. This type has four rounded longitudinal ridges. The areas between the ridges bow out slightly and have a raised stripe running from end to end.

The core temporal range for frit-core beads is 1560-1610 at archaeological sites in northeastern North America (Karklins 2016:64), but two specimens have been recovered from much later contexts, the Seneca Power House (1640-1655) and Marsh (1650-1670) sites in New York state (Karklins 2019:75). In these cases, it is likely that they are heirloom beads.

MODERN AFRICAN IMITATIONS

Earlier this year, several members of the Bead Collector Network (<http://beadcollector.net/>) informed me of a number of Type 6 beads obtained from traders in several parts of West Africa over the past few decades. While some appear to have some age to them (Figure 3),

Under the microscope, the “black” glass is revealed to be a finely ground mix of bright blue and beer



Figure 3. Modern African copies of Type 6 frit-core beads. These were likely made prior to the 1950s (photo: Chris Prussing).

bottle brown. The stripes and dots are “painted on” fused yellow and white powder glass. I say “painted on” because this powder glass does not resemble the stuff from Ghana? ... I still think they’re Kiffa beads, based upon manufacture technique and what strikes me as a feminine design (Prussing 2008).

Other examples are bright, shiny, and obviously quite modern (Figure 4). Jürgen Bush (2020: pers. comm.), a long-time student of Mauritanian powdered-glass beads, examined images of the various beads and opined that some of them are “certainly pre-1950 or older” (Figure 3) and while they are of “Unusual irregular-round shapes. Unusual colors! Unusual designs, [they are] still definitely Mauritanian Muraqat.” Thomas Stricker (2020: pers. comm.), an expert on Mauritania Kiffa beads, agrees.



Figure 4. Recent (21st century ?) Type 6 imitations collected in Cotonou, Benin, in 2014 (photo: Hans van der Storm).

Certainly the cores of some of the beads consist of a compact gray mass (Figure 5, top) similar to that observed on broken Kiffa beads (Figure 5, bottom), although some others have black granular cores (Figure 6). A number of beads exhibit bubbling or burned spots (Figure 6), having been overheated during the production process. This suggests they were made by artisans not well versed in beadmaking, possibly those at the Cooperative Nasser in



Figure 5. Modern Type 6 imitations with compact gray cores (top) (photo: Thomas Stricker) and the core of a traditional Kiffa bead (bottom) (photo: Karlis Karklins).

Kiffa which revived powder-glass beadmaking there around 1992 (Jürgen Busch 2020: pers. comm.). The Oppers (1993:43) report that the new beads “are markedly different in appearance from the older ones, indicating the use of less-perfected techniques by beadmakers whose experience is not as profound as their predecessors.”

The beads are all a dark blue color and the form of the applied decoration matches that of the early Type 6 frit-core bead recovered from excavations in Rouen, France (Karklins and Bonneau 2019), which has a white undulating line around the middle and a floral pattern of six light blue dots around a central yellow dot in each of the four undulations (Figure 7). In the case of the modern beads, only one is an



Figure 6. Imitation Type 6 bead exhibiting bubbling and a burned spot, having been overheated during the production process. The unusual black core is clearly visible (photo: Hans van der Storm).

exact match while all the others have white dots around the yellow one (Figure 4, bottom).

Where the inspiration to produce this stylistic variant came from is a bit of a mystery in that, to my knowledge, there was no published image of a Type 6 bead until 2019 when the Rouen specimen was described and illustrated in vol. 31 of this journal (Karklins and Bonneau 2019). The bulk of the modern beads examined for this study were collected before the turn of the century. One possibility is that someone saw the Rouen bead at the Musée des Antiquités and passed the description on to Mauritanian artisans. The modern beads are 14-18 mm in diameter and 11-16 mm in length (Hans van der Storm and Thomas Stricker 2020: pers. comm.). This matches well with the Rouen specimen which is 16.8 mm in diameter and 13.8 in length. The one measurable Type 6 frit-core bead from a North American site is 9 mm in both diameter and length (Karklins and Bonneau 2019).



Figure 7. The Type 6 frit-core bead from Rouen, France, attributed to the early 17th century (© Musée-Métropole-Rouen-Normandie; Cliché Yohann Deslandes).

The majority of the imitations are round but there is one dumbbell-shaped example (Figure 8). Whether this is an intentional form or represents two beads accidentally fused together during firing remains undetermined.

It is interesting to note that no copies of the other eight frit-core bead styles have been encountered... so far.



Figure 8. Dumbbell-shaped Type 6 imitation from the Ivory Coast (photo: John Picard).

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My thanks to Marie-José Opper, John Picard, Chris Prussing, Hans van der Storm, and Thomas Stricker for bringing their beads to my attention and permitting the use of their images in this article. Thanks also to Jürgen Busch for sharing his knowledge of muraqat beads and to Dorothea Larsen for updating Figure 2 to incorporate the new type.

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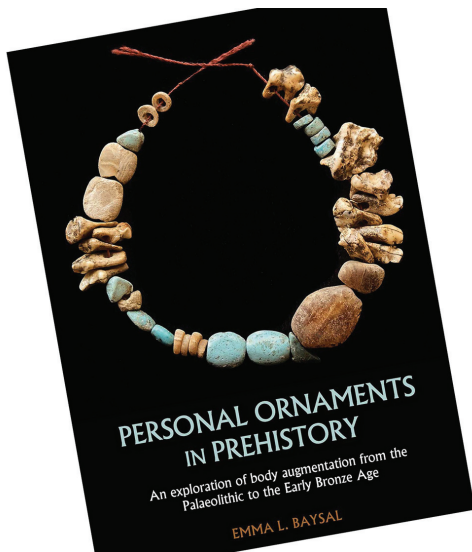
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BOOK REVIEWS

Personal Ornaments in Prehistory: An Exploration of Body Augmentation from the Palaeolithic to the Early Bronze Age.

Emma L. Baysal. Oxbow Books, Oxford and Philadelphia. 2019. 272 pp., 19 color plates, 63 B&W figs. ISBN 978-1-78925-286-6. £38.00 (paper cover).

This brilliant book emphasizes how and why the human relationship with ornaments developed and continued over tens of thousands of years from the hunter-gatherer life to urban elites, from the use of natural resources to complex technologies. It is based on evidence from archaeological sites across Turkey, the Near East, Greece, the Balkans, and beyond.



Chapter 1, **Introduction**, presents the aims of the book which include tracing the diachronic role of ornaments during the periods of socio-economic transformation, questioning how personal ornaments are approached theoretically and practically by archaeologists, and providing a document of the state of knowledge and interpretation in the field. The author postulates that besides the aesthetic value, manufacturing technology, and economic worth of ornaments, the motivation for their use should also be allowed space within academic discourse.

Chapter 2, **Personal ornaments: why are they important in prehistory?**, underscores the usefulness of personal ornaments from archaeological excavations for not only studying the materials and technology, but also past identities and relationships, as well as socio-economic matters. These seemingly indisputable issues still require educating in current academic research. The author criticizes terminology that “pre-interprets” ornaments as well as imprecise typologies. She underlines that using bead typologies based on shape as the only or primary category, still common among researchers, is an outdated approach.

Chapter 3, **Geography, temporality and interpretation**, reviews the tendencies in tracing the use of ornaments and the materials they are made of from a geographical and chronological perspective, warning how they impact the construction of archaeological narratives. Modern concepts of geographical barriers and proximity, which do not apply to the identification of potential routes of the past, are an example. Furthermore, periodization, as a means to mark relevant and identifiable change in practices, can vary depending on the type of archaeological object. Two tables which provide terminology for various regions and chronological phases facilitate navigation through the prehistoric section of the book.

In general, the first three chapters provide observations on past and present approaches to ornament studies and describe the ideal research that every bead/ornament specialist wishes to conduct and publish, i.e., one that uses well-defined data from perfectly excavated and dated contexts, involves typological studies based on clear divisions (including the use-life of beads), and employs appropriate scientific methods. Such work avoids misleading interpretations and is carried out in an academic atmosphere that is free from ignorance about ornaments, gender stereotypes, feminism, sexism, orientalism, modern and Western perspectives, capitalist economy, all kinds of selectiveness and determinism, and hypothetical proposals that are accepted as factual.

The next five chapters are arranged chronologically, starting with the Paleolithic period and ending with the Early Bronze Age. The chapters are structured around themes of continuity, distance, and meaning. The bead technology of

each period is analyzed in relation to the economy and way of life: mobile (until the Epipaleolithic) and sedentary (from the Early Neolithic onwards). Each chapter closes with a box presenting a chosen artifact. These box “biographies” show how a single item was used and changed during its life, and how it can be (re)interpreted to fit in with the knowledge about a given period.

In chapter 4, **Starting at the beginning: the Palaeolithic and Epipalaeolithic**, interesting points are made on the procurement, use, and manufacture of beads as one of the earliest indicators of human self-expression. The author discusses the choice of the basket form in early bead production, the use of small marine gastropod shell beads and deer canines in clothing ornamentation, and the preference for animal parts and marine shells from species of little calorific value. Widespread practices of shell procurement and use continued into the Epipaleolithic when the use of stone beads may have caused the shift in bead use from clothing to body ornamentation.

Chapter 5, **Changing times? The Early Neolithic**, opens with a discussion of features which continued from the previous periods. The continued use of marine shell beads despite settled life may have resulted from the earlier procurement system set up by seasonal group movements, now turned into exchange networks. Moreover, stone butterfly beads from the Euphrates region and beyond and perforated animal teeth show extended use patterns during the Neolithic, with the teeth also being imitated in bone and stone. While stone beads made of very hard materials are rarely recorded in assemblages, tools for perforating stone were used during the Early Neolithic in both household workshops and separate open working areas. Interestingly, it appears that the link between green stones and fertility or agriculture argued before for the Neolithic Near East is not supported by a statistical significance of green in assemblages from Turkey and the northern Levant. Another fascinating argument concerns the value of ornaments as demonstrated by their recycling or mending. Colored wood and plaster beads, and the relationship between beads and cordage are also discussed.

Chapter 6, **Settled life and identity: the established Neolithic**, reveals that despite some continuity from the Paleolithic, a major change in ornament materials and types, as well as their role in society, is observed for the first time in the Late Neolithic. Settled life in the established Neolithic increased the preference for larger ornaments and those white in color. The author also explores the technology of changing color and texture that was based on experimentation with materials and the beginnings of specialization, both likely the result of household production within a community. Other sections focus on

the interpretation of body ornaments according to patterns on human clay figurines and the study of manifestations of social differentiation through ornaments.

In chapter 7, **New technologies and interactions: the Chalcolithic**, the author discusses the interregional trade in raw materials and finished products as well as shared practices, including new technologies. Important observations are made on the already established use of blue fluorapatite beads as well as marine shell (*Spondylus*) and marble for the large-scale production of annulets and disc beads, and their life extension through recycling and intentional breakage. New ornament types include artificial enstatite disc and cylinder beads, ring idols, and stone beads used as seals.

Chapter 8, **Ornaments and the coming of civilization? The Early Bronze Age**, discusses metals, vitreous materials, hard stones and minerals, and the accompanying lapidary technologies, that began to be widely used during this period. Additionally, the value of ornaments, in terms of personal and community wealth, is stressed. Pins, diadems, and hair spirals – new types of ornaments that seem gender-neutral – accompanied beads and pendants, which were also found as bichrome composite clothing ornamentation. The apotropaic, semiotic, social, and economic values of raw materials and finished products are discussed, as are the many functions of the stamp and engraved cylinder seals and their links with ornamentation practices. Equally important is the debate on the nature of specialized production and the complex technologies that flourished during this period, as well as the conclusion on specialized craft activity that can exist in almost any context and does not have to be limited to stratified societies.

The structure of the last chapter, **Personal ornaments: dependencies, interactions and long-term change**, reflects the three points discussed throughout the book, i.e., economy, society, and identity. The summary presents an alternative approach to the traditional archaeological narrative, which should use the full potential of the evidence provided by personal ornaments.

This book is very welcome and holds a crucial position in the literature on prehistoric ornaments and prehistory in general. On a personal note, this is one of the most insightful narratives on beads I have read. For archaeologists and anthropologists, as well as those who struggle with studying and collecting beads, it can be an eye-opening volume on the very human meanings hidden behind bead specimens, behind the imperfect past and modern discourse, and behind the endless typological classifications, with the latter still equally important.

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Journal: Borneo International Beads Conference 2019.

Heidi Munan and Anita MacGillivray (eds.). Crafthub, 1st Floor, 96 Main Bazaar, 93000 Kuching, Sarawak, Malaysia. 2019. 246 pp., 16 color plates, 15 B&W figs. RM 95 (paper). To order, contact: sarawakmuseumshop.com.

This attractive compilation consists of papers from the 6th Borneo International Beads Conference (BIBCo) which was held in Kuching, Sarawak, Malaysia, in October 2019. Heidi Munan has held the directorship of BIBCo since its inception and, with a talented team in Kuching, has brought together experts from around the world to share the results of their research, their experience, and their very real practical knowledge. This conference had as its theme “Beads of our Time.” As a result some timely papers are to be found in this volume.



Ritu Sethi and Moe Chiba write of “Protecting the Material Culture Based on/of Indigenous Knowledge” (pp. 149-180). Exploring how to protect Indigenous Intellectual Property is an issue that concerns Indigenous peoples around

the globe, from North America to the Pacific Islands and particular ethnic groups in India. Ritu Sethi’s international experience with UNESCO and as chairperson of a number of national craft-related bodies in India make her an ideal person to tease out the common pitfalls, whilst seeking resolution to the desire for legal protection. Cultural flow and the diffusion of cultural forms has always taken place, but with a plethora of current internet sites that display a vast array of visual forms, that global flow occurs minute by minute. The authors recognize that this flow cannot be stopped, but rather they suggest ways of mitigating it through Collective marks (p. 165) and/or Geographical Indicator (GI) tags (p. 166). These suggestions involve essentially branding a product whereby the collective, rather than an individual, assumes ownership of what they understand to be their Indigenous knowledge. This practice falls outside the realm of the legal system of any given country, which may make the reader ask where the IP aspect comes in. The suggestion is remarkably practical, however, given the ubiquitous flow of things and their design. The authors do describe nations that have gone the legal IP route, yet we are living at a time when the first two decades of the 21st century are almost complete. The rate of technological change is increasingly rapid. These changes affect every piece of craft, including beads, made on the planet. “Developments in new technologies of mass replication from 3D printing, AI and other regular new technological developments that besides multiplying the numbers, lowers the costs to a fraction of the handmade” (p. 154).

It is thus to another paper that I now turn. Technological change alerts us to new fields opening up in the realm of craft-related research. “Viking Beads – Evidence of Long Distance Trade and Local Glass Bead Production” by Torben Sode (pp. 181-202) examines the means of dating found objects – beads made in the 8th and 9th centuries. This project, involving a team of researchers, was begun in 2011 and involved 500 samples of specific glass beads found in the general geographic region of southern Scandinavia. The analyses of glass beads and glass objects was conducted by Dr. Bernard Gratuze at the University of Orléans in France using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS). Who would ever have read of research such as this in a craft-related article or book twenty years ago? The method requires no sample preparation and is particularly well adapted to composite objects and small objects like beads. The article is detailed and scientific. The conclusion has implications that could go well beyond the origin and spread of these particular glass beads, for

the fascinating finding is that the beads were not made in southern Scandinavia, but rather at Islamic glass centers in the Abbasid Caliphate and may well have been traded along the Russian river systems. "In this way the glass bead import in Late Iron Age and Viking Age Scandinavia make out an important archaeological material, which testified to far Oriental trade connections. This is in contrast to most other archaeological materials which have not been preserved in the same numbers. Glass beads are one of the earliest archaeological objects which confirm the early long-distance trade and the first contacts between ancient cultures" (p. 195). These Abbasid glass beads have been found as far east as Thailand and Indonesia as well as in Scandinavia, Central Russia, and North Africa.

Could textiles also have spread in this way? Dating of threads has improved considerably, but knowledge of much older movement of textiles relies on historical trade import/export data as well as written records of travelers, pilgrims, and envoys. Much of this information is from European records, although Indian, Chinese, Turkish, and Arabian sources are now accessed by serious scholars. Research into modes of travel, whether by ship or overland, forms part of this picture, as do meteorological studies of prevailing winds and contemporaneous knowledge of disruptive historical conflict. The knowledge of ancient glass bead manufacture plus current technological dating methods opens up a new page in research into possible trading routes of cognate craft domains.

As a companion to the Abbasid beads of the 8th century, there is an article on glass beads in India, "Chevron and Millefiorie in India," by Alok Kumar Kanungo from the Archaeological Sciences Centre, IIT Gandhinagar, in which the state of glass beadmaking in the 21st century is examined. Competition from China has led to a number of production centers closing, a story that can be repeated in many places around the world.

Studies of material culture most often draw on the richness of design theory in combination with a broad range of anthropological theory. The opening article on the Western Sioux Lakota people of the Central Plains of the United States of America gives a comprehensive account of the way that beads, and quills, were and are used in both ritual practices and everyday life of the Lakota. "Living Bead Cultures of Gujarat," by Niyati Kukadia and Sonal Mehta, takes a similar approach in examining the beadwork of four communities in the Gujarat region – Kathi Darbar, Mahajan, Rabari, and Mir/Mirasi. There is a wealth of material in each

of these articles, each of which draws on extensive in-depth field study by the authors.

Contemporary studies of Borneo are not forgotten and are found in the article about making beads from sago processing residue by Chan Margaret Kit Yok and two others. This is a pertinent topic for our world. Waste is too often discarded rather than used. A local perspective with a gender dimension is given by Dora Jok in her article, "Belawan's Beaded War-Sword: Material Symbols of a Kayan Spirit-Hero." This article pictures the beaded swords that are made both for the tourist market and also as wedding gifts. The same sword can happily serve a dual purpose, a fact that substantiates the theme, "Beads of Our Time." As recognition of the number of locals attending the conference, each of the articles in the journal begins with an abstract in the Malay language.

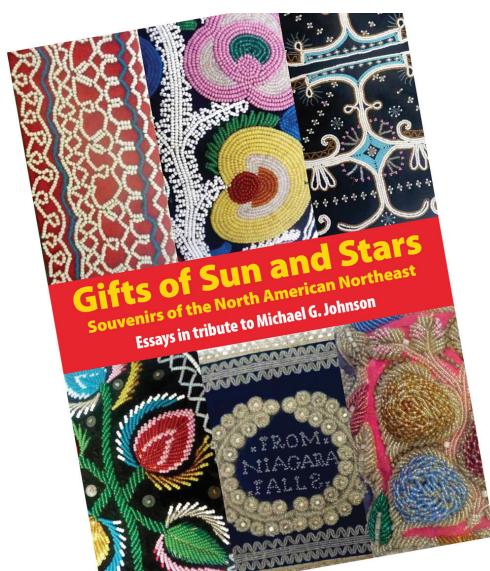
I shall conclude by drawing attention to the article "Beaded Textiles of the Katu Ethnic Group Living in South Laos and Central Highlands, Vietnam," by Linda S. McIntosh. These are isolated places where the weavers incorporate tiny white beads onto the weft thread as they weave their garment, thus creating what might be seen as three dimensional cloths, decorated with attractive geometric designs where the background colors are predominantly red and black. It is painstaking work which still takes place in the 21st century, albeit with considerable aid from Japan for both production and marketing, the latter being a crucial aspect of all small-scale craft production. With advanced technological expertise and dedicated local creativity, we do indeed live in a rich and varied world where studies of beads give one window into that vast vista.

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Gifts of Sun and Stars. Souvenirs of the North American Northeast: Essays in Tribute to Michael G. Johnson.

Richard Green. Spellicans Press, Oxford. 2020. 145 pp., 560+ color figs. ISBN 978-1-64945-514-7. £17.99 GBP sterling (paper).

In crafting *Gifts of Sun and Stars* during the time of coronavirus, Richard Green proves that unlike many of us, he quickly grasped the imperative that the values we support during times of great crisis determine what we have when it is over. Sobered, like us all, by a mounting death toll, savage economic fallout, and a newly exposed level of social injustice, Green perceived that, as the late activist poet Toni Morrison (2015) wrote, in times like these, “There is no time for despair, no place for self-pity, no need for silence, no room for fear. We speak, we write, we do language. That is how civilizations heal.” So, while others made banana bread and uploaded dances to TikTok, Green chose to answer this call to arms. In so doing, he has produced a book that not only celebrates a thriving, cross-cultural, global community of enthusiasts, scholars, and collectors, but that also places focus on a group which, when threatened with total destruction, also chose to respond through the medium of art.



From the 1990s onwards, psychologists have identified the occurrence of “post traumatic growth,” a state in which, when accepted structures are upended, mortality is confronted, and creative boundaries are exponentially challenged, the ability to adapt and grow is strengthened and individual priorities are altered (Linley and Joseph 2005). It could be argued that the Indigenous peoples of the northeastern part of North America’s collective, cross-tribal response to what Green identifies as the “alien white world that fast encroach[ed] upon theirs” bears all the hallmarks of this phenomenon. In charting the genesis and evolution of the “beadwork novelties” and eye-catching souvenirs created by the Seneca, Tuscarora, Mohawk, and Wabanaki, the author demonstrates that the solutions found by the First Nations people to the blatant attacks on their way of

life were not merely artistic (though, as I hope this review proves, the significance of this cannot be overestimated), but were also wholly practical. With notable speed, they perceived and then exploited the insatiable European desire for material things, social status, and exoticism. Showing what ethnologist and Smithsonian curator Otis Mason (1896) termed an extraordinary “plasticity of... mind,” they remained confident in the value of their own cultures but adapted ancient skills to appeal to their new audience, eventually creating a “myriad of objects,” each of which, once they had traveled many miles across the Atlantic, “brought color, beauty and infinite variety into European domestic life.” Far more importantly, however, the goods created helped to secure the future, albeit a precarious one, of the aboriginal people of the North American Northeast. For with Mohawk, Seneca, Tuscarora, Huron, or Wabanaki moccasins on their feet, the Europeans could not entirely ignore this culture in decline.

Other noted scholars have documented the unique challenges faced by the various tribes that made up the First Nations in the late 18th and early 19th centuries. Numerous others have gone some way to map the artistic evolution evident in the objects that the indigenous peoples created for the burgeoning numbers of European tourists, soldiers, and émigrés who visited the northeastern parts of North America. But few experts, if any, have produced a text that so clearly and so methodically charts these changes in technicolor.

Drawing largely on his own collection of Native American souvenirs, Green offers page after page of annotated images. We are treated to a sizeable grouping of early Seneca purses with stylized beadwork imagery, no less than nine examples of early multi-lobe pincushions from the Tonawanda Seneca, many dozens of mid-19th-century Mohawk purses, and a wealth of Tuscarora and Kahnawake Mohawk treasures made throughout the 19th and early 20th centuries, to mention but a few of the many categories of objects described and illustrated. Moose-hair, porcupine-quill, and glass-beading techniques are given equal prominence and in each case attention is paid to how tribal methods were adapted over time in accordance with market forces. Though his knowledge is apparent, Green allows the objects to speak for themselves. The reader cannot but be struck by the skill and creativity of the artisans and the many hours of work that each piece represents. For in his celebration of the intricate beauty of these Native American *objets d’art*, the author reminds us of the makers’ ability to move and to uplift long after she or he has passed.

Green’s self-proclaimed aim to “lift the spirits and bring joy” during this time of global struggle is not limited to his elevation of aboriginal souvenirs. *Gifts of Sun and Stars*

was written in tribute to Michael G. Johnson, a prominent figure in the field of Native American studies. Green speaks openly of the debt of knowledge owed to Johnson and to other members of this tight-knit community. As a relative newcomer to Northeastern beadwork and other souvenir arts, I have experienced this munificence first hand – and not least from the author himself. In times of crisis such as we now face, such generosity, in whatever form, is one of those values that we must seek to promote and emulate.

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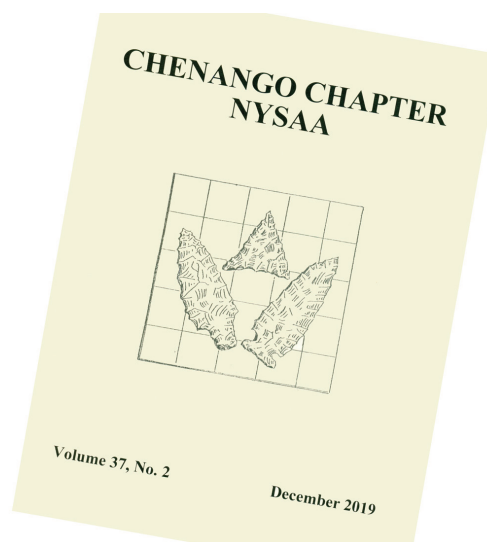
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Oneida Glass Trade Bead Chronology.

Douglas Clark. Chenango Chapter of the New York State Archaeological Association. 2019. 94 pp., 22 figs. \$18.00 (paper). Order from rpmason@roadrunner.com.

There are two great challenges in trying to convert archaeological information on beads into a format where others can use it. One is typological – establishing a common descriptive system that can be used widely. For eastern North America, the system devised by Ken and Martha A. Kidd and amended by Karklins has provided that standard. Based on the beads recovered from Seneca Iroquois sites



by Charles Wray, the Kidd and Kidd system provides the means for describing and presenting bead data from the mid-16th century to end of the 18th century.

The second challenge is building samples that are large and diverse enough to make comparisons. Good as the Kidd and Kidd system is, it has the limitation of coming primarily from Seneca sites. To counter this bias, several scholars have added detailed reports on beads from other Iroquois site sequences in the Northeast. Among these are descriptions of bead assemblages from Mohawk, Onondaga, Ontario Iroquoian, and Susquehannock sites. Clark's recently published *Oneida Glass Trade Bead Chronology* is a welcome addition to this literature.

Ironically, glass trade beads from Oneida sites provided one of the first attempts to establish a reliable descriptive system for this highly variable class of material culture. Peter Pratt's *Oneida Iroquois Glass Trade Bead Sequence, 1585-1745*, published in 1961, provided not just a descriptive system but a context for understanding how radically glass beads changed in terms of shape, color, and production technology over a period of nearly two centuries. Unfortunately, while Pratt has continued to build on this initial effort, he has never made the results available. Thankfully, Douglas Clark has stepped forward to bring the Oneida story up to date.

Drawing on the work of Monte Bennett and other members of the Chenango Chapter, New York State Archaeological Association, Clark begins with a brief methodological introduction. He then proceeds through the eighteen post-European Contact Oneida sites in

chronological order, as that sequence is currently understood (pp. 3-43). For each site, Clark provides the NYSAA site number, a brief description of the site and key material culture traits, and references to past publications. He also presents a detailed list of the glass beads known from each site by Kidd and Kidd code and frequency. Sample sizes vary from n=2 at the mid-16th-century Bach site to n=4682 at the early-17th-century Cameron site. Along the way, Clark adds useful commentary on historical context and similarities with other published bead assemblages. Clark concludes with an assessment of what glass trade beads might mean in terms of color preference over time, how well glass beads serve as chronological markers, where glass beads were produced, and how they correlate with national origins in Europe (pp. 44-54). A very useful bibliography, especially for some of the more obscure Chenango Chapter site reports (pp. 54-61), completes the volume. Although Clark provides color figures of beads and assemblages from different sites, they do leave the reader longing for more.

Aside from his invaluable site-by-site bead lists, Clark provides two important observations. One is that there are still unknown, or at least poorly known, sites in the Oneida

sequence. His discussion of the March (Ond 6-4) and Collins (Ond 7-4) sites may be brief but they serve as a reminder that all these data need to be seen through the filter of bias rather than as accepted fact. Clark's other contribution is his observation that some of these sites are multi-component. For example, the late precontact Brunk site (Ond 18-2) has also produced a sample assemblage of wire-wound beads, clearly from the early to mid-18th century. As Clark reminds us, we still don't know the whole story.

While one may not always agree with Clark's conclusions, they are based on the information he has assembled, and we must be truly grateful for his dedication and perseverance. Otherwise the data from the many private and small museum collections he tracked down simply would not be available to the rest of us.

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INFORMATION FOR AUTHORS

Manuscripts intended for *Beads: Journal of the Society of Bead Researchers* should be emailed to Karlis Karklins, SBR Editor: karlis4444@gmail.com.

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 - d. **Acknowledgements:** these are to be placed at the end of the article, before Endnotes and the References Cited section.
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 - f. **References Cited:** these and reference citations should generally follow the style of *Historical Archaeology* <<https://sha.org/assets/documents/SHASStyleGuide-Dec2011.pdf>> (Section VII).
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