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Four Blue Beads from Gardom's Edge

Caroline Jackson

Gardom's Edge is located in the Peak District National Park, near Baslow in Derbyshire, U.K., and its landscape displays a long history of prehistoric occupation and use. It is especially known for its rock art engraved into the gritstone, its ring cairns and standing stones. It was inhabited and farmed during the Bronze Age, and occupation is known to have continued after that date.

Excavations were commenced, by the University of Sheffield in collaboration with the Peak District National Park, in the 1990s, when many Bronze Age cairns and structures were investigated. During the 1999 season, a distribution of postholes from structures, some of which may have been circular, was found in Trench 8. The finds from this area included some fragmented turquoise blue beads in association with potsherds, flint flakes, scrapers and knives, potboiler stones, and a white stone pendant.[1] Because of the relative density of artifacts in this part of the site (more than 1,500 in total), the excavators suggested that this was an area of occupation. However, they noted that the duration of occupation here was more extended than in other parts of the site. The pottery from the area was tentatively dated to the Late Bronze Age or Early Iron Age. The lack of precisely datable material associated with the beads, as well as the absence of decoration or stylistic features on them, meant that they could not be closely dated to either the Bronze Age or the Iron Age. Within this context, the beads were analyzed to determine whether their composition, in comparison with known glass compositions from the second to first millenniums B.C., could help to date them.

Bronze Age and Iron Age Glass in Britain

The first millennium B.C. was a period marked by changes in production practices and an increase in trade. Glassmaking traditions from that time in northern Europe, and particularly in Britain, have seldom been investigated. This is due, in part, to the limited numbers of excavated glass objects, especially from the British Bronze and Iron Ages, when glass beads were considered "exotic" and relatively rare, and to the reluctance of many curators to allow destructive sampling of the beads because of their rarity. Therefore, only a limited number of published compositions is available for

[1]. John Barnatt, Bill Bevan, and Mark Edmonds, "A Prehistoric Landscape at Gardom's Edge, Baslow, Derbyshire: Excavations 1999 & 2000, Fifth Interim Report," p. 27, www.academia.edu/962780/gardoms_edge_interim_report_1999 (accessed December 1, 2014).

British material.[2] However, as more beads are found and studied, both in Britain and farther afield, the database continues to grow, and patterns of bead colors and styles, compositions, and spatial distributions begin to emerge.

It is generally assumed that the beads of the Bronze and Iron Ages found in Britain were part of a wider European distribution, and so may have originated in Britain, continental Europe, or farther afield.[3] Most of the beads from British contexts have been excavated from cremation urns or related funerary deposits, although some larger assemblages have been found on occupation sites, such as Rathgall in Ireland (ninth–seventh centuries B.C.) and, more recently, an Iron Age industrial center at Culduthel.[4] These beads are usually simple translucent annular beads, many blue or turquoise green, but others represent decorated types in colorless, dark blue, yellow, and white glass.

The Beads from Gardom's Edge

The four bead "fragments" (some in many small fragments) found in different contexts at Gardom's Edge are small turquoise blue annular beads. All are undecorated and stylistically similar to those described by Guido as Group 6 (possibly iv).[5] At the

2. By far the largest data set is in Julian Henderson, "X-Ray Fluorescence Analysis of Iron Age Beads," Ph.D. diss., University of Bradford, U.K., 1982; and *idem,* "Electron Probe Microanalysis of Mixed-Alkali Glasses," *Archaeometry*, v. 30, pt. 1, February 1988, pp. 77–91.

3. Margaret Guido, *The Glass Beads of the Prehistoric and Roman Periods in Britain and Ireland*, Reports of the Research Committee of the Society of Antiquaries of London, no. 35, London: the society, 1978, p. 3.

4. Julian Henderson, "The Earliest Glass in Britain and Ireland," in *Le Verre préromain en Europe occidentale*, ed. Michel Feugère, Montagnac, France: Editions Monique Mergoil, 1989, p. 21; "Iron-Masters of the Caledonians," *Current Archaeology*, October 11, 2007, www.archaeology.co.uk/articles/features/iron-masters-of-the-caledonians.htm (accessed January 9, 2015).

5. Guido [note 3], p. 65.

time of publication, Guido assigned them a Continental origin, noting that they were being imported from the sixth century B.C. The beads are of a common style that had a long life. This precludes any stylistic comparison with beads from other sites that would aid in dating or provenance. An estimation of size can be attempted from only one of the beads (H. 0.3 cm, OD. 0.6 cm; hole D. 0.3 cm; Fig. 1), half of which survives, although it is thought that the other beads may have been of similar dimensions.

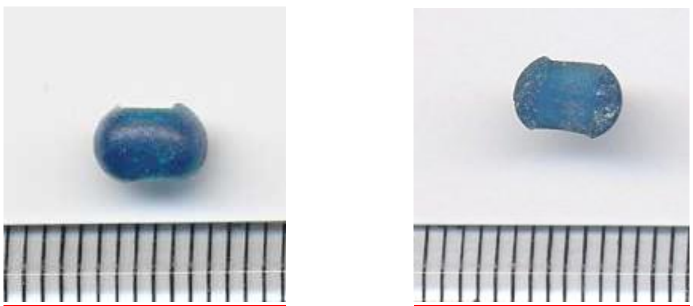

FIG. 1. Turquoise blue glass bead from Gardom's Edge (Context 599, S.F. 1015; scale in mm).

Analysis of the Beads

Analysis of the glass was performed by electron probe microanalysis, using a Cameca SX100 electron probe microanalyzer at the Department of Geology, University of Manchester, U.K. The Corning A standard was used to check the integrity of the data. Precision and accuracy were generally better than 10 weight percent and often better than five weight percent for the major oxides.

Three small fragments from three different beads (nos. 81204, 8105, and 8709) were analyzed. The fourth half-bead (no. 1015) was the most complete, and therefore it was not sampled. The data presented in Table 1 are the mean of 12 analyses taken from different spots on each of the beads (36 analyses in all); each point analysis represents three iterations. The standard deviation was relatively wide for many elements, and it is particularly pronounced for lead; this is due predominantly to the heterogeneity within the glass matrix, because the analytical precision is good. This heterogeneity, which resulted from incomplete mixing of the glass when the beads were produced, is typical of many early glasses.

Bead Compositions of the Bronze and Iron Ages

British and European Bronze Age glass beads generally fall into two broad compositional types. They have either a high-magnesium (HMG) composition, which is typical of glasses found both in Bronze Age Europe and especially in the Near East, or a low-magnesium and high-potassium (LMHK, or mixed alkali) composition, which is characteristic of beads from continental Europe dating to about 1200–900 B.C.[6] Both compositional types are generally thought to be indicative of glasses manufactured using plant ashes, explaining the higher concentrations of magnesia and potash (2 wt %–6 wt % MgO and 2 wt %–4 wt % K_2O).

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[6]. Henderson [notes 2 and 4]; Gilberto Artioli and Ivana Angelini, " Evolution of Vitreous Materials in Bronze Age Italy," in *Modern Methods for Analysing Archaeological and Historical Glass*, ed. Koen Janssens, v. 2, Chichester, U.K.: John Wiley & Sons Ltd., 2013, pp. 355–368.

More rarely, Late Bronze Age beads are found with a soda-lime-silica composition. They are called low-magnesia (LMG) glasses, and they were produced using an evaporite mineral alkali. Evaporite sources, such as natron, are generally assumed to have come from Egypt, although other sources are known. In a few cases, these compositions are mixed in a single object. For example, a Bronze Age bead from Rathgall, Ireland, has a turquoise blue decoration of soda-lime-silica LMG composition, but a body of LMHK composition, which is more typical of Bronze Age glasses.

In the Iron Age, the soda-lime-silica glasses of the LMG type, together with the HMG glasses, are more common. The range of compositions seen in British beads from both the Bronze and Iron Ages is probably a feature of the location of Britain, linked to trading networks from continental Europe, Ireland, and possibly the Near East.

The change from HMG glasses using plant ashes to glasses produced with natron occurred sometime around the 10th–eighth centuries B.C., based on present evidence. The earliest natron-type LMG glasses reported in northern Europe are dated to the eighth century B.C. These compositions are occasionally found in beads from England, Ireland, and (more commonly) France, Slovenia, and Germany (Hallstatt C and D),[7] dating

[7]. Julian Henderson, "The Scientific Analysis of Ancient Glass and Its Archaeological Interpretation," in *Scientific Analysis in Archaeology and Its Interpretation*, ed. Julian Henderson, Oxford University Committee for Archaeology, Monograph 19, and UCLA Institute of Archaeology, Archaeological Research Tools, v. 5, Oxford, U.K.: the committee, and Los Angeles: the institute, 1989, pp. 36–43; J. Henderson and S. E. Warren, "X-Ray Fluorescence Analyses of Iron Age Glass: Beads from Meare and Glastonbury Lake Villages," *Archaeometry*, v. 23, pt. 1, February 1981, pp. 83–94; Ch. Braun, "Analysen von Gläsern aus der Hallstattzeit mit einem Exkurs über römische Fenstergläser," in *Glasperlen der vorrömischen Eisenzeit I*, Marburger Studien zur Vor- und Frühgeschichte, v. 5, ed. Otto-Herman Frey, Mainz am Rhein: Phillip von Zabern, 1983, pp. 129–178; Gerald Hartmann and others, "Chemistry and Technology of Prehistoric Glass from Lower Saxony and Hesse," *Journal of Archaeological Science*, v. 24, no. 6, June 1997, pp. 547–559; Bernard Gratuze and Françoise Lorenzi, "Les Éléments de parure en verre

between the eighth and first centuries B.C. The picture is similar in the east. In Mesopotamia, Anatolia, Egypt, and Iran, natron glasses began to replace glasses made with plant ashes at a comparable time. This transition may have taken place as early as the 10th century B.C. in Egypt,[8] but it was certainly established throughout the east by the eighth century B.C.

The most common colorants employed to produce various shades of blue were copper and cobalt. The use of copper as a colorant was more usual for Bronze Age beads from Mesopotamia and surrounding regions, and also from continental Europe. Beads from Egypt were colored blue with copper between the 11th and seventh centuries B.C., but with cobalt before and after that period. Cobalt also became more common in Europe during the Iron Age.

Composition of the Beads from Gardom's Edge

The three analyzed beads from Gardom's Edge are soda-lime-silica glasses of the LMG type (Table 1). The very low concentrations of potash (0.2 wt %) and magnesia (0.4 wt %) suggest that a natron-type evaporite was used in their manufacture; a glass

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du site de Lumaca (Âge du Fer, Centuri, Haute-Corse): Compositions et typochronologie," *Bulletin de la Société Préhistorique Française*, v. 103, no. 2, 2006, pp. 379–384; Bernard Gratuze, "Les Premiers Verres au natron retrouvés en Europe occidentale: Composition chimique et chrono-typologie," *Annales de l'Association Internationale pour l'Histoire du Verre*, v. 17, Antwerp, 2006 (2009), pp. 8–14; Susanne Greiff and Suzanne Hartmann, "Compositional Groups of Iron Age Glass Beads from Novo Mesto (Slovenia)," abstract and poster, 19th congress of the Association Internationale pour l'Histoire du Verre, Slovenia, Programme and Abstract Book, 2012, p. 123; T. Purowski and others, "A Study of Glass Beads from the Hallstatt C–D from Southwestern Poland: Implications for Glass Technology and Provenance," *Archaeometry*, v. 54, pt. 1, February 2012, pp. 144–166.

8. Birgit Schlick-Nolte and Rainer Werthmann, "Glass Vessels from the Burial of Nesikhons," *Journal of Glass Studies*, v. 45, 2003, pp. 11–34.

made with high-soda plant ashes would normally have concentrations of potash and soda above 1 wt %. The very low concentrations of phosphorus pentoxide (< 0.01 wt %) also support the use of a mineral alkali. The most unusual feature of these beads, however, is the extremely low concentrations of alumina (below 0.4 wt %), iron oxide (below 0.35 wt %), and titania (below 0.1 wt %), which indicate the use of extremely pure sands, or more likely crushed quartz, as the main glass former. These low concentrations of impurities for alumina, titania, potash, and magnesia suggest that these are not typical LMG glasses.

Lime is seen at concentrations typical of LMG glasses (7–8 wt %). However, the small number of analyses does not allow any correlations between elements to be calculated, and so it is not possible to determine whether the lime (CaO) was added separately as limestone, shells, or something similar, or whether it was associated with some other glassmaking raw materials. Because the glass is relatively low in other impurities that would normally be associated with the use of sand (high alumina, iron, and titania) or plant ashes (higher magnesia, potash, and phosphorus pentoxide), it is difficult to determine the origin of the lime. Although desert sands from Egypt have been recorded with sufficient calcium to act as a stabilizer, the low impurity levels in the glass might suggest that this high-lime sand was not used. The consistent composition of the three glasses (lead excepted; see below) may indicate that they are of the same provenance and were possibly made from the same glass batch.

The high percentage of copper oxide (up to 4 wt %) explains the vivid turquoise blue color of the beads. The color derives from the oxidized (cupric) state of the copper, which would have been added deliberately. The relative absence of tin may suggest that the source of the copper was relatively pure (from a pure copper metal or refined ore) rather than a bronze alloy, for example. The presence of lead (about 0.5 wt %) in two beads (81204 and 8105) is often explained in terms of the recycling of glass or the addition of an impure copper colorant, and either explanation may have been the case here.[9] The reason for the absence of lead in the third bead (8709) is not clear, although lead often segregates in glasses, so its absence may be either because this glass does not contain lead or because the area of the glass analyzed was lead-poor.

Compositional Parallels

In 2006, the time of analysis and publication of the preliminary report, there were few comparative analyses for these compositionally unusual beads.[10] However, because more prehistoric glass beads have now been analyzed, a larger database is available in which to situate this material (Table 1); this expanded data set has permitted a new interpretation of the beads, which is presented here. The glasses in Table 1, ranging in date from the ninth to first centuries B.C. and recovered from contexts in Britain, continental Europe, and the Near East, are mineral alkali (natron) Iron Age glasses, and all are compositionally similar in some respect to the glasses from Gardom's Edge; they

[9]. Caroline M. Jackson, "From Roman to Early Medieval Glasses: Many Happy Returns or a New Birth?," *Annales de l'Association Internationale pour l'Histoire du Verre*, v. 13, Pays Bas, 1995 (Lochem, the Netherlands, 1996), pp. 289–302.

[10]. Caroline Jackson, "Four Blue Beads from Gardom's Edge," report submitted to the Gardom's Research Project, 2006.

are used here as a basis for discussion.[11] The increasing number of analyses suggests that these curious compositions are more widespread than was initially thought.

Comparison with British beads of that date yields few compositional similarities (Table 1). Some of the Late Iron Age beads from Meare[12] in Somerset (where, it has been suggested, the beads were manufactured) have low potassium (0.4 wt %), but the alumina is higher (well over 1 wt %; three examples are given here: G1CC, G73, and G57). One Middle Iron Age bead (no. 64) from Wetwang[13] in North Yorkshire is low in alumina (0.4 wt %), but has marginally higher concentrations of potash and much higher iron. As an isolated find in a La Tène cemetery, it was probably brought to the region. Therefore, using this published data, there is no indication that the Gardom's Edge beads, or beads found at other British sites, originated in Britain.

The best compositional matches come from Early Iron Age beads recovered in France and Corsica,[14] various sites in Poland from Hallstatt C and D (approximately 800–

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[11]. Henderson and Warren [note 7]; Gratuze [note 7]; Gratuze and Lorenzi [note 7], pp. 381–382; Schlick-Nolte and Werthmann [note 8]; Julian Henderson, "A Report on the Glass Excavated from Meare Village West, 1979," in *Somerset Levels Papers*, no. 7, ed. John M. Coles, Hertford, U.K.: Stephen Austin and Sons Ltd., 1981, pp. 55–60; Henderson, "X-Ray Fluorescence Analysis" [note 2], p. 392; Wendy Reade, Ian C. Freestone, and St John Simpson, "Innovation or Continuity? Early First Millennium BCE Glass in the Near East: The Cobalt Blue Glasses from Assyrian Nimrud," *Annales de l'Association Internationale pour l'Histoire du Verre*, v. 16, London, 2003 (Nottingham, U.K., 2005), pp. 23–27; Schlick-Nolte and Werthmann [note 8]; Jackson [note 9].

[12]. Julian Henderson, "The Archaeology and Technology of Glass from Meare Village East," in *Meare Village East*, *Somerset Levels Papers*, no. 13, ed. John M. Coles, Hertford, U.K.: Stephen Austin and Sons Ltd., 1987, pp. 170–182; *idem*, "A Report" [note 11]; *idem*, "X-Ray Fluorescence Analysis" [note 2]; Henderson and Warren [note 7].

[13]. Henderson, "X-Ray Fluorescence Analysis" [note 2].

[14]. Gratuze and Lorenzi [note 7]; Gratuze [note 7] (compositions not published but noted); Bernard Gratuze and Philippe Gruat, "Les Eléments de parure en verre du Puech de Mus (Sainte-Eulalie-de-Cernon, Aveyron): Typologique et composition chimique," in *L'Agglomération du* Puech de Mus *à Sainte-Eulalie-de-Cernon*, ed. Philippe Gruat, forthcoming.

475 B.C.) and in Germany,[15] and Tomb 19 from Tumulus 32 at Novo Mesto, Slovenia, which were noted by Greiff and Hartmann.[16] While the concentrations of alumina, potash, and especially soda and lime vary within the group, most of these glasses follow a compositional trend similar to that of the beads from Gardom's Edge. They show the use of a low-potash/magnesia alkali source, and they contain low levels of alumina. The use of a low-alumina glass former in all of these glasses suggests that quartz rather than sand was employed, and Gratuze notes that this may indicate a Near Eastern rather than Egyptian origin.[17]

However, a review of published compositions of contemporaneous beads from Egypt and the Near East here identified only two broadly comparable analyses of glasses that *may* have been made with mineral soda. Stylistically similar beads of the ninth to eighth centuries B.C. from Nimrud, colored with cobalt, also contain low concentrations of alumina, but the potash and magnesia concentrations are much higher, the former indicating some plant-ash contribution in the alkali. A Syro-Palestinian or Egyptian origin has been suggested for these glasses (Table 1). Much earlier glass from the tomb of Nesikhons in Egypt is low in potash and magnesia but has high concentrations of alumina, and so does not provide a good compositional parallel.[18] Thus, neither of these published glass compositions is a good match for the beads from Gardom's Edge or for other low-alumina glasses found in Europe, and so a Near Eastern origin for the beads from Gardom's Edge cannot be determined using present evidence. In this context, Grief

15. Purowski and others [note 7]; Hartmann and others [note 7].

16. Greiff and Hartmann [note 7]; no data were available at the time the current article was published.

17. Gratuze [note 7].

18. Schlick-Nolte and Werthmann [note 8].

and Hartmann tentatively suggest a local production for their low-alumina beads from Novo Mesto,[19] and it may be that the beads from Gardom's Edge originated in Europe. Whatever their provenance, these beads clearly were produced using a tradition different from that of the more common natron beads dating to the Iron Age and into the Roman period.

The concentrations of lead in the Gardom's Edge beads shown in Table 1 are worthy of comment, although there were no obvious correlations between lead and other elements that would indicate its source. Similar low concentrations of lead have been recorded in comparable low-alumina beads from Puech de Mus, France, and Corsica, and in LMG beads from Meare Lake Village. Other beads of low-alumina/potash/magnesia composition from Poland, France, and Slovenia show high lead concentrations (up to 15 wt %), but this is often associated with other elements, such as tin or antimony, to which lead was added as part of the opacifier to produce opaque white or yellow glass.[20] The lead in the Gardom's Edge glasses may therefore be a feature of recycling or of mixing with contemporaneous lead-containing glasses, or it may have been unintentionally added with the copper colorant.

The use of copper as a colorant was common, and it would fit with either a Bronze Age or Iron Age date, although it was more common in the British Bronze Age. However, many of the LMG and low-alumina LMG beads from sites in Europe, Egypt, and the Near East are similarly colored with copper (Table 1), and these range in date

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19. Greiff and Hartmann [note 7].
20. Gratuze [note 7]; Greiff and Hartmann [note 7]; Purowski and others [note 7].

throughout the period under study. Similarly, although there are chronological differences in the use of copper as a colorant in Egypt and the Near East, it is not exclusive to any area or time period.

Comments

Of what date are the beads? While it is not possible to assign the Gardom's Edge beads to the Bronze or Iron Age stylistically, and while the use of copper to produce the blue color might indicate an earlier date, comparative compositional data suggest that these beads are most similar to beads found in Europe that date to the Early Iron Age (about 800–400 B.C.). In addition, the soda-lime-silica LMG composition is more characteristic of the Early Iron Age; examples are more rare in the Late Bronze Age.

Where were they made? The LMG compositional group, produced using natron, is an Iron Age glass composition that is now known to be found throughout Europe and the Near East. Gratuze has suggested that some of the more common LMG groups, those that were manufactured from natron but with higher concentrations of alumina, may have originated in Egypt.[21]

The low-alumina Gardom's Edge glasses form a tradition different from that of the typical LMG glasses. Various hypotheses relating to their provenance may therefore be advanced:

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[21]. Gratuze [note 7].

1. *The beads were manufactured elsewhere and imported*. Following Gratuze, one suggestion is that these beads were made within a Near Eastern production zone, where the use of ground quartz and natron had a long tradition (although secure examples outside Europe have yet to be found).

2. *They were made from imported glass, brought in as ingots or blocks, possibly from the Near East, and colored locally at various centers in western Europe*. Copper-colored blue glass may have been a local tradition/preference (and perhaps easily obtained), which may explain the use of copper, rather than cobalt, to color these Early Iron Age beads.[22]

3. *They may have been produced locally from local sands*, as Greiff and Hartman suggest for their beads from Novo Mesto.[23] In this instance, it can only be presumed that the natron would have been imported because it is not found in temperate climates.

The low-potash, low-alumina compositions reported here from Gardom's Edge, as well as comparative compositions from throughout Europe, show a generalized coherence. All of them seem to have been manufactured with quartz rather than sand, with mineral alkalis, and presumably with an added source of lime. The low concentrations of impurities in the beads suggest specialized manufacture using very pure raw materials. However, there is some degree of heterogeneity within the low-alumina

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[22]. In Iron Age Europe, natron glass was sometimes colored in a way that was regionally distinctive (for example, using stannates for opaque yellow and cobalt, with various levels of iron for blue). See Julian Henderson, "Industrial Specialisation in Late Iron Age Britain and Europe," *The Archaeological Journal*, v. 148, 1991, pp. 104–148. Henderson's data are for Wetwang, fifth to second centuries B.C.

[23]. Greiff and Harmann [note 7].

LMG group as a whole, that may hint that these glasses were made at different centers, using slightly different raw materials (including colorants or opacifers). The three analyzed beads from Gardom's Edge show a compositional coherence suggesting that they have a common provenance.

These different groups potentially offer an insight into the technological changes and the number of workshops operating in the Iron Age. Although the provenance of these very unusual beads has not yet been established, they do show that northern Britain was part of a very large exchange network that included glasses produced in the Near East (this is certainly true for the more common LMG compositions), but also potentially some that were produced closer to home, and certainly distributed within Europe. These beads are of a relatively rare composition, which has been recognized only recently at a small number of centers in western Europe. That these beads were found in such a remote settlement in upland Britain at that time is extraordinary, and it may suggest that this distant and relatively unaccessible location was populated by individuals, or visited by travelers, of a more elevated status. As Helms[24] argues, gifts from "afar," especially those produced by skilled artisans (as these beads must have been), are more available to powerful elites and are a means of embodying power and honor to the owner. These beads therefore shed new light on the production, movement, and consumption of glass, and on the people who used it in the Early Iron Age.

ABSTRACT

[24]. Mary W. Helms, *Craft and the Kingly Ideal: Art, Trade, and Power*, Austin: University of Texas Press, 1993.

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Four blue glass beads from the prehistoric site of Gardom's Edge, in the upland area of the Peak District in Britain, were analyzed to determine their composition, date, and origin. The simple annular beads were of unknown date, although they were recovered from contexts that were either Bronze Age or Iron Age in date. The compositions of the beads are relatively unusual. They were manufactured with mineral alkalis, but they contained extremely low concentrations of impurities and were colored with copper. Comparison with other recently analyzed glasses shows (rare) parallels in Europe of Iron Age date, but not in the eastern Mediterranean (Egypt, Near East), which suggests an origin somewhere in the west. This is an extraordinary find in a marginal area, which suggests far-reaching trade and exchange networks.

FIGURE CAPTION

FIG. 1. Turquoise blue glass bead from Gardom's Edge (Context 599, S.F. 1015; scale in mm).

TABLE 1

Composition of Blue Glass Beads from Gardom's Edge and Elsewhere

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