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LA-ICP-MS analyses of complete glass bead sets from the Merovingian cemeteries Lent-Lentseveld, Elst-'t Woud and Wijchen-Centrum (the Netherlands)

by

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1. Introduction

Beads are found in many graves in early medieval Northwestern Europe, they are not confined to rich graves only, but are found in rural cemeteries as well. During the past decades the research potential of these beads has been increasingly recognised.[1] For example, beads from 6th and 7th-century (rural) graves can be used to study the exchange networks a rural population was connected to, as they have provenances ranging from Europe to India and Sri Lanka.[2] Furthermore, ethnographic research has shown that beads can be used as much more than personal adornments. The latter is a typical 'disenchanted' modern Western notion. The choice to make, acquire and wear beads is driven by the value and meaning society associates with them and the belief that beads are able to convey complex social and cultural messages.[3]

Plus, it has been argued that beads are essentially suited to symbolic and ritual practices, and there are many ethnographic examples that illustrate this.[4] For example, beads can be used as an aid for prayer and marker of a certain religious conviction, as is shown by the use of rosaries among Roman Catholics and the use of prayer beads among followers of

1 Koch 1977; Sasse/Theune 1997; Siegmund 1998; Brugmann 2004; Pion 2014; Poulain et al. 2013; Boschetti et al. 2020; Pion et al. 2020.

2 For a detailed discussion on bead techniques and their provenances, see Pion 2014, 178–229 and references therein. See also Pion/Gratuze 2016; Drausche 2011; Langbroek 2018.

3 Mannion 2015, 90.

4 Küçükerman 1988, 41.

Islamic religions. Among the Samburu of Kenya the way a woman wears beads changes through life in specific ways that reflect her age, eligibility for marriage, marital and social status. When Samburu women are widowed they usually stop wearing beads altogether.[5] Amidst the women of the Somali Zigula in Africa a similar bead-use is noted. There, beads are linked to the individual and to group identity: some beads are associated with the founding ancestress and these and other beads play a part in all female rites of passage. The beads associated with the ancestress and the individual transition beads are worn combined on the same string. These strings of beads thus display not only the accumulation of experiences and life stages in the life of the wearer, but also associate her with the ancestress.[6]

There are many ethnographic examples of cultures in which beads accumulate more value the longer they circulate. For the Kelabit people of Sarawak on Borneo, the most important and valuable aspect of a bead is its age and its former owners, preferably ancestors. Their appearance is less important. Some of the most valuable beads are over a thousand years old. According to the Kelabit, heirloom beads represent *lalud*, or raw life force. The higher an individual's social status and prestige, the more valuable (ancient and inherited) beads a Kelabit can display. This also works the other way around: as beads are markers of prestige, it is hoped that their possession will legitimate status mobility.[7]

With this world-wide variety in bead-use comes the understanding that the way people used and perceived beads in the Merovingian period was potentially very different than we do today. There is clearly much more to bead-use than simple bodily decoration and display in terms of meaning and symbolism. This calls up an almost endless stream of questions: Were the strings of beads we find in early medieval graves assembled especially for the burial, or were they worn as they were during life as well? Adding to that, did beads stay together on a single string all their 'lives', or were they strung and restrung on and for various occasions? Did Merovingian beads represent the life-stage of the wearer as the Samburu example illustrated, and could they be 'read' by others in society? Did they play a role in other rites of passage than the burial ritual, as they do with the Somali Zigula? Did Merovingian beads accumulate more significance through time and circulation, as with the Kelabit? Were they perhaps exchanged across generations as gifts at special occasions, from (grand)mother to (grand)daughter at her wedding, or from (grand)father to (grand)son at coming of age? Considering the varied provenances of Merovingian beads, how was the production and near-global exchange of these beads organised? Did the production and exchange of beads during the 6th and 7th centuries have a commercial or a social character, or perhaps both? In other words, were beads mass produced in static workshops and exchanged as commodities, were they rather made to order by travelling craftsmen as a form of customised production for special occasions, or did these alternatives exist side by side? In this article, we would like to tackle some, but not all, of these questions: we are especially interested in establishing whether strings of beads were collected one bead at a time, or all at once, as the answer to this question can give more insight into many (but not all[8]) of the other questions posed above.

In a former article we have thoroughly explained and tested a method with which chemical groups of beads from a single Merovingian cemetery could be distinguished.[9] In short, this was accomplished by chemically analysing the complete glass bead assemblage of the 6th-century cemetery Lent-Lentseveld typologically and with both pXRF and LA-ICP-MS. Then, Principal Component Analyses (PCA) were performed to identify chemical groups per bead-type and per grave. The results were very promising: for imported bead-types from the Eastern Mediterranean and further East clear chemical groups per bead-type were recognised, and for both imported and European beads distinct groups per grave were identified. These findings suggest that in the 6th century beads were imported over long distances to Lent on several occasions, and that once strung, beads tended to remain together as a distinct set as opposed to the idea that they were collected one by one over time. This prompted us to ask whether the same patterns could be recognised for bead assemblages excavated from other Merovingian cemeteries in the region.

5 Carey 1998, 89.
6 Sciama/Eicher 1998, 17.
7 Janowski 1998, 237–241.
8 The available archaeological evidence does not (yet) allow us to argue for one of the known cultural-anthropological meanings presented above.
9 Langbroek et al. 2023.

Fig. 1 Locations of the cemeteries in this study. 1. Lent-Lentseveld; 2. Elst-'t Woud; 3. Wijchen-Centrum.

In this article we aim to compare the chemical composition of beads from three Merovingian cemeteries from the eastern part of the Netherlands: Lent-Lentseveld, Wijchen-Centrum and Elst 't Woud (Fig. 1). Most beads excavated from these cemeteries were interred during the 6th century. We want to establish whether the chemical patterns observed for Lent-Lentseveld can also be found in the glass bead assemblages of Wijchen-Centrum and Elst-'t Woud, in order to start formulating some answers to the questions on bead-use, production and exchange posed above. Finally, to find out whether the observed patterns are specific to the region these beads were excavated from, or are in fact a Pan-European phenomenon, we want to compare the results observed for the bead-assemblages of these three cemeteries to the bead-assemblage of the cemetery Campo-Marchione, Italy, for which the LA-ICP-MS analyses were published in 2020.[10] The study therefore consists of a complete approach ranging from photography and determining each bead's typology to provenance determination and chemical analyses.

2. The Sites

2. 1. Lent-Lentseveld

The cemetery of Lent-Lentseveld is a small 6th-century cemetery of 79 graves that has been excavated by the municipality of Nijmegen in 2011 and 2015 in the village of Lent, north of the town

[10] Boschetti et al. 2020.

of Nijmegen in the Netherlands.[11] It dates between 500 and 600 CE. In total 1205 beads were found in Lent in 29 different graves: 26 inhumations and 3 cremations, found in 40 different 'groups'.[12] The beads were mainly found in children's and women's graves: 7 children's graves, 19 women's graves and 1 man's grave.[13] In Tab. S1 in the appendix an overview of all the beads per grave is provided. Most groups of beads were found near the neck or chest. It is most likely that these were necklaces, although they could also have been sewn onto the neckline of clothing. In two cases beads were found near an arm: these were probably bracelets, or might have been embroidered on the sleeves. And in at least one case beads must have been attached to a chatelaine, since they were found near the hip, just as several of the large glass 'spindle whorl beads'.

2. 2. Elst-'t Woud

The cemetery of Elst-'t Woud is a cemetery of 95 inhumation and 165 cremation graves located on the northern riverbank of the Rhine that dates to the 5th, 6th and 7th century CE. It was excavated by the *Rijksdienst voor Oudheidkundig Bodemonderzoek* (ROB) in 1981, but was first published much later, in 2015.[14] In total 1771 beads were excavated from 39 inhumation graves and 18 cremation graves, in 81 different 'groups' (Tab. S2). 1742 of these beads were physically available for study, the rest were determined with the help of photographs and descriptions. Most groups of beads were found in the neck/chest area, or at the hip or upper legs: beads were deposited as necklaces, in a purse at the hip or, in the case of large spindle whorl beads, suspended from a belt.

2. 3. Wijchen-Centrum

The cemetery of Wijchen-Centrum is a cemetery of 309 inhumation and 36 cremation graves located between rivers Waal and Meuse just southwest of the town of Nijmegen, that roughly dates between 400 and 640 CE. It was excavated by the *Rijksdienst voor Oudheidkundig Bodemonderzoek* (ROB) in 1991, 1992 and 1996 but was first published much later, in 2010.[15] In total 1009 beads were excavated from 64 inhumation graves and 2 cremation graves, in 87 different 'groups' (Tab. S3). Only 417 beads were physically available for study: the other 592 were studied from photographs, if these were available, as they remained on display in *Museum Kasteel Wijchen* and *Museum het Valkhof*. Most groups of beads were found in the neck/chest area as necklaces, or as single beads at the hip. In comparison to Lent and Elst fewer beads were found per grave in Wijchen, which can probably be explained by the disturbances created by the settlement that occupied the site from the Carolingian period onwards.

3. Materials

The vast majority of beads of all three sites are made of glass, using a variety of techniques: wound beads, drawn beads, perforated beads, folded beads and mosaic beads all occur in the same string of beads. After glass, amber is the most common material. Only a few beads are made of other materials (Tab. 1). The beads from Lent, Elst and Wijchen have various provenances: North-Western Europe, the Baltic, the Eastern Mediterranean, Egypt, the Syro-palestinian coast, Mesopotamia[16] and the southern part of the Indian peninsula are all represented.[17]

4. Methodology

As one of the aims of the research presented in this article is to see whether beads of the same type (within a region, within a cemetery and within a grave) share the same composition, this study considers the classification of beads as well as the Laser

11 Hendriks 2021.

12 For a detailed study of the beads from Lent-Lentseveld, see Langbroek 2021.

13 These are sex determinations based on a physical-anthropological study of the preserved skeletal material from the graves of Lent-Lentseveld; Van der Linde 2021.

14 Verwers/Van Tent 2015.

15 Heeren/Hazenberg 2010.

16 In this article we refer to the region between the Euphrates and Tigris rivers as 'Mesopotamia', which literally means 'land between rivers'. With this term we do not refer to the Mesopotamian empire, as it no longer existed in the 6th century.

17 For a detailed study of the beads from Lent-Lentseveld, see Langbroek 2021.

Tab. 1 Overview of the materials out of which the beads excavated from the cemetery of Lent-Lentseveld, Elst-'t Woud and Wijchen-Centrum were made.

	Lent		Elst		Wijchen	
Material	**no. of beads**	**no. of graves**	**no. of beads**	**no. of graves**	**no. of beads**	**no. of graves**
glass	1028	28	1366	57	855	61
amber	164	22	392	22	145	30
antler	0	0	1	1	0	0
beryl	1	1	0	0	0	0
bone	0	0	1	1	0	0
ceramic	0	0	1	1	1	1
copper	0	0	1	1	0	0
faience	5	3	4	3	4	3
flint	0	0	2	2	0	0
jet	0	0	2	1	0	0
marble	3	3	0	0	0	0
meerschaum	1	1	1	1	1	1
metal	1	1	0	0	0	0
rock crystal	1	1	0	0	1	1
samian ware	1	1	0	0	0	0
silver	0	0	0	0	2	2
total	**1205**	**29**	**1771**	**57**	**1009**	**66**

Ablation-Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) of beads from all three sites described above.

First, all beads were classified using the classification from Pion, which is based on the seriation of over 21.000 beads found in six Merovingian cemeteries from Belgium. It was later adjusted and improved by Vrielynck, Mathis and Pion in 2018.[18] For every bead from Lent-Lentseveld, Elst-'t Woud and Wijchen Centrum the material, condition, production technique (Fig. 2), size, colour, decoration and provenance (based on typology) were documented. Finally, all the beads were photographed using a camera on the stereomicroscope used to study the beads. As bead collections from sites across Europe show remarkable similarities,[19] a typology based on early medieval bead collections from Belgium can be applied to early medieval bead sets found in the Netherlands without difficulty. In this typology, each bead-type is dated to one or multiple periods (P1, P2, P3, P4 or P5) within the Merovingian era (Tab. 2). It is structured based on the techniques used to manufacture Merovingian beads, a factor that had not been considered in previous typologies.[20] In Europe only evidence for the production of wound beads has been excavated, whereas other forming techniques were used in the Mediterranean, Egypt, the Levant, Mesopotamia, and India (Tab. 3).[21]

Then, LA-ICP-MS analyses were performed on all polychrome beads and a representative subsample of all monochrome beads (Tab. 4).[22] As in previous works, since we want to distinguish patterns within and amongst graves as well as diachronically and spatially it is important to analyse the complete glass bead-assemblages of several cemeteries. Analysing every bead is the only way to see if, within a bead-type, beads from different graves cluster to-

18 Vrielynck et al. 2018.

19 Langbroek 2023.

20 E. g. Siegmund 1998.

21 For a detailed discussion on bead techniques and their provenances, see Pion 2014, 178–229 and references therein.

22 For a thorough explanation of the methodology, we would like to refer to our previous paper, Langbroek et al. 2023. The LA-ICP-MS data collected for this study can be accessed at: www.earlymedievaleurope.org/downloads

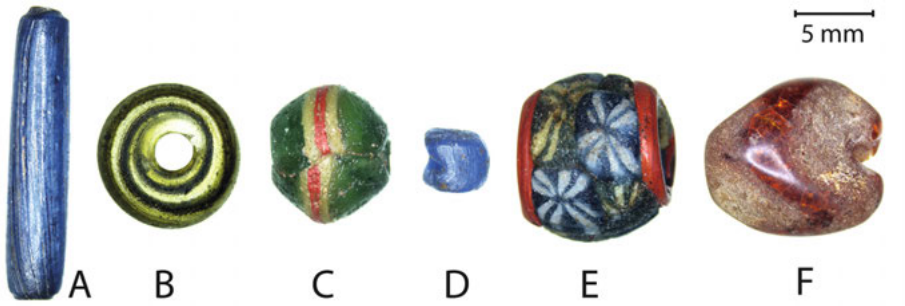

Fig. 2 Examples of beads from the cemetery Lent-Lentseveld made with various production techniques. A drawn bead with lines parallel to the perforation; B wound bead with concentric lines around the perforation; C folded bead with visible seam; D perforated bead with one irregular side; E mosaic bead formed by various slices of mosaic glass; F: amber bead with cut and polished faces (Photos: M. B. Langbroek).

Tab. 2 Overview of the bead periods by Pion 2014, with Legoux phases and date-approximation.

Period	**Legoux 2004**	**Date (approximation)**
P1	MA1	480–530
P2	MA2	530–570
P3	MA3	560–610
P4	MR1	600–640
P5	MR1/MR2	620–670

Tab. 3 Bead making techniques and their provenances (based on Pion 2014).

Technique	**Type group**	**Provenance**
Drawn Beads	A	India/Mesopotamia/Egypt/Syro-Palestinian coast
Wound Beads	B	Europe (mostly)
Folded Beads	C	Egypt/Syro-Palestinian coast
Perforated Beads	D	Mesopotamia/Egypt/Syro-Palestinian coast
Mosaic Beads	E	Egypt
Beads from other materials	F	Various Provenances
Prehistoric or Roman beads	G	Various Provenances

Tab. 4 Amount of LA-ICP-MS measurements taken per cemetery in this study.

	LA-ICP-MS	
	measurements	**no. of beads**
Lent-Lentseveld	1008	578
Elst-'t Woud	997	692
Wijchen-Centrum	516	365

gether. You need enough data to actually be able to make such statements. In order to distinguish those groups PCA analyses of the LA-ICP-MS data were performed, whereby the data was normalised to a mean of zero and a standard deviation of one. The LA-ICP-MS data were also used for the chemical interpretation of these groups. We start with the same colours as in our previous paper (black, green-blue/blue-green opaque (turquoise) and red opaque). Since we are considering different cemeteries, we restrict ourselves to bead-types that occur in at least two of the three cemeteries in this study (except for types A2.1-04, A3.1-05 and A3.2-06 that are found in one cemetery only, but of which there are many examples and analyses).

Furthermore, the LA-ICP-MS results for beads made with colourless glass were considered to determine the glass group(s) they fit into (and to see if we could distinguish between bead-types in order to get a better understanding of the chaine-operatoire of the production of different bead-types). Similarly, the LA-ICP-MS results for opaque yellow glass were studied in order to observe whether the colourant (and thus production) of yellow glass changed during the period of bead-interment of all three cemeteries.

5. Results: General Glass Chemistry

5. 1. Glass groups in Colourless (parts of beads)

As colourants and opacifiers usually are associated with trace elements they might affect the ratios usually used to distinguish different glass groups. Therefore, for each major bead-type (and hence provenance) glass groups will be determined and discussed based on the colourless beads only. As noted in our previous work almost all the glass beads are soda-lime-silica glasses with mineral soda used as flux (MgO and K_2O < 1.5). Occasionally one of those oxides is above 1.5% and this can be attributed, in particular for K_2O to contamination by fuel ashes during bead making (which happens in open fire).[23]

5. 1. 1. A-beads

Glass can be naturally colourless if the used raw materials are quite pure. Often, an additive is used to decolour glass: in Egyptian glass from the Roman period this usually is antimony (Sb), in Syro-Palestinian glass and late antique glass manganese (Mn) is used as a decolourant, and the presence of both Mn and Sb is a sign of mixing and/or recycling of glass with two distinct provenances (in time and/or space). In this paper a glass is considered Mn decolored if Sb < 0.025 and Mn > 0.05, Sb decolored if Sb > 0.025 and Mn < 0.05 and mixed if Sb > 0.025 and Mn > 0.05, these thresholds are slightly higher than Gliozzo's.[24]

Most A-beads are decoloured by manganese (Fig. 3). There are a few exceptions, where, using our criterium glasses would be considered mixed (L21B9[25], L13B70 (IL and OL)[26], L36B20 (IL and Olr), L34B61 (OL), L40B44 (IL), E216B176 (OL), E216B67, E216B81, E118B10 (IL), W52B11(IL), W52B15 (IL), W52B39 (OL), W235B9 (OL)). As having inner and outer layers of the same bead from a different base glass composition seems counter-intuitive, we propose that this might be either because our rules to assign them to a particular group are too stringent, or because of some inhomogeneity in the glass or contamination with Sb or Mn from nearby coloured parts of the bead.

In order to determine to what glass group the beads can be classified the TiO_2/Al_2O_3 ratio is plotted against the SiO_2/Al_2O_3 ratio (Fig. 4). Reference ratios are also plotted. Almost all the A-beads correspond to the Foy 2 glass group of Egyptian origin. The only exceptions are a number of beads from Wijchen. A2 and A3 beads as well as the A4 beads from Lent all have a composition corresponding to an Egyptian origin in the Foy 2 glass group. Amongst the A4 beads from Wijchen three groups can be distinguished, most falling in the Foy 2 group. A number have a Syro-palestinian composition close to the Roman-Mn glass, but with lower TiO_2 contents, corresponding exactly to the theoretical composition calculated by Brill[27] for the Jalame

[23] Tal et al. 2008; Paynter 2008.

[24] Gliozzo 2017.

[25] To be read as FIRSTLETTEROFCEMETERYgravenumberBbeadnumber, hence L21B9 is bead 9 from grave 21 in Lent-Lentseveld.

[26] Here and further: IL inner layer; OL Outer Layer.

[27] Brill 1988.

Fig. 3 A bead-types with colourless glass addressed in this paragraph.

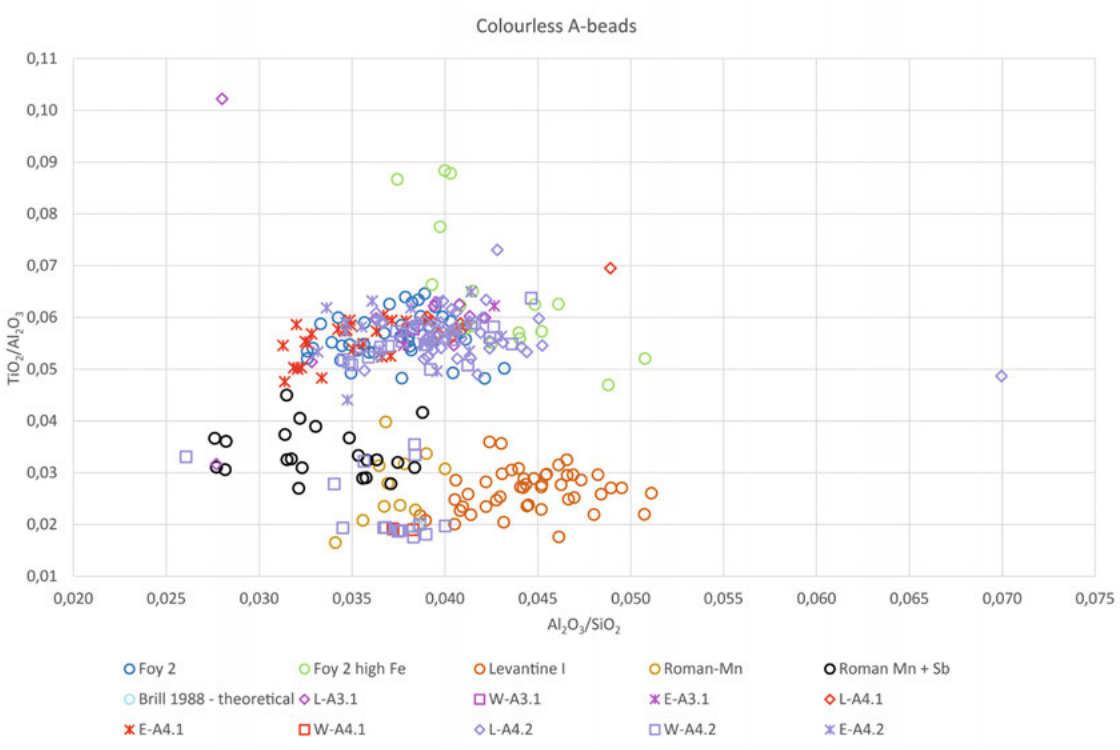

Fig. 4 Biplot of TiO_2/Al_2O_3 ratios against SiO_2/Al_2O_3 ratios of colourless A bead-types. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

glasses if produced with sorted sands from the Belus river and natron from the Wadi Natrun (W142B1 (the only A4.1 bead in this category), W52B15, W52B36, W92B4, W92B5). Finally, some beads seem to 'float' between the Foy 2 and the Syro-Palestinian composition (W52B11 (which is a mixed glass), W51B10, W228B4, W228B5). The presence of a mixed Mn-Sb glass in this intermediate group is not surprising since it indicates a mixture between an Egyptian and Syro-Palestinian type of glass, with intermediate TiO_2/Al_2O_3 and SiO_2/Al_2O_3 glasses.

A-beads are typically thought to have been made in Egypt or the Syro-Palestinian coast. But for gold in glass beads in particular, there are various hypotheses on production location. During the Hellenistic period they were produced in Rhodes, using locally produced primary glass as evidenced by the remains of a glass workshop.[28] The gold in glass beads from Caerleon, Faras and Panticapaeum analysed by Dekówna[29] all have a glass composition consistent with Roman-Sb decolored (Egyptian glass). In the same publication Boon suggests that there might have been a production in Western Europe during the Merovingian period (since these beads were so ubiquitous at that time) and also some production around the Black Sea to account for their widespread occurrence there.[30] Spear in his 1993 review repeats all of the findings above, and adds the possibility of production in Egypt and Nubia.[31] For Egypt in particular, he mentions the excavation of a gold-in-glass bead production site in Kom-el Dikka, Alexandria dating from the 4th to 6th century.[32] Since most of the A-beads in this study clearly correspond to an Egyptian composition and correspond in time to the production site of Kom-el Dikka this seems a viable option. Spear speculates that some gold-in glass beads must also have been produced in Syria, but so far no production sites have been found.[33] For the beads with a Syro-Palestinian and a mixed signature the production in Europe suggested by Boon remains intriguing, but in the absence of proof and since the vast majority of the beads correspond to Foy 2 Egyptian production, an Egyptian manufacture of the beads seems most likely at this point.

5. 1. 2. B-beads

In Fig. 5–6 the B bead-types with colourless glass of which more than 1 one was measured using LA-ICP-MS are depicted and plotted. All the B10.1 beads have a Foy 2 composition, whilst the B2.1 and B1.1-11 beads are evenly distributed between the Foy 2 group and a mixed Mn-Sb Roman signature, none of the beads have a Syro-Palestinian composition. Both B2.1-01 beads (W81B1 and E135B2) with a mixed Mn-Sb Roman signature, also fall in this group using the above-mentioned criterion for Mn and Sb concentration. For the three B1.1-11 beads two have a Mn concentration indicative of Mn-decolouring (L34B5 and E155B27) and have both elevated Mn and Sb (E161B93) concurring with the observations on the graph. So, it seems the B-beads, which were most likely made in Europe,[34] were manufactured both using "fresh" Foy 2 glass imported from Egypt and recycling Mn and Sb decolored Roman glass. The use of recycled Mn and Sb decoloured glass in the B1.1-11 and B2.1 beads and Foy 2 for B10.1 beads also fits well with the chronology of the beads. The beads produced with recycled "Roman" glass are older corresponding to strings of beads dated to P1, whilst those produced using Foy 2 glass are from strings dated to the P2 period. Hence the beads reveal a movement from recycling Roman glass to importing fresh Foy 2 glass between the P1 and P2 periods.

5. 1. 3. E-beads

E-beads (Fig. 7) are known to be made in Egypt and it is therefore not surprising to see that all of them plot with Foy 2 glass (Fig. 8), the one exception being E161B31 which also has 5.7 wt% PbO. This elevated lead concentration is presumably due to some of the red glass around having been ablated together with the colourless glass as evidenced by the elevated CuO and ZnO contents also found in this analysis (1.04 wt% and 0.72 wt% respectively).

28 Boon/Dekówna 1977; Weinberg 1983.
29 Boon/Dekówna 1977.
30 Boon/Dekówna 1977.
31 Spear 1993.
32 Spear 1993; Kucharczyk 2019.
33 Spear 1993.

34 For a detailed discussion on bead techniques and their provenances, see Pion 2014, 178–229 and references therein.

Fig. 5 B bead-types with colourless glass addressed in this paragraph.

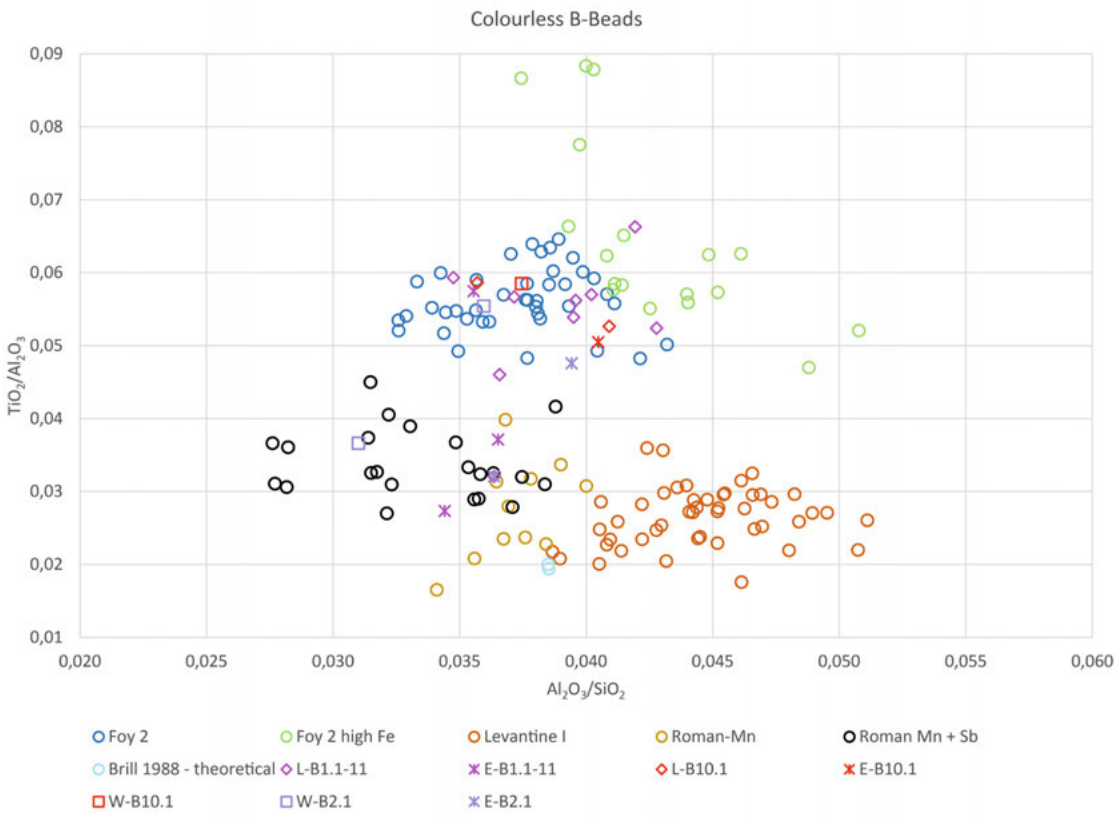

Fig. 6 Biplot of TiO_2/Al_2O_3 ratios against SiO_2/Al_2O_3 ratios of colourless B bead-types. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

Fig. 7 E bead-types with colourless glass addressed in this paragraph.

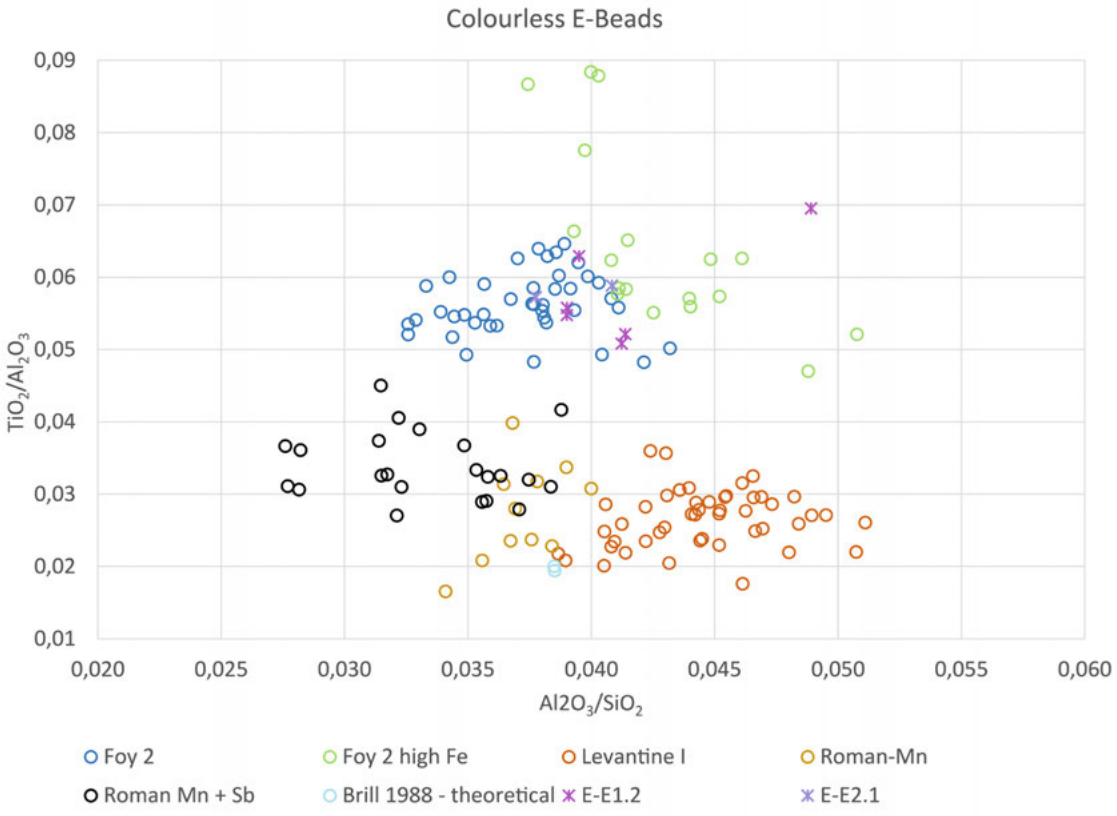

Fig. 8 Biplot of TiO_2/Al_2O_3 ratios against SiO_2/Al_2O_3 ratios of colourless E bead-types. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

Tab. 5 Archaeological evidence for the production of yellow opaque glass in Western Europe.

Location	period (CE)	colourant	remark	reference
Schleitheim, Switzerland	7th c.	PbSn-II	production of colourant mixing with primary glass	Heck et al. 2003
Dunmisk, Ireland	6th–10th c.	PbSn-II	glassmaking (probably only making yellow colourant)	Henderson/Ivens 1992
Tarbat Ness, Scotland	8th c.	PbSn-II	Production of colourant (?)	Peake/Freestone 2014
Maastricht and Rijnsburg, Netherlands	late 6th–7th c.	PbSn-II	Mixing of colourant with primary glass	Sablerolles et al. 1997, Dijkstra et al. 2010
Wijnaldum, Netherlands	6th–7th c.	x	yellow opaque glass, recycled tesserae	Sablerolles 1994

5. 2. Glass groups in "naturally coloured" glass (green-blue, blue-green, and yellow translucent)

In the colourless group above only beads with no hue at all were considered, in most cases a decolourant was added to achieve this result. In this part beads with hues considered "natural" are discussed: in this assemblage most of them have a yellowish hue and a few have a bluish hue (Fig. 9). Unsurprisingly most beads plot in the Foy 2 group as was the case for the colourless material (Fig. 10). Both of the Roman beads (L51B40 and W52B35) fall in the Roman Mn+Sb group. They are indeed enriched in Sb_2O_3 0.63 wt% and 0.36 wt% respectively, furthermore L51B40 also contains 4.67 wt% PbO. All the B-beads (Fig. 11) also fall in the Foy 2 group except L20B47: its odd signature is due to the low Al_2O_3 concentration (1.13 wt% compared to > 2 for the others) (Fig. 12). Also, it is not enriched in TiO_2 which is actually much lower than for Foy 2 or any of the other Egyptian glass types. It has a high SiO_2 (72 wt%) and CaO (9.54 wt%) content, but low Na_2O (14 wt%) content, which might point to a different, pure sand source (Sr concentrations are also low: 270 ppm compared to > 600 ppm for the other glasses).

5. 2. 1. Yellow opaque beads

Opaque yellow trails and beads are of particular interest for two reasons: firstly, because a transition in technology occurs for yellow opaque glass from the use of antimony (Sb)-based colourants to tin (Sn)-based colourants[35], secondly because there is archaeological evidence for the production of yellow opaque glass in Western Europe (see Tab. 5).

All the opaque yellow beads are opacified using lead and tin. This is clear from the graph in Fig. 13 where you see the clear correlation between the Sn and Pb content. Interestingly, there does not seem to be any difference between the European B bead-types and the imported A, C and E bead-types. It must be highlighted that an overwhelming part of the yellow opaque beads are of European making, further analysis of imported beads might nuance this picture. There is no trace of Sb-opacified yellow glasses which would indicate recycling of Roman tesserae (Fig. 14). However, in the European beads the level of Sb is higher than what would be expected from fresh raw materials which might indicate recycling/re-use or mixing of Sb-decolored glasses with the lead stannate colourant. Most imported beads contain 1–3 wt% SnO_2 and 10–25 wt% PbO, with two exceptions (L35B17 with 14.02 w% SnO_2 and L5B32 with 5.46 wt% SnO_2). However, for those two beads the crystals are visible, it is likely most of the ablation was carried out on such a crystal. European beads generally tend to be more enriched in both SnO_2 and PbO, though they spread out over the complete concentration ratio with a Pb to Sn ratio of approximately 7 (= 1/0.145 see trendline on Fig. 13). From this analysis it can be concluded that in the studied burial grounds all the yellow opaque beads are opacified using lead stannate, that the European beads are probably made using a mixture of recycled colourless/slightly coloured glass and freshly made lead

[35] Tite et al. 2008.

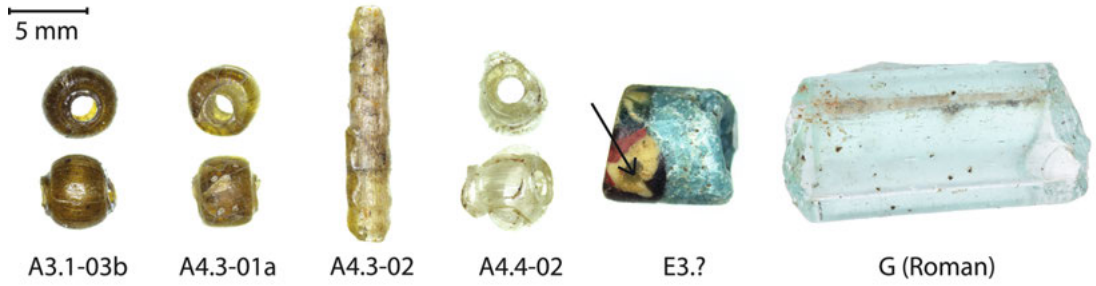

Fig. 9 A, E and G bead-types with naturally coloured glass addressed in this paragraph.

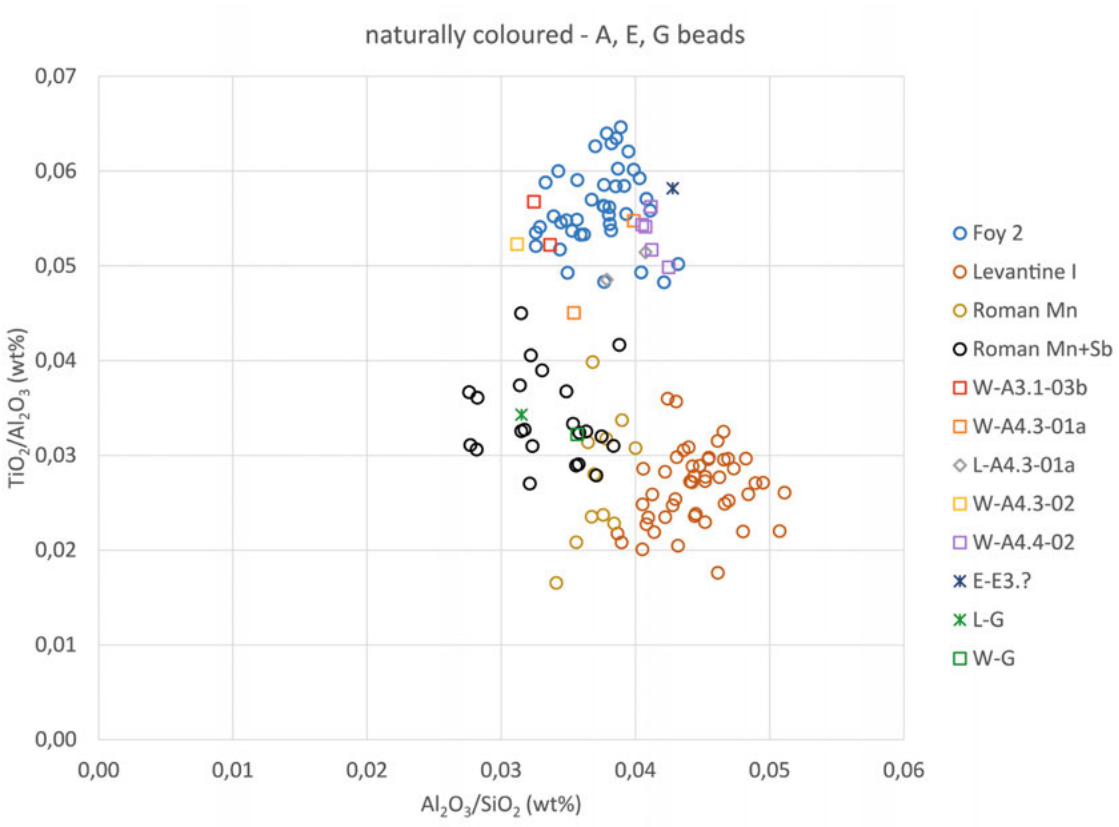

Fig. 10 Biplot of TiO_2/Al_2O_3 ratios against SiO_2/Al_2O_3 ratios of naturally coloured A, E and G bead-types. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

Fig. 11 B bead-types with naturally coloured glass addressed in this paragraph.

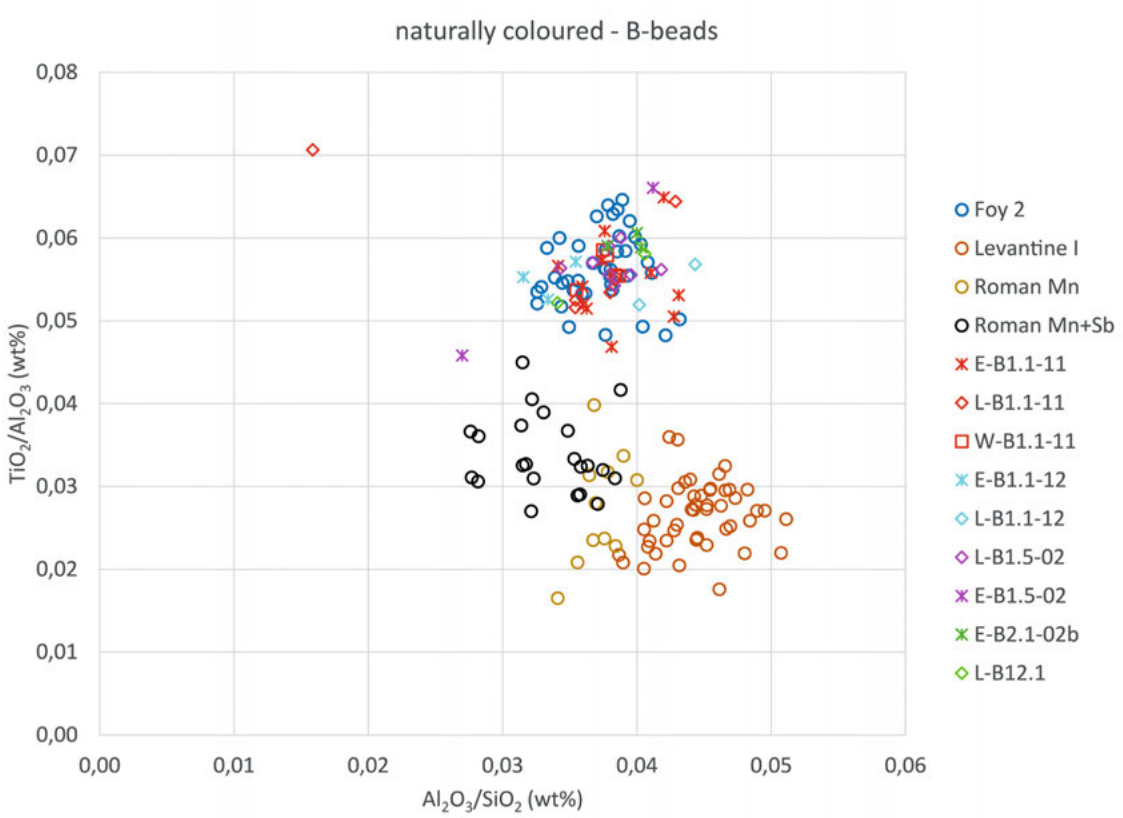

Fig. 12 Biplot of TiO_2/Al_2O_3 ratios against SiO_2/Al_2O_3 ratios of naturally coloured B bead-types. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

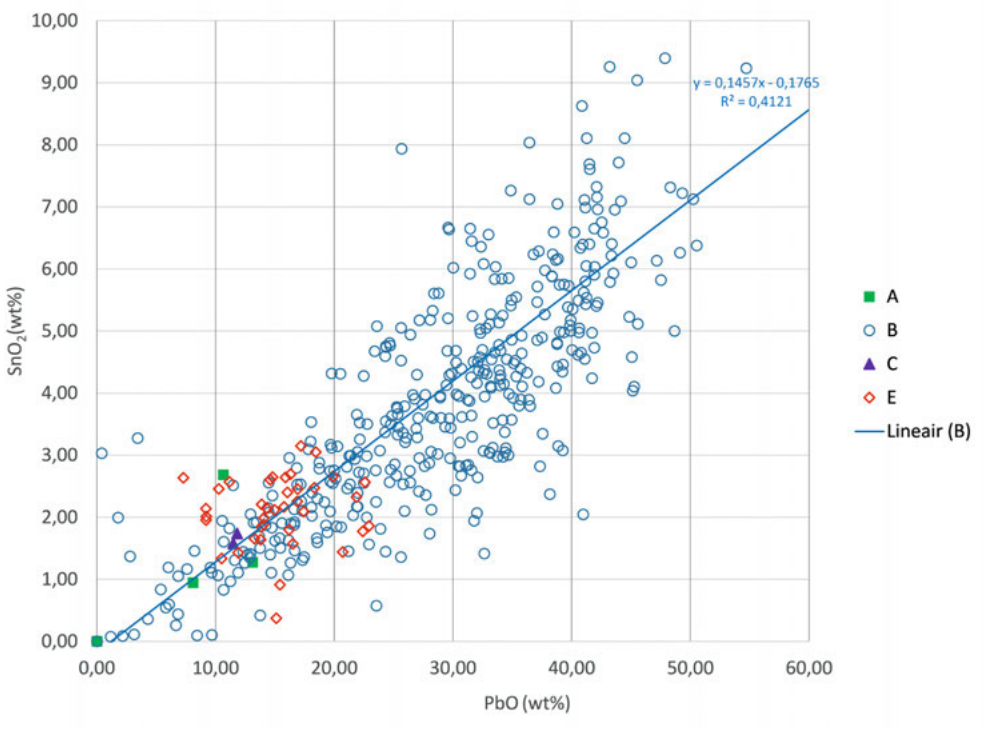

Fig. 13 Biplot of SnO_2 ratios against PbO ratios of yellow opaque bead-types.

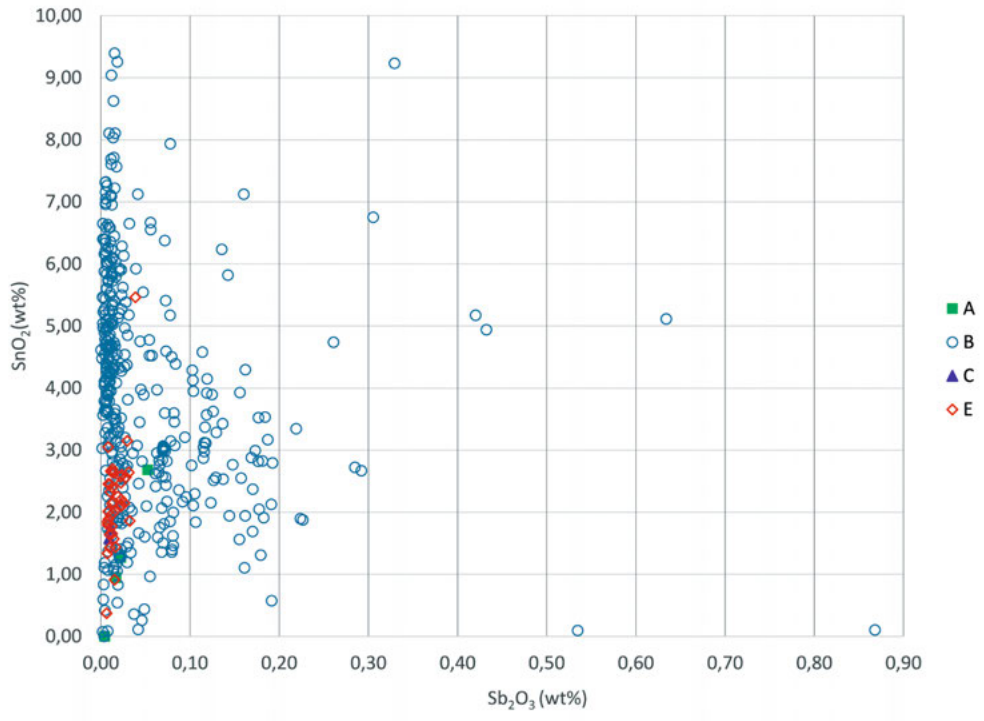

Fig. 14 Biplot of SnO_2 ratios against Sb_2O_3 ratios of yellow opaque bead-types.

stannate glass with generally more lead and tin than was added in the Near Eastern glasses made using "cleaner" raw glass and less colourant and particularly lead (high lead being a general feature of coloured beads of made in European workshops).

5. 2. 2. Black beads

Three bead-types made of black glass were excavated in at least two of the three cemeteries in this study: B1.1-01a, B1.1-01b and B1.8-01 (Fig. 15). In total 81 beads of these bead-types were analysed by LA-ICP-MS (Tab. 6). The chemical compositions obtained by these analyses were plotted in two different PCA-plots: one per bead-type (Fig. 16) and one per bead-grave (Fig. 17).

In our previous paper the clear distinction in chemical composition of B1.1-01a beads in comparison to other wound B bead-types was noticed. The analyses of B1.1-01a beads from Elst confirm this pattern: in the PCA graph they plot away from other black B bead-types, with the B1.1-01a beads from Lent (Fig. 15). When they are plotted per grave, clear groups per grave can be observed in the PCA graph (Fig. 16): in general, B1.1-01a beads from the same grave are chemically more alike than B1.1-01a beads from another grave. B1.1-01b and B1.8-01 beads from all three cemeteries plot together on the left side of the PCA graph, whereby B1.8-01 beads show greater chemical coherency than B1.1-01b beads: they plot closer together. When multiple examples of one of these bead-types are found in a grave (more common for B1.8-01 than for B1.1-01b beads), they generally plot together on the PCA graph and are thus more similar in chemical composition in comparison to the same bead-types found in other graves.

A similar picture emerges from the chemical composition of the beads. The B1.1-01a tiny wound black beads (blue in Fig. 17) have much higher PbO contents than the other beads (> 27 wt% typically 40 wt%, except W52B2 that contains 16 wt% PbO), are rich in Fe_2O_3 (6–15 wt%), and have low SrO concentrations (< 350 ppm) and contain usually < 1 wt% Na_2O with a few exceptions around 5 wt% Na_2O and 2 beads with 2 wt% Al_2O_3 and ~ 10 wt% Na_2O (L40B81 and W52B2). For these beads the black colour is due to the elevated iron content. If a reduced composition is determined, their Al_2O_3* concentration ranges between 5 and 15 wt%, which could correspond to an Indian or Turkish signature for the primary glass.[36] However, as showed in our previous paper[37] and in agreement with finds from at least one black bead dating between 450 and 650 from Eriswell, Suffolk,[38] it is concluded that this is due to the addition of an iron rich slag containing K_2O and Al_2O_3 as colourant. Beads with similar composition and we think the same typology are also reported for Grez-Doiceau (group 1).[39] In that work, and later publications a link with lead slags was suggested. These studies excluded the lead ore smelting site of Melle as potential source because the beads contain more PbO than the slags and

Tab. 6 Black bead-types from Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W) that were analysed by LA-ICP-MS, documented per grave.

Grave/Type	B1.1-01a	B1.1-01b	B1.8-01
L-5		2	
L-9		1	
L-13	2	2	
L-16		2	
L-20		1	3
L-26	8		
L-28		4	
L-40	4		
L-42		1	
L-43	4		
L-50		1	
L-53	4		
E-88	1	1	
E-127	2		5
E-175	9		10
E-214		1	
E-216	8		
E-234	2		
W-52	1		
W-179		1	
W-235			20
Total	45	17	38

[36] Lankton/Dussubieux 2006; Dussubieux et al. 2010.
[37] Langbroek et al. 2023.
[38] Peake/Freestone 2012.
[39] Elias 2011.

Fig. 15 Black bead-types in this study.

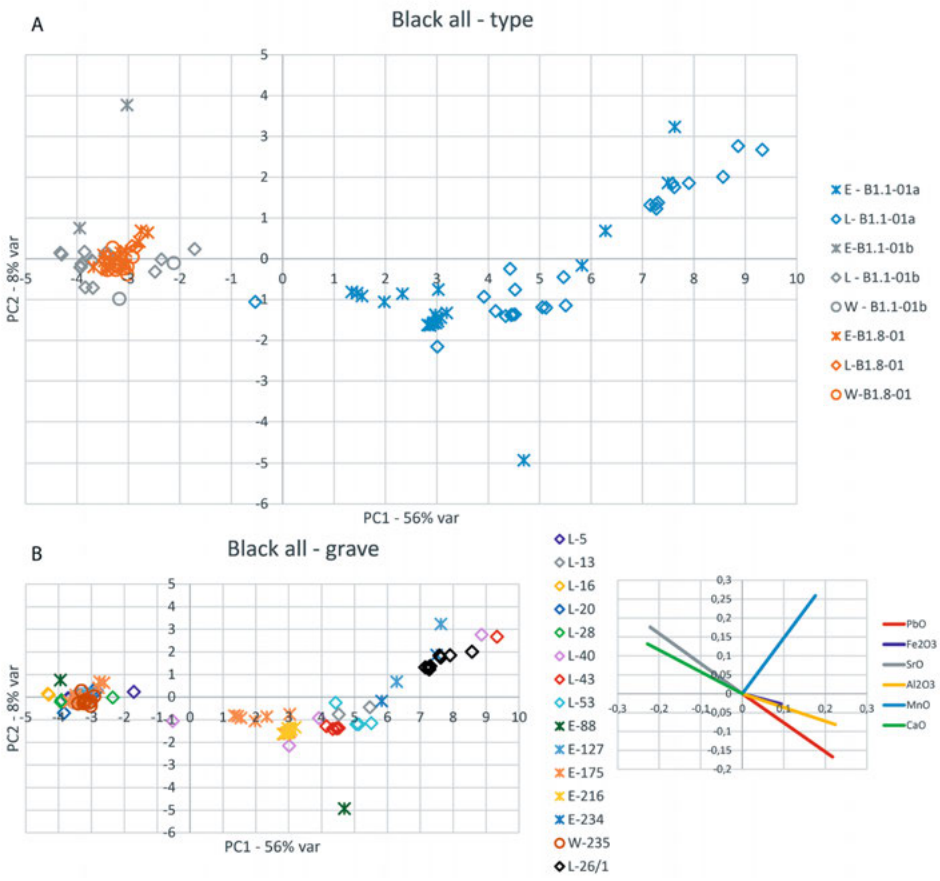

Fig. 16 Black beads: PCA results LA-ICP-MS. a) by bead-type b) by grave.

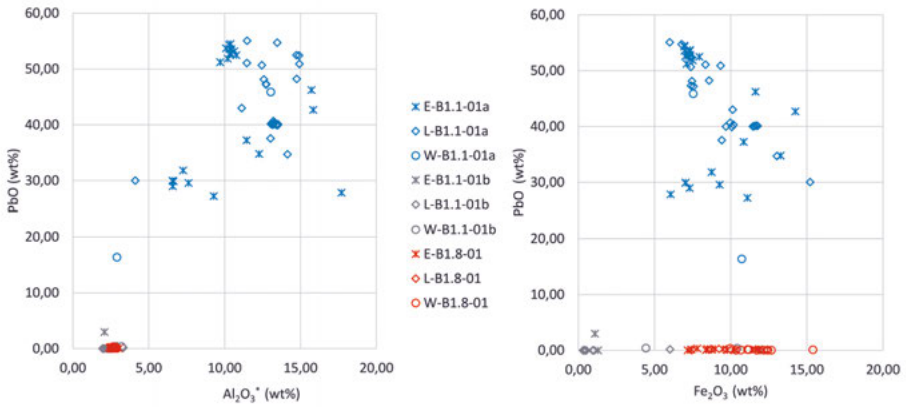

Fig. 17 Biplots of PbO ratios against Al_2O_3 ratios and PbO ratios against Fe_2O_3 ratios of black bead-types.

Al_2O_3 and Fe_2O_3 which should enter the glass with the lead are not positively correlated to PbO, indicating they have a different source.[40] This link with metallurgy is intriguing and will be further investigated in future research[41].

The B1.1-01b beads contain nearly no lead or iron (apart from a few exceptions – L28B81, W179B6). Rather they are characterised by SrO concentrations ranging from 450–720 ppm, Na_2O concentrations around 17 wt% and elevated boron concentrations (> 400 ppm B2O3). These glasses usually contain 2–3 wt% MnO, less than the B1.1-01a beads, but more than the B1.8-01 beads. The addition of MnO can lead to dark purple to black colours in glass.[42] Finally the B1.8-01 beads are characterised by the absence of PbO and the presence of 6–12 wt% Fe_2O_3 (which induces the colour). They contain 15–16 wt% Na_2O and > 720 ppm SrO.

Lead, strontium and iron are thus good elements to discriminate between these groups. It is probable that the addition of large quantities of lead to the B1.1-01a beads is to increase the workability of the glass in order to wind them as tiny beads. Since the iron content in the B1.1-01a and B1.8-01 beads is similar it might be that iron slags or scrapings were also added to these beads, though there is slightly less proof of it and microscopic analysis would be needed to confirm it. For the B1.1-01b beads the colour is achieved through MnO instead of Fe_2O_3: it is unclear why both technologies exist side by side in Europe.

5. 2. 3. Blue-Green/Green-Blue beads

Eight bead-types made of blue-green or green-blue glass were excavated in at least two of the three cemeteries in this study: they can be observed in Fig. 18. Besides these, three bead-types, namely A2.1-04, A3.1-05 and A3.2-06, were found in one cemetery only, but were found in such great numbers that their incorporation in this study became worthwhile. In total 97 beads of these bead-types were analysed by LA-ICP-MS (Tab. 7). The chemical compositions obtained by these analyses were plotted in two different PCA-plots: one per bead-type and one per bead-grave (Fig. 19).

The three blue-green/green-blue A bead-types, as well as the C and D bead-types all form clear clusters per bead-type in the PCA graphs (Fig. 20,A–B). A3.1-05, C1.4-02 and D1.1-02 form a larger cluster in the upper left quarter of the graph; these all are opacified using lead stannate in increasing concentrations from A3.1-05, to D1.1-02 to C1.4-02. They are also characterised by less Al_2O_3, CaO SrO and MgO than A2.1-04 and D1.5-02, which are opacified with lead antimonate (Fig. 21). These last two bead-types overlap significantly, which was already noted for Lent in a previous article: this cluster distinguishes itself by higher levels of antimony and lower levels of tin, confirming LA-ICP-MS analyses on A2 and D1 beads found in Merovingian cemeteries in Belgium. It is likely that these beads were made by recycling Roman tesserae.[43] That leaves the very tight cluster of A3.2-06 beads from Wijchen which plots away from the other A, C and D bead-types. Chemically speaking, these beads contain more K_2O and MgO (close to the limit for mineral soda glass and very low SnO and PbO contents, fitting for translucent rather than opaque glass). All A3.2-06 beads from Wijchen were found in the same grave, which may explain the tightness of the cluster: all blue-green/green-blue A, C and D beads form clear groups per grave within the type-clusters, which may indicate that they were made during a single bead-making event (Fig. 20,A–B).

The blue-green/green-blue B-bead-types are divided over two clusters: one for B1.6-01 beads in the upper right quarter of the graph and the other for B1.2 and B1.3 beads in the lower half of the graph (Fig. 20,C). The division between these clusters can be explained by the fact that the B1.6-01 group is found in graves dating to the second half of the 6th century, and the other in graves dating to the first half of the 7th century. This might be reflective of a switch in colour recipe from opaque to translucent blue-green/green-blue glass around the turn of the century.[44] The exact reasons behind such a switch remain elusive: there is no easy link between colouring compounds and ore sources, or an alloy type which would allow an interpretation of these differences. The B1.2 and B1.3 groups sit close to the A2.1-04 and D1.5-02 cluster which

40 Mathis et al. 2010.

41 Currently we are working on this with Alexandre Disser and Bernard Gratuze.

42 Bidegaray et al. 2019.

43 Pion 2014, 219–222.

44 As was also demonstrated for yellow Merovingian beads in the German Rhineland by Matthes et al. 2004.

Tab. 7 Blue-green/Green-blue bead-types from Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W) that were analysed by LA-ICP-MS, documented per grave.

Grave/ Type	A2.1-04	A3.1-05	A3.2-06	B1.1-08d	B1.2-05	B1.3-06	B1.4-04a	B1.6-01e	C1.4-02	D1.1-02	D1.5-02
L-9	2										
L-13	3								1	2	
L-16				1							1
L-27								2			
L-34											
L-40	4										3
L-43								1			
L-50	1										
E-59					1		1				
E-82							1		4		
E-88						1			1		
E-92											
E-112				2							
E-118		1									
E-127										1	
E-136											
E-175		8									
E-192					1						
E-208		1									
E-209				1							
E-210					1						
E-214					1						
E-216		18									
E-238							1			2	
E-249							1				
W-0						4					3
W-4										1	
W-49							1				
W-65									1	1	
W-92						1					
W-98											
W-106			5		2		1				
W-127										2	
W-194											1
W-235		1									
W-253								2		2	
total	**10**	**29**	**5**	**4**	**6**	**6**	**6**	**5**	**7**	**11**	**8**

Fig. 18 Green-blue and blue-green bead-types in this study.

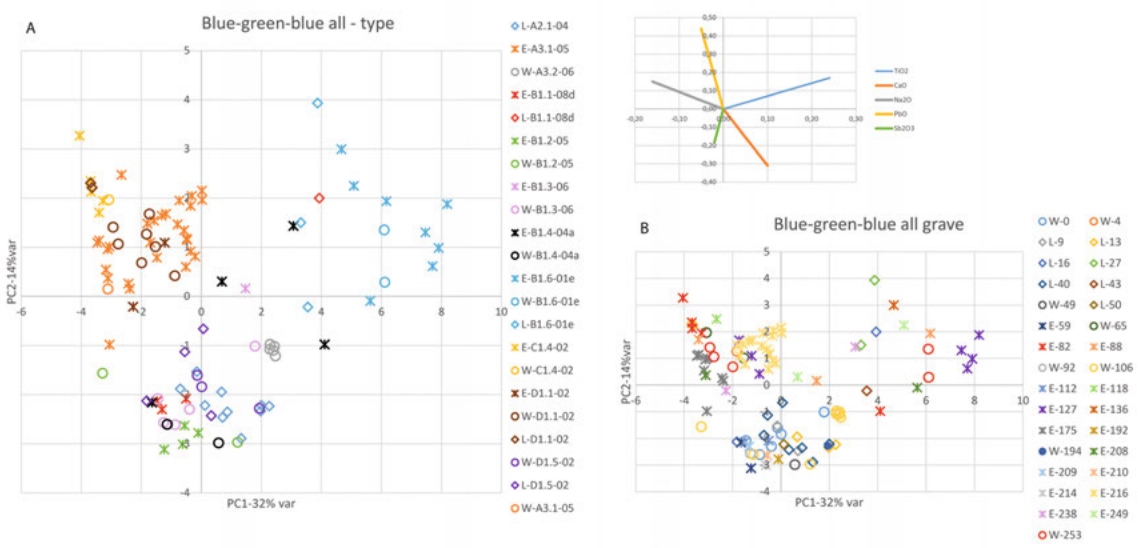

Fig. 19 Blue-Green/Green-Blue beads: PCA results LA-ICP-MS. a) by bead-type; b) by grave.

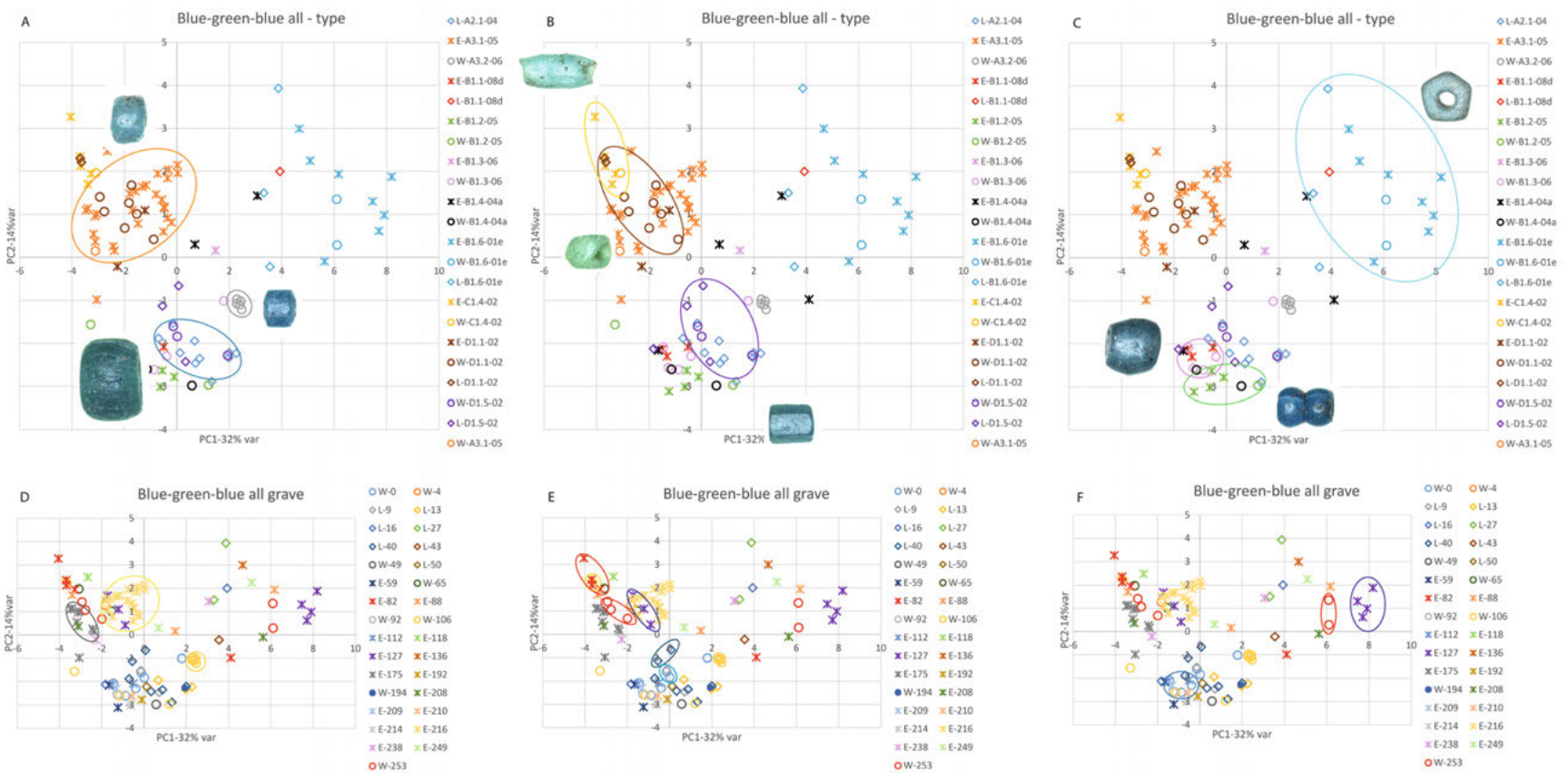

Fig. 20 Blue-Green/Green-Blue beads: PCA results LA-ICP-MS by bead type and by grave. a) A bead-types; b) C and D bead-types; c) B bead-types; d) A bead-graves; e) C and D bead-graves; f) B bead-graves.

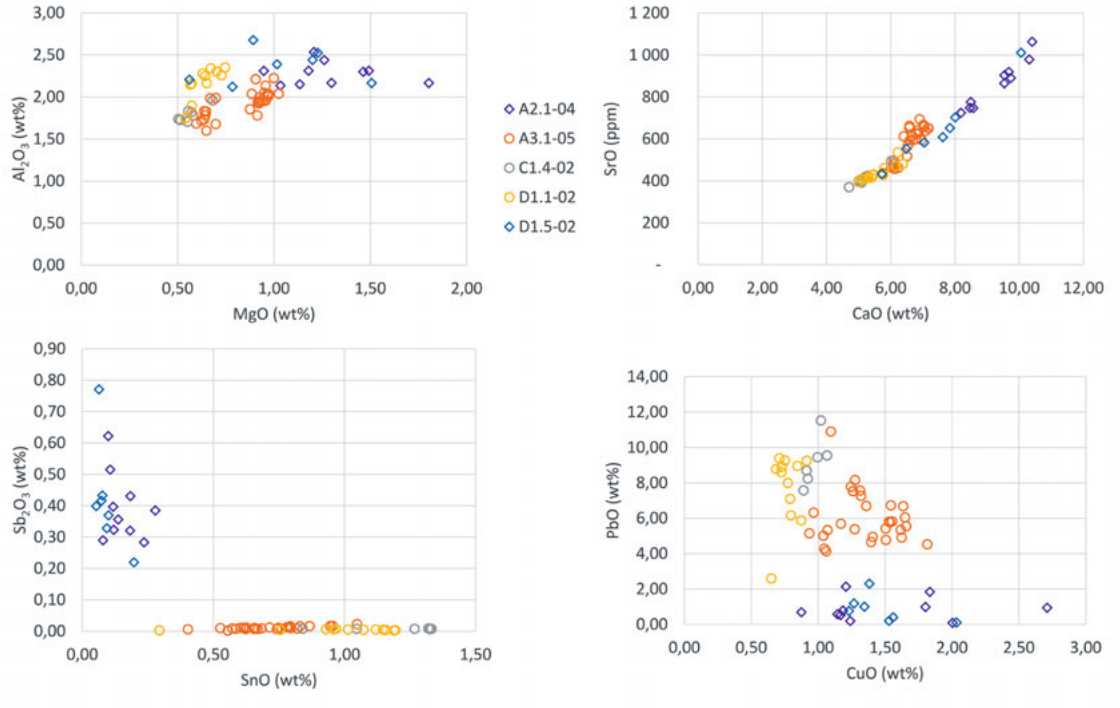

Fig. 21 Biplots of Al_2O_3 ratios against MgO ratios, SrO ratios against CaO ratios, Sb_2O_3 ratios against SnO ratios and PbO ratios against CuO ratios of blue-green/green-blue A, C and D bead-types.

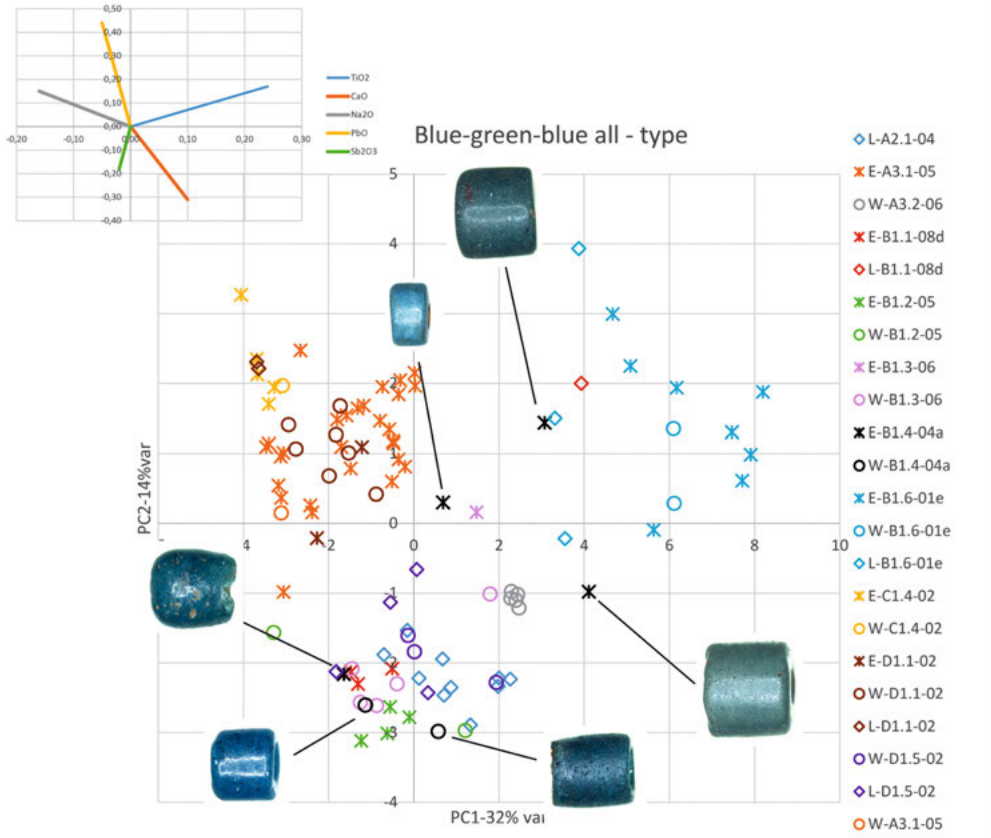

Fig. 22 Blue-Green/Green-Blue beads: PCA results LA-ICP-MS by bead type, in which B1.4-04 beads are pointed out, with a photograph of the bead represented by each measurement. You can clearly see the varying appearance of these beads, despite being assigned to the same type.

are translucent beads with very low SnO (< 0.2 wt%) and PbO (0–5 wt%) contents, coloured by addition of copper in larger concentrations than for other types (1–3 wt%, compared to usually around 1.5 wt%). B1.4-04 beads generally date to the late 6th and early 7th century and can be found in both B-bead clusters (Fig. 22). Judging by the varying appearance of these beads, it is not surprising they do not cluster as a type-group, as the other B bead-types do.[45] Much like A, C and D beads, when multiple examples of a B bead-type are found in a grave they generally plot close together on the PCA graph and are thus more similar in chemical composition in comparison to examples of the same bead-type found in other graves.

5. 2. 4. Red beads

Thirteen bead-types made of red glass were excavated in at least two of the three cemeteries in this study: they can be observed in Fig. 23. In total 293 beads of these bead-types were analysed by LA-ICP-MS (Tab. 8). The chemical compositions obtained by these analyses were plotted in two different PCA-plots: one per bead-type and one per bead-grave (Fig. 24–26). To keep the graphs readable, they were split into three groups: one for red A,C and E bead-types, one for monochrome red B bead-types and one for polychrome red B bead-types.

Red A, C and E bead-types form clear but overlapping groups in the PCA graph (Fig. 24). The red A, C and E bead-types from Elst and Wijchen confirm the patterns already noticed for Lent in our previous article: E2.1 and C3.1-01 beads have a more specific chemical range than A3.1-07 and E1.2 beads. Possibly, the former two bead-types were produced for a shorter period of time than the latter. For each red A, C, D and E bead-type some groups per grave can be discerned (Fig. 24,D). In E bead-types these groups generally correspond to beads with identical mosaic patterns.[46]

The Indian production attributed to bead W52B1 (A1.1-?) is confirmed by the chemical analysis which shows indeed a high Al_2O_3* content (12–14 wt%), elevated ZrO_2 (> 400 ppm), La_2O_3 (~ 30 ppm), CeO_2 (~ 56 ppm), ThO_2 (> 8 ppm), UO_2 (> 5ppm), no lead as also reported by Pion and Gratuze 2016.[47] A-Beads L5B25, L5B37, L5B47, L5B67 and L16B14 and all the D-beads are plant ash glasses possibly produced in Mesopotamia. The other A beads plot neatly together on Fig. 27 with $1 < K_2O < 1.5$ (sometimes a little more) and MgO* < 1.5. Similarly, the C and E beads plot below the MgO* = 1.50 line, with sometimes elevated K_2O* levels. This is possibly due to contamination of the glass by fuel ashes, as beads would be particularly prone to this since the glass to form them is reheated directly in the fire.

Much like black B bead-types made in Europe, red B bead-types do not form specific clusters or groups per bead-type. Rather they all overlap (Fig. 25–26). Red B1.1-03 beads have a much wider chemical range than other red B bead-types though. This may be explained in multiple ways: firstly, B1.1-03 beads occur throughout the Merovingian period and thus occur in a wider date-range of graves than the other red B bead-types in this study. Secondly, annular beads like B1.1-03 beads require less specialist tools and knowledge to make and may therefore have been produced by more people and in more locations than the other red B bead-types. Taking this into account, it makes sense that they are more chemically diverse in comparison. Despite the lack of chemical variation between red B bead-types, clear groups per grave can be observed in Fig. 25,D and Fig. 26,D. Red B bead-types from the same grave are more similar in chemical composition in comparison to examples of the same bead-type found in other graves, which may indicate that they were made during a single bead-making event. B-beads are characterised by higher PbO and lower SrO contents than the other bead-types with a linear correlation between boron and strontium contents (Fig. 28). All the red B-beads are mineral soda lime silicate glasses with the red colour coming from copper.

[45] With some exceptions per bead-type: B beads seem to be less 'chemically organised' than A, C or D beads with a non-European origin.

[46] See Langbroek et al. 2023. for a discussion of this observation.

[47] For a full study on Indo-Pacific beads from India in Merovingian graves see Pion/Gratuze 2016 and Pion et al. 2020.

Tab. 8 Red bead-types from Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W) that were analysed by LA-ICP-MS, documented per grave.

Grave/ Type	A3.1-07	B1.1-03	B1.2-02	B1.3-02	B1.4-02a	B1.6-01b	B3.2-01	B4.3-02	B5.2-01d	10.1-02	C3.1-01	E1.2	E2.1
L-1		3											
L-2		2											
L-5		3		1							2	11	2
L-9		4											2
L-13	2	2										1	1
L-16		2											1
L-20		3											
L-21	1	2											1
L-23		3											
L-26	2												
L-27						3							
L-28		4											
L-34		10											
L-35		2								1			
L-40	3	2											1
L-41		2								3			
L-42		2											
L-43	3	2				2						2	
L-50		3											1
L-51		4								2			
L-52		2								2			
L-53	1	13				2							
L-55	1												
L-105		1											
E-81		1			6	2	3		2				
E-82		1			1		2						
E-87	4	5											
E-88		3		3		2	1		3	1		1	
E-91					4		1						
E-92		2			1								1
E-127	6	4			1	3	1					1	
E-129					1								
E-155										1			
E-161	5									1		1	1
E-162									1				
E-192			2										
E-193		1			2			1					
E-204									1				
E-208												2	

Tab. 8 (cont.) Red bead-types from Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W) that were analysed by LA-ICP-MS, documented per grave.

Grave/ Type	A3.1-07	B1.1-03	B1.2-02	B1.3-02	B1.4-02a	B1.6-01b	B3.2-01	B4.3-02	B5.2-01d	10.1-02	C3.1-01	E1.2	E2.1
E-209		1											
E-210			2										
E-211					2								
E-216		1											
E-235						1							
E-238		4			2	2							1
E-249		3			4	2	1	7	1	2		1	
W-0			1	3					1		1		
W-9							1						
W-37							1						
W-45							2						
W-49			1										
W-51		5											
W-55		1											
W-58					1								
W-59							1						
W-65	1												
W-92				1									
W-98							2	1					
W-102							1						
W-104					1								
W-127				3			4						
W-132					1		1						
W-134					2		1						
W-149			2	1									
W-179		2											
W-194				2									
W-228		1											
W-230		1		2									
W-239		1	2		1				1				
Total	**29**	**103**	**10**	**12**	**30**	**19**	**23**	**9**	**10**	**13**	**3**	**20**	**12**

Fig. 23 Red bead-types in this study.

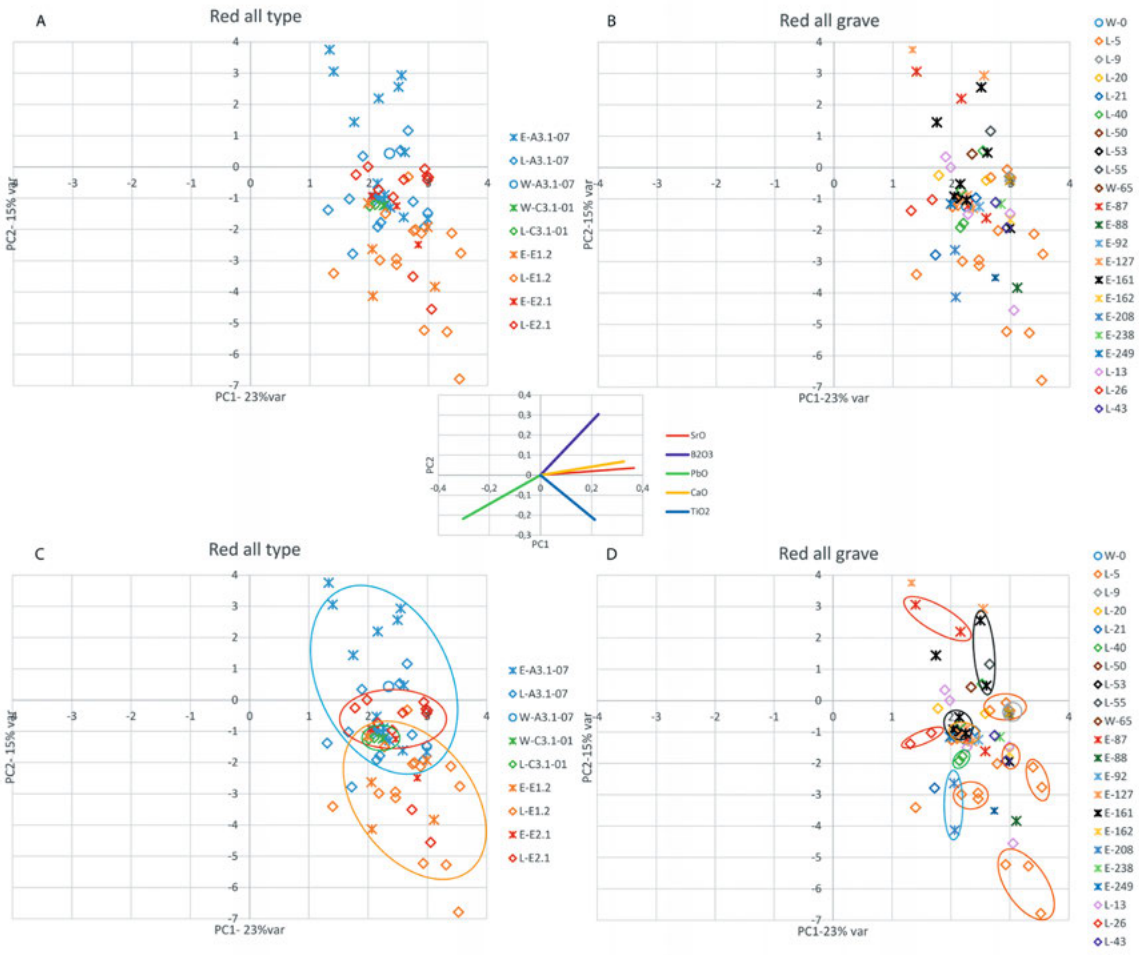

Fig. 24 Red A-C-E bead-types: PCA results LA-ICP-MS.
a) by bead type b) by grave c) type-groups indicated d) grave-groups indicated.

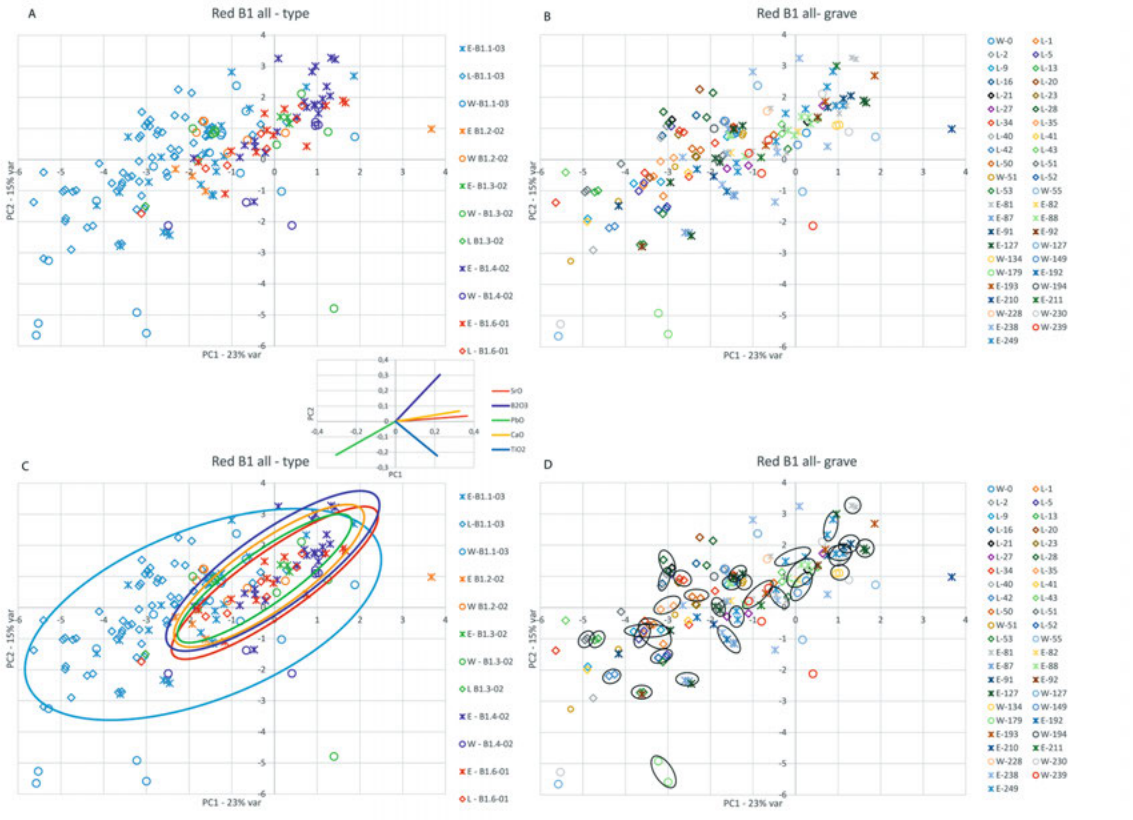

Fig. 25 Red monochrome B bead-types: PCA results LA-ICP-MS.
a) by bead type b) by grave c) type-groups indicated d) grave-groups indicated.

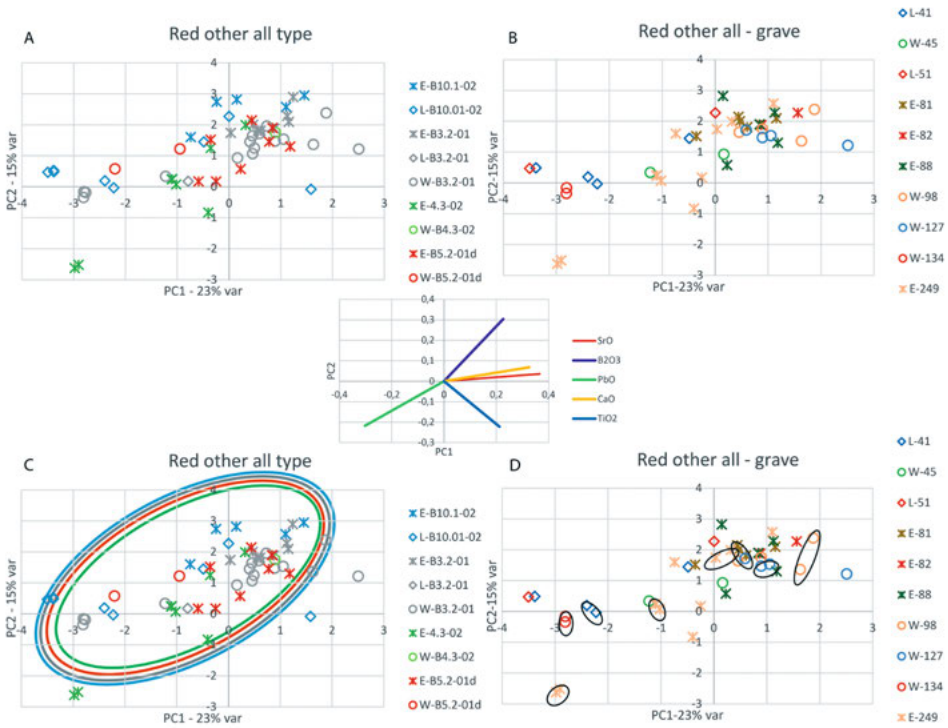

Fig. 26 Red polychrome B bead-types: PCA results LA-ICP-MS.
a) by bead type b) by grave c) type-groups indicated d) grave-groups indicated.

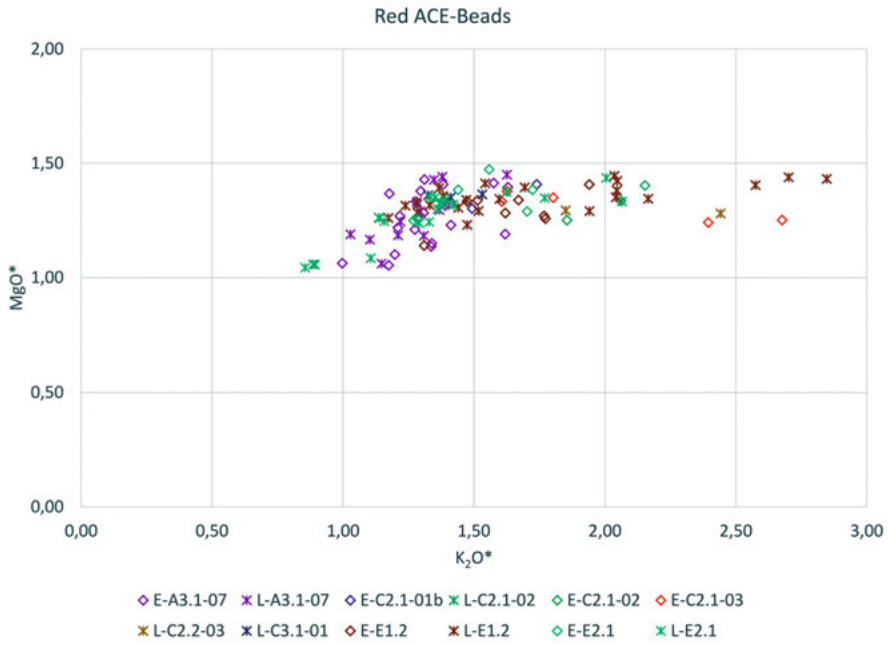

Fig. 27 Biplot of MgO ratios against K_2O ratios of red A, C, D and E bead-types.

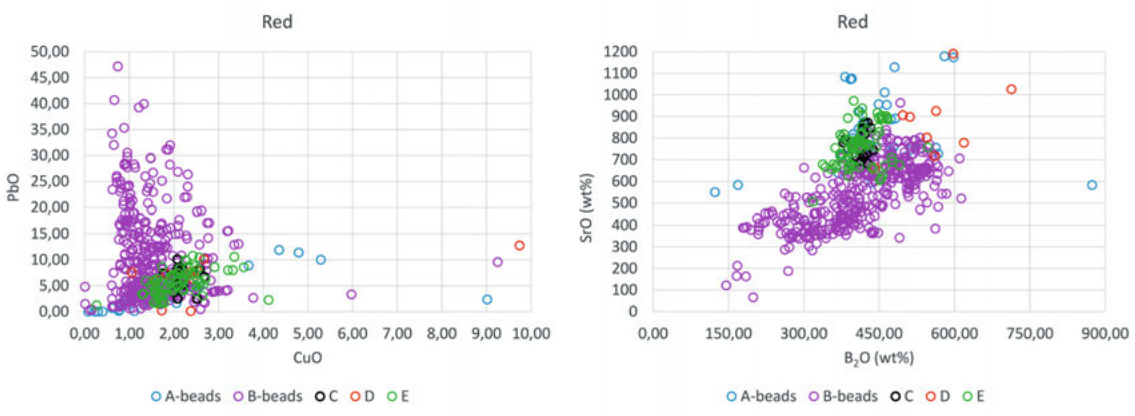

Fig. 28 Biplots of PbO ratios against Cuo ratios and SrO ratios against B_2O ratios of red bead-types.

6. Comparison to beads from Campo-Marchione, Italy

Since bead assemblages throughout Europe appear to be very similar during the Merovingian period[48], we want to assess whether similar patterns as observed for Lent-Lentseveld, Wijchen-Centrum and Elst-'t Woud emerge among bead assemblages from cemeteries elsewhere in Europe. To achieve this, we are looking at the beads from Campo-Marchione, north of the village of Leno (province of Brescia) in Italy, which were published by Boschetti and colleagues.[49] These are of specific interest because the LA-ICP-MS analyses of these beads were performed by the same machine in the same laboratory as the beads from the three Dutch cemeteries presented above. They suggest that the trade of beads was a European-wide trade, possibly involving beads as a non-monetary currency, as *'despite the lack of archaeological evidence in this respect, the modern era offers countless parallels (Pallaver 2009).'*[50] The cemetery of Campo-Marchione is dated from 570 to the 7th century CE (after the establishment of the Lombard kingdom), although the bead-types that are present may reflect an earlier start during the middle decades of the 6th century (see Tab. 9 for dates based on the beads).[51] This cemetery is associated with a rural site, situated 20 km south of Brescia, which at the time was a Lombard ducal capital. Approximately two-third of the cemetery was excavated, revealing a total of 247 tombs, 156 of which contained grave goods. Beads were found in only 22 burials, for a total of 384 beads. This low number of beads and grave-goods in general is attributed to the fact that this is a rural site. This is in stark contrast to the evidence from the Netherlands where beads are found in a much larger proportion of graves, even in rural cemeteries. The reasons for this difference must thus be found elsewhere, possibly in regionally-specific burial customs.

Tab. 9 P-Periods of strings of beads excavated from the cemetery Campo-Marchione, Italy. Based on the typology developed in Pion 2014.

Grave	Pion Phase	Grave	Pion Phase
97	P2	168	P3
104	P2	186	P?
106	P2	195	P3–P4
123	P2	208	P3
149	P2	220	P2
167	P2–P3	246	P2

For the beads from Campo Marchione 135 LA-ICP-MS measurements were performed on 77 beads from 13 graves. For most of these graves, of the occurring bead-types only one bead was analysed, which makes it difficult to observe groups per grave or even groups per type. Therefore, we will mainly focus on determining whether the chemical composition of the beads from Campo-Marchione matches the same bead-types found in Lent-Lentseveld, Wijchen-Centrum and Elst-'t Woud (Fig. 29). First, we will briefly consider the chemical composition of the colourless and yellow opaque beads from Campo-Marchione. Then, in the absence of black beads from Italy, the blue-green/green-blue and red beads will be discussed, using new PCA analysis performed on this set of beads together with the data from the Netherlands.

The colourless beads from Campo-Marchione are plotted in Fig. 30. From this graph it can be seen that beads of the same type like the A3.1-07 and B1.8-? beads, even though they are from the same grave (graves 167 and 186 respectively) do not plot in the same glass group. In the case of the A3.1-07 bead Lema 48 is Sb-decolored, it was classified as "Roman" by Boschetti and colleagues, even though it does not plot in the "Roman" part of the plot in Fig. 31 where it plots with the Magby glasses (as does an A3 bead from Lent-Lentseveld); Lema 47 on the other hand is Foy 2. In the case of B1.8-? bead lema 51 was classified as HIMT whereas Lema 52 is Roman (no Sb detected). The results from the chemistry on both B1.8-? beads is confirmed by their very different outlook, clear for the Sb-decolored and more greenish for the other one. For both of these

48 Outside the Merovingian world this period is often known as the Migration or *Völkerwanderungs*period, and in the Mediterranean as the late Antique period.

49 Boschetti et al. 2020.

50 Boschetti et al. 2020, 337.

51 This is mostly based on the historical date of the Lombards moving into Italy around 570 AD. However, it is very well possible that the burial custom of burying the dead with grave goods appeared earlier, and might not be a reflection of a Lombard ethnicity. Many of the bead-types found at Campo-Marchione appear to date to the middle of the 6th century (P2) rather than the late 6th century (P3). There are many parallels with the bead-types excavated in Lent-Lentseveld, Wijchen-Centrum and Elst-'t Woud.

Fig. 29 Bead-types mentioned in this paragraph found in both Campo-Marchione ('C') and one of the cemeteries in this study: Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W).

graves we are actually looking at later graves with the re-use of older beads, something that also occurs in the later periods in the Netherlands and which explains the "confetti-pattern". In general, the most common glass group is Foy 2, as was seen for the Dutch cemeteries as well. This is also observed for the yellow opacifier, which is lead stannate in each case (as was the case in the Netherlands). So far evidence for the production of yellow opacified glass for beads is mainly concentrated in north-western Europe and the British Isles (as shown in Tab. 5). Could this be an indication that opaque yellow B bead-types were traded south-wards, or should we expect to find production places further south?

Since for the blue-green/green-blue beads there were no measurements of two beads of the same type from a single grave, the type of analysis performed on the beads from the Netherlands was impossible. The PCA analysis does clearly show though that the compositional groups per bead-type, whether excavated in Italy or the Netherlands, are complementary (Fig. 32). The red beads from Campo-Marchione of European making (B-beads) are, like their counterparts in the Netherlands, characterised by higher PbO contents, which is shown in the PCA in Fig. 33. The A, C and D beads are shown in one graph, and the B-beads in a different plot in order to increase their legibility. From the A, C and D graph, similar observations can be made as for the blue-green/green-blue beads: the recipes for each bead-type are the same across the different cemeteries. Again, the lack of measurements of the same bead-type from a single grave in Campo-Marchione prevents us from commenting on the chemical variability within and amongst graves. Still, the uniformity in bead-types and necklace assemblages across Europe are confirmed by the chemical analysis of the beads.

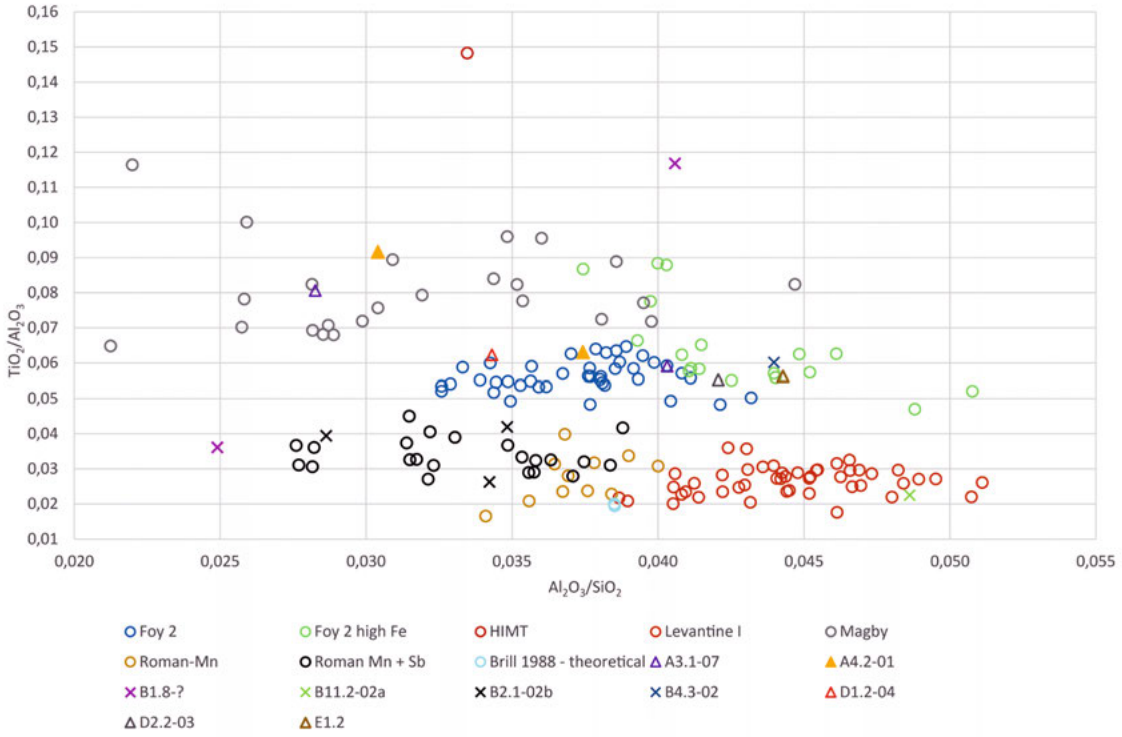

Fig. 30 Biplot of TiO_2/Al_2O_3 ratios against Al_2O/SiO_{23} ratios of colourless bead-types from Campo-Marchione. Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

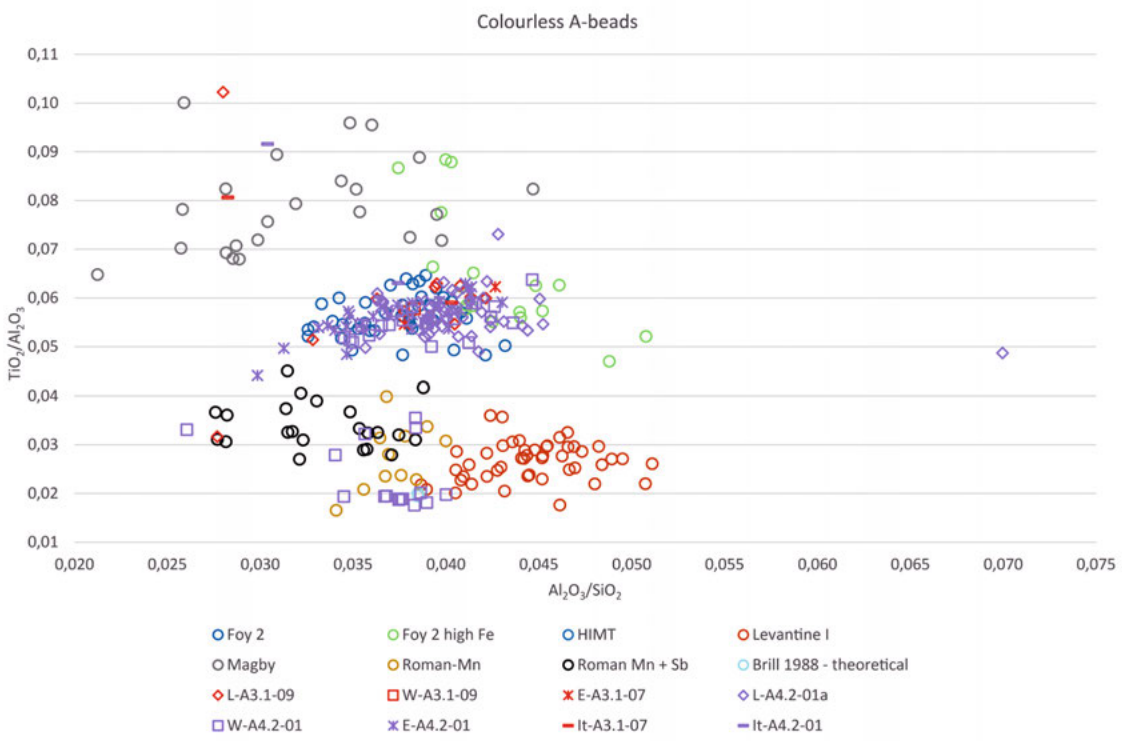

Fig. 31 Biplot of TiO_2/Al_2O_3 ratios against Al_2O/SiO_{23} ratios of colourless A bead-types found in both Campo-Marchione (It) and one of the cemeteries in this study: Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W). Reference ratios are also plotted (De Juan Ares 2019 [Fory 2, Foy 2 high Fe, Levantine 1], Schibille 2017 [Roman Mn and Roman Mn+Sb], Brill 1988).

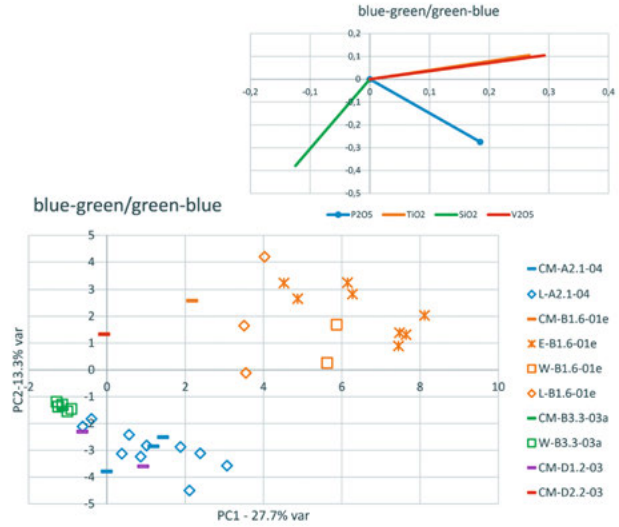

Fig. 32 PCA results LA-ICP-MS of blue-green/green-blue bead-types found in Campo-Marchione (CM) and one of the Dutch cemeteries in this study: Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W).

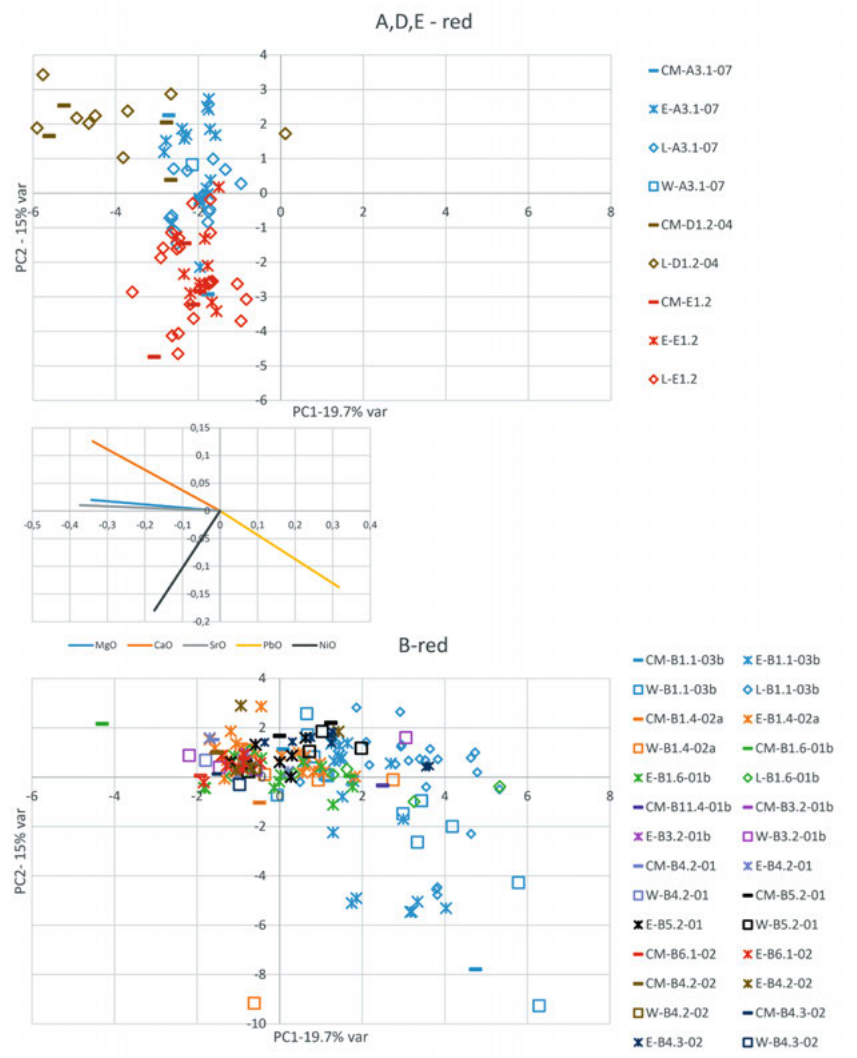

Fig. 33 PCA results LA-ICP-MS of red bead-types found in Campo-Marchione (CM) and one of the Dutch cemeteries in this study: Lent-Lentseveld (L), Elst-'t Woud (E) and Wijchen-Centrum (W): a) A, D and E bead-types b) B bead-types.

7. Discussion

7. 1. European beads vs non-European beads

European and non-European bead-types from all three sites discussed in this paper have in common that beads of the same type from the same grave generally form chemical clusters, and were mostly made with Foy 2 glass originating in Egypt. All three sites show very similar patterns: beads of the same type, whether found in one cemetery or another, are generally chemically more similar than other bead-types. This is especially visible in imported A, C, D and E beads that generally have distinctive groups. European made bead-types generally plot together in one large area on the PCA graphs (they usually are enriched in PbO compared to non-european beads); specific groups per B bead-type cannot be discerned. However, red B1.1-03 annular beads have a much larger chemical variability than other red B bead-types. This high variance may be explained by the fact that we have many more measurements of B1.1-03 beads, and by the fact that B1.1-03 beads were made throughout the Merovingian period, in contrast to other red B bead-types. Furthermore, annular beads are the simplest beads to make, and manufacturing may thus have occurred at more places than other red B bead-types, that require more specific skills to make.

7. 2. Travelling craftsmen and stationary workshops

The chemical groups per bead type from the eastern Mediterranean and beyond (A, C, D and E bead-types) and the specialist skills and tools needed to make beads suggests their production in stationary workshops. Indeed, evidence of a workshop for the production of drawn A3.1 and A4 bead-types has been excavated in Kom-el-Dikka, Egypt.[52] Supporting this, most colourless A4 beads in this study are made of Egyptian Foy 2 glass. E bead-types are generally thought to have been manufactured in Egypt as well.[53] This is reflected in the red case-study, where A3.1-07 and E bead-types from all three cemeteries were demonstrated to be of similar chemical composition. In the blue-green case-study a separation between A2, A3.2 and D1.5 bead-types on the one side and A3.1, C, D1.1-02 and E bead-types on the other side was observed. The first cluster may have been produced in a separate region: Mesopotamia,[54] the second, as mentioned above, in the Syro-Palestinian coast or Egypt.[55]

Whether wound B beads from Europe were produced in stationary workshops or by travelling craftsmen is still subject of some debate. Remains of bead production, including crucibles containing glass remains and/or glass colourants,[56] coloured glass rods and 'punty glass' have been excavated at several sites dating to the late 6th and early 7th century in Europe.[57] Clearly, beads were made at various locations during this period. The evidence is generally too scarce to determine whether each workshop focused on producing specific bead types. However, in Maastricht a workshop dating to the late 6th century has been excavated in which evidence for large-scale production of specific bead types was found: the largest proportion of the bead-manufacturing waste consists of discarded 'seconds' of blue, yellow, white and red pentagonal B1.6 beads.[58] Similarly, in the workshop found at Rijnsburg, dating to the first half of the 7th century, the bead-makers seem to have focussed on making a series of segmented annular yellow, red and white beads.[59] The bead types manufactured in both workshops have been excavated from many European cemeteries. Possibly, beads made in Rijnsburg and Maastricht were transported across the continent. However, the small amount of production waste and the rudimentary furnace recovered in Rijnsburg suggests the workshop was in use for a short period of time, perhaps only for a few days. This opens up the possibility that specialist beadmakers travelled the continent manufacturing the same bead types at several locations. Although it dates two centuries later, the bead production site excavated at Ribe, Denmark, might help to clarify the above. Bead production was clearly a seasonal affair in 8th and 9th century Ribe: a new bead production station was built at varying locations in the same house each year.[60] The archaeological evi-

52 Spear 1993.
53 Pion 2014, 223–227; Volkmann/Theune 2001, 523–524.
54 Cf. Pion 2014, 219–222.
55 Cf. Pion 2014, 198–200.
56 Heck et al. 2003.
57 Pion 2014, 180.
58 Sablerolles et al. 1997, 301; Pion 2014, 181–182.
59 Dijkstra et al. 2010; Pion 2014, 183.
60 Barfod et al. 2022; Sindbæk 2023.

Fig. 34 Biplots of SnO ratios against Sb_2O_3 ratios, PbO ratios against Sb_2O_3 ratios, SnO against CuO ratios and PbO ratios against CuO ratios of red B1.1-03 bead-types, sorted per date (Pion's P-periods) of the set of beads they were found with.

dence clearly suggests that specific bead types were produced in large numbers each season: we are not dealing with bead-making on demand by travelling craftsmen, but rather with a regular bead-production intended for exchange. It is very well possible that bead production in Rijnsburg and Maastricht was organised in a similar manner.

Nonetheless, many of the beads excavated from Lent-Lentseveld, Elst-'t Woud and Wijchen-Centrum pre-date the bead-production workshops mentioned above. Consequently, chemical analyses of beads from 6th century contexts are (for now) the only source from which their production can be deduced. Chemical analyses of white opaque glass used for bead making from bead-production sites dating to the late 6th and first half of the 7th century excavated in Maastricht, Rijnsburg and Wijnaldum point towards the regional fabrication of coloured glass.[61] The chemical analyses of 1493 beads from several Merovingian cemeteries along the Rhine in Germany confirm the appearance of regional and local colour recipes from the late 6th century onwards.[62] However, the same study has shown that beads dating to the late 5th and ongoing 6th century were made using interregional colour recipes, suggesting a more centralised production of coloured glass in the first half of the 6th century; a continuation of late-antique traditions. Possibly, coloured glass was made at sites where other fire-related practices such as metalworking and glass-vessel making were undertaken: the materials needed to colour raw glass, with the exception of cobalt, would have been at hand there.[63] We did not find evidence for supra-regional and later more regional colour recipes for the red B1.1-03 beads, both the LA-ICP-MS display a lack of uniformity in colour recipe within a given time-period (Fig. 34).

The overlapping chemical groups for many of the B bead-types identified above could be a reflection of such centrally produced coloured glass. Coloured glass in the form of glass rods may have been dispersed to different workshops and/or with travelling craftsmen that produced beads in various places, that need not have left archaeological traces: experiments have shown that it is possible for skilled beadmakers to produce wound beads in open

61 Dijkstra et al. 2010, 194; Dijkstra 2011, 314.
62 Matthes et al. 2004.
63 Cf. Pion 2014, 189–190; Crocco et al. 2021, 155; Peake/Freestone 2012.

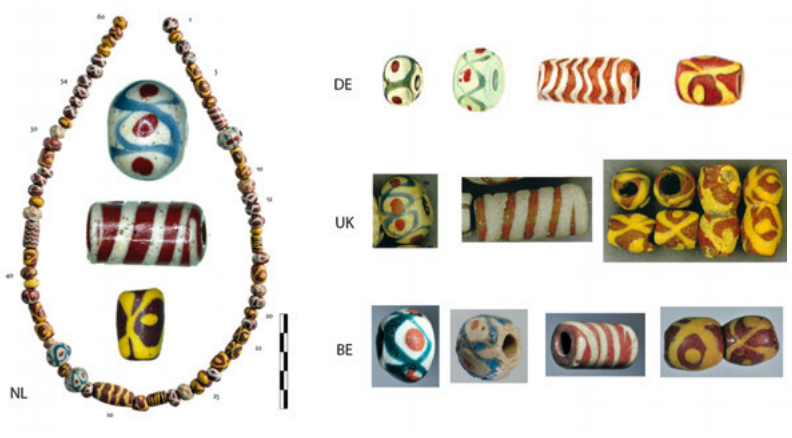

Fig. 35 NL: String of 60 beads found in grave 15 of the small cemetery Uden-Schepersweg, of which 3 polychrome bead types are highlighted (Photos M. Hemminga and M. B. Langbroek). DE identical beads found in Schretzheim, Germany (after Koch 1977); UK identical beads found in Morning Thorpe, Mill Hill and Buckland, England (after Brugmann 2004); BE identical beads found in Bossut-Gottechain, Broechem, Verlaine-Oudomont and Vieville, Belgium (after Pion 2014).

hearths.[64] However, as nearly identical B beads can be found in cemeteries across Europe (Fig. 35), travelling beadmakers would have had to produce the same bead-types at different locations. It may have been more straight-forward to produce a series of a specific bead-type in one location, and exchange the finished beads themselves: bead-making at stationary (seasonal?) workshops seems to fit the available evidence better and is archaeologically attested for the later period. Further chemical analyses of beads from other cemeteries may provide more clarity on this matter: for now, the LA-ICP-MS analyses of several beads from Campo-Marchione do not refute it.

7. 3. Production and exchange: Assembling a string of beads

In a former article it was already noticed that in Lent, those strings of beads that date to P1 are mostly made up of bead-types that form chemical groups.[65] P2 and P2–P3 strings from Lent generally also contain beads of the same chemical group, but are strung together with beads that form a chemical 'confetti pattern'. The same distinction was noticed for Elst and Wijchen (Tab. 10, Appendix Tab. S4): the majority of the strings of beads dating to P1 contain beads that form chemical groups. It is likely that beads in these strings were made together, exchanged together and strung together. From then onwards, as the 6th century progressed, more and more strings were interred that consist of both beads of the same chemical group in combination with beads that form a chemical 'confetti pattern': beads of the same type that were most likely made at different occasions. These 'combination-strings' peak in the late 6th century (P2–P3 and P3), after which pure 'confetti-strings' take the lead (P4). Strings from graves dating to P4 from Elst and Wijchen generally contain less beads on average than strings of beads dating to the 6th century (Tab. 11). Also, the pure 'confetti-strings' do not often contain multiple beads of the same type: it is impossible to establish whether these were acquired at the same time, or during various occasions. Still, in each period 'group-strings' are represented. As only a few strings from Wijchen date to the middle and second half of the 7th century (P4–P5 and P5), there is too little information to determine which type of string occurs mostly in this period. However, no pure confetti strings were found for this period, which could be reflected by the fact that many mid to late 7th century strings excavated throughout Europe are

64 Krzyżanowska/Frankiewicz 2015.

65 Some of the bead-types occur only once in a string of beads: for these it is not possible to see whether they form chemical groups or not: that only works when multiple beads of the same type from a single string could be analysed. For these it is not possible to say whether they were acquired with the rest of the beads in the string or separately.

Tab. 10 Results from appendix tab. S4 summarised per bead-period.

Elst + Lent + Wijchen	P1	%	P1–P2	%	P2	%	P2–P3	%	P3	%	P3–P4	%	P4	%	P4–P5	%	P5	%
group-grave	8	73	6	40	3	18	1	14	2	19	1	16	1	11	0	0	1	33
combination-grave	1	9	7	47	8	47	5	71	4	38	2	33	3	33	1	100	2	66
confetti-grave	0	0	0	0	3	18	1	14	3	27	2	33	4	44	0	0	0	0
?	2	18	2	13	3	18	0	0	2	19	1	16	1	11	0	0	0	0
total graves	11		15		17		7		11		6		9		1		3	

Tab. 11 Average amounts of beads per grave considering the beads from Lent-Lentseveld, Elst-'t Woud and Wijchen-Centrum.

P-Period	Average amount of beads per grave
P1 (n = 21)	37
P2 (n = 34)	42
P3 (n = 22)	42
P4 (n = 22)	23
P5 (n = 4)	12

very much alike (Fig. 36), just as strings dating to the first half of the 6th century (Fig. 37). The occasional chemical confetti pattern occurring in these strings may have been personal additions to ready-made and strings of beads. There is a major difference between early 6th and late 7th century strings of beads though: the first contain a large proportion of imported beads from the eastern Mediterranean and beyond mostly, whereas the latter contain European-made beads mostly. In contrast, strings dating from the mid-6th till the mid-7th century show much more variation in both bead-types and bead-combinations, even when these contain similar bead-types across the continent (recalling Fig. 35).[66]

This could reflect a shift from the exchange of 'integer' strings made up of mostly imported beads in the early 6th century towards the exchange of regionally manufactured beads themselves in the late 6th and early 7th century. Perhaps it is not coincidental that the date of this change corresponds with the emergence of European bead-production workshops: there simply may have been more 'bead-acquiring opportunities'.

A similar shift from imports to regional production was already reported for ceramics excavated in the Mosane Valley by Line van Wersch.[67] She reports a uniformity of imported ceramic wares in the first half of the 6th century followed by a pluriformity of regionally produced ceramic wares between 550 and 640 CE. From 640 onwards ceramic wares became imports again. The emergence of regional bead- and ceramic production sites in the second half of the

[66] The late 6th and early 7th century are therefore somewhat of a nightmare for those that make bead-typologies: the bead phases developed for this period are generally rather long, overlap one another and contain a huge variety of bead-types and bead-combinations see for example Brugmann 2004; Siegmund 1998; Koch 1977).

[67] Van Wersch 2015.

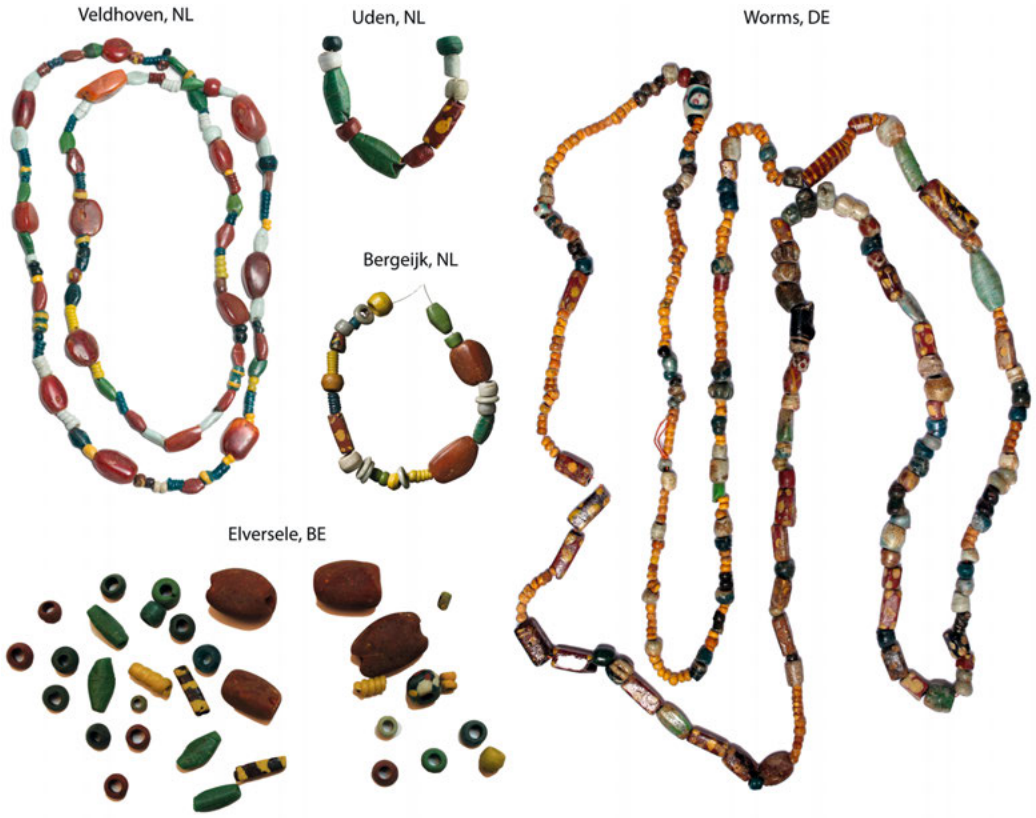

Fig. 36 Strings of beads dating to the 7th century with large amber beads paired with flat diamond shaped beads of opaque green glass, rectangular beads of opaque red glass decorated with yellow dots, and twisted or segmented beads of opaque yellow glass (Photos: Noord-Brabants Museum, M. Hemminga, A. Dekker, B. Mestdagh; C. Weissert, Museum der Stadt Worms im Andreasstift).

Fig. 37 Strings of beads dating to the 6th century with small wound beads made of opaque black glass and amber beads (Photos: M. Hemminga, A. Dekker, O. Vrielynck, R. Legoux, Archäologisches Pilgermuseum).

6th century coincides with the emergence of many new cemeteries in northwestern Europe.[68] Clearly, the population underwent significant growth during this time and with that created a larger demand for the objects that were eventually deposited in graves. This demand may have kick-started the organisation of bead production in northwestern Europe on a larger scale than before. It seems logical that once population levels in northwestern Europe grew large enough, people were able to specialise and carry out specific skills themselves: the large-scale imports of the first half of the 6th century (with significantly lower population levels) were no longer needed and/or wanted. During the mid and late 7th century CE, the growing population (and demand for beads) of northwestern Europe may have caused 'industrial production' to become relevant, and make the shift towards more centralised production once again.

As was mentioned in the introduction, we are especially interested in establishing whether strings of beads were collected one bead at a time, or all at once. Judging by the findings above, during the first half of the 6th century most strings from Lent, Wijchen and Elst were strung once with beads that were produced and exchanged together. That is not to say all beads in these strings were all coming from the same source: they usually contain a combination of beads from Europe, the Baltic and several regions in the Eastern Mediterranean and beyond. The chemical analyses presented above demonstrate that during the exchange of beads from the Eastern Mediterranean and beyond into Europe beads with similar composition, presumably from the same bead-making event or workshop, were kept together somehow, possibly in bags or strung onto long strings for transport. It betrays a surprisingly regular and well-organised trade in beads over significant distances during this period. The fact that strings sporting the same bead combinations (recalling Fig. 36–37) can be found in graves across Europe supports this theory and proffers the idea that complete strings of beads may have been exchanged instead of individual beads or loose beads.

Where were these strings containing beads with so many different provenances which nevertheless remained grouped strung, why and by whom? Were they considered simple commodities at that point? How did they then come to be buried in cemeteries across Europe, and at what point during their 'lives' did these strings become so especially valued that it warranted their interment with the deceased? A possible answer could be that at specific life events these strings of beads were gifted to the person they were eventually buried with. Perhaps they became so entangled with that person that their redistribution to others after the person had died was simply not done: strings of beads may have become inalienable.[69] Still, this theory does not explain why small children, who had presumably not taken part in many rites of passage, were buried with similar composite strings of beads as well, or why beads were taken from graves during grave-reopening practices.[70] Unfortunately, we still cannot prove whether the strings excavated from graves were worn by the person buried in that grave during life.[71] One thing seems clear: strings of beads dating to the first half of the 6th century were not built up of beads that were obtained one by one. It therefore also seems unlikely that the individual beads in these strings, with the occasional exception, were taken out of their original combinations to be exchanged over several generations, or become individually valued for their age.

From the second half of the 6th century onwards, assembling a string of beads seems to have become a bit 'messier' than before: the majority of the strings were strung with a combination of bead-types that were likely made together and bead-types that were more chemically diverse. As was argued above, beads may have become more readily available as regional production took off, and the second half of the 6th century may have seen an exchange of singular beads instead of complete strings. This could explain the emergence of chemical 'confetti patterns' among beads of the same type found on the same string: it may reflect an increase in 'bead-acquiring opportunities'. With the increase in regionally produced beads, imported beads from the Eastern Mediterranean and beyond started to play a smaller role: from the late 6th century onwards, they had become the exception rather than

[68] Source: www.earlymedievaleurope.org (Online Database ERC Rural Riches).

[69] Weiner 1992; see also Klevnäs 2015.

[70] Van Haperen 2017.

[71] The wear on many of the beads does seem to show that they were in fact worn during life, we just cannot tell by whom (McGloin 2021).

the rule.[72] When they do appear, however, they generally still form chemical groups. Also, new bead-types from the Eastern Mediterranean and beyond still appear across Europe in the late 6th century[73]: the method of bead exchange between 'the East' and Europe does not seem to have changed much in the second half of the 6th century. As most strings dating from the second half of the 6th century onwards also contain beads that were probably made during a single bead-making event, the increase in separately made beads does not necessarily mean that strings of beads had become less integer. Beads of the same type with a varying chemical pattern may still have been strung at the same time, and even acquired together. This depends on whether beads were strung directly from the maker without intermediate exchange of whatever nature and/or whether one could acquire beads from different bead-making events together, both of which are very hard to prove. What does seem to support the 'integer strings' theory is the lack of many older bead types[74] in strings from graves dating from the second half of the 6th century onwards: if intergenerational exchange of beads took place, and these were eventually deposited in graves, it must have been the exchange of complete strings.[75] However, the strings we do find in graves are generally of similar date as the other grave goods found buried with them, which suggests that these strings had not been exchanged across several generations.[76]

Taking all of the above into account, are we closer to answering whether the production and exchange of beads during the 6th and 7th centuries have a commercial or a social character? Since beads and strings of beads across Europe are very similar and occur in rather large amounts, Ursula Koch has referred to certain types of Merovingian beads as '*billige Massenware*': or cheap, mass-produced commodities that anyone could access.[77] The fact that many beads of the same type excavated from a grave were most likely kept together from production to deposition, especially when they were produced in significant amounts far away, betrays a regular and well-organised exchange of beads that supports this view of Merovingian beads. Accordingly, several bead production sites that have been excavated in- and outside of Europe do seem to have had the capacity to produce beads on a large scale.[78] People from a wide array of places were able to obtain beads from the same sources that were widely available. From this perspective, at the start of their 'lives', beads must have been considered commodities. Once strung and worn, the very same beads may have gained enough meaning for their wearers to motivate their role in funerary practices. It is possible that these strings of beads, once deposited in a grave, took on a different meaning than they had before their burial because of the transformative rite of passage they went through, much like the person whose body was buried. As it is not possible to prove or disprove such a theory based on the chemical analyses presented in this article, it will be addressed in future work.[79]

8. Conclusion

In the introduction to this article several questions inspired by examples of bead-meaning and bead-use from ethnographic examples were posed concerning bead-use, bead-production and bead-exchange in 6th century Europe. We were especially interested in establishing whether strings of beads were assembled one bead at a time, or all at once. In a former article we developed a method to distinguish chemical bead-groups in the glass bead assemblage excavated from the Merovingian cemetery of Lent-Lentseveld. This was achieved by incorporating typological bead data in the results of LA-ICP-MS analyses of nearly every glass bead from the site and by using principal component analysis to distinguish between chemical groups. These analyses suggested that in the 6th century beads were imported over long distances to Lent on several occa-

72 Pion 2014, 230–235.

73 Pion 2014, 233.

74 With the occasional exception.

75 This is of course based on those strings of beads that were deposited in the graves: you would not expect to find those beads that were exchanged across generations in graves, as they would not have been interred but passed on.

76 This is also supported by the fact that every 30 years or so there seems to appear an almost completely new set of bead-types in strings of beads, resulting in strings that look almost completely different every generation; Pion 2014, 134–158.

77 Koch 1977, 202.

78 See Pion 2014, 178–229 for an overview of bead production sites in and outside of Europe during the Merovingian period. Of course, there must have been many more workshops than we know so far.

79 Langbroek in prep.; Langbroek forthcoming.

sions, and that once strung, beads tended to remain together as a distinct set. For this article we wanted to apply the same method to bead-assemblages from two other sites dating to the 6th century, in order to establish whether the chemical patterns observed for Lent-Lentseveld could also be found in the glass bead assemblages excavated from the Merovingian cemeteries Wijchen-Centrum and Elst 't Woud.

Our observations on the glass groups in Elst, Wijchen and Lent are in line with what was seen when considering only Lent. The A-beads identified as of Egyptian origin on archaeological and stylistic grounds fit an Egyptian (manganese-decoloured Foy 2 glass) composition, as do the E-beads. For the European beads the picture is slightly more complex. The colourless beads of European manufacture are dominated by a fresh Foy 2 glass composition indicating the import of fresh glass from Egypt, to which lead was added in various amounts (depending on the colour), presumably to increase its workability. There are a few examples of recycled mixed Mn-Sb decoloured beads amongst the European samples, but most were made fresh Foy 2 glass decoloured with manganese. A very common colour in European beads is opaque yellow, for which there is evidence of production in North-Western Europe and the British Isles. In our study all opaque yellow beads were coloured using lead stannate, corresponding to these productions. For the red and black beads different colouring recipes were distinguished, usually linked to specific bead-types with strong links to metallurgy, as already found by other colleagues. When we compared this to the published LA-ICP-MS data of the beads excavated from Campo-Marchione similar patterns emerged, indicating a common recipe and origin of various types of glass beads excavated in the Netherlands and Italy.

The three case studies for black, blue-green/green-blue and red beads presented above have demonstrated that, as already observed for Lent-Lentseveld, many bead-types, whether excavated in the Netherlands or Italy, form specific chemical groups. Chemical groups were established for both bead-types with provenances in the eastern Mediterranean and beyond as well as for bead-types that were produced in Northwestern Europe. This indicates that bead-production must have taken place in specialist workshops during the 6th century, especially for those beads that were imported from afar (A, C, D and E bead-types). As discussed above, the chemical composition of Europe-made B bead-types and the available evidence of bead-production sites suggests that central (seasonal?) bead production in large numbers by specialists is more likely than their occasional production by travelling craftsmen.

Within most type groups, beads excavated in the same grave were found to cluster together, although 'chemical confetti patterns' do start to occur in strings dating from the mid-6th century onwards. Most likely, this indicates that the strings of beads buried with the dead were strung with groups of beads that were made and exchanged together. This means that during the largest part of the 6th century bead exchange from production sites to the person assembling a string of beads was organised in such a way that allowed beads from the same production or 'bead-making event' to stay together: a pan-European exchange network must have been in place. Most of the beads in the strings excavated in Lent, Elst and Wijchen were clearly not acquired or exchanged one at a time: we are dealing with integer strings of beads that, after their assembly, may even have been exchanged as complete strings, which may also be reflected by the symmetry and similarity observed in many strings of beads excavated across Europe. That is not to say beads were considered commodities from production to deposition: Once strung and worn, the very same beads once exchanged as commodities may have gained enough meaning to motivate their role in funerary practices. Use-wear analyses of complete Merovingian strings of beads, informed by cultural anthropological theory and ethnographic examples, may help to inform several possible scenarios that illustrate such a shift from commodity to meaningful grave-gift.

This article has mostly dealt with bead-assemblages dating to the 6th century excavated from a specific part of the Netherlands. In the future, we hope to extend our research in time and space to incorporate 7th-century bead-assemblages and bead-assemblages from other European regions as well.

9. Appendix

Supplementary Tables S1–4

Tab. S1 Overview of graves with beads from the cemetery Lent-Lentseveld. A drawn beads; B wound beads; C folded beads; D perforated beads; E mosaic beads; F cut beads.

Grave	Sex	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period
1	female (?)	adult	neck	10	1	glass	B	Europe	500–600	P1–P3
2	female (?)	adult	neck	52	1	glass, amber, faience	B, F, A	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast, Middle East, Roman	480–530	P1
5	female (?)	adult	neck	72	1	glass, amber	B, F, A, E, C	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast	530–570	P2
9	female	adult	neck	25	1	glass, amber	B, F, A, E	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast	500–550	P1–P2
12	child	3–4	?	1	1	amber	F	Baltic	500–600	P1–P5
13	child	5–6	neck, hip	82 + 22	2	glass, amber	B, F, A, E, C, D	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast, India	500–550	P1–P2
16	female	adult	neck, hip	26 + 1	2	glass, amber, marble, beryllium	B, F, A, D	Europe, Baltic, Egypt/Syro-Palestinian coast, Roman	480–530	P1
20	female	adult	neck,loose bead, hip	92 + 1	2	glass, amber	B, F, A, E	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast, Middle East	500–550	P1–P2
21	child	5–6	belt?	12	1	glass, amber, faience	B, F, A, E	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast, Roman	480–530	P1
23	female	adult	neck	32	1	glass, amber	B, F, A, C	Europe, Baltic, Egypt/Syro-Palestinian coast, Roman	480–530	P1
26	child	5–6	neck, arm	61 + 37	2	glass, amber	B, F, A	Europe, Baltic, Egypt/Syro-Palestinian coast	540–560	P2
27	child	4–5	belt	7	1	glass, faience	B	Europe, Roman	530–570	P2
28	female	adult	neck, loose bead	109	1	glass	B	Europe	500–550	P1–P2
34	female	adult	neck, arm/stomach, hip, knees	98 + 5 + 1 + 1	4	glass, meerschaum	B, F, A	Europe, Baltic, Mediterranean	500–550	P1–P2
35	female	adult	chest, hip	41 + 1	2	glass, amber	B, F, E, C	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast	500–550	P1–P2
36	female	adult	chest	11	1	glass, amber	B, F, A, D	Europe, Baltic, Egypt/Syro-Palestinian coast	480–530	P1

Grave	Sex	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period
40	child	young child	neck	120	1	glass, amber	B, F, A, E, C, D	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast, Middle East, India, Roman	500–550	P1–P2
41	female	adult	neck	27	1	glass, amber	B, F	Europe, Baltic, Mediterranean	530–570	P2
42	female	adult	neck	28	1	glass, amber	B, F, C	Europe, Baltic, Egypt/Syro-Palestinian coast	500–550	P1–P2
43	female	adult	neck, bag	46 + 31	2	glass, amber	B, F, A, E	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast	530–570	P2
45	female	adult	disturbed grave	5	1	glass, amber, faience	B, F	Europe, Baltic, Roman	480–610	P1–P3
50	female	adult	neck, hip	19 + 1	2	glass, amber, marble	B, F, A, E	Europe, Baltic, Egypt, Egypt/Syro-Palestinian coast	500–550	P1–P2
51	female	adult	neck	46	1	glass, amber	B, F, D	Europe, Baltic, Egypt/Syro-Palestinian coast	550–600	P2–P3
52	female	juvenile	neck	7	1	glass	B	Europe	480–610	P1–P3
53	female	adult	neck, loose bead	66 + 1	2	glass, amber	B, F, A, C	Europe, Baltic, Egypt/Syro-Palestinian coast, India	530–570	P2
55	child	infant	chest	5	1	glass, amber	B, F, A, C	Europe, Baltic, Egypt/Syro-Palestinian coast	530–570	P2
102	male	19–28	cremation	1	1	glass	B	Europe	480–610	P1–P3
105	?	20–40	cremation	1	1	glass	B	Europe	480–610	P1–P3
112	?	?	cremation	1	1	glass	E	Egypt	530–570	P2

Tab. S2 Overview of graves with beads from the cemetery Elst-'t Woud. A drawn beads; B wound beads; C folded beads; D perforated beads; E mosaic beads; F cut beads.

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
2	?	?	cremation	5	1	glass	B	Europe	650–700	P5–P6	640–710
5	?	?	cremation	1	1	glass	B	Europe	?	?	x
8	male	adult	cremation	14	1	glass	?	?	?	?	610–710
13	?	?	cremation	2	1	glass, antler	B, F	Europe	?	?	580–650
24	?	?	cremation	6	1	glass	?	?	?	?	610–710
28	?	?	cremation	8	1	glass	?	?	?	?	610–680
38	female	adult	cremation	18	1	glass	B	Europe	620–670?	P5?	610–710
54	?	?	cremation	4	1	glass	B	Europe	?	?	610–710
55	?	?	cremation	1	1	glass	B	Europe	?	?	610–680
58	?	?	cremation	1	1	glass	B	Europe	?	?	610–710
59	female	adult	chest	3	1	glass	B	Europe	620–670?	P5?	640–710
65	?	?	cremation	1	1	glass	?	?	?	?	610–680
66	?	?	cremation	2	1	glass	B	Europe	?	?	610–680
78	?	?	cremation	4	1	glass	?	?	?	?	x
81	female	adult	upper body	120	1	glass, amber	B, C, F	Europe, Egypt/Syro-Palestinian coast, Baltic	570–610	P3	610–710
82	female	child	neck, side	33	1	glass	B, C, D	Europe, Egypt/Syro-Palestinian coast	570–610	P3	580–710
87	female	adult	neck, leg	79, 1	2	glass, amber	A, B, C, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	530–570	P2	510–590
88	female	adult	hip, neck	33, 74	2	glass, amber, copper	A, B, C, E, F	Europe, Egypt, Egypt/Syro-Palestinian coast, Baltic	550–600	P2–P3	565–590
91	female	adult	neck	41	1	glass, amber	B, F	Europe, Baltic	590–620	P3–P4	540–590
92	female	adult	upper arm	13	1	glass, amber	B, C, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	530–570	P2	x

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
112	female	adult	left leg, upper leg, stomach/hip, head	2,6,24, 3	4	glass, amber	B, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–530	P1	565–590
114	?	?	cremation	1	1	glass	B	Europe	?	?	565–650
118	female	adult	hips, stomach/ chest, leg	5, 33, 1	3	glass, amber, flint	A, B, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	480–530	P1	540–590
127	female	adult	hip, neck/chest	16, 108	2	glass, amber, meerschaum	A, B, C, D, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic, Mediterranean	530–570	P2	565–590
129	female	child	neck	7	1	glass	B	Europe	560–610	P3	565–590
133	male	adult	purse/hip	1	1	glass	?	?	?	?	510–590
135	female	adult	scattered	3	?	glass, amber	B, F	Europe, Baltic	480–530	P1	510–565
136	female	adult	fill coffin	2	1	glass	B	Europe	550–570	P2b	510–590
140	?	?	cremation	1	1	glass	?	?	?	?	565–650
141	?	?	cremation	5	1	glass	?	?	?	?	610–710
152	?	?	cremation	1	1	glass	B	Europe	600–640	P4	610–710
155	female	adult	upper legs, in opening glass bell-beaker, chest	1, 4, 21	3	glass, amber, faience	A, B, E, G	Europe, Egypt/Syro-Palestinian coast, Baltic, Egypt, Roman	530–570	P2	510–565
159	female	adult	neck	19	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–610	P1–P3	580–620
161	female	child	neck/chest	84	1	glass, amber	A, B, C, D, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	530–570	P2	510–620
162	female	child	chest/stomach	43	1	glass	A, B, D	Europe, Neat East	530–570	P2	510–590
175	female	adult	chest, neck	105, 96	2	glass, amber, jet	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–530	P1	510–590

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
183	?	?	cremation	2	1	glass	?	?	?	?	510–650
192	female?	adult	neck	12	1	glass	B	Europe	600–640	P4	x
193	female	child	head/neck	14	1	glass	B, C, D	Europe, Egypt/Syro-Palestinian coast	560–610	P3	610–680
201	female	child	centre grave	7	1	glass, amber, faience	D, F, G	Egypt/Syro-Plestinian coast, Baltic, Roman	480–530	P1	450–525
204	female?	adult	?	1	1	glass	B	Europe	530–570	P2	x
205	female	child	southwestern corner: neck?	8	1	glass	B	Europe	480–610	P1–P3	400–525
208	female	adult	fill grave, neck/ chest, hip	2, 33, 2	3	glass, amber	A, B, D, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	510–540	P1–P2	565–650
209	female	child	neck/chest	7	1	glass	B	Europe	480–610	P1–P3	x
210	female	adult	neck	33	1	glass, ceramic	B	Europe	600–640	P4	x
211	female	adult	upper legs, neck/ chest	1, 9	2	glass	B, C, D, E	Europe, Egypt/Syro-Palestinian coast, Egypt	550–600	P2–P3	540–590
214	female	child?	neck, in biconical pot	9, 1	2	glass	B, D	Europe, Egypt/Syro-Palestinian coast	600–640	P4	565–650
216	female	adult	neck, upper legs	5, 166	2	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–530	P1	565–620
217	female	child	?	2	1	glass	B	Europe	450–610	P0–P3	400–525
224	?	?	cremation	2	1	glass	B	Europe	480–610	P1–P3	565–710
234	female	child	neck	11	1	glass, amber	A, B, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	530–570	P2	x
235	female	adult	head	4	1	glass, amber	A, B, D, F	Europe, Baltic, Egypt/ Syro-Palestinian coast	530–570	P2	x

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
238	female	adult	neck/head/chest, arm/hip, knees	103, 24, 1	3	glass, amber, flint	A, B, D, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	550–600	P2–P3	540–590
239	female	adult	neck/head, legs	17, 1	2	glass, amber, bone	B, F	Europe, Baltic	480–610	P1–P3	540–565
242	female	adult	chest	4	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	590–620	P3–P4	before 610
243	female	adult	head/neck	11	1	glass	B	Europe	600–640	P4	x
249	female	adult	head/neck/chest, hip	185, 38	2	glass, amber, faience	A, B, C, D, E, F, G	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic, Roman	560–610	P3	540–565

Tab. S3 Overview of graves with beads from the cemetery Wijchen-Centrum. A drawn beads; B wound beads; C folded beads; D perforated beads; E mosaic beads; F cut beads

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
2	?	?	left side	1	1	glass	A	Egypt/Syro-Palestinian coast	480–610	P1–P3	555–640
4	female	?	legs, grave fill	2	2	glass	D	Egypt/Syro-Palestinian coast	480–610	P1–P3	555–640
5	female	adult	head/neck	22	1	glass, amber	B, F	Europe, Baltic	600–640	P4	570–610
8	?	?	head end grave	1	1	glass	A	Egypt/Syro-Palestinian coast	450–610	P0–P3	570–640
9	female	adult	scattered	3	3	glass	B	Europe	560–610	P3	530–555
10	?	?	outside coffin	1	1	glass	B	Europe	480–530	P1	530–555
22	?	?	head end grave	2	1	glass	B	Europe	560–670	P3–P5	610–640
29	female	adult	neck	12	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–530	P1	450–530
34	female	25-35	neck	113	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	570–620	P3–P4	570–610
35	?	?	outside coffin	1	1	glass	B	Europe	?	?	570–610
37	female	?	head/neck	1	1	glass	B	Europe	560–610	P3	530–640
40	?	?	scattered	2	2	glass	B	Europe	480–530	P1	570–640
44	female	adult	grave fill	1	1	glass	B	Europe	675–750	x	530–640
45	female	?	upper body	5	1	glass	B	Europe	570–620	P3–P4	530–640
49	female	?	lower body	5	5	glass, amber	B, F	Europe, Baltic	570–620	P3–P4	450–570
50	male	child	chest	2	2	glass, ceramic	A, F	Egypt/Syro-Palestinian coast, Europe	480–530	P1	490–530
51	female	?	upper body	19	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–610	P1–P3	450–530
52	female	17-35	neck/chest	39	1	glass, amber	A, B, F, G	Europe, Egypt/Syro-Palestinian coast, India, Baltic, Roman	480–530	P1	490–530

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
55	female	?	head end grave	6	1	glass, amber	B, F	Europe, Baltic	600–640	P4	610–640
58	female	?	neck	11	1	glass, amber	B, F	Europe, Baltic	620–670	P5	610–640
59	?	child	upper body	2	2	glass, faience	B, G	Europe, Roman	600–640	P4	530–570
65	female	?	neck/chest	32	1	glass, amber	A, B, C, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	550–600	P2–P3	570–610
67	?	7-25	mouth	1	1	amber	F	Baltic	480–670	P1–P5	570–640
75	female	adult	head	1	1	glass	B	Europe	600–640	P4	570–610
81	female	?	feet	1	1	glass	B	Europe	480–530	P1	570–610
87	?	child	container next to coffin	2	2	amber, faience	F, G	Baltic, Roman	480–610	P1–P3	450–530
92	female	?	head end grave	13	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	600–640	P4	570–640
93	female	child	head	4	1	glass, amber	B, F	Europe, Baltic	480–610	P1–P3	555–640
98	female	?	head	29	1	glass, amber, silver	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	570–620	P3–P4	570–640
99	male	?	lower body	1	1	glass	B	Europe	500–550	P1–P2	570–640
102	?	?	head end grave	2	1	glass	B	Europe	560–610	P3	570–610
104	female	17-25	neck	6	1	glass	B	Europe	560–610	P3	570–610
106	female	?	left side	14	1	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	580–620	P3–P4	530–640
107	female	?	right side upper body	1	1	amber	F	Baltic	480–670	P1–P5	555–640
108	?	child	?	2	1	glass, amber	B, F	Europe, Baltic	480–610	P1–P3	530–640
127	female	?	neck	40	1	glass, amber	B, C, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	550–600	P2–P3	570–640
128	?	?	head end grave	2	1	glass	B	Europe	560–670	P3–P5	570–640

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
132	female	child	neck	16	1	glass, amber	B, D, F	Europe, Egypt/Syro-Palestinian coast, Baltic	560–610	P3	530–555
134	female	2-18	neck	20	1	glass	B	Europe	560–610	P3 (some P4)	555–640
142	?	?	hip	1	1	glass	A	Egypt/Syro-Palestinian coast	480–530	P1	450–570
149	female	0-10	neck	10	1	glass	B	Europe	600–640	P4	570–640
152	male	?	corner of grave outside coffin	1	1	glass	B	Europe / Mediterranean	530–570	P2	555–640
154	?	?	centre grave: hip/ stomach?	1	1	amber	F	Baltic	600–640	P4	610–640
156	female	?	neck	160	1	glass, amber	A, B, E, F	Europe, Egypt/Syro-Palestinian coast, Egypt, Baltic	600–640	P4	610–640
160	female	?	legs, neck	1,69	2	glass, amber, meerschaum	B, F	Europe, Baltic, Mediterranean	480–610	P1–P3	530–555
161	female	?	hip, stomach	2, 3	2	glass	B	Europe	480–530	P1	450–530
171	female	?	neck/chest	76	1	glass, amber	B, F	Europe, Baltic	550–600	P2–P3	555–570
179	female	10-18	neck/shoulder	7	1	glass	A, B	Europe, Egypt/Syro-Palestinian coast	620–670	P5	610–640
194	female	?	neck	12	1	glass	B, D	Europe, Egypt/Syro-Palestinian coast	600–650	P4–P5	570–640
199	?	child	left side	1	1	amber	F	Baltic	480–670	P1–P5	555–640
211	female	?	neck	2	1	glass	A	Egypt/Syro-Palestinian coast	500–550	P1–P2	555–570
219	female	child	neck	84	1	glass, amber, silver	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	480–530	P1	490–530
226	female	?	head/neck	3	1	glass, amber	B, F	Europe, Baltic	480–610	P1–P3	530–555

Grave	Sex/ gender	Age	Position beads	Number of beads	Number of bead groups	Material	Bead techniques	Provenance beads	Date beads	Period	Date grave
228	female	?	feet, hip/purse	1, 6	2	glass, amber	A, B, F	Europe, Egypt/Syro-Palestinian coast, Baltic	530–570	P2	530–555
230	female	17-25	neck	16	1	glass, amber	B, F	Europe, Baltic	560–610	P3	530–570
235	female	17-25	stomach, chest	5, 41	2	glass, amber, faience	A, B, F, G	Europe, Egypt/Syro-Palestinian coast, Baltic, Roman	480–530	P1	490–530
239	female	?	head end grave	14	1	glass	A, B	Europe, Egypt/Syro-Palestinian coast	600–640	P4	570–640
244	male	adult	hip	1	1	glass	B	Europe	?	?	610–640
249	?	?	hip	1	1	glass	B	Europe	530–570	P2	570–640
253	female	?	neck	23	1	glass	B, D	Europe, Egypt/Syro-Palestinian coast	550–600	P2–P3	530–555
258	female	child	upper body	5	1	glass, amber	B, F	Europe, Baltic	550–600	P2–P3	570–610
266	female	?	scattered	15	1	glass	?	?	?	?	490–570
285	?	?	lower body	1	1	glass	B	Europe	600–640	P4	570–640
304	?	?	scattered	3	3	glass	B	Europe	560–610	P3	570–640
317	?	12	cremation	5	5	glass, rock crystal	B, F	Europe, Egypt (?)	480–550	P1–P2	450–500
324	?	20-40	cremation	1	1	glass	?	?	?	?	530–640

Tab. S4 In this table it is documented per grave whether specific bead-types from that grave form one 'chemical group' (green), multiple 'chemical groups' (yellow) or display a 'chemical confetti pattern' (red) in the PCA graphs. Sometimes a '+' is added, to indicate the presence of one or two 'chemical outliers'. Abbreviations; cbn combination; cf confetti; gr group; grs groups; oy only.

Lent Grave	Date	child/adult	A2.1-04	A3.1-05	A3.2-06	A3.1-07	B1.1-01a	B1.1-01b	B1.1-03	B1.1-08d	B1.2-02	B1.2-05	B1.3-02	B1.3-06	B1.4-02a	B1.4-04a	B1.6-01b	B1.6-01e	B1.8-01	B3.2-01	B4.3-02	B5.2-01d	B10.1-02	C1.4-02	C3.1-01	D1.1-02	D1.5-02	E1.2	E2.1	Summary
1	P1–P3	adult							gr+																				gr
2	P1	adult							gr+																				gr
5	P2	adult					gr	gr+	gr				oy1												gr			grs+	cf	gr
9	P1–P2	adult	cf					oy1	cf																				gr	cbn
13	P1–P2	child	gr+			cf	gr	gr	gr															oy1		gr		oy1	oy1	gr
16	P1	adult							gr	oy1																	oy1			gr
20	P1–P2	adult					oy1	oy1	grs+										gr										oy1	gr
21	P1	child				oy1			gr+																				oy1	gr
23	P1	adult							gr																					gr
26	P2	child				gr	gr																							gr
27	P2	child							gr								gr+	cf												cbn
28	P1–P2	adult						gr+	grs+																					gr
34	P1–P2	adult							grs+	oy1																				cbn
35	P1–P2	adult							gr														oy1							gr
40	P1–P2	child	cf			gr+	cf		cf																	gr+		oy1	cbn
41	P2	adult							gr+														cf							cbn
42	P1–P2	adult						oy1	gr+																					gr
43	P2	adult				gr	gr+		cf								cf	oy1										gr		cbn
50	P1–P2	adult	oy1					oy1	gr+										oy1										oy1	cbn
51	P2–P3	adult							gr+														cf							cbn
52	P1–P3	child							gr+																					cbn
53	P2	adult							grs+								cf													cbn
105	P1–P3	adult							oy1																					?

Elst Grave	Date	child/adult	A2.1-04	A3.1-05	A3.2-06	A3.1-07	B1.1-01a	B1.1-01b	B1.1-03	B1.1-08d	B1.2-02	B1.2-05	B1.3-02	B1.3-06	B1.4-02a	B1.4-04a	B1.6-01b	B1.6-01e	B1.8-01	B3.2-01	B4.3-02	B5.2-01d	B10.1-02	C1.4-02	C3.1-01	D1.1-02	D1.5-02	E1.2	E2.1	Summary
59	P4	adult										oy1				oy1														cf
81	P3	adult							oy1						grs		cf			cf		cf								cbn
82	P3	child							oy1						oy1	oy1		oy1						gr						cbn
87	P2	adult				cf			grs+																					cbn
88	P2–P3	adult					oy1	oy1	gr				gr	oy1			gr	oy1		oy1		gr+	oy1	oy1				oy1		gr
91	P3–P4	adult													gr					oy1										gr
92	P2	adult							cf	oy1					oy1									oy1					oy1	cf
112	P1	adult								gr																				gr
118	P1	adult		oy1																										?
127	P2	adult				gr+	cf		gr+						oy1		gr+	gr	gr	oy1						oy1		oy1		gr
129	P3	child													oy1															cf
136	P2b	adult																oy1												?
155	P2	adult																					oy1							?
161	P2	child				gr+																	oy1					oy1	oy1	cbn
162	P2	child																				oy1								cbn
175	P1	adult		gr			gr												grs											gr
192	P4	adult									gr	oy1																		cbn
193	P3	child							oy1						cf						oy1									cf
204	P2	adult																				oy1								?
208	P1–P2	adult		oy1														oy1										gr		cbn
209	P1–P3	child							oy1	oy1																				cf
210	P4	adult									cf	oy1																		cbn
211	P2–P3	adult													cf															cf
214	P4	child?						oy1				oy1																		cf
216	P1	adult		gr			gr		oy1																					gr
234	P2	child					cf																							cf
235	P2	adult															oy1													cf
238	P2–P3	adult							cf		cf				cf	oy1	cf	gr								cf			oy1	cbn
249	P3	adult							gr+						gr+	oy1	gr	oy1		oy1	grs+	oy1	cf					oy1		cbn

Wijchen grave	Date	child/adult	A2.1-04	A3.1-05	A3.2-06	A3.1-07	B1.1-01a	B1.1-01b	B1.1-03	B1.1-08d	B1.2-02	B1.2-05	B1.3-02	B1.3-06	B1.4-02a	B1.4-04a	B1.6-01b	B1.6-01e	B1.8-01	B3.2-01	B4.3-02	B5.2-01d	B10.1-02	C1.4-02	C3.1-01	D1.1-02	D1.5-02	E1.2	E2.1	Summary
0	P1 and p5	?									oy1		gr	gr+								oy1			oy1		gr			gr
4	P1–P3	?																								oy1				?
9	P3	adult																		oy1										?
37	P3–P4	adult																		oy1										?
45	P3–P4	?																		cf										cf
49	P3–P4	?									oy1					oy1														cf
51	P1–P3	?							gr+																					cbn
52	P1	adult					oy1																							?
55	P4	?							oy1																					cf
58	P5	?													oy1															cbn
59	P4	child																		oy1										?
65	P2–P3	?				gr+																		oy1		oy1				cbn
92	P4	?											oy1	oy1																cf
93	P1–P3	child							oy1																					cf
98	P3–P4	?																		gr	oy1									cbn
102	P3	?																		oy1										?
104	P3	adult													oy1															cf
106	P3–P4	?			gr							cf				oy1														cbn
127	P2–P3	?							cf											gr+						gr				cbn
132	P3	child													oy1					oy1										cbn
134	P3	child													gr					oy1										gr
149	P4	child									gr		oy1																	gr
179	P5	child						oy1	gr																					cbn
194	P4–P5	?											gr														oy1			cbn
228	P2	?							oy1																					cbn
230	P3	adult							oy1				gr																	gr
235	P1	adult		oy1															gr											gr
239	P4	?							oy1		gr				oy1							oy1								cbn
253	P2–P3	?							cf									gr								gr				cbn

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Zusammenfassung: Frühmittelalterlicher Perlen-Boogie. LA-ICP-MS-Analysen kompletter Perlenensembles aus den merowingerzeitlichen Gräberfeldern Lent-Lentseveld, Elst-'t Woud und Wijchen-Centrum (Niederlande)

In einem vorangegangenen Artikel wurden alle Glasperlen aus dem Gräberfeld von Lent-Lentseveld (Niederlande) aus dem 6. Jahrhundert mit LA-ICP-MS und pXRF chemisch analysiert. Mit Hilfe der Hauptkomponentenanalyse (PCA) wurden chemische Gruppen pro Perlentyp und pro Grab identifiziert. Die Ergebnisse waren sehr vielversprechend: Für importierte Perlentypen aus dem östlichen Mittelmeerraum und weiter östlich wurden klare chemische Gruppen pro Perlentyp erkannt. Sowohl für importierte als auch für europäische Perlen wurden unterschiedliche Gruppen pro Grab identifiziert. Für diesen Artikel wurden die Perlen von zwei weiteren Gräberfeldern aus dem 6. Jahrhundert in derselben Region (Elst-'t Woud und Wijchen-Centrum) auf die gleiche Weise analysiert, um festzustellen, ob ähnliche Muster zu erkennen sind. Die Ergebnisse der chemischen Analysen der Perlen aus Elst, Wijchen und Lent stimmen mit den Ergebnissen überein, die sich bei der Betrachtung von Lent ergeben haben: Im 6. Jahrhundert wurden mehrmals Perlen über weite Entfernungen in die Region importiert, und einmal aufgereihte Perlen neigten dazu, als ein bestimmtes Set zusammenzubleiben. Die in Lent, Elst und Wijchen ausgegrabenen Perlen wurden eindeutig nicht einzeln erworben oder ausgetauscht, und es ist nicht auszuschließen, dass ganze Perlenstränge ausgetauscht wurden. Der Austausch von Perlen zwischen den Produktionsstätten und der Person, die eine Perlenkette zusammenstellt, war also während des größten Teils des 6. Jahrhunderts so organisiert, dass die Perlen derselben Produktion oder desselben "Perlenherstellungsereignisses" zusammenblieben: Es muss ein europaweites Austauschnetz bestanden haben.

Abstract: Early medieval bead-boogie. LA-ICP-MS analyses of complete glass bead sets from the Merovingian cemeteries Lent-Lentseveld, Elst-'t Woud and Wijchen-Centrum (the Netherlands)

In a previous article the complete glass bead assemblage of the 6th-century cemetery Lent-Lentseveld (Netherlands) was chemically analysed with LA-ICP-MS and pXRF. Principal Component Analyses (PCA) was used to identify chemical groups per bead-type and per grave. The results were very promising: for imported bead-types from the Eastern Mediterranean and further East clear chemical groups per bead-type were recognised. Whereas for both imported and European beads distinct groups per grave were identified. For this article, the bead assemblages of two other 6th-century cemeteries in the same region (Elst-'t Woud and Wijchen-Centrum) were analysed in the same manner, in order to establish whether similar patterns can be recognised. The results of the chemical analyses of the beads from Elst, Wijchen and Lent are in line with what was seen when considering only Lent: during the 6th century beads were imported over long distances to the region on several occasions, and once strung, beads tended to remain together as a distinct set. The beads excavated in Lent, Elst and Wijchen were clearly not acquired or exchanged one at a time and the possibility that complete strings of beads were exchanged cannot be ruled out. Hence, during the largest part of the 6th century, bead exchange from production sites to the person assembling a string of beads was organised in such a way that allowed beads from the same production or 'bead-making event' to stay together: a pan-European exchange network must have been in place.