NICO ROYMANS · HANS HUISMAN · JOAS VAN DER LAAN · BERTIL VAN OS

LA TÈNE GLASS ARMRINGS IN EUROPE

INTERREGIONAL CONNECTIVITY AND LOCAL IDENTITY CONSTRUCTION

The first glass objects, beads and pendants, appear late in the 3rd millennium BC, but large-scale production only started late in the 16th and in the 15th centuries BC, both in Mesopotamia and Egypt (Freestone 2006)[1]. In the course of the Late Bronze Age and Early Iron Age glass beads circulated on a small scale in Western and Central Europe. It was not until the La Tène period, however, that we observe a massive increase in the production and use of glass in this region, in combination with the appearance of complex typologies of beads and bracelets. Since the publication of T. E. Haevernick's study »Die Glasarmringe und Ringperlen der Mittel- und Spätlatènezeit aus dem europäischen Festland« (1960) glass bracelets count as one of the diagnostic artefact types of the La Tène culture in Western and Central Europe (**fig. 1**). In the past decades an important number of regional studies has appeared on glass bracelets, in particular for southern Germany (Gebhard 1989), Austria (Karwowski 2004), Bohemia and Moravia (Venclová 1990; Venclová et al. 2009), the Upper and the Lower Rhine area (Wagner 2006; Roymans / Verniers 2010), and southern France (Feugère 1992). Everywhere in Europe, detailed typo-chronological research provided evidence of region-specific armring variants, indicating a decentralised production of bracelets, roughly covering the last three centuries BC, or the period LT C-D.

At this moment the Lower Rhine area is the only region where we have a fairly representative picture of the real distribution and intensity of use of glass bracelets[2]. Almost 7000 items are known here, spread over many hundreds of sites (**fig. 2**). If we proceed from the assumption that we actually know some 2 % of the

Fig. 1 Fragments of La Tène glass armrings from the Lower Rhine region. – (Photo Vrije Universiteit Amsterdam).

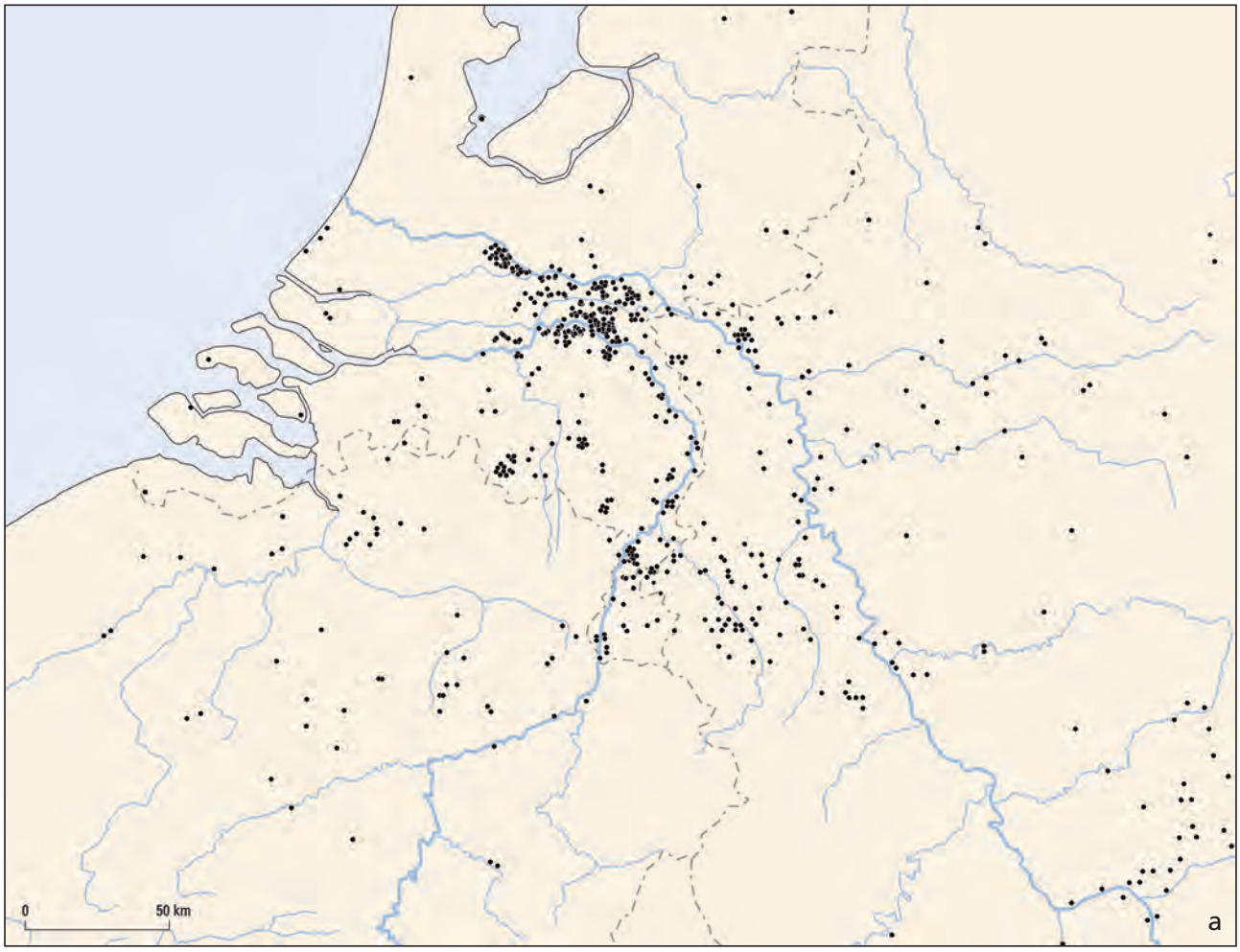

Fig. 2 Distribution area of La Tène glass bracelets in the Lower Rhine region (**a**) and of sites where large numbers (>50) of bracelet fragments have been found (**b**). – (After Roymans / Verniers 2010, figs 2-3).

real number of armrings once in circulation here, the latter number can be estimated at roughly 350,000 specimens. So we are clearly dealing here with mass production. The Lower Rhine region – with the eastern part of the Dutch Rhine-Meuse delta as its core – now has one of the greatest densities of glass armring finds within all of Western and Central Europe[3]. This is a remarkable observation for a region situated in the (northern) periphery of the La Tène culture.

The study of glass bracelets in Lower Rhine cremation burials shows that they were gender-specific ornaments exclusively worn by females (Roymans / Verniers 2010, tab. 3), a conclusion already drawn before for some other La Tène regions on the basis of the occurrence of bracelets in inhumation burials.

Although concrete evidence for glass workshops is extremely scarce, it is accepted that in Western and Central Europe the production of bracelets and/or beads was decentralised and took place in *oppida* (e.g. Manching, Lkr. Pfaffenhofen an der Ilm/D; Nages, dép. Gard/F; Stradonice, okr. Beroun/CZ; Entremont, dép. Bouches-du-Rhône/F) or open nucleated settlements (e.g. Levroux, dép. Indre/F; Bad Nauheim, Wetteraukreis/D; Dürrnberg, Bez. Hallein/A; Němčice, okr. Prostějov/CZ). In the Lower Rhine region, where *oppida* are absent, the production must have been realised in open settlements. However, the question remains whether this picture of a regionalised manufacture of La Tène glass armrings in Western and Central Europe also corresponds with a decentralised production of raw glass. Alternatively, one could think of

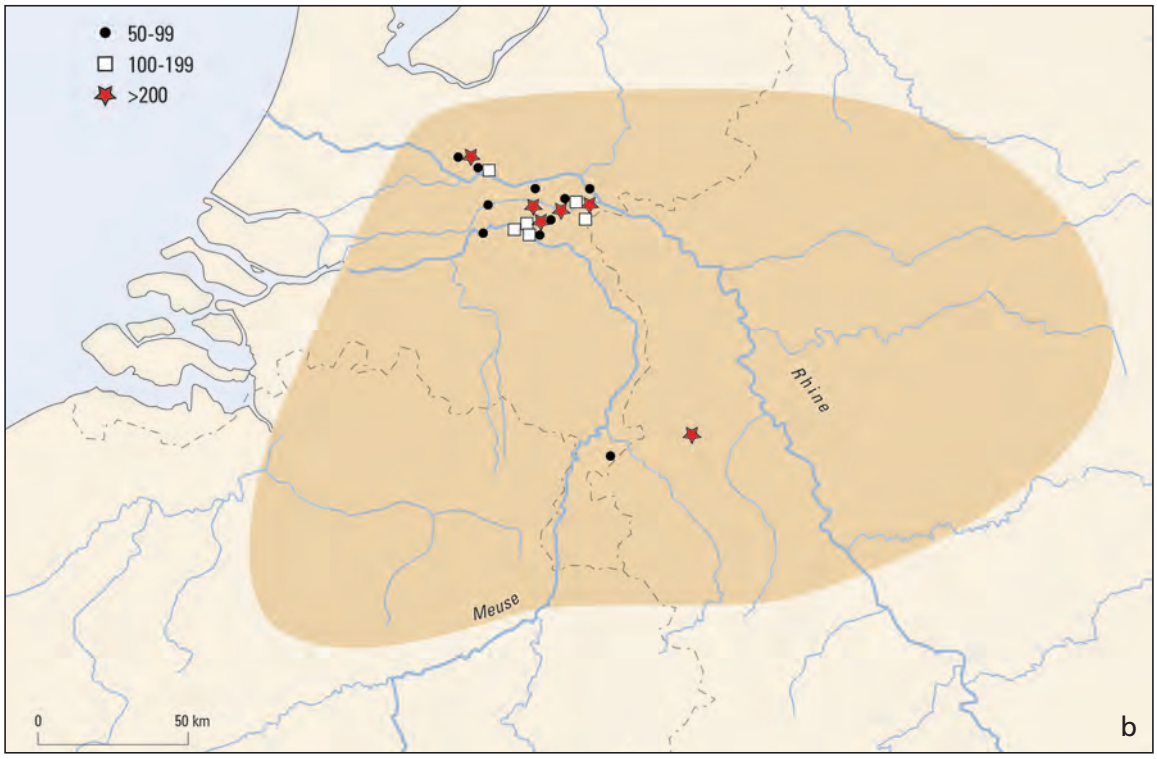

Fig. 2 Continued.

a model of semi-manufactured imported raw glass that was processed locally into finished products in secondary workshops.

The above question about the origin of the raw glass can only be answered by conducting chemical analyses in order to characterise the provenance of the raw materials – including pigments – used in the glass from various glass producing regions of the La Tène culture. The first analyses of La Tène glass directly led to some surprising results. The glass proved to be characterised by a remarkable uniformity of the major element composition, which would point at the existence of a single glass-making territory using the same source of raw materials and adhering to the same recipe (cf. Gratuze / Janssens 2004; Venclová et al. 2009, 425; Karwowski 2004). Moreover, it was found that we are dealing here with soda glass, which indicates an origin from the Near East (using natron as flux; see also the discussion below and Gratuze / Janssens 2004, 675-677; Fontaine / Foy 2007, 241). However, the empirical basis for these observations is still weak and needs further testing. In this context the Lower Rhine region represents an interesting test case, since it is the most northern production area of glass bracelets, characterised by a broad variety of local types.

This study presents and discusses the results of an extensive programme of chemical analysis of glass bracelets from the Lower Rhine region. In combination with published glass analyses from some other La Tène

sites it may be concluded that the Lower Rhine glass bracelets are indeed made of soda glass imported from the Eastern Mediterranean region. Next we pay attention to the cultural interpretation of these new insights. There are two interesting discussions here: 1. How does the large-scale import of raw glass fit into the actual picture of the exchange relations between the area of the La Tène culture and the Mediterranean world?; 2. How does the exotic origin of the raw glass relate to the cultural role of glass armrings in the construction of local identities of individuals and groups?

CHEMICAL ANALYSES OF GLASS BRACELETS: RESEARCH METHODS

We analysed 2607 glass objects from the Museum Het Valkhof at Nijmegen (NL). This so-called Jansen collection encompasses artefacts from 130 locations in the Lower Rhine basin, gathered by a group of amateur archaeologists. The collection is well documented, and all objects have been classified according to their typology in the near past (Roymans / Verniers 2010). Non-destructive analyses were done using a Niton XL3t hand-held XRF with a large area silicon drift detector, using the Cu/Zn mining mode. The detector is flushed with helium to enable measurements of the lighter elements (Mg and Al). Heavy elements are measured at the surface and inside the object, while light elements (Mg to K) are mainly measured at the surface of the object. Clean surfaces were measured as much as possible, but in some cases contamination by adhering clay could not be avoided. The use of hand-held XRF allows for the rapid non-destructive construction of large datasets, albeit at a lower accuracy. When interpreting such datasets the focus should therefore be on groups and patterns. Bracelet fragments of all colours were analysed. In this paper, the analyses of the yellow and white glass paste decorations that occur on many bracelets are not included.

The chemical composition of glass artefacts – like ceramics and metal alloys – is determined by several factors. First and foremost is the choice – conscious or unconscious – of a specific raw material in specific quantities to produce raw glass with the desired properties. This choice is generally reflected in the major element composition of an object (**fig. 3**). A second choice that affects composition is the mineralogy of the raw material used, e. g. the choice between aragonite (shells) and calcite (limestone) as raw material for making soda-silica-lime glass. Different minerals used as raw materials can have different chemical properties and hence concentrations of trace elements. For instance calcite from limestone has different contents of the element strontium (Sr) than aragonite from shells (e. g. Freestone et al. 2003). A third choice is the exact provenance of the raw materials used: the same minerals that originate from different locations may differ in their composition due to differences in the contents of accessory minerals or impurities. Finally, the composition may be affected by the choice of methods of processing and treatments that transform the raw materials into artefacts.

When investigating provenance of glass – and variations therein – it is essential to take into account the potential effects of all choices outlined above (which specific raw material, which minerals, which provenance) on the composition of the artefacts. This can be a daunting task since glass is made from at least two or three, and most commonly four or more different raw materials, each with a specific function. Glass always includes:

1. Silica; sand or crushed quartz pebbles.
2. Flux or alkali; commonly soda (natron) or a variety of plant ashes. The flux is added to lower the melting temperature of the raw material mixture. The flux used can be derived from the concentrations of potassium (K) and magnesium (Mg), as seen in **figure 3**.
3. Lime; shells or limestone. Lime is added as a stabiliser. The lime could have been present in the sands used as a silica source, and is therefore not always seen as a separate raw material.

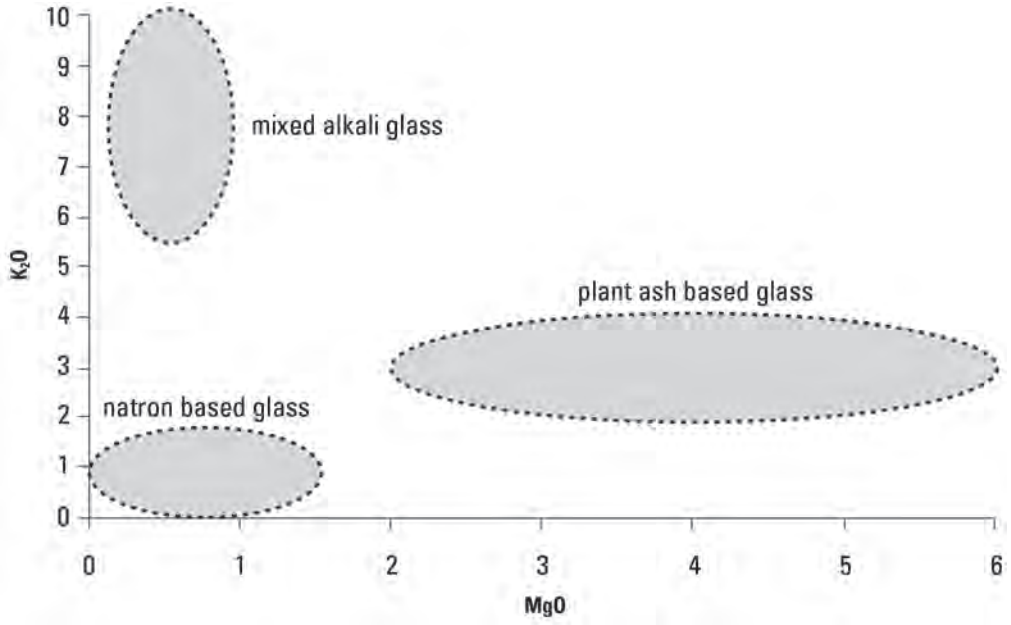

Fig. 3 A plot showing the classification of the main glass chemical groups according to the fluxing agent that was used (modified from Arletti et al. 2010). – Natron-based glasses (Iron Age to Early Medieval; subrecent and recent) are characterised by low concentrations of potassium and magnesium. Halophytic plant ash-based glasses (Bronze Age and Late Medieval) have higher contents of both magnesium and potassium. Mixed soda-potash glasses (Late Bronze Age) contain large amounts of potassium. – (Illustration J. van der Laan).

In addition, components are often added to change the optical appearance of the material, like:

4. Colourants; a variety of metals like copper (Cu), cobalt (Co), lead (Pb), manganese (Mn), iron (Fe).
5. Decolourants; manganese or antimony (Sb).
6. Opacifiers; antimony, lead, tin (Sn) or a combination.

It must be stressed that the provenance of raw materials is by no means equal to the provenance of an artefact. The commonly accepted mode of glass production prior to c. 850 AD is that glass was made from its constituent raw materials in a very limited number of workshops or primary production sites. Ingots or lumps of raw glass subsequently were transported far and wide. Local, so-called secondary workshops then manufactured glass objects from glass that may have had its origins far away. Glass colouration or decolouration is assumed to have been part of the primary production process.

This model of glass production supports discrete local typologies in combination with non-local compositional data, a situation that is in fact not too different from metalwork.

INTERPRETING THE LA TÈNE GLASS COMPOSITIONAL VARIATION

The raw materials

A summary of the measurement data for the main elements of the Lower Rhine glass fragments is presented in table 1. The spectrum of raw materials is fairly uniform. Overall low contents of potassium (K; fig. 4A) preclude the use of plant ashes or potash raw material in all glass objects, regardless of their colour. Higher outliers of K (above c. 2 %, less than 17 % of the glass fragments) are most likely caused by

		blue (n = 1643)	purple (n = 865)	yellow* (n = 231)	green (n = 18)	colourless (n = 96)	amber (n = 69)	total avg.
K (%)	min.	0.22	0.37	0.34	0.49	0.36	0.19	
	avg.	1.4	1.2	1.1	0.96	1.2	0.97	1.3
	max.	5.6	4.5	4.6	3.5	3.8	3.1	
Ca (%)	min.	1.6	2.2	1.4	2.2	2.9	2.8	
	avg.	4.8	4.9	3.3	3.8	5.0	4.6	4.7
	max.	9.8	9.2	6.5	4.9	7.5	6.8	
Sr (ppm)	min.	90	234	51	183	88	62	
	avg.	457	551	346	359	452	388	474
	max.	700	817	774	447	796	600	
Zr (ppm)	min.	< LOD	< LOD	< LOD	29	< LOD	< LOD	
	avg.	37	32	4.6	122	37	35	34
	max.	194	59	92	194	166	158	
Cu (ppm)	min.	62	< LOD	< LOD	115	< LOD	< LOD	
	avg.	1130	65	307	401	44	6.0	683
	max.	4947	1567	1969	500	88	109	
Co (ppm)	min.	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	
	avg.	793	20	156	19	3.9	< LOD	465
	max.	2621	877	1003	343	373	< LOD	
Mn (%)	min.	< LOD	0.57	0.02	< LOD	< LOD	0.01	
	avg.	0.76	1.8	0.74	0.93	0.71	0.19	1.1
	max.	2.7	3.5	2.0	1.5	2.1	2.0	
Pb (%)	min.	< LOD	< LOD	< LOD	0.01	< LOD	< LOD	
	avg.	0.23	0.20	4.5	0.13	0.19	0.10	0.56
	max.	7.2	7.7	22	0.54	3.2	3.7	
Sb (ppm)	min.	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	
	avg.	86	39	580	924	1962	24	177
	max.	2561	1208	11984	4143	5789	871	
Sn (ppm)	min.	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	
	avg.	324	77	3923	102	93	40	520
	max.	7088	10993	26762	385	2175	991	
Fe (%)	min.	0.15	0.20	0.23	0.41	0.15	0.20	
	avg.	0.81	0.36	0.63	5.0	0.40	0.34	0.67
	max.	3.1	1.2	2.6	9.6	1.0	1.3	

Tab. 1 Summary of measurement data for the main elements of Late Iron Age glass bracelets from the Lower Rhine region (LOD = Limit of Detection). All magnesium (Mg) concentrations were below LOD (2.5 %) and are therefore not reported in this table. – * measurements from yellow decorations are influenced by the main glass body in varying degrees, and might not be representative for the actual concentrations in the yellow glass.

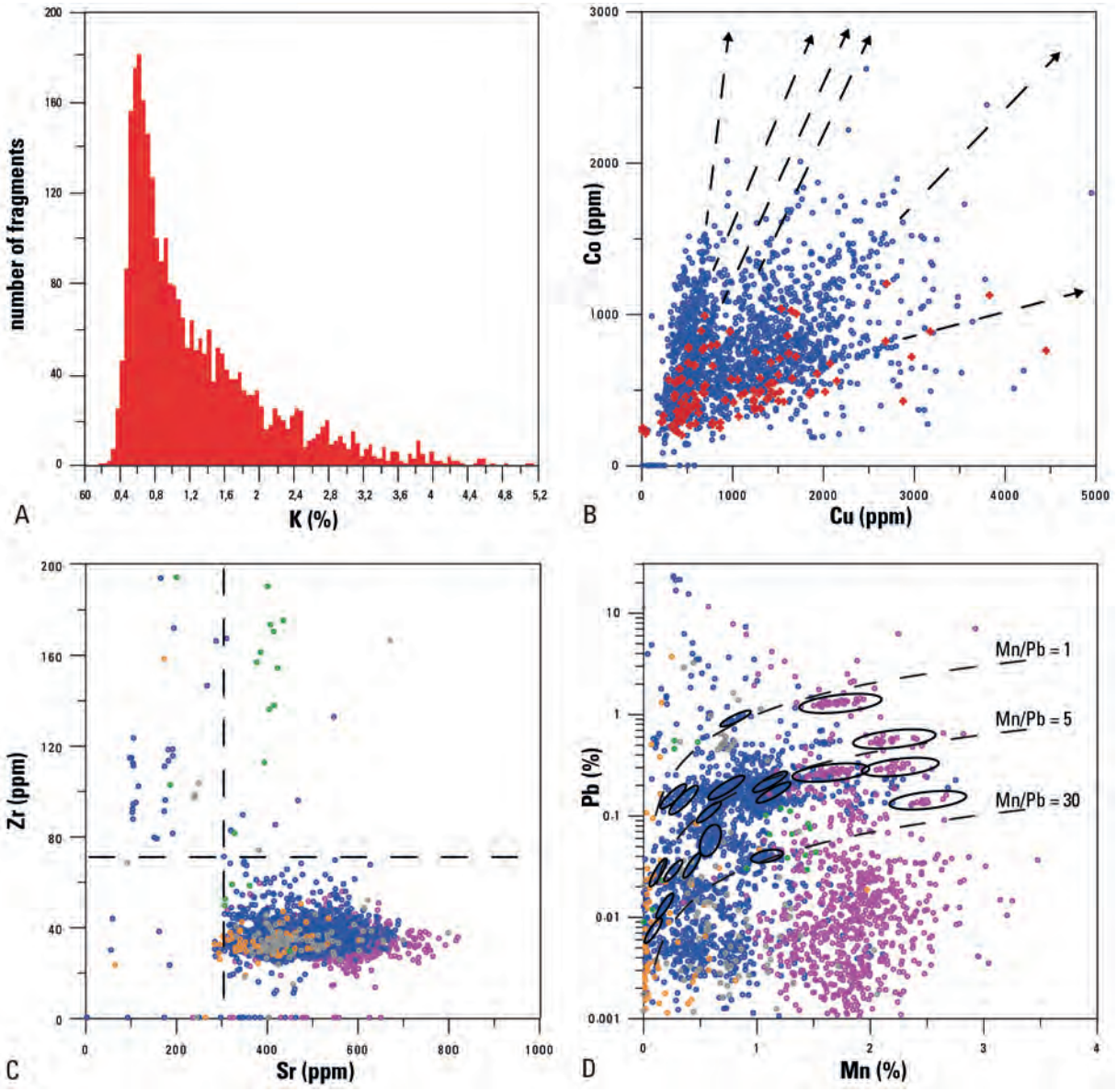

Fig. 4 Scatterplots of selected elements in La Tène glass bracelets from the Netherlands. Most of the glass from the Netherlands is purple or blue (colours indicated in scatterplots), but smaller amounts of amber, colourless (indicated in grey in **C-D**), and green are also represented. – **A** K-histogram of glass from the Netherlands. K values above c. 2 % are probably due to contamination. The peak lies between 0.6 and 0.65 %. – **B** Cu versus Co, with the southern Germany dataset (in red) plotted in for comparison. Arrows indicate trends of constant Co/Cu ratios in the most prominent groups. – **C** Sr versus Zr. Dashed lines separate glass made with very pure quartz and limestone (lower right) from glass made using less pure sand and shells (upper left). Green glass is affected by elevated Sr in the green colourant (iron). – **D** Mn versus Pb (logarithmic scale). Constant Mn/Pb ratios in broken lines for reference. Ellipses indicate homogeneous compositional groups. – (Illustration J. van der Laan).

clay that is adhering to or embedded in fissures, bubbles or irregularities in the glass surface, as clay minerals can be rich in potassium (Dixon / Weed 1989) and potassium is only measured on the surface. Due to the non-destructiveness of the measurements contaminated surfaces could not always be avoided, and due to the surface measurements even small amounts of clay can influence the measured potassium concentrations. However, even with the contamination, the levels of potassium are still lower than those in mixed-alkali or potash glasses (cf. Gratuze / Janssens 2004; Henderson 2000, 24 f.), and more than 83 % of the analysed fragments falls neatly into the natron glass group. Furthermore, concentrations of magnesium

were lower than the detection limit (around 2.5 %) in all analysed pieces, which is expected in glass made using natron. Fragments of Dutch La Tène bracelets analysed by other researchers (Van der Linden et al. 2009; Venclová et al. 2009) also showed low concentrations of both K and Mg. Therefore, all glass analysed must have been made using natron as alkali flux (**fig. 3**).

The most common colourant elements in the glass analysed are cobalt (blue), copper (blue), manganese (purple in high concentrations) and lead (yellow), the decolourants antimony and manganese (in low concentrations), and the opacifiers lead, tin and antimony (in high concentrations). All blue glass was coloured using a combination of cobalt and copper; cobalt to produce an intense blue colour and copper to compensate for the purple by-effect of cobalt (Girdwoyn 1986). The plot of Co versus Cu (**fig. 4B**) shows several groups of blue glass that differ in their Co/Cu ratios – from c. 1:10 to 5:1. Within this spread, several groups appear to be present with a similar Co/Cu ratio but with a high variation in the absolute contents. Each of the groups probably represents glass objects that were made with a different recipe for producing the blue colour with the available colouring agent(s). The large variation in absolute concentrations within each group, moreover, precludes that these artefacts originate from a single batch.

Variations in raw materials

The plot of strontium (Sr) versus zirconium (Zr; **fig. 4C**) clearly shows a large group where relatively high Sr is combined with low Zr. The very rare green glass forms a separate group with high Zr and moderate Sr contents due to Sr from the (iron) colourant. The rest of the objects fall mostly in the low Sr-high Zr sector. Sr is an earth alkaline element that occurs in most calcium-bearing minerals. However, its concentration differs considerably between various minerals. A low Sr concentration in glass is indicative for the use of limestone, and high concentrations for shells as type of raw material (Wedepohl / Baumann 2000). Zirconium occurs almost exclusively in the mineral zircon ($ZrSiO_4$). Zircon is highly weathering-resistant and is commonly found in the fine sand and silt fraction of sandy sediments. Therefore, glass with a high Zr concentration was likely made using sand, while – in contrast – glass with a low Zr content was most probably made from a more pure silica source, such as crushed pebbles of quartz or flint – although a very pure quartz sand source cannot be excluded.

The clear separation between the two groups is remarkable. It indicates that the glass was either made with a combination of very pure sand or crushed pebbles and limestone, or with a combination of sand and shells. Since there is no obvious reason to restrict production to these combinations of raw materials as silica and calcium sources, the most likely explanation is that the two types of glass were made on different locations – and perhaps also in different periods, as the typologically younger objects from the Netherlands are absent in the low-Sr, high-Zr group.

The plot of Mn (purple colourant) against Pb (associate metal) in **figure 4D** shows even more variation: groups of purple glass objects can be discerned that were made with manganese ores with different lead content. The same plot also indicates groups in blue glass, representing Co ores with different contents of Mn and Pb. This plot shows groups that are so homogeneous that they may represent glass made with the same batch of colourants.

To sum up, the Iron Age glass from the Netherlands was soda-lime-silica glass that was coloured, decoloured or opacified with a variety of metals. Two groups can be discerned with different sand and lime sources. As for the colourants, multiple groups can be identified: some differ in the recipes for colourants (e. g. the Co/Cu ratio), others represent differences in the origin of the raw materials (e. g. the Pb contents of cobalt and manganese ores).

CULTURAL INTERPRETATIONS AND DISCUSSION

La Tène glass and Mediterranean connectivity

Compositionally distinct groups like those in the Lower Rhine region are encountered in La Tène period glass datasets from other areas in Europe as well, like southern Germany (Wagner 2006), Austria (Jokubonis et al. 2003; Karwowski 2004; 2006), Bohemia and Moravia (Venclová 1990; Venclová et al. 2009)[4]. From these datasets, it is clear that La Tène period glass in all these regions is soda-based. Their main element compositions are all comparable, indicating that all glass was made using a similar soda-silica-lime ratio. The Co-Cu plots in figure 4B demonstrate that the southern Germany blue glasses all coincide with groups from the Lower Rhine. Two distinct groups in a Zr-Sr plot were also identified by M. Karwowski in La Tène period glass from Austria, and appear in a dataset on glass from the same period from southern Germany (Karwowski 2004; Wagner 2006). However, due to differences in analysis techniques, further direct comparison in trace element concentrations is not feasible. Still, the ubiquity of such compositional groups confirms that throughout the Late Iron Age, glass was transported regularly through Europe from a very limited number of primary production sites.

The location of primary production sites in later prehistory, and the properties of the glass manufactured, has been subject of many publications. The general model, based on a large number of analyses from many comparative studies, is now that glass production started in the Bronze Age in Mesopotamia and the Levantine coast, and shortly after was also adopted in Egypt. This glass was made first using the ash from desert or coastal plants as flux. In the Late Bronze Age local production of glass based on plant ashes occurred in northern Italy (Angelini et al. 2004; 2011), but production stopped at the beginning of the Iron Age. At the beginning of the 1st millennium BC, natron that was most likely derived from the Wadi Natrun lake in Egypt was used in the Eastern Mediterranean. After that, the natron-based glass production in the Eastern Mediterranean formed the basis for the manufacture of glass objects throughout Europe until c. 850 AD (Shortland et al. 2006; 2011). Since the only known source for natron in antiquity is in Egypt (Wadi Natrun), production centres for the raw La Tène glass most likely were situated in the Eastern Mediterranean area (Gratuze / Janssens 2004, 675 ff.; Henderson 2000; Tite / Shortland 2008).

How did the raw glass from the Eastern Mediterranean area arrive in Western and Central Europe? Maritime transport must have played an important role (fig. 5). The study of cargos of shipwrecks from the Bronze and Iron Age points at an interregional trade in raw glass of different colours in the Mediterranean region (Dannheimer / Gebhard 1993, 287 no. 115; Foy / Vichy / Picon 2000). Especially relevant are the glass cargo of an estimated 1000 kg of blue glass lumps in a 3rd century BC shipwreck near the Sanguinaires isles off the western coast of Corsica, and glass lumps reported from at least two other shipwrecks from the La Tène period in the Western Mediterranean (Fontaine / Foy 2007, 241; they also mention blocks of raw glass recovered from the wrecked ships Lequin 2 and Jeanne-Garde along the coast of the Provence). The presumed production of bracelets and beads in the *oppida* of Nages and Entremont (dép. Bouches-du-Rhône) in the south of France suggests that raw glass was shipped in via the sea and then transported via the Rhône valley to Central Gaul. More important, however, seems to have been an eastern sea route along the Adriatic coasts to northern Italy. From here the production places of bracelets in the Upper Rhine and Upper Danube region could be reached via land routes using the Alpine passes. The supply route of raw glass to the Lower Rhine region will have run via the Upper and Middle Rhine area. A more western supply route seems improbable given the rare occurrence of glass bracelets and beads in northern France (fig. 5).

The study of La Tène glass bracelets offers evidence for a wide geographic extension of trade networks, including a surprising Mediterranean connection. But how does this large-scale import of raw glass fit into

Fig. 5 Primary production area of soda glass in the Eastern Mediterranean (**A**) and major trade routes of raw glass to secondary production centres of La Tène glass bracelets in Central and Western Europe (**B** as yet unidentified production site[s] within a region; **C** identified production site[s]; **D** wrecked ships with cargos of raw glass). – (Illustration N. Roymans).

our current picture of the exchange relations between the La Tène culture and the Mediterranean world? Late Iron Age societies in Western and Central Europe are known for their large-scale import of Mediterranean products in the form of Italian wine transported in Dressel 1 amphorae and bronze drinking equipment (Roymans 1990, ch. 7, with further references). The import of Mediterranean glass, however, reaches much further to the north and east than that of Dressel 1 amphorae. Moreover there is a chronological distinction. The glass import already reaches a substantial level in the second half of the 3rd century BC (LT C1) in a phase that the influx of elite Mediterranean consumer goods is at a low ebb, followed by a phase of explosive growth during LT D. All this suggests that the long-distance trade of Mediterranean raw glass and that of wine and bronze vessels passed via separated and differently organised exchange networks. The import of raw glass went hand in hand with a rapid diffusion of secondary glass workshops and associated specialised craftsmen over the La Tène cultural area (Karwowski 2006, 140). However, the specific organisation of the glass trade and the spectrum of other commodities exchanged in this network (part of which may not have survived in the archaeological record) remain largely unknown to us.

The import of raw coloured glass in Western and Central Europe represents a unique case of the import of semi-manufactured products from the Mediterranean region. All other imports from the Mediterranean consisted of end products or consumer goods in the form of above all wine and drinking equipment, categories connected with the feasting and drinking culture of privileged social groups. This exchange has often been conceptualised in terms of core-periphery models and prestige goods models (e. g. Haselgrove 1987; Cunliffe

1988). The La Tène glass ornaments, however, were different in the sense that they were accessible for broad groups of society; wearing them was certainly not a privilege of an elite (Roymans / Verniers 2010).
An intriguing question remains whether the wearers of La Tène armrings still had any notion of the Mediterranean origin of the raw glass. While for the average wearer this seems very improbable, specialist craftsmen working in the (secondary) glass workshops may well have been informed about the exotic origin of the glass thanks to their direct contacts with tradesmen.

La Tène glass and local identity construction

Regional studies demonstrate that people in different regions of the La Tène culture showed considerable typological preferences in their glass ornaments (Gebhard 1989; Feugère 1992; Wagner 2006; Karwowski 2006; Deiters 2008; Roymans / Verniers 2010). In fact a raw material of Mediterranean origin was transformed into a range of typical La Tène products, which then played a role in the cultivation of multiple identities at a local level. Within local groups they functioned as markers of gender and age class identities, and on top of that they were probably significant as ethnic or cultural markers[5]. This latter topic was explored in the Lower Rhine region by studying distribution patterns of glass bracelets. Certain Late Iron Age societies distinguished themselves here – through specific women's attire involving bracelets – from neighbouring groups in the coastal area and north of the Rhine (cf. **fig. 1**). Bracelets may have played a role here in cultivating ethnic differences. In boundary settings in particular, certain groups may also have used material culture to associate themselves with the cultural ideas and values of the southern La Tène culture and to profile themselves in relation to groups seeking a different cultural orientation. However, it needs to be emphasised that the use of glass bracelets was not uniformly spread over the La Tène culture. Even within its core zones there are regions (e. g. northern France and the Trier area) where glass ornaments were rare, and where women did not characterise themselves by wearing bracelets.
We can conclude that the use of glass bracelets was highly significant at different levels of society, and was clearly associated with both individual and group identities. Moreover, the large-scale availability throughout the La Tène culture of a raw material with such an exotic origin points towards the existence of robust and stable networks of exchange that spanned the Late Iron Age European continent and the Mediterranean world.

Acknowledgements

We would like to thank Louis Swinkels and the Museum Het Valkhof in Nijmegen for permission to analyse their collection of Iron Age glass bracelet fragments. We are also grateful to Maciej Karwowski, Heiko Wagner and Natalie Venclová for making their data available to us.

Notes

1) For a general overview of the literature on early glass production, see Gratuze / Janssens 2004.
2) See the recent study with distribution map and further references in Roymans / Verniers 2010.
3) This picture, however, may be distorted by favourable find conditions in the Lower Rhine river landscape and the absence of systematic surveys of glass bracelets from amateur collections in many other La Tène areas.
4) These datasets were made with comparable X-ray based measurement techniques. This makes comparison of these analyses possible, but inter-laboratory differences may affect especially trace elements.
5) Cf. the discussion in Roymans / Verniers 2010. For a more general perspective on the role of material culture in the symbolic construction of communities, see Hodder 1982.

References

Angelini et al. 2004: I. Angelini / G. Artioli / P. Bellintani / V. Diella / M. Gemmi / A. Polla / A. Rossi, Chemical analyses of Bronze Age glasses from Frattesina di Rovigo, Northern Italy. Journal of Archaeological Science 31, 2004, 1175-1184.

Angelini et al. 2011: I. Angelini / C. Nicola / G. Artioli / R. C. De Marinis / M. Rapi / M. Uboldi, Chemical, Mineralogical and Textural Characterisation of Early Iron Age Vitreous Materials from the Golasecca Culture (Northern Italy). In: I. Turbanti-Memmi (ed.), Proceedings of the 37th International Symposium on Archaeometry, 12-16th May 2008, Sienna, Italy (Berlin, Heidelberg 2011) 25-32.

Arletti et al. 2010: R. Arletti / C. Maiorano / D. Ferrari / G. Vezzalini / S. Quartieri, The first archaeometric data on polychrome Iron Age glass from sites located in northern Italy. Journal of Archaeological Science 37, 2010, 703-712.

Cunliffe 1988: B. W. Cunliffe, Greeks, Romans and barbarians. Spheres of interaction (London 1988).

Dannheimer / Gebhard 1993: H. Dannheimer / R. Gebhard (eds), Das keltische Jahrtausend. Ausstellungskataloge der archäologischen Staatssammlung München 23 (Mainz 1993).

Deiters 2008: S. Deiters, Haevernick Gruppe 3B. Überlegungen zu einem Glasarmringtyp der ausgehenden Eisenzeit. In: F. Verse / B. Knoche / J. Graefe / M. Hohlbein / K. Schierhold / C. Siemann / M. Uckelmann / G. Woltermann, Durch die Zeiten … Festschrift für Albrecht Jockenhövel zum 65. Geburtstag. Internationale Archäologie: Studia honoraria 28 (Rahden/Westf. 2008) 315-337.

Dixon / Weed 1989: J. B. Dixon / S. B. Weed, Minerals in soil environments. Soil Science Society of America Book Series 1 (Madison/Wis. ²1989).

Feugère 1992: M. Feugère, Le verre préromain en Gaule méridionale: acquis récents et questions ouvertes. Revue Archéologique de Narbonnaise 25, 1992, 151-176.

Fontaine / Foy 2007: S. D. Fontaine / D. Foy, L'épave Ouest-Embiez 1, Var: le commerce maritime du verre brut et manufacturé en Méditerranée occidentale dans l'Antiquité. Revue Archéologique de Narbonnaise 40, 2007, 235-265.

Foy / Vichy / Picon 2000: D. Foy / M. Vichy / M. Picon, Lingots de verre en Méditerranée occidentale (IIIe siècle av. J.-C.-VIIe siècle ap. J.-C.). In: Annales du 14e Congrès de l'Association Internationale pour l'Histoire du Verre, Italia, Venezia – Milano 1998 (Lochem 2000) 51-57.

Freestone 2006: I. C. Freestone, Glass production in Late Antiquity and the Early Islamic period: a geochemical perspective. Geomaterials in Cultural Heritage 257, 2006, 201-216.

Freestone et al. 2003: I. C. Freestone / K. A. Leslie / M. Thirlwall / Y. Gorin-Rosen, Strontium isotopes in the investigation of early glass production. Byzantine and Early Islamic glass from the Near East. Archaeometry 45, 2003, 19-32.

Gebhard 1989: R. Gebhard, Der Glasschmuck aus dem Oppidum von Manching. Die Ausgrabungen in Manching 11 (Stuttgart 1989).

Girdwoyn 1986: A. Girdwoyn, Celtic glass bracelets from excavations in Poland. A technological study. Archaeologia Polona 25-26, 1986 (1987), 199-208.

Gratuze / Janssens 2004: B. Gratuze / K. Janssens, Provenance analysis of glass artefacts. In: K. Janssens / R. van Grieken, Non-destructive microanalysis of cultural heritage materials. Wilson & Wilson's comprehensive analytical chemistry 42 (Amsterdam 2004) 663-712.

Haevernick 1960: T. E. Haevernick, Die Glasarmringe und Ringperlen der Mittel- und Spätlatènezeit auf dem europäischen Festland (Bonn 1960).

Haselgrove 1987: C. Haselgrove, Culture process on the periphery. Belgic Gaul and Rome during the late Republic and early Empire. In: M. Rowlands / M. Larsen / K. Kristiansen (eds), Centre and periphery in the ancient world (Cambridge 1987) 104-124.

Henderson 2000: J. Henderson, The Science and Archaeology of Materials. An Investigation of Inorganic Materials (London 2000).

Hodder 1982: I. Hodder, Symbols in action. Ethnoarchaeological studies of material culture (Cambridge 1982).

Jokubonis et al. 2003: C. Jokubonis / P. Wobrauschek / S. Zamini / M. Karwowski / G. Trnka / P. Stadler, Results of quantitative analysis of Celtic glass artefacts by energy dispersive X-ray fluorescence spectrometry. Spectrochimica Acta Part B 58, 2003, 627-633.

Karwowski 2004: M. Karwowski, Latènezeitlicher Glasringschmuck aus Ostösterreich. Mitteilungen der Prähistorischen Kommission der Österreichischen Akademie der Wissenschaften 55 (Wien 2004).

2006: M. Karwowski, Major questions concerning Celtic glass from the eastern regions of the La Tène culture. Analecta Archaeologica Ressoviensia 1, 2006, 133-159.

Roymans 1990: N. Roymans, Tribal societies in Northern Gaul. An anthropological perspective. Cingula 12 (Amsterdam 1990).

Roymans / Verniers 2010: N. Roymans / L. Verniers, Glass La Tène bracelets in the Lower Rhine region. Typology, chronology and social interpretation. Germania 88, 2010 (2013), 159-219.

Shortland et al. 2006: A. Shortland / L. Schachner / I. Freestone / M. Tite, Natron as a flux in the early vitreous materials industry: sources, beginnings and reasons for decline. Journal of Archaeological Science 33, 2006, 521-530.

Shortland et al. 2011: A. J. Shortland / P. Degryse / M. Walton / M. Geer / V. Lauwers / L. Salou, The evaportic deposits of lake Fazda (Wadi Natrun, Egypt) and their use in Roman glass production. Archaeometry 53, 2011, 916-929.

Tite / Shortland 2008: M. S. Tite / A. J. Shortland, Production technology of faience and related early vitreous materials. Oxford University School of Archaeology Monograph 72 (Oxford 2008).

Van der Linden et al. 2009: V. Van der Linden / P. Cosyns / O. Schalm / S. Cagno / K. Nys / K. Janssens / A. Nowak / B. Wagner / E. Bulska, Deeply coloured and black glass in the northern provinces of the

Roman empire: differences and similarities in chemical mposition before and after AD 150. Archaeometry 51, 2009, 822-844.

Venclová 1990: N. Venclová, Prehistoric glass in Bohemia (Praha 1990).

Venclová et al. 2009: N. Venclová / V. Hulínski / J. Frána / M. Fikrle, Němčice a zpracováni skla v laténské Evropě (Němčice and glass-working in La Tène Europe). Archeologické Rozhledy 61, 2009, 383-426.

Wagner 2006: H. Wagner, Glasschmuck der Mittel- und Spätlatènezeit am Oberrhein und angrenzenden Gebieten. Ausgrabungen und Forschungen 1 (Remshalden 2006).

Wedepohl / Baumann 2000: K. H. Wedepohl / A. Baumann, The use of marine molluskan shells for Roman glass and local raw glass production in the Eifel area (Western Germany). Naturwissenschaften 87, 2000, 129-132.

Zusammenfassung / Abstract / Résumé

Latène-Glasarmringe in Europa. Überregionale Verbindungen und lokale Identitäten

Dieser Artikel diskutiert die Herstellung, den Austausch und die gesellschaftliche Funktion von späteisenzeitlichen Glasarmringen in West- und Mitteleuropa. Jüngere Regionalstudien haben überzeugende Belege für eine dezentrale Produktion von Glasarmringen in den Oppida und in offenen Siedlungen erbracht. Trotzdem lassen erste chemische Untersuchungen vermuten, dass das gesamte Rohglas aus dem Mittelmeerraum importiert wurde. Hier werden die Ergebnisse eines umfangreichen chemischen Analyseprojektes vom Niederrhein vorgestellt und diskutiert. Zusammen mit bereits publizierten Glasanalysen aus anderen Regionen der Latènekultur kann gefolgert werden, dass die Glasarmringe aus Sodaglas, das aus dem östlichen Mittelmeergebiet stammt, hergestellt wurden. Deshalb schlagen wir ein Modell von importiertem aufbereiteten Rohglas vor, aus dem in lokalen Werkstätten die Endprodukte gefertigt wurden. Weiter können zwei interessante kulturelle Schlüsse aus diesen neuen Ergebnissen gezogen werden. Zum einen ist zu vermuten, dass der umfangreiche Rohglasimport aus dem Mittelmeergebiet und der Zustrom von italischem Wein und den damit zusammenhängenden Bronzegefäßen über getrennte und unterschiedlich organisierte Austauschsysteme liefen. Zum anderen ist es überraschend, dass der exotische Ursprung des Rohglases nicht verhinderte, dass Glasschmuck ein sehr gewöhnliches Hilfsmittel beim Entstehen von einer Reihe lokaler Identitäten von Personen und Gruppen wurde, bei der der Schwerpunkt eher auf Gemeinsamkeit als auf elitärer Abgrenzung liegt.

La Tène glass armrings in Europe. Interregional connectivity and local identity construction

This article discusses the production, exchange and social use of Late Iron Age glass bracelets in Western and Central Europe. Recent regional studies have produced convincing evidence for a decentralised production of glass bracelets in *oppida* and open settlements. However, the first chemical analyses of La Tène glass suggest that all the raw glass was imported from the Mediterranean region. This study presents and discusses the results of an extensive programme of chemical analysis of glass bracelets from the Lower Rhine region. In combination with published glass analyses from some other La Tène regions, it can be concluded that the glass bracelets are indeed made of soda glass imported from the Eastern Mediterranean. We therefore propose a model of semi-manufactured imported raw glass that was processed locally into finished products in secondary workshops. In addition, we pay attention to the cultural interpretation of these new insights. Two interesting points are made. Firstly, the evidence suggests that the large-scale import of Mediterranean raw glass and that of Italian wine and wine-related bronze vessels passed via separate and differently organised exchange networks. Secondly, it is surprising to observe that the exotic origin of the raw glass did not prevent glass ornaments from becoming a very common medium in the construction of a series of local identities of both individuals and groups in which the emphasis is on commonality rather than elite distinction.

Diffusion suprarégionale et identité locale des bracelets de verre laténiens en Europe
Cet article discute de la production, des échanges et du rôle social des bracelets en verre de la fin de l'âge du Fer dans l'Ouest et le centre de l'Europe. Des études régionales antérieures ont bien démontré que la production des bracelets de verre était décentralisée dans les *oppida* et les habitats ouverts. Malgré cela, les premières analyses chimiques laissent à penser que tous le verre brut était importé depuis les régions méditerranéennes. Le présent article présente et discute les résultats d'une large étude reposant sur des analyses chimiques de bracelets en verre du Rhin Inférieur. Les résultats s'ajoutent à ceux études préalablement publiées de verre en provenance d'autres régions de la culture de La Tène et indiquent que les bracelets sont composés de verre sodocalcique qui provient de l'Est méditerranéen. C'est pourquoi nous proposons un modèle d'importation de verre brut qui aurait été transformé en produit fini dans des ateliers locaux. Nous tirons deux autres conclusions intéressantes de l'étude, au niveau culturel. Premièrement, on peut supposer que les larges importations de verre brut méditerranéen et les flux de vin italique et des vaisselles de bronze connexes relèvent de systèmes d'échanges distincts et organisés différemment. Deuxièmement, il est surprenant que l'origine exotique du verre brut n'ait pas limité la diffusion très populaire des bracelets et leur utilisation comme marqueur social et identitaire pour différents groupes et personnes qui se caractérisent par une communauté plutôt que par une distinction des élites. Traduction: L. Bernard

Schlüsselwörter / Keywords / Mots clés

Niederrhein / Latène / Glasarmringe / chemische Analysen / Austauschbeziehungen
Lower Rhine region / La Tène / glass bracelets / chemical analyses / exchange networks
Rhin Inférieur / La Tène / bracelets de verre / analyses chimiques / réseaux d'échange

Nico Roymans
Joas van der Laan
Vrije Universiteit Amsterdam
Research Institute CLUE
Archeologisch Centrum
De Boelelaan 1105
NL - 1081 HV Amsterdam
n.g.a.m.roymans@vu.nl
joasvanderlaan@gmail.com

Hans Huisman
Bertil van Os
Rijksdienst voor het Cultureel Erfgoed
P. O. Box 1600
NL - 3800 BP Amersfoort
h.huisman@cultureelerfgoed.nl
b.vanos@cultureelerfgoed.nl

Römisch-Germanisches Zentralmuseum
Forschungsinstitut für Archäologie

R G Z M

BESTELLUNG DES ARCHÄOLOGISCHEN KORRESPONDENZBLATTS

Das Archäologische Korrespondenzblatt versteht sich als eine aktuelle wissenschaftliche Zeitschrift zu Themen der vor- und frühgeschichtlichen sowie provinzialrömischen Archäologie und ihrer Nachbarwissenschaften in Europa. Neben der aktuellen Forschungsdiskussion finden Neufunde und kurze Analysen von überregionalem Interesse hier ihren Platz. Der Umfang der Artikel beträgt bis zu 20 Druckseiten; fremdsprachige Beiträge werden ebenfalls angenommen. Unabhängige Redaktoren begutachten die eingereichten Artikel.

Kontakt für Autoren: **korrespondenzblatt@rgzm.de**

Abonnement beginnend mit dem laufenden Jahrgang; der Lieferumfang umfasst 4 Hefte pro Jahr; ältere Jahrgänge auf Anfrage; Kündigungen zum Ende eines Jahrganges.

Kontakt in Abonnement- und Bestellangelegenheiten: **verlag@rgzm.de**

Preis je Jahrgang (4 Hefte) für Direktbezieher 20,– € (16,– € bis 2007 soweit vorhanden) + Versandkosten (z. Z. Inland 5,50 €, Ausland 16,– €).

HIERMIT ABONNIERE ICH DAS ARCHÄOLOGISCHE KORRESPONDENZBLATT

Name _____

Straße _____

Postleitzahl/Ort _____

Sollte sich meine Adresse ändern, erlaube ich der Deutschen Post, meine neue Adresse mitzuteilen.

Datum _____ Unterschrift _____

Ich wünsche folgende Zahlungsweise (bitte ankreuzen):

❍ bequem und bargeldlos durch **SEPA-Lastschriftmandat** (innerhalb des Euro-Währungsraumes)

Gläubiger-Identifikationsnummer: (DE19ZZZ00000089352) Mandatsreferenz: (Kunden-Nr.) _____
Ich ermächtige hiermit das Römisch-Germanische Zentralmuseum, Zahlungen für offenstehende Forderungen von meinem Konto mittels SEPA-Lastschrift einzuziehen. Zugleich weise ich mein Kreditinstitut an, die vom Römisch-Germanischen Zentralmuseum auf mein Konto gezogenen Lastschriften einzulösen.
Hinweis: Ich kann innerhalb von acht Wochen, beginnend mit dem Belastungsdatum, die Erstattung des belasteten Betrages verlangen. Es gelten dabei die mit meinem Kreditinstitut vereinbarten Bedingungen.

Name _____

Straße _____

Postleitzahl/Ort _____

IBAN |__|__|__|__| |__|__|__|__| |__|__|__|__| |__|__|__|__| |__|__|__|__| |__|__|

Bankname _____

BIC |__|__|__|__|__|__|__|__|__|__|__|

Ort, Datum _____ Unterschrift _____

❍ durch sofortige **Überweisung** nach Erhalt der Rechnung (Deutschland und andere Länder)
Ausland: Nettopreis 20,– €, Versandkosten 12,70 €, Bankgebühren 7,70 €

Bei Verwendung von Euro-Standardüberweisungen mit IBAN- und BIC-Nummer entfallen unsere Bankgebühren (IBAN: DE 08 5519 0000 0020 9860 14; BIC: MVBM DE 55), ebenso, wenn Sie von Ihrem Postgirokonto überweisen oder durch internationale Postanweisung zahlen.
Das Römisch-Germanische Zentralmuseum ist nicht umsatzsteuerpflichtig und berechnet daher keine Mehrwertsteuer.

Senden Sie diese Abo-Bestellung bitte per Fax an: 0049 (0) 61 31 / 91 24-199, per E-Mail an **verlag@rgzm.de** oder per Post an

Römisch-Germanisches Zentralmuseum, Forschungsinstitut für Archäologie,
Archäologisches Korrespondenzblatt, Ernst-Ludwig-Platz 2, 55116 Mainz, Deutschland

1/2014