THE TRADITION OF FACET-CUT BOWLS FROM PANNONIA: STYLE, DISTRIBUTION AND CHEMICAL COMPOSITION •

A FACETTÁLT-VÉSETT DÍSZÍTÉSŰ TÁLAK TRADÍCIÓJA PANNÓNIÁBÓL: STÍLUS, ELTERJEDÉS ÉS KÉMIAI ÖSSZETÉTEL

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Abstract

The method of facet-cutting was invented in the 1st century A.D. The craftsmen began to create zoned facet-cut decoration to arrange the facets in horizontal zones divided by linear grooves mostly in Isings 96 bowl in the second half of 2nd century and first half of 3rd century A.D. The western part of the Roman Empire is emphasized in production. Above all, we need to highlight the Rhine region (perhaps at Cologne), and Pannonia as production sites from which we now publish chemical compositions of this type for the first time. The existence of workshops at Dura Europos and Tanais is uncertain in the eastern part of the empire. Facet-cut vessels often appear also southern Germany, Bavaria. There are also rich places in Northern Italy as Bresca for example, and also known in France and Great Britain, but not in big quantities. The archaeometric study revealed that the chemical compositions of facet-cut bowls from Brigetio and Intercisa are the same, which indicates that they were made of the same raw glass. The appearance of another high-quality glass ware, the snake-thread beakers, coincided both in time and place in Pannonia with the facet-cut bowls. Therefore, we wondered how similar the composition of the base glass was and whether a further relationship could be assumed between them in terms of production. Interestingly, the chemical compositions of these two types are partly identical (Sb-decolourized facet-cut bowls and snake-thread beakers) and partly different (the two Mn-decolourized snake-thread beakers). The appearance of the Mn-decolourized objects needs further investigation.

Kivonat

A facettált-vésett díszítést a Kr. u. 1. században fedezték fel. Az üvegművesek facettált oválisok és vésett vonalak segítségével vízszintes zónákra osztották az edények felületét és azon komplex díszítési rendszereket hoztak létre a 2. század második felében és a 3. század első felében. Az edény teljes felszínét beborító vésett vonalak és facettált oválisok, körök és rizsszemekből álló komplex díszítés esetén feltételezhető, hogy ezeket szakosodott műhelyekben gyártották. A típus gyártásában a nyugati birodalomrész volt hangsúlyos. A Rajna-vidéket és Pannoniát kell kiemelnünk mint biztos gyártóhelyeket, ha az edények elterjedési területét megvizsgáljuk. Pannoniából most először közlünk anyagvizsgálati eredményeket erről a típusról. A keleti birodalomrészben feltételezett műhelyek működése bizonytalan (Tanais és Dura Europos). A facettált tálak gyakoriak Dél-Németországban (Bajorországban) és Észak-Itáliában (például Brescia) is. Franciaországban és Nagy-Britanniában is ismertek, de nem nagy mennyiségben fordulnak elő. Az archeometriai vizsgálat szerint a Brigetioban és Intercisaban feltárt facettált tálak kémiai összetétele azonos, kémiai összetételi alapon nem megkülönböztethetőek, ami arra utal, hogy azonos nyersüvegből készültek. Ugyanakkor azonos időben és azonos helyeken jelentek meg szálrátétes poharak, amelyek szintén kiváló minőségű üvegtermékek. Ezért kíváncsiak voltunk, hogy mennyire hasonló az alapüveg összetétele a két típusnál és feltételezhető-e további kapcsolat a gyártás tekintetében. Az alapüvegek részben azonos kémiai összetételűek (az Sb-színtelenítettek), részben eltérőek (2 db Mn-színtelenített szálrátétes pohár). A Mn-színtelenített üvegek megjelenése további vizsgálatokat igényel.

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KULCSSZAVAK: FACETTÁLÁS, PANNONIÁBAN FELTÁRT ÜVEGEDÉNYEK, SZÁLRÁTÉT DÍSZÍTÉSŰ POHARAK, ISINGS 96 TÁL, EDS

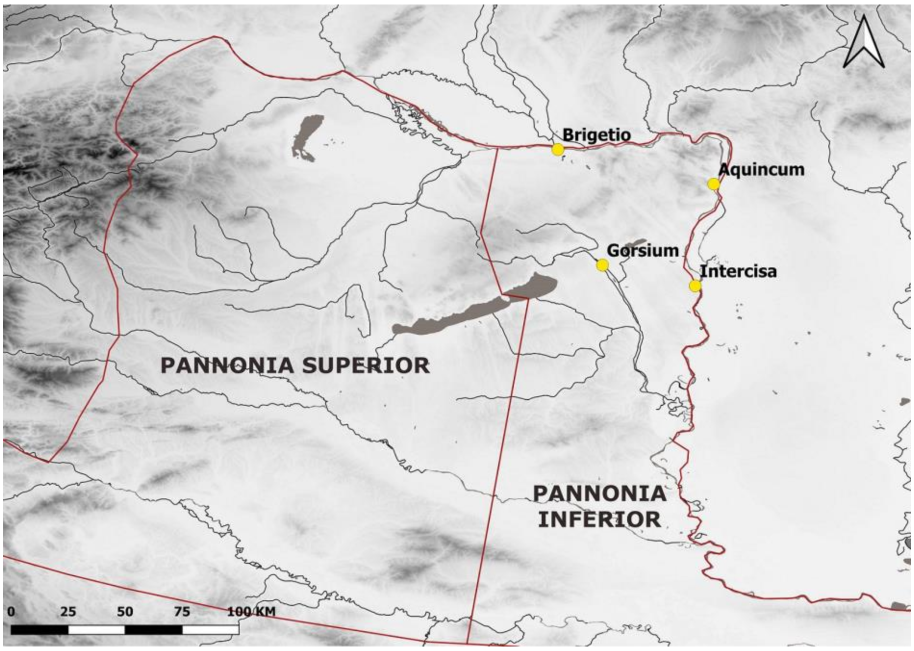

Fig. 1.: The characteristic sites of facet-cut bowls (Isings 96) in Pannonia

1. ábra: A facettált-vésett tálak (Isings 96) jellegzetes lelőhelyei Pannóniában

Introduction

Hemispherical bowls with facet-cut ornamentation were used during a brief period in Pannonia (**Figs. 1-4.**). These colourless, good quality vessels have a fairly thick wall of 3–4 mm and are decorated with carefully designed and executed engraved motifs. The vessel body is divided into bands by one or more wheel-cut lines, while the bands are filled with oval or round facets separated by single or double rod-shaped motifs (Barkóczi 1988a, Form 25. A-B; Isings 1957, Form 96; Rütti 1991, Form AR 56 and 60.1; Harter 1999, Form A 16; Hoffmann 2002, Form C3.3.1.9; Paolucci 1997, 100–101; Sakl–Oberthaler & Tarcsay 2001, Taf. 3.23–24; Šaranović-Svetek 1986, Tab. I.4,8). One essential precondition to the spread of this decorative mode was the growing popularity of colourless glass for tableware on which this type of ornamentation was truly attractive.

The use of facet-cut motifs arranged into rows can be noted from the 60s and 70s AD in Italy, where it was employed to decorate beakers and bowls, which soon became highly popular. Decoration of glassware with engraved lines spread across the entire empire and attained immense popularity on colourless or greenish bowls (Fünfschilling 2015). Simple wheel-cut and incised lines could be easily added at the place of production, in the glass workshops. However, it seems more likely that more elaborate designs of engraved lines and facet-cut oval and circular motifs combined with rice-grain facets were made in specialised workshops (Fünfschilling 2015).

An upswing in the use of this decorative technique can be noted in the later second century AD, when it was principally employed on hemispherical bowls, whose ornamentation followed elaborate decorative schemes that covered the entire vessel surface (Paolucci 1997) (**Figs. 2-4.**). Several origins have been proposed for facet-cut motifs, which made their first appearance in the band under the rim of first-century AD *terra sigillata* vessels. However, on glass vessels, facets were made in a different size and as part of an elaborate decorative system; moreover, glass vessels have no other motifs aside from the facet-cut ones, while these are often used in combination with other motifs on *terra sigillata* bowls. Moreover, the vessel forms differ substantially and thus we can only speak of the similarity of the motifs (Paolucci 1997). It has been convincingly demonstrated that the workshops and artisans producing this type of engraved decoration worked closely together with the glass-blowers. Bowls and beakers decorated in this manner were distributed across entire Western Europe, from Scandinavia to Britain, and from Gaul and Germany to Spain and Italy. Nevertheless, a visible concentration can be noted in the Cologne area. In the east, this glass ware is attested in Pannonia, Syria and Palestine, Egypt and the Pontic (Stern 2001).

A look at the distribution and the major concentrations of sites reveals that they had been manufactured in four main regions according to previous research: the Rhine region (perhaps at Cologne), Pannonia, Syria (possibly at Dura Europos) and the Pontic, at Tanais (Stern 2001, 137; Paolucci 1997, 68). The first two regions are certain, however, there is little evidence for facet-cut glass vessel production at the second two regions. It is certain that in the production of facet-cut bowls, the western part of the empire is emphasized, including one of the manufacturing sites in Pannonia. The area around Pannonia and Cologne seems to be the safest place to produce in terms of distribution and density of facet-cut bowls (Isings 96). Two Eastern workshop circles have also been hypothesized in the past, and their existence is possible, but we have little evidence of it. Its popularity is best indicated by the fact that this elegant ornamental technique began to be applied on silverware, which clearly imitated the glass bowls, as shown by the adoption of the Isings 96 hemispherical bowl form that was lacking from among silver vessels (Paolucci 1997, 67). The peak in the production of these vessels fell into the later second and early third century, after which their production ceased in the Pontic, Syria and Pannonia, although their manufacture continued up to the fourth century in the west, alongside the creation of increasingly more sophisticated and elaborate geometric patterns (Stern 2001, 137).

Archaeological evaluation

The facet-cut bowls from Pannonia were first analysed in detail by L. Barkóczi, who distinguished three main groups (Barkóczi 1986, 166–189). Vessels representing the types principally came to light in Intercisa, Gorsium, Brigetio and Aquincum, but were also attested at Poetovio, Mursa and Sirmium (**Fig. 5.**).

Barkóczi distinguished three main groups among the intact and fragmentary bowls known to him based on their decorative motifs (**Fig. 5.**). As a matter of fact, only his Groups I and II can be regarded as independent groups since his Group III is essentially made up of the vessels with a unique design that could not be fitted into his other two (Barkóczi 1986, 166). Group I is made up of the earlier vessels dating from later second century, while Group II of vessels with a more elaborate decorative scheme that can be clearly distinguished from the earlier pieces (**Figs. 2-4.**).

The detailed publication of the glass finds and the identification of stylistic groups is essential to gaining a better understanding of the exact distribution of this attractive and highly decorative ornamental system. The localisation of workshops likewise calls for reports with a focus on the detailed description of the sophisticated patterns

Fig. 2.: Facet-cut bowl fragment from Intercisa. Inv. Nr.: 68.112.2. Intercisa Museum (Intercisa Múzeum), Dunaújváros, Hungary. Photo: K. Dévai

2. ábra: Facettált-vésett tál töredéke Intercisából. Leltári szám: 68.112.2. Intercisa Múzeum, Dunaújváros. Fotó: Dévai K.

Fig. 3.: Facet-cut bowl fragment from Intercisa. Inv. Nr.: 1.142.18. Intercisa Museum (Intercisa Múzeum), Dunaújváros, Hungary. Photo: K. Dévai

3. ábra: Facettált-vésett tál töredéke Intercisából. Leltári szám: 1.142.18. Intercisa Múzeum, Dunaújváros. Fotó: Dévai K.

Fig. 4.: Facet-cut bowl fragment from Brigetio. Inv. Nr.: 4.1932.82. Hungarian National Museum (Magyar Nemzeti Múzeum), Budapest, Hungary. Photo: K. Dévai

4. ábra: Facettált-vésett tál töredéke Brigetióból. Leltári szám: 4.1932.82. Magyar Nemzeti Múzeum, Budapest. Fotó: Dévai K.

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Fig. 5.: Facet-cut bowls. Barkóczi L., 1988, Taf. IV. Kat. Nr. 39, 41-42.
5. ábra: Facettált-vésett tálak. Barkóczi L., 1988, Taf. IV. Kat. Nr. 39, 41-42.

and decorative schemes created from the combination of wheel-cut lines and oval, round and rice-grain facets covering the vessel bodies. The exact description of the patterns themselves and of the thickness of the cuts, an indication of the size of the cutting wheel, is similarly important, as is the description of the design's layout, of whether the facets are loosely or, conversely, closely set, or virtually touching, since this can provide useful clues regarding workshop traditions.

Conclusions of archaeological evaluation

This decorative technique is wholly perfected on this type, which flourished during a briefer period in Pannonia, for a few decades around the mid-third century. Several pieces, both intact and fragmented, are known principally from Intercisa, Gorsium, Aquincum and Brigetio (**Fig. 1.**). These bowls disappear from the Pannonian material as abruptly as they had appeared. One curious coincidence is that the period during which these bowls were used as well as the sites on which they came to light more-or-less coincides with the popularity of the bowls with snake-thread beakers, suggesting an association between the two finely decorated glass types. In the case of snake-thread glassware we have evidence of production from workshops in Pannonia and can be clearly linked to the migration of the Syrian population to Pannonia, while in the case of faceted bowls we have no data for this.

Although we have no evidence of this connection, the following can be said of sneak-thread glass vessels: "It is particularly interesting to consider that snake-thread beakers in Pannonia were found primarily in a settlement context (examples are known from Brigetio and Intercisa), and it seems that they were not deposited in graves. There is an evidence for glass workshops operating in all two towns." (Dévai 2019, 337) and "At Intercisa five glass kilns as well as 220 kilograms of waste (raw glass, molten glass, semi-finished products) were recovered by Zs. Visy. This workshop was in

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operation until the 260s AD. After the Roman *cohors I Aurelia Antoniniana milliaria Hemesenorum* had been assigned to station at Intercisa, a considerable amount of civilian settlers must have arrived in several waves from the recruitment area. According to the testimony of grave inscriptions and personal names many people of Eastern origin settled in the canabae of Intercisa, to whom we may attribute the introduction of glass making tradition in Pannonia. As we have seen it was in this period when the first examples of snake-thread beakers appeared in Brigetio and it was this time when the production of similar beakers at the Brigetio workshop started. Thus, one may hypothetically conclude that Intercisa and Brigetio were the major production centres where snake-thread beakers were produced in Pannonia, and that the activity of these workshops was connected to glass manufacturers migrating here from the East" (Dévai 2019, 337 and see also: Dévai 2021, 55-66).

Archaeometric study

From two archaeological sites twelve facet-cut glass fragments – all colourless – were submitted to archaeometric analyses to determine whether the particularly good quality, thick-walled, colourless vessels had a specific composition and whether there are any differences in their composition. We were also curious to learn whether these complex ornamental schemes with deep-cut facets called for a special composition and whether the raw glass used for these bowls came from one specific location. Because the appearance of these facet-cut bowls coincided both in time and place with another high-quality glass vessel, the snake-thread beakers (in few cases bottles or goblets), we compared the chemical composition of facet-cut bowls with the colourless base glass of the snake-thread beakers to check whether they were made from the same raw glass or not. The base glass of the snake-thread beakers is colourless with a faint bluish-greenish tint in few cases. The snake-thread decorations are coloured on some vessels, while colourless on other vessels. As an illustration of snake-thread decoration, **Fig. 6** shows two of the best-preserved snake-thread vessels with basically colourless decorations. For analytical investigations 11 small fragments were selected (those on **Fig. 6** have not been analysed). In this paper only the base glass chemical composition of snake-thread vessels is used.

Samples and applied methods

Three facet-cut bowls from Brigetio and 9 facet-cut bowls from Intercisa have been submitted for chemical analysis in the Institute for Geological and Geochemical Research, (Research Centre for Astronomy and Earth Sciences, Budapest, Hungary) by EPMA-EDS (JEOL Superprobe 733 attached with X-Act (Oxford Instruments) energy dispersive X-ray spectrometer). Applied conditions: 20 kV accelerating voltage, 3 nA beam current, spot size: between 50×50 micrometre and 100×100 micrometre rectangle, acquisition time: 5 minutes. The eleven snake-thread beakers from Intercisa have been analysed in the same institute by SEM-EDS (JEOL JSM-IT700HR scanning electron microscope attached with X-Act (Oxford Instruments) energy dispersive X-ray spectrometer). Applied conditions: 20 kV accelerating voltage, 2.5 nA beam current, spot size: between 50×50 micrometre and 150×150 micrometre rectangle to prevent the escape of sodium (Na) from the glass, acquisition time: 5 minutes. For the above-mentioned analyses, small pieces (0.5 to 2 mm) have been taken off from the archaeological glass fragments, then were embedded in resin, polished and coated with thin layer of carbon. In both cases, factory calibration was applied and the results were normalized to 100%. The reliability of the measurements was checked with glass standards (reference glasses) from the Corning Museum (Adlington 2017). See **Appendix 1** for the accepted and measured chemical compositions of the Corning glass standards. Data are given in mass percent (m%) throughout the paper. For the detection limits see **Appendix 2**. Because the same EDS detector was used for both sets of samples (the Oxford Instruments X-Act detector first was attached to the JEOL Superprobe 733 electron microprobe, then the same detector was reinstalled on the JEOL IT700 scanning electron microscope), only one table of the measured composition of Corning glass standards (**Appendix 1**), and one table of the detection limits (**Appendix 2**) is provided.

Results of chemical analyses

Facet-cut samples

The results of the analyses of facet-cut samples can be seen in **Table 1.** The glass is a typical Roman composition (soda-lime-silica glass: low-magnesia, low-potash (LMLK)) with manganese (Mn) below detection limit and very low iron (Fe), which means that the raw material was of good quality. Just 0.5 m% antimony was used as decolouriser. The calcium content, which is characteristic for the sand used for glass making, varies in a narrow range around 6%. The chemical compositions of the facet-cut samples from Brigetio and Intercisa are rather close to each other. Not only the major components, but also the minor ones (Cl, Al, Mg, K, S, Fe) are very similar to each other. It seems to be there is a small difference in the antimony contents between the two sets of samples (Brigetio, Intercisa), but we have to keep in mind that the uncertainty of antimony data is very high (cca. 0,4 m%), because of the strong overlap between the

Table 1.: Chemical composition (m%) of facet-cut samples from Brigetio and Intercisa determined by EPMA-EDS

1. táblázat: A Brigetióból és Intercisából származó facettált-vésett minták EPMA-EDS módszerrel meghatározott kémiai összetétele tömeg%-ban.

	Brigetio			**Intercisa**								
	DKD64	DKD65	DKD66	DKD3	DKD4	DKD5	DKD6	DKD7	DKD8	DKD9	DKD10	DKD11
Na_2O	18.75	18.20	18.36	16.65	18.37	19.40	19.97	18.77	17.63	19.57	19.90	17.23
MgO	0.59	0.63	0.64	0.44	0.60	0.45	0.41	0.28	0.63	0.47	0.46	0.46
Al_2O_3	1.73	1.94	1.94	1.70	1.94	1.64	1.63	1.83	1.87	1.69	1.69	1.72
SiO_2	69.91	70.22	69.68	72.24	70.16	69.44	68.80	71.08	71.41	69.45	69.31	71.80
P_2O_5	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_3	0.29	0.33	0.33	0.25	0.32	0.38	0.39	0.31	0.30	0.40	0.39	0.22
Cl	1.17	1.13	1.10	1.11	1.14	1.18	1.26	1.17	1.08	1.16	1.14	1.12
K_2O	0.35	0.39	0.39	0.36	0.43	0.38	0.36	0.39	0.39	0.39	0.38	0.36
CaO	5.95	5.97	6.20	6.34	5.98	6.04	6.06	5.21	5.70	5.85	5.72	6.21
TiO_2	0.07	0.06	0.09	0.07	0.04	0.06	0.06	0.04	0.08	0.03	0.07	0.07
MnO	0.03	0.02	0.02	0.01	0.01	0.04	0.02	0.03	0.01	0.00	0.02	0.02
Fe_2O_3	0.36	0.40	0.43	0.29	0.40	0.36	0.40	0.28	0.39	0.36	0.34	0.31
Sb_2O_3	0.78	0.71	0.81	0.53	0.60	0.64	0.63	0.61	0.50	0.62	0.59	0.48
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

characteristic X-ray peaks of antimony and calcium. Actually, the 0.2 m% difference in Sb_2O_3 content is less than the analytical uncertainty, therefore we have to neglect this virtual difference. Practically the two sets of samples are indistinguishable by their chemical composition. This fact indicates that they were made by the same recipe and may be that from the same raw glass which was produced in the same workshop.

Snake-thread samples

The chemical composition of the base glass of eleven snake-thread beakers found at Intercisa is shown in **Table 2.** Unlike facet-cut vessels, the set of snake-thread beakers is not homogeneous, it consists of two groups: antimony (Sb)-decolourized (9 pieces: DKR1-3, 6-7) and manganese (Mn)-decolourized (2 pieces: DKR4-5) samples. The difference is manifested not only in the type of decolourant, but also in the major components like calcium (Ca). The calcium content of the Mn-decolourized samples (mean CaO = 7.6 m%) are higher than those of Sb-decolourized ones (mean CaO = 5.8 m%). Seemingly the sample DKR4 contains 0.25 m% Sb_2O_3, but this value is around the detection limit, and we have to keep in mind that there is a strong overlap between the peaks of antimony and calcium, therefore the existence of antimony in this sample is not proved, further analysis is needed to validate the measured value. The SiO_2/CaO ratio characterizes the sand used for glass making. This ratio in the final glass should vary in a narrow range when the sand comes from the same place. On **Fig. 6.** we can see that the ratio of Mn-decolourised snake-thread beakers (yellow) is significantly lower than the others, practically inversely mirroring the difference in the CaO content. From this fact, we can infer that different sand was used for the Mn-decolourized and for the Sb-decolourized glass vessels. If raw glass was transported from the Mediterranean region, then likely it originated from different primary workshops. Comparing the chemical compositions of the antimony decolourised base glass of snake-thread beakers and the facet-cut bowls we can see that not only the major components (Na, Si, Ca), but also the minor components (Mg, Al, S, Cl, K, Fe) are similar to each other (**Table 1-2.**). This similarity is well demonstrated on the plot of SiO_2 vs. Na_2O (**Fig. 7.**), where the two Mn-decolourized samples are outliers. The SiO_2/CaO ratio of the two sets, facet-cut and snake-thread (**Fig. 8.**), varies in the same range with the exception of the two Mn-decolourized samples. The similarity (almost identity of major and trace elements) between the chemical compositions of the antimony decolourised base glass of snake-thread beakers and the facet-cut bowls is an indication that they were made probably from the same batch of raw glass. Further trace element analyses could prove this hypothesis.

Table 2.: Chemical composition (m%) of snake-thread samples from Intercisa determined by SEM-EDS

2. táblázat Az Intercisából származó szálrátétes minták SEM-EDS módszerrel meghatározott kémiai összetétele tömeg%-ban.

	DKR1	DKR2	DKR3	DKR4	DKR5	DKR6	DKR7	DKR8	DKR9	DKR10	DKR11
Na_2O	17.10	16.98	17.08	17.84	16.28	19.14	20.00	18.47	19.93	16.67	16.89
MgO	0.40	0.39	0.39	0.60	0.52	0.33	0.43	0.44	0.43	0.44	0.40
Al_2O_3	1.94	2.01	1.98	2.22	2.73	1.75	1.71	1.91	1.69	2.04	1.95
SiO_2	72.40	72.43	72.39	68.58	68.88	70.48	68.68	69.73	68.76	71.90	72.49
P_2O_5	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_3	0.25	0.27	0.23	0.23	0.18	0.33	0.39	0.31	0.36	0.22	0.24
Cl	1.12	1.12	1.14	1.06	1.22	1.24	1.19	1.14	1.30	1.09	1.14
K_2O	0.45	0.45	0.44	0.58	0.65	0.42	0.43	0.45	0.44	0.46	0.46
CaO	5.58	5.61	5.55	7.05	8.06	5.20	5.94	6.30	5.85	6.21	5.64
TiO_2	0.04	0.03	0.09	0.08	0.08	0.03	0.08	0.10	0.07	0.10	0.09
MnO	0.00	0.00	0.00	0.97	1.01	0.00	0.00	0.00	0.00	0.00	0.00
Fe_2O_3	0.39	0.40	0.39	0.52	0.42	0.32	0.43	0.41	0.40	0.51	0.41
Sb_2O_3	0.37	0.34	0.37	0.25	0.00	0.78	0.75	0.78	0.79	0.38	0.33
Total	100.00	100.00	100.01	100.00	100.00	100.00	100.00	100.01	100.00	99.99	100.00

Fig. 6.: Snake-thread goblet decorated with tendrils and leaves (left) and bottle with snake-thread decoration (right). Intercisa Museum (photo: Tamás Keszi).

6. ábra: Kígyózó szálrátétes kehely levelekkel és indákkal díszítve (balra) és kígyózó szálrátéttel díszített palack (jobbra). Intercisa Múzeum. Fotó: Keszi Tamás.

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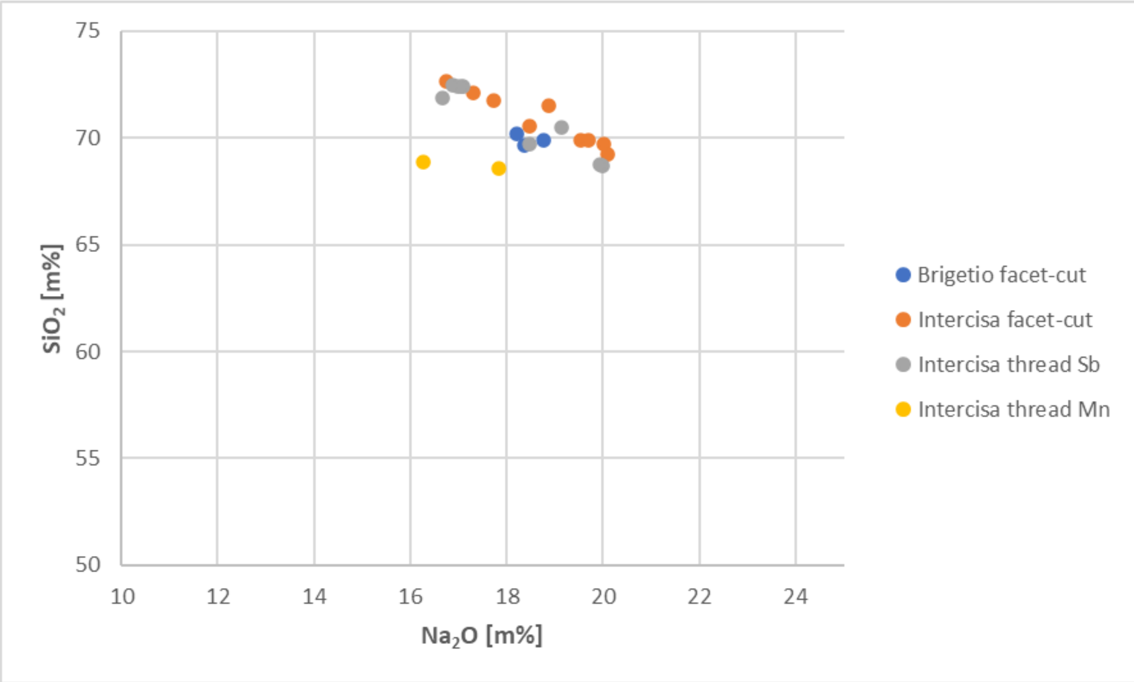

Fig. 7.: The SiO_2 vs. Na_2O plot of all the analysed samples. Legend: Brigetio facet-cut = facet-cut beaker from Brigetio, Intercisa facet-cut = facet-cut beaker from Intercisa, Intercisa thread Sb = antimony decolourised snake-thread cup from Intercisa, Intercisa thread Mn = manganese decolourised snake-thread cup from Intercisa.

7. ábra: Az összes elemzett minta a SiO_2 - Na_2O ábrán. Jelmagyarázat: Brigetio facet-cut = facettált-vésett tál Brigetióból, Intercisa facet-cut = Facettált-vésett tál Intercisából, Intercisa thread Sb = Sb-színtelenített szálrátétes pohár Intercisából, Intercisa thread Mn = Mn-színtelenített szálrátétes pohár Intercisából.

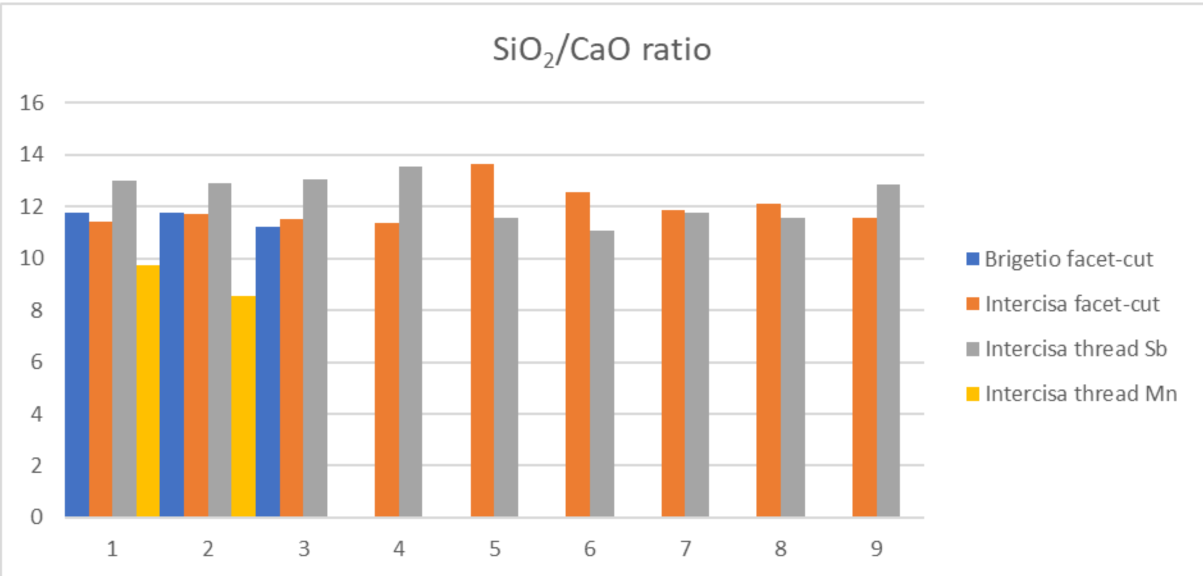

Fig. 8.: The SiO_2/CaO ratio of all the analysed glass fragments. For the legend, see **Fig. 7.**

8. ábra: Az összes elemzett üvegtöredék SiO_2/CaO aránya. A jelmagyarázatot lásd a **7. ábránál**.

Chemical composition of facet-cut glass vessels in other parts of the Roman Empire

Although the Ising 96 type facet-cut vessel findings are concentrated in four distinct regions (see above), our survey for their published chemical analyses have been unsuccessful. Therefore, we compare our data to all types of facet-cut glass vessels. It is interesting that the majority of the chemical data comes from Britain (Paynter 2006, 2010; Paynter & Jackson 2019; Baxter et al. 1995; Baxter et al. 2005; Charlesworth & Price 1987; Jackson 2005), and one from Egypt (Rosenow &

Rehren 2014). The British findings have got some interesting features. For example, based on an extensive data base Baxter et al. (2005) found that facet-cut beakers are generally compositionally distinct from cast bowls, wheel-cut beakers and cylindrical cups. What is more interesting they found that there were at least two subgroups of facet-cut beakers distinguished by different levels of iron, aluminium, calcium, antimony and lead oxides in the glasses. The variations in the levels of aluminium, calcium and iron oxides suggest that distinct silica sources were used to make these glasses found in Britain. The mean chemical composition of our Pannonian pieces is very similar to that of "High Al" facet-cut beakers (Table 4 in Baxter et al. 2005), but not identical, there is some difference in MgO and K_2O contents, but this small difference between the average values may be resulted from the bad statistics (small number of samples) of Pannonian vessels. There is a strong similarity between the chemical composition of our Pannonian facet-cut bowls and those facet-cut vessels published by Paynter & Jackson (2019) from different sites in Britain. Actually, the range of concentrations of components of the Pannonian samples are narrower than those of British ones, and there is total overlap between the Pannonian and British sets. Paynter (2010) published the chemical composition of 12 facet-cut samples among other types of glass vessels excavated in Binchester (1st-3rd centuries). Their calcium (3.49-6.41 m% CaO) contents vary in such a wide range, that most probably they were made of raw materials from different sources. Having a look over the chemical compositions of all the facet-cut vessels we can state that most probably they were made of raw glasses from different workshops. Regarding the major and minor elements there are strong similarities between the Pannonian and some British facet-cut vessels indicating that they may have been made from the same raw glass, but this statement should be checked by trace element analyses in the future.

Sb- vs. Mn-decolourized glasses in the Roman Empire

As we could see above, the CaO content of the Mn-decolourized snake-thread vessels are significantly higher than those of Sb-decolourized ones. If we have a look generally on these two types of Roman glasses, not only the snake-thread ones, this character seems to be valid for the majority of the colourless glasses. Foy et al. (2004) categorized the colourless Roman glasses (2nd/3rd c. AD.) found in a cargo of a shipwreck at Ambiez and at several Mediterranean sites and Gaul (cca. today France) into four groups, where Group 3 is the Mn-decolourized glass having 7.81 m% CaO, and Group 4 is the Sb-decolourized glass having 5.56 m% CaO. Based on an extensive database (792 analyses) Gliozzo et al. (2017) published mean chemical composition for Roman colourless Sb- and Mn-decolourized glasses. They got almost the same CaO content as Foy et al. above: 5.5 m% for Sb-decolourized, and 7.8 m% for Mn-decolourized. These numbers are very close to what we have got for just a few samples from Pannonia: 5.9 m% in Sb-decolourized, 7.6 m% in Mn-decolourized. This character seems to be common for Roman colourless glasses, although not exclusive (e.g. Foster & Jackson 2010 "Colorless 2a", Silvestri et al. 2018, Maltoni et al. 2015). Gliozzo (2017) put this question into chronological context based on a set of 1496 analyses. For Sb-decoloured glass she determined average CaO content as 5.36 m% for the period of 1st-3rd c. AD, and 5.62 m% for the period of 4th-7th c. AD. For the Mn-decoloured glass she determined average CaO content as 7.84 m% for the period of 1st-3rd c. AD, and 7.30 m% for the period of 4th-7th c. AD. May be there was some change in time, but not significant and it does not modify our observation above.

Summary

The facet-cut decoration flourished during a briefer period in Pannonia, for a few decades around the mid-third century. Several pieces, both intact and fragmented, are known principally from Intercisa, Gorsium, Aquincum and Brigetio (see also for the distribution of facet-cut glass bowls from Pannonia: Dévai 2021, 253-265, Figure 1). Interestingly the period during which these bowls were used as well as the sites on which they came to light more-or-less coincides with the popularity of the bowls with snake-thread beakers, suggesting an association between the two finely decorated glass types. It is possible, although we have no evidence that they had been produced in the same workshops and by the same craftsmen. Because they were used during the same period and have a similar distribution, it is possible that the two types of glassware may be combined, however our evidence is only for the manufacture of snake thread glass vessels.

The archaeometric study revealed that the chemical composition of facet-cut bowls from Brigetio and Intercisa are the same (both major and minor components), practically they are indistinguishable on chemical basis. This fact indicates that they were made of the same raw glass. However, the snake-thread beakers fall into two categories, antimony-decolourized and manganese decolourized, with significantly different calcium content indicating that different raw glasses were used for their production. The chemical composition of the facet-cut and Sb-decolourized snake-thread vessels are very close to each other, they are practically identical. Further trace element analyses would be needed to answer the question whether their raw glass came from the same source or not.

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