Façon de Venise *vessels made of potassium rich glass excavated in Elbląg (Elbing), Poland*

In search of quality

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fig. 1a and b

Fragment of a beaker, ice glass. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXXI/3661. (Photo: Piotr Ligier)

Introduction

Several *façon de Venise* vessels made of potassium rich glass have been identified among the artefacts found during the archaeological excavations of the Old Town in Elbląg (Elbing), Poland. In the following article I will explain the rarity of these finds and embed them in the wider context of the development of European glass technology of that time.

Glass has been used for the replication of precious and semi-precious stones for centuries, if not for thousands of years. Numerous descriptions of such attempts are found in various alchemical manuscripts and other historical sources, emerging in many cultures and periods (Beretta 2009). One of the reasons for these tenacious efforts was a desire to achieve something beautiful and exceptional that resembles or imitates expensive and rare precious stones. Actually, manufacturing gems in this way constituted one of the alchemical main goals. Efforts to imitate various objects made of rock crystal are also an example of glass usage with a similar purpose (e.g. Vickers 1996). In both cases, the quality of the resulting material was equally important as the quality of the object in terms of its artistic value, expressed form, shape and decoration. To achieve the desired effect, the quality of the glass had to be better and better; thus a history of glass might be considered as the history of successive efforts to improve its quality.

fig. 2

Fragment of a wafelbeaker, mould blown, enamelled, gilt. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/5301. (Photo: Piotr Ligier)

Historically, glass was made of at least two raw materials – sand and a flux. The role of a latter was to lower the melting temperature of a batch; historical furnace temperatures were too low to melt the sand itself. Thus, to some extent, the history of glass is also a history of application of various fluxes. The invention of *cristallo* in Venice, of a quality that surpassed glasses such as *vetro commune* and *vitrum blanchum*, constituted one of the most obvious manifestations of this process. One of many innovations and improvements that stood behind this achievement was the application of plant ash soda, obtained by the

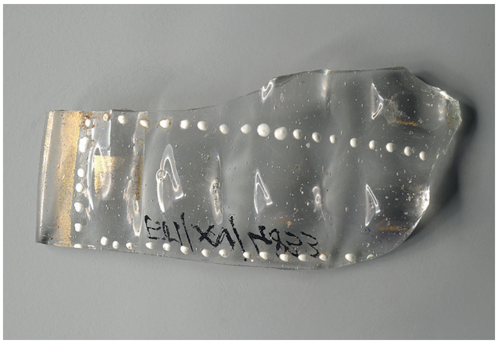

fig. 3 a/b

Fragment of a goblet, mould blown, enamelled, gilt. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XV/4833. (Photo: Piotr Ligier)

leaching and extraction of plant ash (Italian: *liscivazione*) instead of raw plant ash as a flux (Jacoby 1993; Verità 1985, 2013, 2014; McCray 1999). The use of this refined plant ash soda and *quarziti del Ticino* (quartz pebbles from the Ticino river) as a source of silica meant that *cristallo* contained much lower levels of impurities and significantly less stabilizing ingredients, such as calcium oxide (CaO). Both the use of best-quality material, i.e. cristallo and objects made from it quickly became a kind of benchmark in almost all of Europe. Wealthy people wanted to possess cristallo objects; possessing them was an expression of the owners' position, wealth and good taste. However, this glass and these objects were extremely expensive, not easily or everywhere accessible. The phenomenon of *façon de Venise* glass was a response to the growing demand for genuine Venetian products.

Venetian and *façon de Venise* glass

Venetian blown glass technology generally remained unchanged from the development of *cristallo* in the mid-15th century up to the late 17th century, in part because sources of raw materials used, methods of their purification, and melting technology were virtually almost unaltered during this period, at least for colourless vessel glass production. Venetian glass was a public good protected by the State. However, it should not be considered a fully consistent and uniform product, if only because of the competition between glassmakers' families and individuals (Trivaletto, p. 154-155). This internal diversity did not affect general rules for local production and the main characteristics of its final products, as seen in the high quality of the glass, the specific forms of these vessels, and their decorations.

In the late 17th century we can observe for the first time new raw materials such as saltpetre used on a wider scale in Venetian recipes. Though saltpetre was mentioned in the third treatise of the Tuscan *Trattatelli* dating to the third quarter of the 15th century, it was found in these recipes more commonly from the 1690's when mentioned in a later addition to the Giovanni Darduin manuscript. The same applies to the use of arsenic, borax, and even lead compounds (McCray 1999, p. 206, n. 41; McCray & Kingery 1995; McCray et al 1995; Moretti 2005, p. 245, 246 & Table 2; Watts & Moretti 2011, p. 19; Zecchin 1986, e.g. p. 224, 228; Zecchin 1998). Northern European influence in this technological transfer seems to be obvious. At least from the beginning of the 18th century, cullet of Bohemian glass was imported to Murano and added to some Venetian batches [see e.g.: '*Boemia (pesta, rotti di Boemia): rottami de vetro prodotto in Boemia e importato a Murano dall'inizio del XVIII secolo; veniva usato come rottame e aggiunto a certi vetri per il suo alto contenuto di potassio e calcio.'* - Moretti (2001, p. 19)]. So, it seems that if the earlier transfer was directed from South to North, now the reverse process is also observable.

Some scholars underline the beginning of a slow decline in Venetian glassmaking to this period (see e.g.: McCray 1999, p. 157-163). However, this process is complex, and the term 'decline' does not fully describe what was happening. Actually, it can be observed in blown glass manufacturing, but not necessarily in the Venetian glass industry as a whole. Between 1678 and 1700 the number

fig. 4

Fragment of a goblet, mould blown, enamelled, gilt. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXV/1813. (Photo: Piotr Ligier)

of crucibles assigned by the Murano guild to blown glass production decreased from 114 to 41 (Trivaletto 2006, p.183, Table 5). However, a shift to other sectors of glass manufacturing (e.g. small mirrors, windowpanes and beads) quickly compensated for the decrease in blown vessels production. At the beginning of the 18th century, the whole glass sector was two times larger than two centuries earlier (Trivaletto 2006, p. 164-167). Therefore, all we can report is the slow decline of the Ve-

fig. 5

Fragment of a goblet with serpent stem. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXIII/5176. (Photo: Piotr Ligier)

netian blown glass production, especially of famous luxury vessels, which (in the long run) could not rival the new English and Czech (Bohemian) competitors. This process, however, did not affect the continuity of *façon de Venise* objects, which is thought to be based solely on sodium rich glass; there was still a huge demand for such objects in Europe. It seems that only the changes that came with the flourishing new baroque style, visible also in glassmaking, led to an ousting of *façon de Venise* vessels from the European market.

But in Renaissance and early Baroque Europe, Venetian glass products were undoubtedly still considered a benchmark of sorts. These 'elegant and fragile vessels,' as described by Jutta-Anne Page (2004, p. 3), were '...in demand across the continent.' As detailed by Whitehouse (Whitehouse 2004, p. ii-vi), their decorative characteristics include gilding and enamelling, the extensive use of moulds and various stamping applied motifs, the inclusion of canes and cane slices, diamond-point engraving, and the ability to assemble objects from multiple components, among others. However, the quality of glass as a material was of no less importance; *cristallo* played an indisputable role in the commercial success of these objects throughout Europe (Verità 1985, 2014; Jacoby 1993; McCray 1999).

Glassmakers tried to imitate the genuine Venetian objects by following genuine Venetian recipes in various places throughout Europe, from France and England to Poland. The beginnings of this process were undoubtedly connected with the migration of Venetian glassworkers. However, glassmakers from Altare in Liguria (Monferrato province) also played a crucial role in this artistic and technological transfer (Maitte 2009; 2014).
Johann Joachim Becher (1635-1682), one of the 17th century polymaths, underlined the importance of the proper material used in the production of *façon de Venise* glass. As Smith writes, 'Chemistry and alchemy gave an understanding of the material composition of natural objects and the processes that involved these objects. The significance

fig. 6

Fragment of a goblet with serpent stem. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXII/9986. (Photo: Piotr Ligier)

fig. 7
Fragment of a goblet. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXV/2866. (Photo: Piotr Ligier)

of such a material understanding for the manufacture of things and the production of material wealth is made clear in a passage in Becher's Kunsthaus Referat. In discussing the glassworks where Venetian glass was to be produced, he stated that two things are to be considered in the production of this glass, the form and the material. The form is beautiful, but

made in such a way that it cannot be communicated to this land except by a long period of apprenticeship, for it is an art and consists in work of the hand. If these Italians [who operated the glassworks] should die or go away, the art will go together with their hands, and *this territory thus will not have been served. Therefore, it would be a good thing to find out [literally, 'get behind'] the correct preparation of the material of the Venetian glass.'*
(Smith 1994, p. 209. For Becher's citation see also Becher 1676, fol 15v.)

Nevertheless, Moretti noted: 'The possession of the recipes to produce the [Venetian] glass was important but we must consider that the recipes were strictly linked with the raw materials originally utilized' (Moretti et al 2005, p. 243). Glass artisans outside Venice tried to follow Venetian recipes, often using local raw materials. For the production of *façon de Venise* glasses, in place of sodium rich ashes (*allume catina*) imported to Murano from the Levant, ashes from other sources were used, and *barilla* (from Spain) often played an important role as a main flux. This phenomenon can be observed not only in the north but also in other areas of glass production in Italy (Cagno et al 2012). The same concerned *quarziti del Ticino* (used in Venice as a source of silica); almost as a rule, local sands replaced them. Vessels resembling original Venetian products, or at least possessing some of their characteristic features, were manufactured with the use of local raw materials, not necessarily of equally good quality as the raw materials used in Venice. Thus, it should not surprise us that these differences in raw materials in many cases allows us now to distinguish original Venetian glasses from *façon de Venise* glass based on the chemical analysis (see e.g. Cagno et al, 2012, De Raedt et al

fig. 8

Fragment of a goblet with applied threads. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXII/476. (Photo: Piotr Ligier)

2001, Ulitzka 1994, Šmit et al 2005).

As to the term *façon de Venise*, probably the earliest known use of it is from 1549 when Jean de Lame from Cremona living in Antwerp was granted the privilege to manufacture '*voires de cristal à la mode et façon que l'on les lebeure en la cyté de Venise'* (Denissen 1985, p. 9-10; El Dekmak-Denissen 1989, p. 121; Liefkes 2004, p. 228).

Façon de Venise glass from Elbląg

As the identified *façon de Venise* vessels made of potassium rich glass come from Elbląg some introductory words about this city are necessary for a wider audience. The city was founded by the Teutonic Order and was a capitol of its state until 1309. Elbląg played an important role in the Hanseatic League. From 1466, it was a part of the Polish kingdom as a city of the autonomous province of Polish Prussia (Prusy Polskie), also known as Royal Prussia (Prusy Królewskie), with its own Diet and, like Toruń (Thorn) and Gdańsk (Danzig), was granted additional privileges. Thus, the city was a part of the huge Polish-Lithuanian Commonwealth. It was also the second largest Polish harbour after Gdańsk and was of great importance in the grain trade. The second part of the 16th and 17th centuries was a golden era of growth and wealth for the city. It was also a staple of the English Eastland Company, founded there in 1579, in opposition to Gdańsk (Davies 2005, p. 213). The city had strong trade and cultural contacts with many German, Dutch and English cities, among others, and trade (especially sea tra-

fig. 9

Fragment of a goblet with liquid encased in the stem, mould blown. The Archaeological and Historical Museum in Elbląg, Poland. Inv. no. EM/XXXI/1900. (Photo: Piotr Ligier) de) greatly contributed to its development. About 90% of Elbląg was destroyed during World War II. Since the beginning of the 1980s, the Old Town has been systematically reconstructed, with the exploration of each lot by archaeologists. To date, the excavations have covered about 8% of the old town area. Numerous *façon de Venise* vessels dated roughly to 16th-17th centuries were discovered, in most cases in the cesspits. Between 1984 and 1995, 40 such vessels were found, comprised mostly of beakers and divisible into a few subgroups: Mould blown beakers, *vetro a filigrana* beakers, 'ice glass' beakers, *calcedonio* beakers, *Humpen* beakers. Types of goblets encompassed: Goblets with relief-cut stems, ribbed stems, baluster-stems, bell-shaped feet and winged goblets. The finds also included single examples of a jug and tankard (Gołębiewski 2005). Among the finds excavated later, objects decorated with stamping applied motifs, such as the lion heads characteristic of Amsterdam's production (Hulst 2013) were found. Most of these finds came from one surveyed patrician quarter.

Unfortunately, only nine of these glasses have been analysed (Kunicki-Goldfinger et al 2008); their simplified chemical compositions are shown in Table 1. Only one of them represents sodium glass technology (no 1) and this is an example of ice glass beaker (*fig. 1a, b*). The remaining eight items (no's 2-9) represent façon de Venise objects made of potassium glass, a surprise in the light of the state of the art. These include an enamelled and gilt, mould blown wafel beaker (*fig. 2*), two enamelled and gilt mould blown goblets (*fig. 3a, b; 4*), two goblets with serpent stems (*fig. 5, 6*), a goblet with hollow stem (*fig. 7*), and a goblet with applied threads (*fig. 8*). The group also includes a mould blown goblet with liquid encased in its stem (*fig. 9*); its chemical composition can be seen in the ninth row of Table 1.

Discussion

Among the items excavated in Elbląg and reported in this article, only one object is made of sodium rich glass, an ice glass beaker (*Table 1, no 1, fig. 1a, b*). From this point of view, this is an exceptional glass when compared to all remaining potassium rich ones, but surely it is not. Already mentioned objects with the lion-masks that still have not subjected to chemical analysis were probably made in Amsterdam, and they should be sodium glass too (Hulst 2013; Hulst & Kunicki-Goldfinger 2017). With the current state of analysis, it is not possible to estimate what portion of *façon de Venise* vessels from Elbląg were made from potassium rich glass. These nine presented objects are not necessarily fully representative and further research must still be carried out.

As there was no glasshouse in Elbląg, all these vessels must have been imported by land or sea. We do not know how much overland trade was carried out, but based on the Elbląg's archival sources related to the importation of goods under maritime trade for the period 1585-1712, some important and helpful information can be gathered (Groth 2006). Import of glass products were quite intensive in the 1640s and 1650s and

Glass type	No.	Object	Fig.	Inv. no.	Na_2O	K_2O	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	MnO	P_2O_5	Cl	PbO
Sodium glass	1	Beaker, ice glass	Fig. 1a, b	EM/XXXI/3661	13.3	5.0	8.6	3.3	65.2	1.5	0.7	0.8	<	0.9	<
Potassium glasses	2	Wafel beaker, mould blown, enamelled, gilded	Fig. 2	EM/5301	1.5	15.2	13.5	2.3	63.3	1.2	0.2	0.6	1.5	0.3	0.1
	3	Goblet, mould blown, enamelled, gilded	Fig. 3a, b	EM/XV/4833	1.4	13.5	15.4	2.3	63.3	1.3	0.3	0.7	1.4	0.3	<
	4	Goblet, mould blown, enamelled, gilded	Fig. 4	EM/XXV/1813	2.5	8.3	16.7	2.5	65.0	1.8	0.3	0.7	1.6	0.6	<
	5	Goblet with serpent stem	Fig. 5	EM/XXIII/5176	4.0	20.7	8.3	1.4	61.8	0.6	0.3	0.4	0.9	0.2	<
	6	Goblet with serpent stem	Fig. 6	EM/XXII/9986	3.1	17.9	13.2	2.0	60.8	0.9	0.3	0.3	1.3	0.1	<
	7	Goblet	Fig. 7	EM/XXV/2866	0.6	18.5	13.1	2.6	61.8	0.7	0.2	0.8	1.0	0.1	<
	8	Goblet, applied threads	Fig. 8	EM/XXII/476	0.2	9.9	16.7	2.4	61.7	1.2	0.3	1.0	2.6	<	<
	9	Goblet, mould blown, with liquid encased in the stem	Fig. 9	EM/XXXI/1900	4.7	18.5	3.1	1.1	69.0	0.8	0.3	0.9	0.7	0.3	<

< - below the limit of detection.

Table 1

Simplified chemical composition of colourless glass made in façon de Venise *style, excavated in the cesspits in the Old Town in Elbląg, Poland. In wt. %. [Kunicki-Goldfinger et al 2008, table 1].*

then again in the 1680s. The assortment of the products declared for customs included mirrors, bottles, beakers and French glass as a distinguished product, but the most commonly declared product was just 'glass,' with no specificity about the object type. In the 1640s and 1650s, ships were arriving most often from Dutch cities; and Amsterdam was the most often mentioned port. For this period, excepting Dutch ports, only Gdańsk, Lübeck and Malmö were listed as ports of non-Dutch origin. In the 1680s and 1690s, Amsterdam is listed as the only Dutch port with virtually no other originating ports for the ships arriving in Elbląg (with the exception of three years, when some ships from Lübeck arrived). These data throw some light on the possible Amsterdam origin of the *façon de Venise* sodium rich glasses found in Elbląg.

Amsterdam was a big international trade hub and important cultural as well as intellectual centre. However for our discussion, it is crucial to underline that Amsterdam was also one of the main centres of *façon de Venise* glass production. The Low Countries were an area where these new ideas and technologies flourished very quickly. '[...] the Protestant Northern Netherlands, with its pronounced anti-papal sentiments, soon resented Italian cultural dominance. This resentment extended to glassmaking, and it was expressed in the patronage of glass production that would surpass Italian prototypes. Italophilia was thus matched by an international movement of Italophobia that was evident from England to Poland' (Page 2004, 4). The presence of Italian glass-masters in the Netherlands who began to manufacture glass in *façon de Venise* style dated back to the beginning of the 16th century; the oldest known glasshouse producing such glass in Amsterdam was founded just before the end of the century. These objects were produced within the city in a few glasshouses operating more or less one after another. The best known and the most important were a glasshouse run by J.H. Soop (until 1625) and the De Twee Rozen glasshouse operating until 1679 (Baart 1998; Henkes 1994, Liefkes 2004, Veeckman et al 2002, Gawronski et al 2010, Hulst 2016, Hulst et al 2012). Nevertheless, even during this time, glass was also widely imported to Amsterdam from various locations, including Venice.

The typological and technological study of selected excavated objects, especially those manufactured by J.H. Soop (Soop) and the De Twee Rozen (Two Roses) glasshouses, has been published (e.g. Hulst & Kunicki-Goldfinger 2017). It was found that all examined 17th century vessels of this style manufactured in Amsterdam were made exclusively of sodium glass. The simplified and averaged chemical compositions of glasses characteristic for the production of two main types of Venetian luxury objects and for *façon de Venise* objects manufactured in the Two Roses glasshouse are shown in Table 2. Those manufactured in the Two Roses glasshouse can be divided into two types. The first one follows the batch composition characteristic for Venetian *vitrum blanchum* (denoted as VB-like), but the raw materials used for its production came from other sources and they represent a slightly poorer quality. We can see this by comparing the concentration of K_2O, Al_2O_3 and Fe_2O_3 in Venetian and Dutch items. The level of the first one of these oxides suggests the possible use of *barilla* in place of Levantine ashes. Also, the increased average levels of Al_2O_3 and Fe_2O_3 suggest the use of a rather inferior quality of sand. Unfortunately, based on this limited number of analyses, we cannot distinguish these VB-like glasses manufactured in the Two Roses glasshouse from those produced earlier in the Soop glasshouse (see Hulst & Kunicki-Goldfinger 2017). But formulation of the second type of glasses produced in the Two Roses glasshouse, at least during the period from 1657 to 1679, suggests that glassmakers followed a recipe characteristic of Venetian *cristallo* (denoted as C-like; see e.g. the level of CaO and SiO_2), again with the use of local (or at least not the same as used in Venice) raw materials while manufacturing at its second location. The chemical composition of the sodium rich ice glass found in Elbląg (*Table 1, no. 1*) fits very well with the composition characteristic for the VB-like glasses manufactured in Amsterdam.

However, Gdańsk, where the Venetian glass master Gasparo Brunoro (born 1599) stayed and worked for some time, should also be considered another possible source for this glass. Though there is still no glasshouse that can be linked with him in Gdańsk and there are no known objects attributed to him, Brunoro is author of a manuscript written in Gdańsk in 1645 and discovered in the Casanatense Library in Rome (Moretti et al 2004).

Origin & data source*		Type**		Na_2O	K_2O	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	MnO	P_2O_5	Cl
Venice [1]		VB	av (n=32)	**13.6**	**2.97**	**9.76**	**3.35**	**66.9**	**1.03**	**0.37**	**0.47**	**0.31**	**0.86**
			min-max	11.0-17.3	1.45-7.50	8.05-12.30	1.15-5.00	63.8-71.0	0.66-1.95	0.22-0.57	0.21-0.95	0.50-0.86	0.60-1.25
		C	av (n=15)	**17.2**	**2.93**	**4.88**	**1.81**	**70.5**	**0.68**	**0.24**	**0.32**	**0.15**	**1.00**
			min-max	14.7-19.2	2.45-3.65	3.90-6.30	1.10-2.35	68.5-73.0	0.48-0.90	0.15-.32	0.15-0.68	0.09-0.25	0.75-1.20
Amsterdam, Two Roses glasshouse [2]	Keizergracht (1621-1657)	VB-like	av (n=12)	**13.7**	**5.1**	**9.0**	**3.1**	**64.6**	**1.6**	**0.7**	**0.6**	**0.3**	**0.9**
			min-max	12.4-15.0	3.7-6.2	7.4-11.2	2.4-3.5	63.3-66.6	0.8-2.4	0.4-0.9	0.3-1.4	0.2-0.4	0.8-1.1
	Rozengracht (1657-1679)	VB-like	av (n=8)	**12.9**	**4.6**	**10.1**	**2.5**	**64.8**	**1.6**	**0.5**	**0.8**	**0.3**	**0.8**
			min-max	10.8-14.8	4.4-5.2	8.1-11.9	1.9-2.9	63.9-65.6	1.3-2.0	0.4-0.7	0.6-1.1	0.2-0.4	0.8-0.9
		C-like	av (n=16)	**15.1**	**4.3**	**5.8**	**1.6**	**69.0**	**1.4**	**0.4**	**0.9**	**0.2**	**0.9**
			min-max	12.8-17.0	3.5-6.1	4.2-6.6	1.3-2.2	67.6-71.7	1.0-2.2	0.3-0.6	0.5-1.2	0.1-0.3	1.1-0.8

[1] - Verità (2013); [2] - Hulst & Kunicki-Goldfinger (2017). **C – *cristallo*; VB – *vitrum blanchum*; C-like – following *cristallo* batch; VB-like – following *vitrum blanchum* batch.

Table 2

Simplified chemical compositions of glasses characteristic for the production of two main types of Venetian luxury objects and for façon de Venise *objects manufactured in the Two Roses' glasshouse in Amsterdam. In wt.%.*

Originating from Murano where his family owned the glasshouse known as the '3 Corone,' he introduced himself in his manuscript's title as *Gasparo Brunoro detto 3 Corone da Muran di Venezia, Mastro di Cristali e di colori famosissimi*. The manuscript contains many recipes that are also common to other earlier works, such as Montpellier's manuscript from 1536, the anonymous recipe book from the mid-16th century, Giovanni Darduin's manuscript from 1644, and the Neri's *L'arte Vetraria* published in 1612 in Florence. Brunoro worked in Murano, Namur, Turin, London, Kopenhagen, Stockholm, and in Poland (where he spent most of his time in Gdańsk and where the manuscript was written) (Moretti et al 2004, 2005; Moretti & Solerno 2007). As Elbląg is located quite close to Gdańsk, the possibility of import of glasses from Gdańsk should also be seriously considered. Thus, in light of current research, it is not possible to untangle to the origin of this sodium rich glass unambiguously.

All other analysed objects, with chemical compositions shown in Table 1, were made of potassium rich glass that is very different and easily distinguishable, as seen in Fig. 10. The question immediately arises as to whether the quality of this potassium glass was worse or not. Potassium glass is often considered by scholars as an inferior material in comparison with the sodium rich glass, was it really always inferior? Brain & Brain (2014), while writing about crystal glass-making in London during the period of 1642-1672, remarked: "At this time the most expensive ingredient for glassmaking was the alkali flux. Over 60% of the value of glassmaking materials, plants and equipment listed in Racketts 1661 inven-

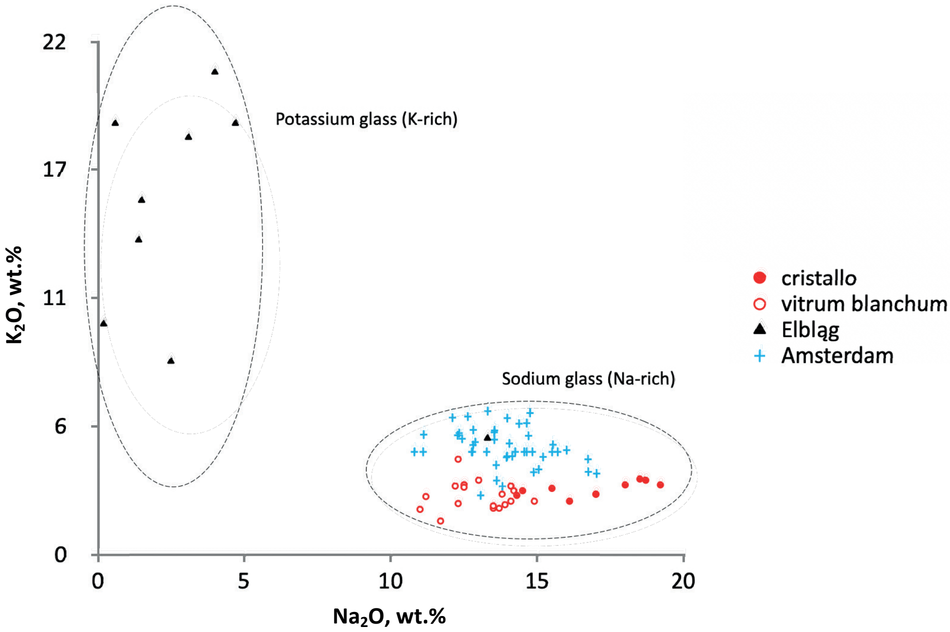

fig. 10

*Venetian glass (*vitrum blanchum *and* cristallo*),* façon de Venise *glass from Amsterdam and Elbląg shown in a scatter plot for K_2O and Na_2O.*

tory was accounted-for by the stocks of alkali." Hereinafter they pointed out that if *barilla* '...was valued at 28s per hundred weight, "potashes" were valued higher at 30s per hundred weight.' Good quality, well refined, potash was thus more expensive than barilla in London. The glassmakers mentioned by Brain & Brain often mixed these two types of fluxes. We can only speculate about if this practice was common also in other European glass production centres.

All the potassium rich glasses discussed here can be linked with Central European production, which had a long tradition of manufacturing this type of glass. Introducing potash as an accompanying flux to wood ash and later as the only flux greatly improved the quality of the glass (Cílová & Woitsch 2012, Adlington et al 2019, Kunicki-Goldfinger 2020). The eight potassium rich glasses featured in Table 1, no's 2-9, were probably produced with the use of wood ash and potash mixed in various proportions. They all contain significant amounts of phosphorus pentoxide (P_2O_5) and magnesium oxide (MgO), which are the main markers for the use of wood ash. Although there is no direct marker in wood ash glass composition that could help us to confirm the use of potash, a comparison of alkalis, silica and lime concentrations can result in this conclusion (Cílová & Woitsch 2012). The composition of glass no 9 (*Table 1*) represents something even better and seems to be very

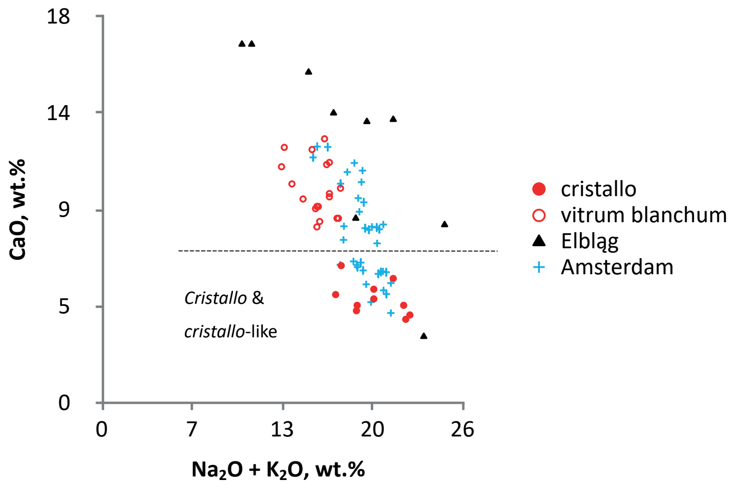

fig. 11

Venetian glass (vitrum blanchum *and* cristallo)*,* façon de Venise *glass from Amsterdam and Elbląg shown in a scatter plot for CaO and a sum of alkali oxides (K_2O and Na_2O).*

unique. If we swap the concentration of sodium and potassium, the chemical composition of this glass would be almost the same as the composition of C-like glass manufactured in Amsterdam (see Table 2) and CaO content is much lower. This can mean that C-like batch glass could be prepared with the similar list of raw materials, mixed in the same proportions but with the use of potassium rich fluxes such as wood ash and potash in place of sodium rich ones like plant ash and plant ash soda (fig. 11). The low concentration of CaO, P_2O_5 and MgO, and higher SiO_2 content might indicate a different value of sand/flux ratio in a batch and a larger proportion of potash in the mixture of potash and wood ash used as a flux. This is a goblet with liquid encased in a hollow knob of its stem, representing a quite sophisticated skill level in manufacture (*fig. 9*). There is not any comparative material for this composition known to the author. Some similarities with this potash/wood ash mixture ratio can be found in the goblet with serpent stem, glass no 5 (*Table 1*), but in this case the concentration of silica is much lower.

Another important characteristic of these potassium rich glasses from Elbląg is the concentration of iron oxide (Fe_2O_3); this tells us about the quality of the sand used, as iron is primarily responsible for the formation of the greenish/bluish tints of glass. These potassium rich glasses represent a very high-quality product, comparable even to Venetian ones, as they contain the oxide on the level comparable with its level in the Venetian glasses (*fig. 12*). Surprisingly, among the discussed Elbląg' vessels, only the ice glass beaker made of sodium rich glass (*Table 1, no 1*) contains significantly more Fe_2O_3.

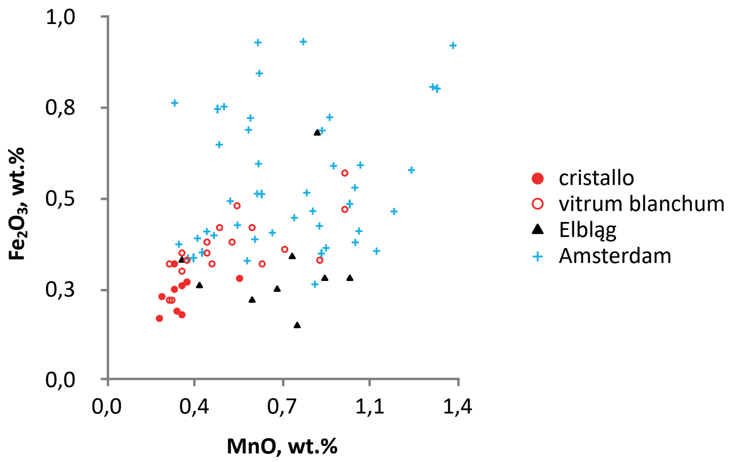

fig. 12

*Venetian glass (*vitrum blanchum *and* cristallo*),* façon de Venise *glass from Amsterdam and Elbląg shown in a scatter plot for Fe_2O_3 and MnO.*

Conclusions

Questions about the quality of *façon de Venise* vessels concern the glass formulation, as well as the type and quality of forms and decorative features of the objects. Though relatively easy to assess the quality of their form and decoration, the quality of glass could be only be judged based on its optical characteristics. The chemistry of the glass was unknown but surely plays a role in its quality. Therefore, if barilla could be used successfully in place of Levantine ashes to counterfeit genuine Venetian products, why couldn't potash be used for the same goal, as this material that was even more expensive than barilla?

Façon de Venise objects excavated in Elbląg and discussed in this article were made, with one exception, of potassium rich glass; they represent so called "wood ash glass technology," which is commonly linked with greenish forest glass. However, all depended on the quality of the raw materials used; the iron content reflects the high quality of sands used for in the production of these potassium rich glasses (*fig. 12*). Their exact origin is unknown, but because of the technology used (potassium rich fluxes), Central Europe should be strongly considered as the area of their production. Nevertheless, bearing in mind their chemical composition, they do not constitute a homogenous group. We can distinguish at least a few sub-groups of them. For example, the glass of the enamelled and gilt mould blown goblet (*table 1, no. 4, fig. 4*) and of a goblet with applied threads (*table 1, no. 8, fig. 8*) are characterised by a higher CaO content. The glass of the mould blown goblet with liquid encased in its stem *(fig. 9*) and of a goblet with serpent stem (*fig. 5*) have much lower percentages of this constituent, but even these two glasses reflect various batch compositions. These potassium rich glasses were probably manufactured in various glasshouses or even in various glass production regions, probably also at various times. The limited number of glasses analysed thus far does not allow for further conclusions. However, it is important to emphasise that the city had enough rich patricians to import sodium rich original Venetian or *façon de Venise* glasses. So why were these different potassium rich glasses present as luxury goods? High quality potassium rich glass was probably appreciated in Central Europe as equally as sodium rich glass and was not necessarily viewed as a cheaper material.

A huge amount of work lies ahead in outlining a chronological and geographical distribution of *façon de Venise* glass compositions in Europe; no definitive conclusions can currently be made. However, *façon de Venise* vessels made of potassium rich glass, often representing the highest quality material which could have been received, are probably characteristic of some Central European production. This, of course, does not change the fact that *façon de Venise* vessels made of sodium rich glass as well as genuine Venetian vessels were also used in this area.

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