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GLASS BEADS FROM SOFIEVKA CEMETERY

The history of glassmaking has been studied for many years and from several angles. Technological, typological, genetic and theoretic studies have been made. All of them, however, aimed at defining the place that in the life of prehistoric communities was occupied by glass. Sometimes, however, we do not have enough data to analyze sources in so many aspects. This is exactly what we have to deal with in the case of glass items from the cemetery in Sofievka. To carry out a formal analysis we are left only with the number of glass items found and their general description and location. Namely, four colour beads were found, two of them in a grave and the other two on the surface. This data is insufficient to conduct a full technological analysis, either. There is not enough data to determine the technique used to make the beads. Despite so many gaps the beads deserve attention because they have been subjected to a chemical composition analysis. Spectroanalytical investigations carried out at the Archaeologico-Technological Laboratory of the Institute of the History of Material Culture in Petersburg have given the following results (Table 1).

An attempt to comment on these results follows from their chronological placement, namely in first half of the 3rd millennium BC [cf. Kadrow, Absolute..., in this volume]. The site's chronology resulting from radiocarbon dating offers us interpreting possibilities for discussion on the origins of glassmaking. In the future, we can expect to have more radiocarbon datings of individual sites where glass objects have been found. We can probably verify the chronology of specific stages in the development of glassmaking.

The beginnings of glassmaking are placed in the 5th/4th millennium conv BC presumably in Mesopotamia. A discussion as to the origins of glassmaking, in which Egypt competes with Mesopotamia as the cradle of glassmaking, has been going on among glass historians since the beginning of this century [a review of opinions on the subject and a description of glassmaking centres in Mesopotamia can be found in: Barag 1962:9-27; Moorey 1985]. The first millennium in the history of glassmaking is believed to be the period of formation of the industry in connection with faience manufacture. Faience, variously characterized by researchers, in its transitional phase leading to the development of glass is treated as a category of the same

Table 1

Resultes of spectroanalytical investigations of the glass beads from Sofievka cemetery

	gr. 123(125)	gr. 123(125)	surface	surface
Lab. No	287/26	287/27	319/40	?
colour	light-green	light-biruse	wine-rose	bright-brown
SiO_2	base	base	base	base
Na_2O	13,0	16,0	6,0	11,0
K_2O	6,0	9,0	6,0	6,0
CaO	12,0	20,0	13,0	4,5
MgO	0,28	0,1	0,35	0,1
Al_2O_3	0,8	0,75	1,4	3,2
Fe_2O_3	0,35	0,75	1,1	0,5
MnO	0,04	0,06	6,0	0,016
PbO	1,2	1,2	0,05	0,09
CuO	0,9	0,75	0,035	0,006
TiO_2	0,012	0,07	0,02	0,01
SnO_2	0,005	–	0,01	–
As	0,35	0,27	–	–

technological process. This makes it difficult to separate centres manufacturing faience from those producing glass. Working on this assumption N. Venclová lists together probable European and non European workshops manufacturing faience and glass in the Early Bronze Age [Venclová 1990:421]. The leading centres are Mesopotamia, Syria with Palestine, the Caucasus, Egypt and Crete. The 3rd and 2nd millenniums BC witnessed also the formation of glassmaking centres on the Crimea, the northern coast of the Black Sea and the Ukraine [Bezborodov, Zadneprovsky 1965:127- 142]. In North Pontic tribes they began to appear at the turn of the 3rd millennium BC. According to A. Ostroverkhov, in the southern district of Kherson, in a kurgan of the late Yamnaya culture, were found glass beads shaped as stars [Ostroverkhov 1981:224-225]. It is in this context that the recording of four glass beads at the cemetery in Sofievka, near Kiev, dated to the 3rd millennium BC, should be analyzed. Specifically interesting in this context are the two beads coming from grave 123(125), a homogenous feature. The other two also come from the same cemetery but it is difficult to attribute them to specific features. The beads were subjected to a spectral analysis. The results thus received were matched to interpretation methods developed by M.A. Bezborodov [1975], Y.L. Shchapova [1973, 1983], M. Dekówna [1982] and T. Stawiarska [1984, 1987]. The major guideline following from the works of these authors is to find out the formula according to which the glass in question has been made and then the types of glass based on its ingredients. Among the ingredients are SiO_2, Na_2O, K_2O, CaO, MgO, Al_2O_3. In the next stage a separate chemical type is separated into subtypes depending on the formula norm. The next stage of the analysis involves special features of glass like colouring, decolouring and fogging agents. The indices calculated below are helpful in these investigations (Table 2).

Table 2

Proportions and sums of glass ingredients

	gr. 123(125)	gr. 123(125)	surface	surface
nN	287/26	287/27	319/40	?
$\frac{Na_2O}{K_2O}$	2,16	1,77	1,0	1,83
$Na_2O + K_2O$	19,0	25,0	12,0	17,0
$\frac{K_2O}{Na_2O+K_2O} \times 100\%$	31,57	36,0	50,0	35,29
$\frac{CaO}{MgO}$	42,85	200,0	37,14	45,0
$\frac{MgO}{CaO+MgO} \times 100\%$	2,28	0,49	2,62	2,17
$FN = \frac{Na_2O+K_2O}{CaO+MgO}$	1,54	1,24	0,89	5,15

The examination of proportions and sums of major glass ingredients justifies the following conclusions.

1. The formula, or a recipe for the kind and amount of basic raw materials consciously introduced to the glassmaking mix has been established. When determining the ratio of alkalic ingredients to calcium-magnesium ones (Na_2O+K_2O: $CaO+MgO$) in finished glass according to Y.L. Shchapova's method, we have found that in glass items no. 287/26, 287/27, 319/40 the ratio is lower than 3. This means that the glass was made according to the three-ingredient formula (sand + soda + limestone). For the unmarked bead found on the surface formula norm = 5.15, which points to a two-ingredient formula (silico-calcium sand+soda).

Two- or three-ingredient formulas co-occurred in the period of their development. We believe that the use of a particular formula depended on the local availability of raw materials.

2. The analysis of the alkalic ingredients suggests that all the beads are made of ash glass. In the glass under discussion it must be ash of continental plants (plant ash is a source of sodium compounds), which is evidenced by the ratio of Na_2O:K_2O lower than 3:1. Beads no. 287/26, 287/27, 319/40 are of the sodium--potassium-calcium-silicon type (Na_2O - K_2O - CaO - SiO_2) while the unmarked bead is of the sodium-potassium-calcium-aluminium-silicon type (Na_2O - K_2O - CaO - Al_2O_3 - SiO_2). Plant ash was used as an alkalic ingredient in the Middle East, Mesopotamia and Central Asia [Shchapova 1983].

3. The proportion of calcium to magnesium shows that the glass is almost magnesium-free and that the calcium component is very pure. The proportion of CaO to MgO in the glass of bead no. 287/27 is 200:1. Such a high proportion of CaO to MgO is similar to that found in glass items from a settlement of the Věteřov culture in Blucin, in Moravia analyzed by J. Olczak. He found the ratio to be 120:1 and 130:1 [Olczak 1993:279-291]. It is highly probable that in Blucin the traces of the oldest glassmaking workshop in Central Europe were found. The proportion of calcium to magnesium may be a relic of a glassmaking tradition brought to Europe from the East.

4. The glass items from grave 123(125) owe their colouring to cupric and lead oxides (CuO and PbO). Glass item no. 319/40, however, displays a higher content of manganese oxide (MnO), namely 6%. Depending on its concentration manganese either colours or discolours glass. According to M.A. Bezborodov [1956:82-83] manganese was a local technological characteristic of glassmaking in the North Pontic region in the Middle Ages. It may have been a remote vestige of an earlier tradition whose trace we found in the bead from Sofievka. This is even more probable when one thinks of rich deposits of manganese ore in the Caucasus.

Also worth noting is the presence of few tenths of a percent of arsen (As) in the two glass items from grave 123(125). It may be a proof of a certain relation between copper- and glassmaking [Bouzek 1985; Klochko 1994:135-166].

The above conclusions show that the four beads from the cemetery at Sofievka, dated at the beginning of the 3rd millennium BC, originate from two different glassmaking traditions: a two- and a three-ingredient one. It is true that all of them were made with the use of plant ash (the source of sodium), but in one case we have recorded exceptionally pure limestone raw material. Of interest is also an increased concentration of manganese. All these elements place the glass items under discussion in the Eastern tradition while suggesting that they may come from various centres, quite possibly from Anatolia as A.S. Ostroverkhov believes [Ostroverkhov 1985:179]. Attention should also be given to the reference, through the CaO/MgO ratio, to the glass from the Věteřov culture settlement in Blucin, which may be evidence of the movement of glassmaking tradition from North Pontic areas to Central Europe.

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