ACCESSORY MINERALS FROM IMPACT MELT ROCKS OF THE BOLTYSH STRUCTURE, UKRAINE. NATIVE METALS AND ALLOYS.

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Introduction: 24 km in diameter Boltysh impact structure was formed in the Precambrian granites and gneisses of the Ukrainian Shield. The annular sheet of impact melt rocks, 12 km in diameter and up to 220 m thick, surrounds the central uplift of the crater. The composition of melt rocks of the crater was studied by the cores of drillholes 50 and 11475 situated in the south-western part of the melt sheet. Two main types of impact melt rocks are distinguished in it. The lower horizon of the melt sheet is composed of glassy matrix melt rocks with microliths of orthopyroxene and feldspars, while the upper one is presented by melt rocks with microliths of feldspars and completely chloritized pyroxene in cryptocrystalline matrix [1, 2]. The study of accessory minerals of impact melt rocks of the Boltysh structure shows their diversity, from native metals to sulfides and phosphates. A short description of native metals and alloys from impact melt rocks of the crater is presented. The data were obtained on polished samples by scanning electron microscope (SEM Jeol 6490) equipped with energy dispersive (EDS) and wave dispersive (WDS) X-rays spectrometers.

Preliminary Results: *Brass* was detected in the impact melt rock with weakly devitrified glassy matrix and microliths of plagioclase and hypersthene (drillhole 11475, interval 761 m). Brass forms irregular grains from 2x3 μm to 10x15 μm in size in the glass (Fig. 1). The zinc content of brass is 35.80 – 37.51 wt.% (Table 1), and the atomic ratio of Cu/Zn is from 1.7:1 to 1.8:1. Earlier, a brass with zinc content from 30 to 45 wt.% was found in lunar basalts as a lunar-only mineral, because it was not known in any rock types of the Earth [3]. Besides brass, two grains of copper-nickel alloy, 3x5 and 5x8 μm in size, were found in the same core sample of impact melt rock (Table 1). The content of nickel in their composition is 16.85 wt.% and 18.85 wt.%, and the atomic ratio of Cu/Ni is 3.8:1 and 4.0:1.

Only one grain of *gold* was discovered in the same core sample. The grain of irregular form is 1.8x2.5 μm in size. The gold content of it is 92.59 wt.%, and admixtures of oxygen, aluminium and silicon in the analysis are connected with the influence of the matrix matter.

Native metals: platinum, copper and silver were found in the basal part of the horizon of impact melt rock with cryptocrystalline matrix and completely chloritized microliths of pyroxene.

Native copper forms irregular homogeneous segregations and vienlets from several μm up to 80 μm in length (Fig. 2). Its segregations and grains occur predominantly at the contacts of the microliths with matrix. The copper content of the mineral is 96-99 wt.%. The main admixture in copper is iron, and its content reaches 3 wt.% (Table 1). The admixture of osmium was determined by SEM-WDS analyses along some profiles of copper grains, but its content is below the detection limits (0.01%).

Native platinum mostly forms irregular inclusions in copper (Fig. 2), also it occurs as individual grains in matrix at the contacts with chlorite segregations. The size of its grains ranges from 2x3 μm to 3x8 μm. The mineral contains up to 99 wt.% of platinum, up to 2.2 wt.% of iron and about 0.5 wt.% of copper. The presence of iridium, osmium, ruthenium, rhodium, and gold in platinum were determined by SEM EDS-WDS quantitative analyses along some profiles of platinum inclusions, which show distinct 2-3-fold excess compared to the content of those platinoids in surrounding matrix. The point counting analysis of platinum grains rarely shows the content of above-mentioned platinoids up to 0.0n – 0.n wt.%.

Cuproplatinum [4] is presented by individual grains of irregular form in the same rock sample, alongside platinum. The composition of mineral corresponds to 80-85 wt.% of platinum and 12-15 wt.% of copper, content of iron reaches up to 1.8 wt.% (Table 1). Cuproplatinum was described for the first time in the rocks of serpentinized and chloritized ultramafic and mafic massifs as the product of the alteration processes [4, 5].

Native silver was found in the same rock sample along with platinum and copper. Silver forms irregular grains and accumulations at the contacts of chlorite with matrix (Fig. 3). The size of silver grains is up to 10 μm, but some vein-like aggregates reach up to 10 μm in thickness and 50 μm in length. The content of silver is 95-99 wt.%, and the main admixtures are iron and silicon (Table 1).

Discussion: The formation of accessory minerals in impact melt rocks of the Boltysh crater comprises various conditions from their exsolution in impact

melts to crystallization at the hydrothermal alteration process.

The exsolution of brass, copper-nickel alloy and gold occurred in the high-temperature impact melt as the result of liquation. The temperature of solidification of brass with the content of zinc of ~ 35% is about 900°C.

The exsolution of brass, copper-nickel alloy and gold occurred in the high-temperature impact melt as the result of liquation. The temperature of solidification of brass with the content of zinc of ~ 35% is about 900°C. Formation of gold may be estimated as occurring at a temperature about 1070°C [6]. The direct contacts of those minerals with microliths were not observed. In the same time the temperatures of their origin are close to the temperatures of formation of orthopyroxenes: from 1140°C for enstatite to 955°C for ferrohypersthene [7], while composition of orthopyroxene in the studied core sample changes from En_{70-75} in the earliest microliths to En_{25-30} in the latest ones.

The mineralization of copper, platinum and silver occurs in intensively altered impact melt rock. It is supposed that their formation was determined by the same alteration process, that the chloritization of pyroxene. The dispersed accessory sulphide mineralization is proposed as the source of native metals in chloritized melt rocks.

	Cu-Zn	Cu-Zn	Cu-Ni	Cu	Cu	Pt	Pt	Ag	Ag
Cu	60.26	61.88	77.91	97.25	99.18	0.55	-	-	-
Ag	n.d.	n.d.	n.d.	n.d.	n.d.	-	n.d.	99.87	100.60
Au	n.d.	n.d.	n.d.	n.d.	n.d.	-	n.d.	-	n.d.
Fe	-	-	2.25	2.39	0.44	1.21	0.96	0.70	-
Ni	-	-	18.85	n.d.	n.d.	-	n.d.	-	n.d.
Zn	35.84	37.51	n.d.	n.d.	n.d.	-	n.d.	-	n.d.
Pt	n.d.	-	n.d.	n.d.	-	96.48	99.04	-	-
Si	-	0.43	0.67	n.d.	0.56	0.70	-	-	0.44
Total	96.10	99.82	99.68	99.64	100.18	98.94	100.00	100.57	101.04

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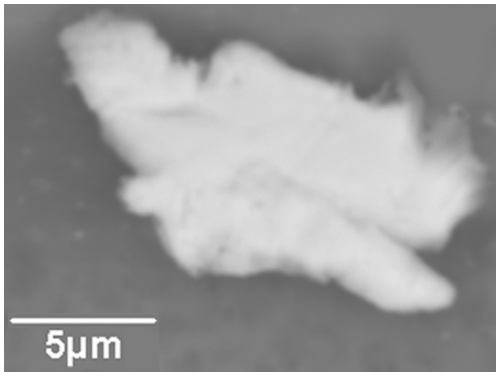

Fig.1. The segregation of brass in glassy matrix (drillhole 11475, depth 761 m). SEM image, BEC mode.

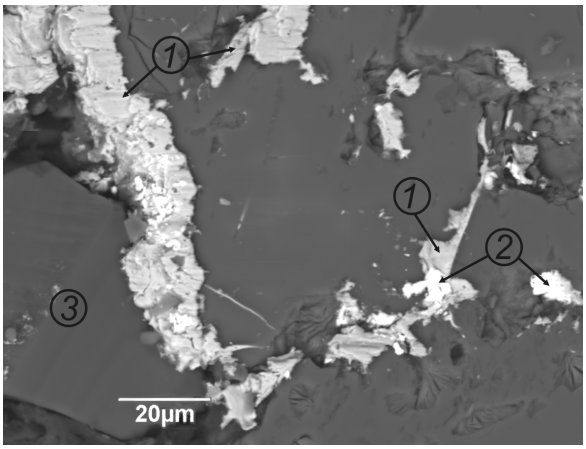

Fig. 2. The copper vienlets and grains (1,light grey) with inclusions of platinum (2, white) in microliths of feldspar (3) (drillhole 50, depth 650 m). SEM image, BEC mode.

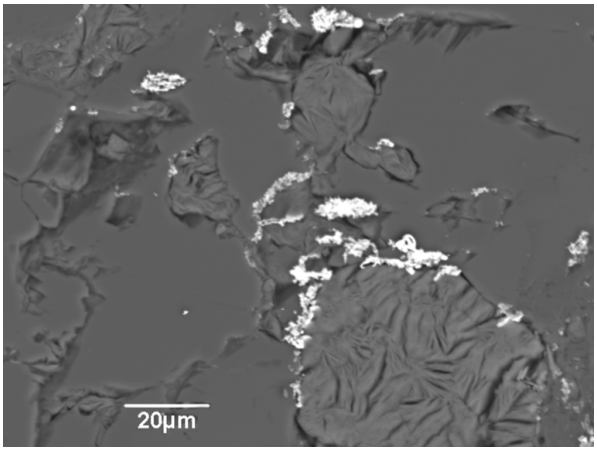

Fig. 3. The silver aggregates (white) at the contacts of chlorite and matrix (drillhole 50, depth 650 m). SEM image, BEC mode.