# EXPERIMENTAL RESULT ON OBSIDIAN EVAPORATION AND ITS APPLICATION TO IMPACT GLASSES COMPOSITIONS

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High velocity impacts lead to melting, selective and then complete vaporization of the target rocks. In this process, selective vaporization changes the chemical composition of the melts comparing to the initial target rocks. However, sometimes it is a problem to find the signatures of the vaporization effects in the products of impact melting. Here we present experimental data on vaporization of the obsidian that permits to reveal the vaporization signatures in impact glasses formed from acidic and intermediate targets.

The experiments were carried out in a pulse-laser setup in the regime of a free generation of laser radiation [1]. The Nd glass laser had the following parameters: a wavelength of $\lambda$=1,06 µm, a pulse energy of 600 J, a power density of radiation of ~$10^6$-$10^7$ W/cm$^2$, and a pulse time of ~$10^{-3}$s. Typical temperature under such condition is 3000-4000 K. The experiments were performed in air at 1 atm. The laser beam focused to a diameter of ~2 mm, melted and vaporized a few tens of milligrams of the sample. A metal screen was installed in the path of the vapor and melt droplets at the distance ~7cm from the sample. The glass spherules were found on the condensate film. They were resulted because high vapor pressure in the vaporization zone produced a vapor flow out of the cavity, carrying out some of the melt as tiny spherical particles (1-5 µm in diameter). The "life time" of droplets in a melted state was estimated to be ≤ 0.01 s. These parameters of the experiments roughly correspond to typical conditions of melting and vaporization at the impact velocity of about ≥10 km/s [1].

The obsidian composition was (wt.%): $SiO_2$ 57.90; $TiO_2$ 1.32; $Al_2O_3$ 15.02; FeO 9.31; MgO 5.11; CaO 7.37; $Na_2O$ 2.99; $K_2O$ 0.53. Chemical analyses of the experimental glasses were made with X-ray microprobe. We analyzed 83 glass spherules and 10 microareas of glass coating in the laser cavity. The results for K, Na, Fe, Si, Mg, Ca, Ti, Al were statistically treated and compared with compositions of the initial obsidian.

Figures 1and 2 show the negative correlation trends between contents of the moderately volatile Na and Si and nonvolatile Al in the glass spherules. These figures show also increase of Al and decrease of Si and Na contents in spherules and the cavity glasses as compared with the contents in obsidian. It's important to note that levels of Al content increase and Si decrease depend on the temperature and thus could be used as a kind of thermometer of the vaporization process. Obviously the larger Al and the smaller Si contents are in the glasses the higher temperature of the melt was.

**Fig. 1**

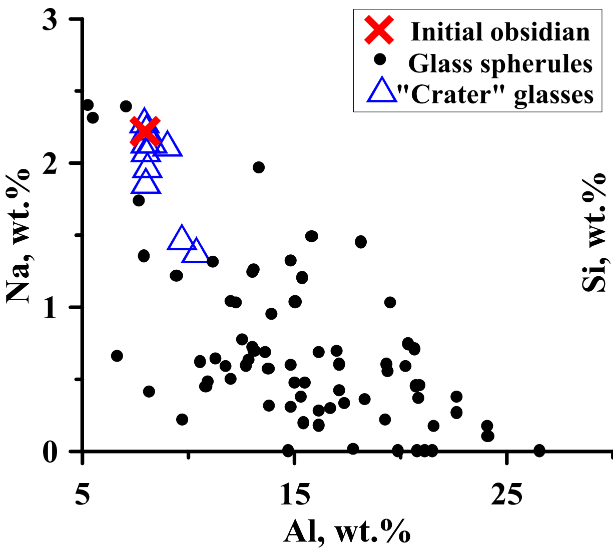
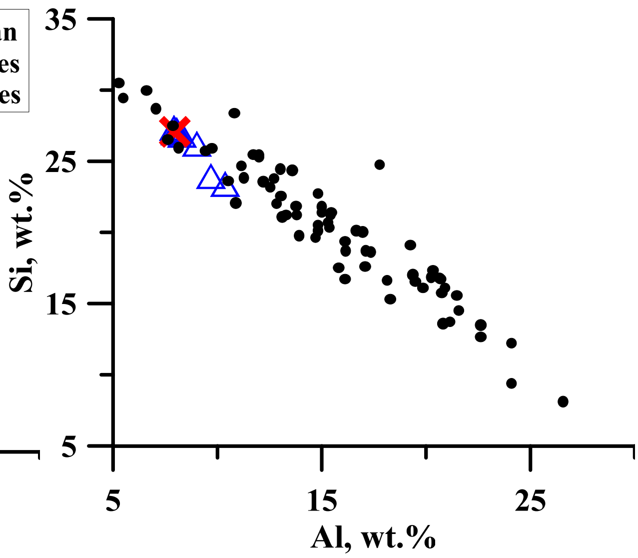
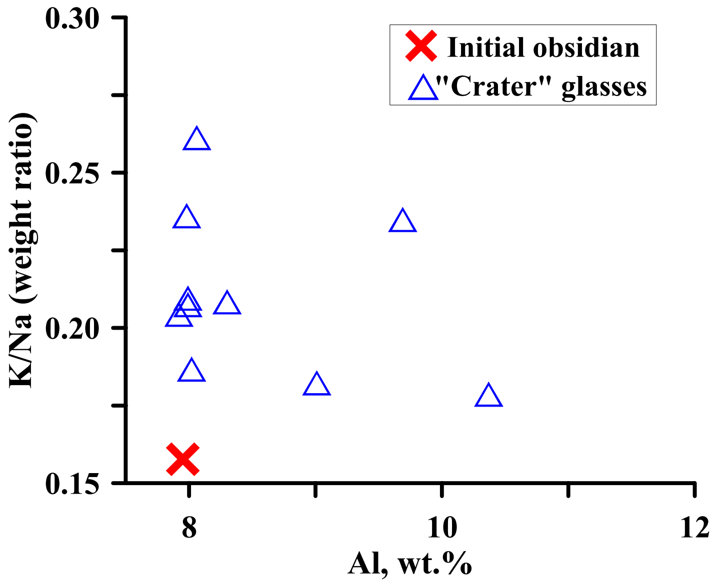



**Fig. 2**



The cavity glasses are compositionally close to the initial obsidian so they may be the low-temperature glasses. They have higher K/Na ratio as compared with the initial one for the obsidian (fig. 3). This is due to different K and Na vaporization rates that is typical for acidic and intermediate melts [2].

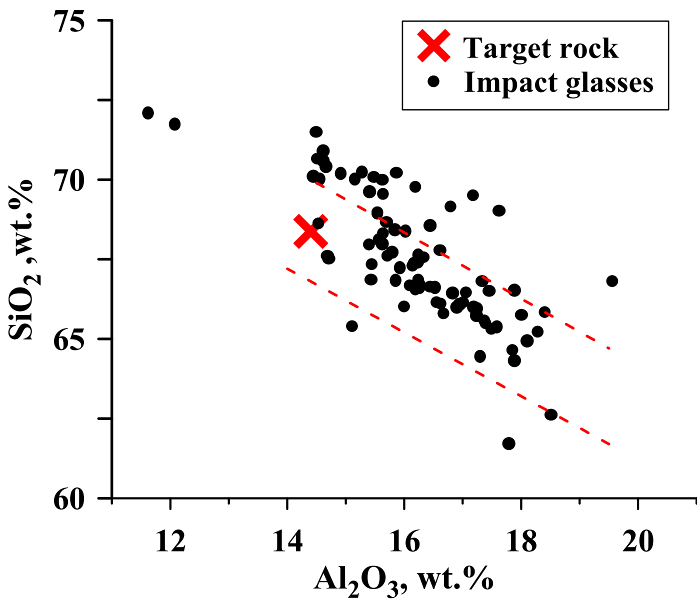
**Fig. 3**




To identify the vaporization effects in natural impact melts we choosed glasses from the Logoi asrobleme (D≈10 km; Belorussia) [3] which has a two-layer target with underlying granite-gneisses and overlying sandstones. Impact glasses here were mainly resulted of granite-gneiss melting. Fig. 4 shows the $SiO_2$ and $Al_2O_3$ contents in the homogeneous impact glasses and their average contents in the granite-gneisses.

The method of identification of the vaporization effects in natural impact glasses consists in “overlaying” of the experimental compositional trends on the natural glass compositions and subsequent selection of those compositions which show chemical trends identical to the discovered in the experiment. Fig. 4 shows the composition field with negative correlation of $SiO_2$ and $Al_2O_3$ contents that is similar to the experimental trend (fig. 2) and it is thought to be a result of the selective vaporization process.

**Fig. 4**



To test if the identification is correct it is necessary to look at the correlation relationships for other melt components, which must be similar to the experimental ones. Fig. 5,6 demonstate Na-Al and K/Na-Al correlation trends for impact glasses from the chosen composition field of fig. 4. On the whole these trends are similar to the experimental ones that confirms the validity of our method.

**Fig. 5**

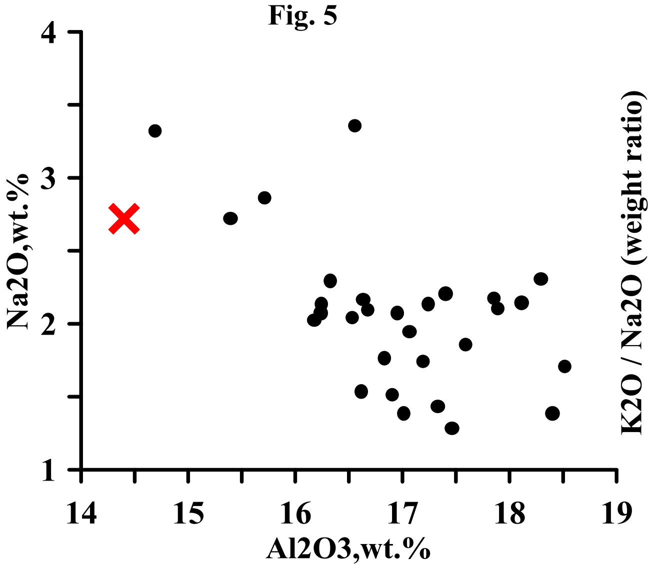
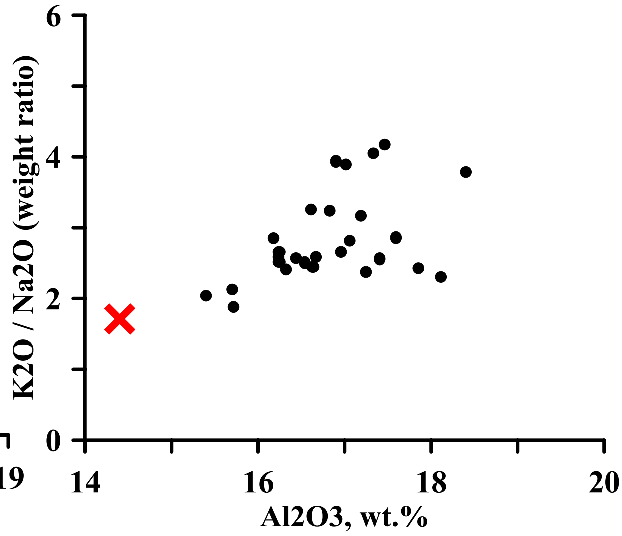



**Fig. 6**




*This work was supported by RFFI grant 01-05-64564-a*

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*Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № - № 1(21)'2003*
*Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2003*
*URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2003/informbul-1_2003/planet-5e.pdf*
*Published on July 15, 2003*