VAPORIZATION BY SHOCK LOADING OF ALBITE, JADEITE, AND PYREX GLASS: EXPERIMENTAL STUDY. D.D.Badjukov(1) and T.L.Petrova(2);(1) - Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin St. 19, Moscow 117975, Russia; (2) - Institute of Lithosphere, Staromonetny per., Moscow.

Produced by shock experiments impact melts of albite,jadeite and pyrex glass demonstrate a loss of both Na and Al relative to Si, which can be due to selective vaporization. It is suggested that the high volatility of Al is related to volatility of a Na-Al compound of proposed $NaAlO_2$ composition. The similar loss of Al and Na seems to be possible during tektite-forming processes.

A degree of selective vaporization and modification of a melt chemical composition during impact processes is still poorly understood. The selective vaporization of some elements has been shown by shock experiments [1,2]. The vaporization and condensation processes can take place in the lunar regolith [3] .On this base there are hypotheses explaining differentiation of planetary bodies through the impact vaporization [4]. On the other hand studies of tektites, impact glasses and lunar soils show that bulk compositions of impact melts are not modified significantly. In order to estimate degree of the vaporization during shock fusion, chemical compositions of experimentally produced impact melts were studied. We chosen Al-containing compositions, because a high volatilization of Al during unequlibrated evaporization had been demonstrated [5,6].

Powder samples of pure albite and jadeite were shocked in steel cylindrical containers surrounded by high explosive. Due to a geometry of a shock wave propagation and a porosity of the samples, high pressure and temperature were generated in an area located along the sample cylinder axis. Unfortunately, we cannot determine achieved shock parameters exactly, but an estimation gives the peak pressure of about 70 Gpa and the shock temperature of about 5000 C. For the study chips of vesiculated glasses were picked up from central part of the samples. In addition, we studied melt containing particles produced by impact experiments on a light gas gun. The experiments were carried out with pyrex glass projectiles, which were launched with velocity of 6 km/s onto a silicate target. The peak pressure depending on impedances of the targets varied from 51 to 65 GPa. Remelted projectile glasses adhering to the shock fused agglutinates were studied.The produced glasses were analyzed by electron probe with using the broad beam method.

The albite and jadeite glasses contain steel droplets, which could come into the melt from walls and bottoms of the containers. In addition, black areas of the albite glass contain dissolved iron as a minor component and the jadeite glass is slightly enriched in Fe. Initial pyrex glass analyses totaled of about 84.5 wt%, that should be due to presence of boron. The shock fused pyrex glass has totals of about 86%, that suggest a B loss during the impact fusion. The compositions of the glasses (Fig.1) show loss of Na and Al too. Assuming that Si was not lost during the shock fusion, the loss of an evaporated matter can be estimated to be about 4 wt.% for the albite and jadeite glasses and to be 3.6 wt.% for the fused pyrex glass. Selective loss of Al is more pronounced, when we consider the ratios of Na_2O and Al_2O_3 to SiO_2 (Fig.2). The Al loss for the pyrex glass appears to be smaller, although it lies out of the range of the analytical uncertainties. The calculated atomic Na/Al ratio in the vapor is equal to 1.3 for the albite and jadeite glasses and to 26 for the fused pyrex glass. This difference could be due to the higher Na/Al ratio in the melt of pyrex glass relative to albite and jadeite, that could lead to the enrichment of the vapor phase in Na.

The unusual behavior of Al as a volatile element conflict with the relative sequence of the element volatilities [7], i.e. Al is lost more readily than Si. The behavior of Al can be explained by the formation of Na-Al clusters in the impact melt.If it is so, then vaporization of Na-Al compound would increase the volatility of Al with provided that the compound has a high volatility. On the base of Na/Al ratio in vapor phase for albite and jadeite glasses the composition of the compound may be $NaAl_2O_4$. Thus, a presence of Na could increase the volatility of Al, and vice versa, a presence of Al could decrease the volatility of Na. This suggestion is supported by the pattern of the Na and K depletion in fused projectiles, produced by laboratory cratering experiments [1]. When an Al-free soda-lime glass melts shows a loss of Na and K, basalt glass melts with 16 wt.% Al_2O_3 do not lose significant amount of Na by a smaller loss of K. However, in contrast to our results the experiments did not show any loss of Al, that may be due to very short time of melt existence. High rate of Al volatilization was observed by a experimental vaporization of feldspars [6].

Tektites is a most suitable object among other impact glasses for a search of traces of selective vaporization. For this reason we constructed a Na_2O/SiO_2-Al_2O_3/SiO_2diagram of average compositions of some tektites groups, irgisites, and their proposed parent materials (Fig.3). In general Figure 3 is similar to Figure 2.

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There are two causes for this similarity. The first may be the appearance of the effect of high rate of the Al volatilization. The second may be due to a variety of a quartz content in target rocks. If the latter is true, then any elements (e.g. Mg) should display a depletion similar to Al. However, the MgO/SiO2 ratio is higher in the tektites except for moldavites, than that in the target rocks. It may indicate a selective loss of Al and Na, because it is difficult to propose the local enrichment of the targets in quartz and Mg-bearing minerals at the same time. On the other hand the suggestion about the Na and Al depletion of the tektite groups depends on choice of parent material.

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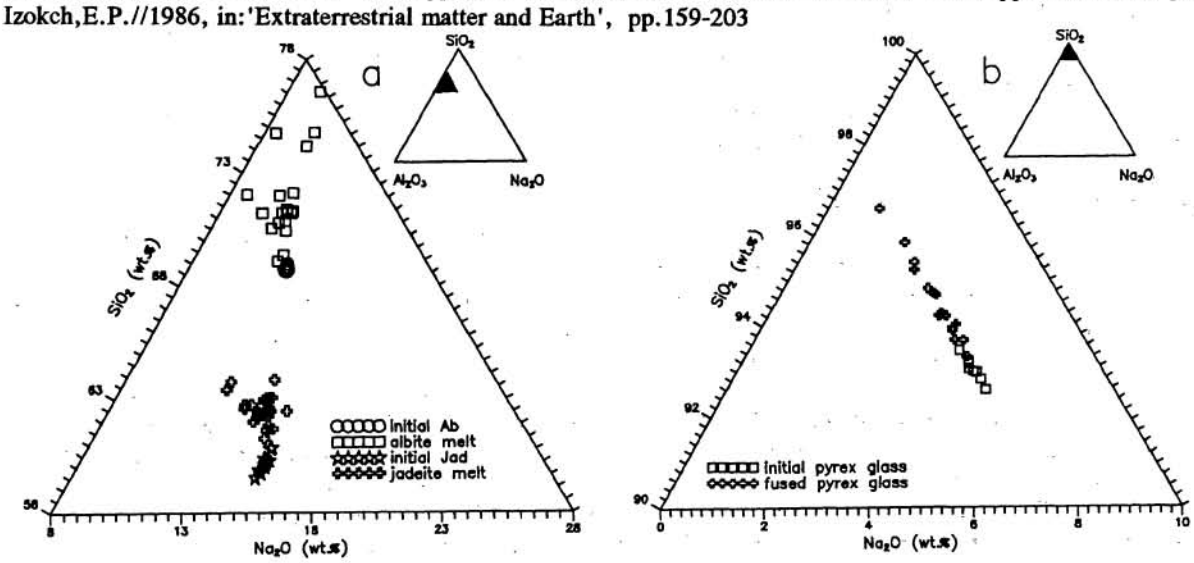

Fig. 1. Bulk chemistry of melts for albite, jadeite (a), and pyrex glass experiments onto a Al_2O_3–SiO_2–Na_2O diagram.

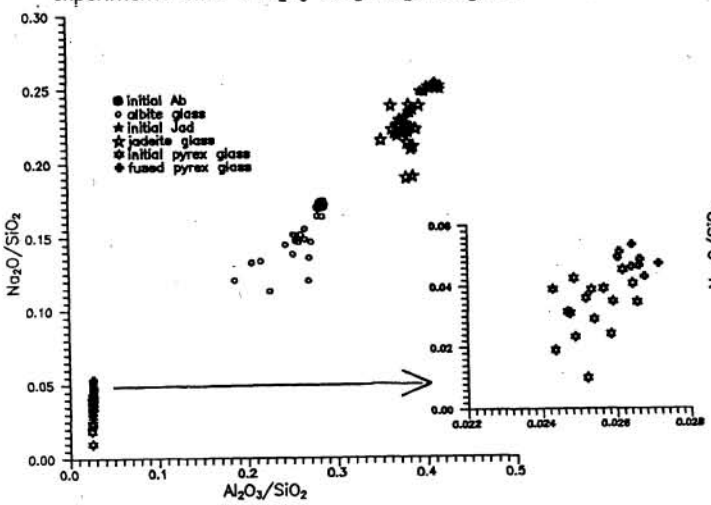

Fig. 2. Na_2O–Al_2O_3–SiO_2 relationships among melts produced by shock experiments. The composition of the melts shows depletion both Na_2O and Al_2O_3 relative to initial matter.

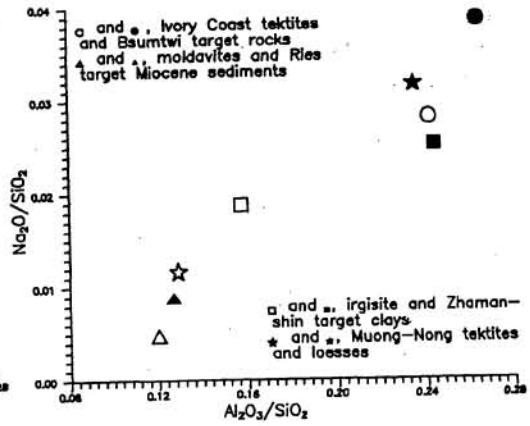

Fig.3. Na_2O–$Al_2O_3SiO_2$ relationship among tektites, irgisites (open symbols) and their proposed source rocks (solid symbols). Data from (8 – 11).