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The study of silicate differentiation during rapid high-temperature heating is important for understanding natural processes such as hypervelocity impacts or explosions. Vaporization processes can be simulated in experiments, but it is not always clear, how relevant these experiments are to naturally occurring processes. In this case it is important to find natural features which are similar to results obtained in experiments.

In our work (1-4) we used a powerful neodymium laser pulse focussed on the flat surface of a sample mounted in a closed cell filled with He at normal temperature and pressure. It was possible to evaporate 10-20 mg of sample using a laser pulse of 10^{-3} s duration and a luminosity density of 5×10^5 - 10^7 W/cm². The temperature at the place of vaporization was estimated as 4000 to 5000 K (1). A crater of melt appears at the place of heating and vaporization proceeds as a bubble process. Vapour bubbles provide good conditions for selective volatilization of elements leaving refractory components in the melt. Released vapour bubbles form a vapour cloud composed mainly of volatile elements. Small droplets of melt (from sub-mm to micron size) are dispersed into the vapour cloud and continue volatilization into the hot cloud. The same bubble boiling process occurs in a superheated melt during impact processes. It leads to a loss of volatile components from impact melts and formation of numerous droplets which are dispersed far from the crater centre (5).

To understand the chemical differentiation in such melts we analysed the melt formed on the crater wall and the dispersed droplets after laser pulse heating of different samples using a SEM with an energy dispersive x-ray analyser. The samples were a tektite and a clinopyroxene (augite) from a mantle xenolith, both of known composition.

In our previous work (4) it was shown that crater melts and droplets are significantly different in composition from the initial augite, i.e enriched in Ca, Al and Ti due to the loss of Na, Si and Fe. Droplets were more differentiated than crater melts. Analyses of crater melt and droplets are shown in the SiO₂-Al₂O₃-CaO ternary plot for experiments with tektite in Fig. 1a and for augite in Fig. 1b. Analyses of melts and droplets form a continuous row of compositions close to a line of constant Al₂O₃/CaO. Using the computer code "Magma" of Fegley and Cameron (6) we calculated the change of composition of a melt in isothermal equilibrium starting with the tektite and augite initial compositions. The results are shown in Fig. 1 as solid lines with indication of the temperatures used. While the thermodynamic data used were extrapolated from data obtained at temperatures below 2500 K to higher temperatures, the calculations are in good agreement with the experimental results (Fig. 1). It appears that a constant Al/Ca ratio is universal for a wide range of temperatures and up to a rather high degree of Si depletion. This effect has a rather simple reason. Calculations show that the quantity of Al and Ca in the melt does not change until it will almost totally be depleted in Na, K, Si and Fe. Thus, while a melt of tektite composition will lose at 3000 K about 98% of Si, the loss of Ca and Al will be less than 1%. Titanium as a refractory element is also conserved in the melt and we found its concentration increasing proportional to Ca and Al. A constant Al/Ca ratio in a continuous row of Si depletions is the signature of a vaporiza-

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tion process where different parts of a melt undergo various degrees of volatilization. The calculations show that the final melt composition depends on the temperature. Below 4000 K it will be corundum, but above 4000 K it will mostly consist of CaO. The good agreement of the experimental results with the calculations argues for a vaporization process close to thermodynamic equilibrium during the laser experiment for a time scale as small as about 10^{-5} s, the characteristic time for spreading of the vapour cloud.

Vaniman and Bish (7) reported the occurrence of yoshiokaite and HASP (high Al, Si poor) glasses in Apollo 14 lunar regolith breccias. They propose that yoshiokaite was formed from anorthite by volatilization of Si in impact melts. Yoshiokaite together with HASP glasses form a continuous row of compositions in the ternary $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO}$ plot with constant $\text{Al}_2\text{O}_3/\text{CaO}$ ratio, which is the same as for anorthite (7, 8). This agrees well with the results of our laser heating experiments and shows that these experiments can be used to explain differentiations due to natural impacts on the moon or other planetary bodies.

References : (1) M.V.Gerasimov et al. *Vestnik Acad.Nauk USSR*, **9**, 1985, 10-25 (in Russian). (2) L.M. Mukhin et al. *Nature* **340**, 1989, 46-48. (3) Yu.P. Dikov et al. *Lunar Planet. Science XX*, 1989, 244. (4) Yu.P. Dikov et al. *Lunar Planet. Sci. XXI*, 1990, 287. (5) Yu.B. Chernyak, M.D. Nussinov, *The Moon* **13**, 1975, 363-376. (6) B. Fegley and A.G.W. Cameron, *Earth Planet. Sci. Lett.* **82**, 1987, 207-222. (7) D.T. Vaniman, D.L. Bish, *Amer. Mineral.* **75**, 1990, 676-686. (8) D.T. Vaniman, G. Heiken, P. Warren, E. Jerde, *Lunar Planet. Sci. XIX*, 1988, 1215.

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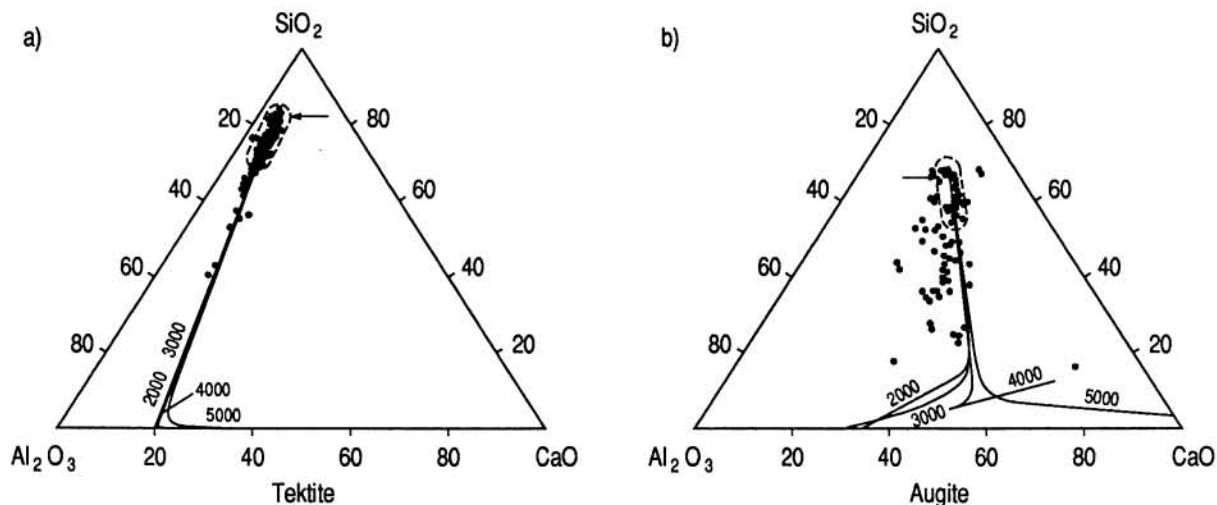


Fig. 1. Analyses of crater melts (points inside dashed outline) and of melt droplets in the ternary system $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO}$ for tektite (a) and augite (b). Arrow points to initial composition. Solid lines show the calculated change in composition due to volatilization at different temperatures (see text).