

STUDY OF EVAPORATION OF MICROELEMENTS FROM ANORTHOSITE AND ICP-MS ANALYSES OF THE CONDENSATE PRODUCTS. O.I.Yakovlev¹, L.I.Ivanov², V.P.Kolotov¹, N.N.Dogadkin¹, V.K.Karandashev³, E.E.Kazilin², and V.S.Popov²; ¹Vernadsky Institute of Geochemistry & Analytical Chemistry, RAS, Moscow 119991, Kosygin St., 19 (yakovlev@geokhi.ru); ²Institute of Metallurgy and Material Sciences RAS, Moscow; ³Institute of Microelectronics Technology and High Purity Materials, RAS, Chernogolovka (karan@ipmt-hpm.ac.ru).

Introduction: It is known that high velocity impacts might lead to melting and evaporation of rocks on the lunar surface. In this process selective evaporation of the melts as well as vapor condensation change the chemical composition of the materials. However there are few data especially for microelement distribution between the vapor phase and impact melt at high temperature conditions even for main rocks such as basalt and anorthosite. Meanwhile such information can provide insight into origin of some chemically exotic lunar rocks.

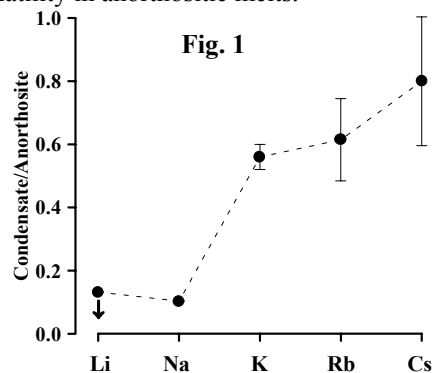
To study possible chemical alterations, which might happen during the evaporation of lunar highland rocks, we carried out the impulse melting experiments using an anorthosite sample. The experiments permitted to collect amount of the condensate matter large enough to make chemical analysis by means of ICP-MS method. The comparison of chemical composition of the condensate with the initial anorthosite allows to predict element redistribution between the products of anorthositic impact melts and their vapor/condensate.

Experimental technique: The evaporation of anorthosite was performed using a laser pulse technique [1]. The Nd glass laser had the following parameters: the wavelength - 1,06 μm , the energy of a pulse 600 J, the irradiation intensity 10^6 - 10^7 W/cm², and a pulse duration $\sim 10^{-3}$ s. Typical temperature reached under such conditions is about 4000 K. The experiments were performed in vacuum at 10^{-3} torr. The sample of anorthosite was fixed in hermetic cell with internal volume about 2000 cm³. The laser beam was focused onto a spot with diameter ~ 3 mm where melting and evaporation of the anorthosite took place. The vapor was precipitated on the superpure Si plates at ~ 6 -8 cm from the sample. The specific feature of these experiments consisted in stepwise moving of anorthosite target to ensure a fresh surface for each laser pulse. The developed technique permitted to increase the mass of the condensate product needed for good quality analysis by ICP-MS method. About a hundred laser pulses provided formation of condensate film of $\sim 10^4$ μm thick. The total mass of the condensate for a single series of the experiments was about 20 mg.

The target sample was fine-grained anorthosite (grain ≤ 0.5 mm) which had the following composition

(wt.%): SiO₂ 45.2; TiO₂ 0.04; Al₂O₃ 36.2; Fe₂O₃ 0.61; MnO 0.13; MgO 0.31; CaO 14.5; Na₂O 2.2; K₂O 0.77.

Results: Analytical data are shown in Figs. 1-3 as ratios of element concentrations in the condensate to the initial anorthosite. The ratios are calculated for alkaline elements (Fig.1), REE and refractory lithophile elements (Fig.2), volatile metals and some siderophile elements (Fig.3). The error bars shown on the Fig. 1-3 correspond to 2σ value. The contents of some elements in the condensate were below the limits of detectability. These results are shown in Fig. 1-3 as point with arrow. The value of such point is equal to ratio of the element detection limit in the condensate to its concentration in the initial anorthosite. As it follows from Fig.3 the evaporation of anorthositic melt leads to the loss of volatile elements. For majority of lithophile elements the ratio condensate/anorthosite is less than 1 (Fig.2) that implies the increasing of concentration of these elements in the residual melt. This conclusion is also valid for the elements whose concentration in the condensate lies below the detection limit. It is worth to pay attention to low ratios for Sr and Ba that allows to suggest the extremely high enrichment of the melt with plagiophile microelements. Low ratios for alkaline elements (Fig.1) are enough unexpected result of these experiments. Particularly prominently such effect is expressed for sodium that may be explained its low volatility in anorthositic melts.



These results allow to conclude that during evaporation of anorthositic melt the sodium contents should be noticeably increased in the residual melt.

The problem of the alkali anorthosites. Lunar alkali anorthosites are rocks enriched both in alkaline and incompatible elements [2,3,4]. The rocks contain

more plagiophile elements (Na, Sr, Ba, Eu) than ferroan anorthosites. To explain origin of these rocks, various models: specific magmatic crystallization, assimilation, and metasomatism, have been invoked but the problem still remains obscure.

It is obvious that impact melting and selective evaporation of lunar anorthosites should result in the similar geochemical trend that is observed in our experiments: depletion of the residual melt with volatile elements and its enrichment with refractory lithophile elements as well as volatile alkali elements. This conclusion, based on the experimental results, is qualitatively in a good agreement with observable geochemical features of the lunar alkali anorthosites. Using ob-

tained data we can suppose that alkali anorthosites form from the residual impact anorthositic melt which was enriched due to selective evaporation in both alkali and incompatible elements.

References: [1] Gerasimov M.V. et al. (1999), *Physics and Chemistry of Impacts*. In: *Laboratory Astrophysics and Space Research*, P. Ehrenfreund et al. (eds.), KAP, 279-329; [2] Papike J.J. et al. (1998), *Lunar Samples. 5*. 1-234. In: *Planetary Materials. Reviews in Mineralogy*, J.J. Papike (eds.), v. 36; [3] Warren P.H., Wasson J.T. (1980), *Proc. LPC*, 11th, 431-470; [4] Snyder G.A. et al. (1992), *Proc. LPSC*, v.22, 399-416.

