THE EVAPORATION PECULIARITIES OF Ca–Al–INCLUSIONS OF CHONDRITES.

O. I. Yakovlev and S. I. Shornikov, Vernadsky Institute of Geochemistry & Analytical Chemistry of RAS, Kosygin st. 19, Moscow 119991, Russia, e-mail: yakovlev@geokhi.ru, sergey.shornikov@gmail.com.

Calcium and aluminium rich inclusions of chondrites (CAIs) are unique geochemistry objects. CAIs represent the most primitive matter of the Solar system with the age of 4.567 billion years.

During the high-temperature evaporation of CAIs melts (consisting mainly of SiO_2, MgO, CaO and Al_2O_3 oxides), there are the inversion of the volatility of SiO_2 and MgO. As a matter of fact the silicon oxide being more volatile than magnesium oxide are becoming less volatile under the evaporation conditions of melts inriched of CaO and Al_2O_3 oxides. The volatility inversion is well explained in the framework of the Korginsky's theory of the acid-base interaction of components in silicate melts [1]. According to the theory, the increase of the CaO content in the melt of the CaO–MgO–Al_2O_3–SiO_2 system leads to increasing of melt basicity, that in turn leads to increasing the MgO thermodinamic activity and volatility, and to decreasing activity and volatility of the SiO_2. In the first approximation the evaporation process of CAIs melts can be described in terms of the ternary CMAS oxide system. The oxides are divided into the next groups on acid-basic properties: acidic (SiO_2), amphoteric (Al_2O_3) and basic (CaO and MgO). Moreover, the CaO as the main basic oxide of melts, is a major donor to oxygen ions, and its concentration indirectly specifies the basic index of the melts.

It follows: 1) the concentration increasing of calcium oxide in the melt should allow: a) to increase activity and the volatility of MgO, and b) to the drop of the activity and the volatility of SiO_2. The activity calculation carried out according to [2] and [3], illustrates the forecast of the theory and clearly shows the inversion in the activity values of SiO_2 and MgO, depending on the CaO content in the melt (Fig. 1); 2) during the evaporation the increasing of calcium oxide concentration in the melt should lead to a reduction in the MgO content and relative increase of the SiO_2 content. As a result of this process the ratio of MgO : SiO_2 in the residual melt should decrease, as observed in the real Ca–Al–inclusions.

As shown by the analysis of the isotopic mass fractionation data of magnesium and silicon in the residue after evaporation of the melts [4], acid-basic factor has a strong influence on the efficiency of the separation isotopes. Fig. 2 clearly shows that the efficiency of isotope separation of magnesium compared to silicon isotopes in the CMAS melts increases with an increasing content of CaO.

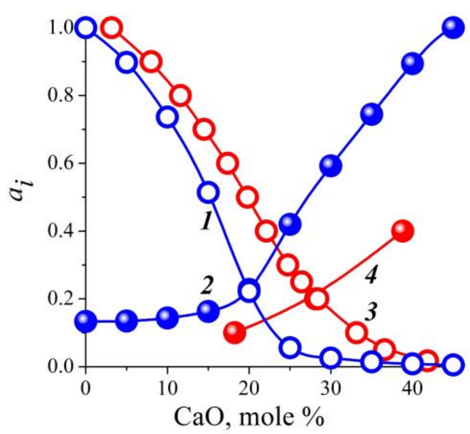

Fig. 1. The activities of SiO_2 (*1*, *3*) and MgO (*2*, *4*) *vs*. the CaO content in the CaO–MgO–SiO_2 system at 1600 °C and MgO : SiO_2 = 2 : 3 mole ratio according to the data: *1* and *2* – [3], *3* and *4* – [2].

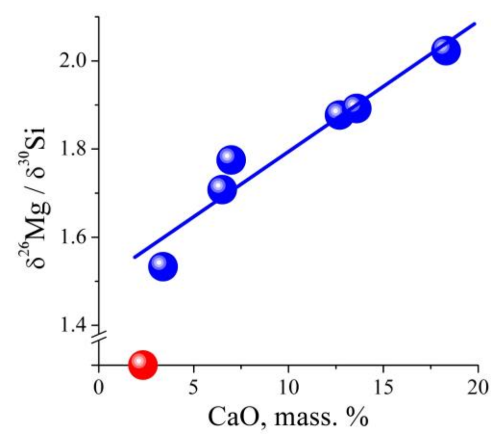

Fig. 2. The fractionation effectivity of the Mg and Si isotopes *vs*. the CaO content. The CaO initial content denoted the red symbol.

References: [1] Korginsky D. S. 1959. *Doklady AN SSSR* 128: 383–386. [2] Rein R. H. and Chipman J. 1965. *Trans. Met. Soc. AIME* 233: 415–425. [3] Shornikov S. I. 2008. *Experiment in Geosciences* 15: 147–149. [4] Mendybaev R. A. et al., 2013. *Geochim. Cosmochim. Acta* 123: 368–384.