FORMATION OF THE HIGH-ALUMINUM REFRACTORY INCLUSIONS IN CARBONACEOUS CHONDRITES AS A RESULT OF EVAPORATION. K.M. Ryazantsev, Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin St. 19, Moscow, 119991; ryazan-konst@rambler.ru

Introduction: Refractory Ca-Al-rich inclusions (CAIs) are the oldest material of the Solar System. Among CAIs there is a group of inclusions highly enriched in. These inclusions contain corundum Al_2O_3, hibonite $CaAl_{12}O_{19}$, grossite ($CaAl_4O_7$) and dmitriyivanovite ($CaAl_2O_4$). In general, the inclusions occur in CR, CH and CB chondrites [1, 2, 3, 4]. Currently they are considered mostly as a result of early high-temperature condensation [5, 6]. Here we present results of two experiments, which show that mineral associations, typical for the high-Al inclusions, could be resulted from high-temperature evaporation.

Experiment: Two sets of experiments were carried out. First set included evaporation of 19 anorthite (An_{90-92}) samples, weighing - 60±1 mg. The evaporation time was 5 min at different temperatures (from 1450 to 2230 °C), the mass losses were from 1 to 91 wt% (the high value may be overstated). The second set included evaporation of a mixture consisting of 30 wt% of anorthite (An_{90-92}), 40 wt% of diopside (1-1,5 wt.% FeO), and 30 wt% of Mg,Al-spinel. 27 samples of the mixture were evaporated at different temperatures (from 1650 to 2200 °C) during 10 min. The weight of each sample was 100±5 mg, , the mass losses – were from 4 to 72 wt%. Each sample was evaporated using the Langmuir effusive technique in a tungsten cell in vacuum. The samples obtained after the evaporation are composed from a glass and new formed phases. They were analyzed using ASEM and EMPA. Bulk compositions of the samples were computed using mineral chemistry and mineral modes.

Results: The new formed phases are Al-spinel, hibonite, grossite, dmitriyivanovite, and corudum. These are the phases which are commonly present in the high Al CAIs. Fig. 1 shows an example of the new formed phases. Based on the bulk composition of the residual samples we got the evaporation sequence that is Mg→Si→Ca→Al and similar to that reported in other experimental studies of the CMAS system [7, 8, 9]. Fig. 2 shows compositions of the residual samples, which form certain trends on the three-element diagram.

Discussion:. Fig. 3 shows compositions of high-Al CAIs from four publications [1, 2, 10, 11]. The evaporation trends obtained in the study lead to the area of the well-known CAIs compositions. The trends successively pass across compositions of 12 assotiations on the three element diagram (Fig. 3): 1) An+Hib+Gel 2) Hib+Gel 3) Hib+Gel+Gr 3) Gr+Gel 4) Gr+Gel+Dm 5) Gel+Dm 6) Dm 7) Dm+Gr 8) Gr 9) Gr+Hib 10) Hib 11) Hib+Cor 12) Cor, where anorthite (An), grossite (Gr), corundum (Cor), hibonite (Hib), dmitriyivanovite (Dm), gelenite (Gel). The most of these associations are present in the high Al CAIs. The CAIs have a round shape similar to that of molten droplets with igneous texture and clear crystallization sequence of minerals. Thus our experimental data suggest that mineral and chemical composition of the high Al CAIs could be produced by evaporation of dust enriched in Ca, Al, Mg, and Si in the solar nebula.

References: [1] Kuruma M., et. al. (1993), *GCA*, 57, 2329-2360. [2] Weber D. and Bichoff A. (1994), *GCA*, 58, 3855-3877. [3] Krot A.N., et. al. (2002), *Meteor. Planet. Sci.*, 37, 1451-1490. [4] Krot A.N., et. al. (2006), *Chem. Erde*, 66, 57-76. [5] Krot A.N., et. al. (2009), *GCA*, 73, 4963-4997. [6] Simon S.B., et. al. (2002), *Meteor. Planet. Sci.*, 37, 533-548. [7] Ulyanov A.A. et. al. (1981) *LPI XII*, 1106-1108. [8] Wang J., et. al. (2001), *GCA*, 65, 479-494. [9] Floss Ch., et. al. (1996), *GCA*, 60, 1975-1997. [10] Krot A.N., et. al. (2001), *Meteor. Planet. Sci.*, 36, 1189-1216. [11] Ivanova M.A. (2002), *Meteor. Planet. Sci.*, 33, 1337-1344.

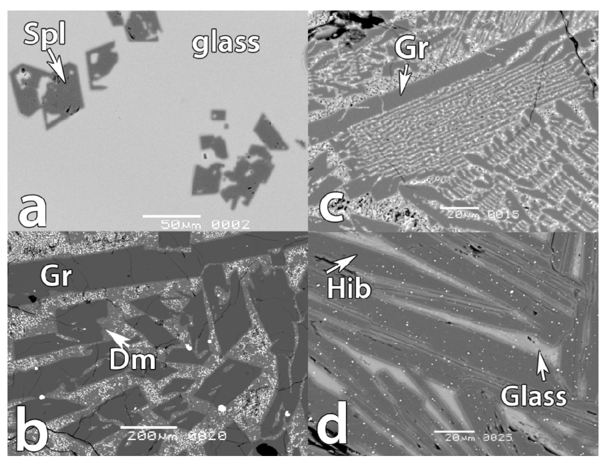

Fig. 1. New formed phases in the residual samples: a – spinel (Spl); b, c – grossite (Gr), dmitriyivanovite (Dm); d – hibonite (Hib).

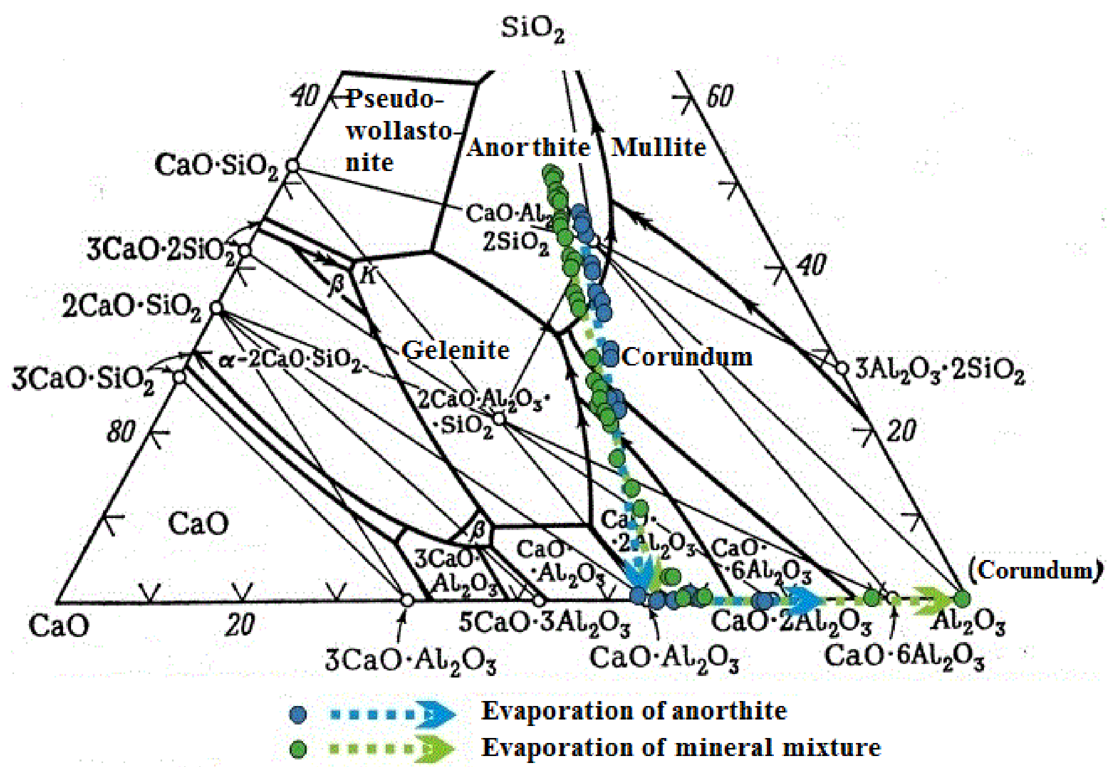

Fig. 2. Trends of evaporation on the three-element diagram.

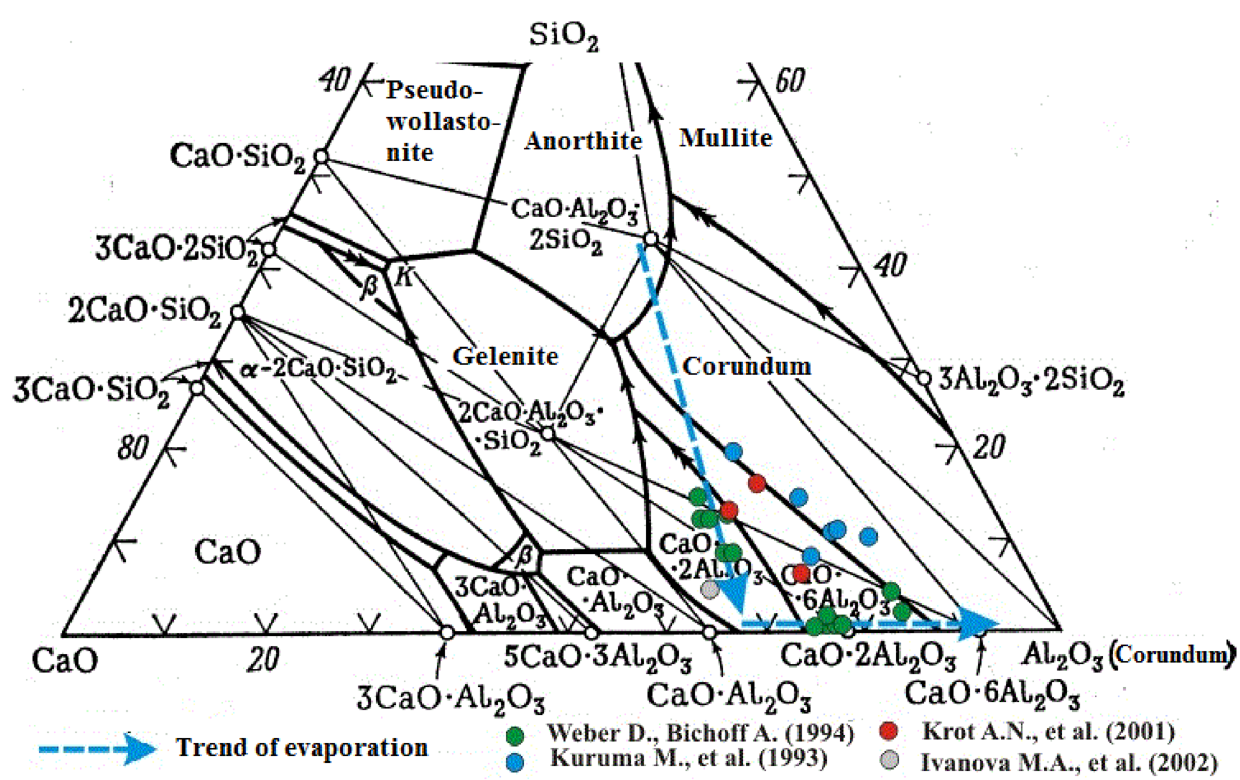

Fig. 3. Compositions of the high-Al CAIs [1, 2, 10, 11] and the trend of evaporation.