Unusual Garnet Megacryst with a partly-crystallized melt inclusion from Cenozoic alkali basalts of Shavaryn Tsaram Paleovolcano (Mongolia): a captured material of the Earth's interior or a ‘melt pocket’

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The ultramafic xenoliths and megacrysts in the intraplate alkali basalts are one of the most important information sources about the composition of substance of the Earth's mantle and the lower part of lithosphere outside the cratons. We studied alkali basalts of Shavaryn Tsaram Paleovolcano (Mongolia), which extraordinarily enriched with the different types of megacrysts and ultrabasic inclusions. We found large (up to 5 cm in diameter) garnet megacryst hosting an aggregate in its core. The aggregate is complex and consists of porous glass and crystallized minerals, such as biotite, orthopyroxene, spinel, clinopyroxene, olivine, and ilmenite. The question arises - Was it a captured substance of the Earth's mantle/upper crust? Or it was a zone of partial melting inside the garnet megacryst, so-called ‘melt pocket’.

The composition of each phase of the garnet megacryst with inclusion was studding with microprobe and ion probe. The data of oxygen isotopy as well as X-Ray images of host garnet and mica from partly-crystallized inclusion were obtained. In addition, we used WinTWQ 2.32 in order to describe PT conditions of minerals forming.

The careful study showed that the system was not completely closed: the crystallization inside the host garnet megacryst occurred not only due to the garnet's own substance, but also due to supply of the magmatic material. There were at least two acts of receipt of the new substance. 1 portion penetrated into the fractured (probably, during the explosion) crystal of garnet and formed Mica, Spinel, Orthopyroxene, and Clinopyroxene. 2 portion had a basically different composition as evidenced ilmenite frosting on the spinel crystals, along with recrystallization of the orthopyroxenes peripheral parts.

WinTWQ 2.32 allowed us to reconstruct conditions of some phases of the garnet transformation. Some point after the formation this garnet megacryst becomes fractured. At T 1120-11400C, P 0.75-0.8 GPA it is captured by basaltic melt and basaltic melt penetrated into it. For some time the aggregate existed at stable conditions, during this time the idiomorphic crystals Mica, Spinel, and Opx (T 1000-11200C, P 0.6-0.7 GPA) were crystallized. At the final stage (metasomatic), symplectites were formed (at T 950-10300C, P 0.55-0.65 GPA).
Thus, the megacryst under consideration was a trap for the Earth's upper crust substances. This rare finding contains evidence of both magmatic events (in secondary melt inclusion) and subsequent metasomatic events (in symplectites). Oxygen isotopy investigation showed that the host garnet and biotite, crystallized in the melt inclusion, has the same values of δ18O, indicating a common mantle source. However geochemical evidence registered supply of the material, which is alien to the garnet and the host alkali basalts.