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Formation of the garnet aggregate of the Khungui eclogite in the Zavkhan Terrane, Western Mongolia

Manzshir Bayarbold[1,2], Atsushi Okamoto[1], Otgonbayar Dandar[1,2], Masaoki Uno[1], and Noriyoshi Tsuchiya[1]

[1]Tohoku, Graduated School of Environmental Studies, Sendai, Japan (bayarbold.manzshir.t1@dc.tohoku.ac.jp)
[2]Geoscience Center, Mongolian University of Science and Technology, Mongolia

Garnet is one of the most important minerals that record the dehydration process within the subduction zone. The chemical composition of garnet is usually used to constrain the *P-T* conditions, but the fluid chemistry and the amounts of fluids related to the garnet formation are not fully understood within the deep subduction zone. For example, previous studies suggested that the mobility of HFSE (Ti, Nb, and Ta) are high in the eclogite-facies conditions compared to the low-grade rocks (Chen et al. 2018). In this study, we report the novel texture of garnet aggregate from the Khungui eclogite in the Zavkhan terrane of western Mongolia. We reveal that the variation of garnet texture and compositional zoning is closely related to the occurrence of the distribution of Ti-bearing minerals (rutile, ilmenite, and titanite).

The Khungui eclogite consists of garnet, omphacite, quartz, amphibole (barrosite, taramite, hornblende), phengite, plagioclase, epidote, Ti-bearing minerals (rutile, ilmenite, titanite) with minor K-feldspar, zircon and carbonate mineral. Based on the mineral assemblage, three metamorphic stages can be classified: prograde, eclogite (2.1–2.2 GPa, 580–610 °C), and decompression (0.1–0.5 GPa, 575–635 °C). The eclogite stage is presented by garnet + omphacite + barrosite + epidote + phengite + rutile. Based on the garnet microstructure and modal abundances of minerals, the Khungui eclogite is composed of two types of layers: layer I consist of garnet aggregate (GA), quartz and abundant Ti-bearing minerals whereas layer II is composed of single garnet grain (SG) with epidote and omphacite. The major element (Fe, Ca, Mg, and Mn) compositional zoning of the GA shows asymmetric zoning whereas the SG shows symmetric zoning. The EBSD analysis reveals that the GA contains numerous small individual garnet grains that are separated by high angle orientations and the grain boundary of the GA is not controlled by the major element zoning. The GA has inclusions of rutile and shows the close spatial relationship with rutile, ilmenite, and titanite in a matrix which are revealed through an analysis of thin section (Microscopy), element map (EPMA), and core sample (μX-ray CT). In addition, each garnet grains of GA and SG show the concentric zoning of a trace element such as Ti and are increasing concentration core to rim. The GA was often fractured and shows the Mn-rich compositions along the fracture that is close to Ti-bearing minerals which reveals that they formed in order of rutile => ilmenite => titanite at the retrograde stage. These observations suggest that nucleation of garnet to form aggregate could be induced by infiltration Ti-rich aqueous fluid at the

eclogite-facies condition, and also later fluid-infiltration caused the modification of garnet to form asymmetric compositional zoning of the GA and Ti-bearing minerals (ilmenite to titanite) at the exhumation stage.