北極圏ウラル、ライ・イズ岩体の斜方輝石岩の記載岩石学

Peculiar orthopyroxenites from Ray-Iz peridotite massif in the Polar Urals: Fossil path of CO_2-bearing aqueous fluids in the upper mantle

*石丸 聡子[1]、薗田 梨衣[2]、三浦 真[3,4]、ウラディミール シュメレフ[5]、荒井 章司[3]
*Satoko Ishimaru[1], Rie Sonoda[2], Makoto Miura[3,4], Vladimir R. Shmelev[5], Shoji Arai[3]

1. 熊本大学大学院 先端科学研究部 地球環境科学分野、2. 熊本大学大学院 自然科学研究科、3. 金沢大学理工研究域 自然システム学系、4. GIA 東京合同会社、5. ロシア科学アカデミーザバリツキー研究所
1. Department of Earth and Environmental Science, Faculty of Advanced Science and Technology, Kumamoto University, 2. Department of Earth and Environmental Science, Graduate School of Science and Technology, Kumamoto University, 3. Department of Earth Sciences, Faculty of Science, Kanazawa University, 4. Gemological Institute of America Inc., 5. Zavaritskii Institute of Geology and Geochemistry, Ural Branch, Russian Academy of Sciences

Orthopyroxene (= opx) is one of the main component minerals in the upper mantle and its modal proportion in a residual peridotite usually decreases with increasing the degree of melting. Orthopyroxenites or opx-rich rocks in the mantle can be formed by igneous, i.e., fractional crystallization from relatively Ca-poor magma (Kurshiro, 1969), or metasomatic processes, i.e., interaction between peridotite and SiO_2-rich or opx-oversaturated melts (Arai et al., 2006; Ishimaru et al., 2007) or SiO_2-rich aqueous fluid (Nakamura & Kushiro, 1974; Arai et al., 2004) at the shallow mantle. In addition, another type of orthopyroxenite, composed of opx and carbonate, has been also known, and is called “sagvandite” (e.g., Pettersen, 1883). Interaction process between peridotite and CO_2-rich fluid has been widely accepted for genesis of the sagvandite (e.g., Gahlan et al., 2015).
The Ray-Iz massif, the Polar Urals, is an allochthonous tectonic block, 400 km^2 in area, and that is thrust over the Paleozoic sedimentary rocks of the East European Platform (Shmelev et al., 2014). It is mainly composed of lherzolite–harzburgite complex, dunite–harzburgite complex and metaperidotites. The presence of orthopyroxenite and sagvandite (carbonate-bearing orthopyroxenite) has been reported in the Rai-Iz peridotite massif (Shmelev et al., 2014), but no detailed petrographical and geochemical data are presented. Detailed petrographical and geochemical descriptions of the sagvandite give us information about the active fluid metasomatism during the formation of metaperidotite and its importance as well.
The Ray-Iz sagvandite is a small block (20 x 20 x 10 m), which is surrounded by a metaperidotite (secondary harzburgite) with a minor garnet amphibolite. The sagvandite is composed of huge radial aggregates of opx within a matrix composed of serpentine (antigorite), olivine, chlorite, tremolite, chromite and talc. The carbonate is only a trace in amount, and then, this rock is not sagvandite in definition, but rather carbonate-bearing olivine orthopyroxenite. A carbonate-rich rock is available at a distant point (≈ 500 m) from the orthopyroxenite block, but is not orthopyroxenite but opx-rich harzburgite. The opx showing radial aggregates replaces in part olivine in the orthopyroxenite. The opx-rich harzburgite contains both the radialy aggregated opx and stout porphyroclasts. The opx in the orthopyroxenite show high Mg# (= Mg/(Mg + total Fe) atomic ratio) (0.91-0.92) with extremely low contents of Al_2O_3 (< 0.1 wt.%), Cr_2O_3 (< 0.1 wt.%) and CaO (< 0.15 wt.%), irrespective of their shapes. The Mg# of coexisting olivine shows constant and almost the same as that of opx (0.905-0.912), although the NiO content is varied (0.23-0.76 wt.%) in the olivine. All of the carbonates in orthopyroxenite and metaharzburgite are magnesites. All chromite is ferritechromite. Mineral assemblage of the orthopyroxenite and surrounding metaperidotite, and mineral compositions of the associated garnet amphibolite indicate that they were metamorphosed at ≈700 ºC and ≈1 GPa. Based on the isothermal

section of magnesite-bearing ultramafic rocks, the fluid composition which formed the carbonate-bearing orthopyroxenite and harzburgite was aqueous fluid containing ≈15 % of CO_2. This is consistent with the low amount of carbonate within the orthopyroxenite, and the fluid also possibly contained an appreciable amount of SiO_2 to form opxs replacing olivine. The opx-rich lithology of Ray-Iz is possibly representative of a path of CO_2-bearing aqueous fluid in the peridotite within the uppermost mantle wedge.

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