Re-fertilization processes in melt flow of the upper mantle as seen from Horoman peridotite.

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The Horoman peridotite is located at the southwestern margin of the Hidaka Metamorphic Belt, Hokkaido, Japan, and is exposed over an area of about 8 x 10 x 3 km. The Horoman peridotite is composed of peridotites ranging in composition from plagioclase lherzolite to harzburgite and dunite, and small amounts of mafic rocks and pyroxenite, and is divided into the Upper and Lower Zones based on differences in stratigraphic styles. The Lower Zone is characterized by thick layers with thicknesses ranging from several tens to several hundreds of meters and a continuous succession of rock types, while the Upper Zone is composed of thinner layers with thicknesses ranging from several meters to several tens of meters, and the boundaries between the rock types change sharply. The Upper Zone is dominated by plagioclase lherzolite and is rich in mafic layers.
The major element compositions and trace element abundances of all peridotite rocks comprising the Lower Zone were determined using XRF and ICP-MS and compared with those of the Primited Mantle (PM: Sun and McDonough, 1989) and Depleted MORB Mantle (DMM: Workman & Hart, 2005). The plagioclase lherzolite with the lowest MgO content (~38 wt%) and the highest Al2O3 and CaO content resembles the composition of a fertile mantle rich in basaltic components, similar to the Primited Mantle. The decrease in Al2O3 and CaO content with increasing MgO content is harmonious with the residual rocks formed by partial melting of fertile peridotite, which has a composition similar to the Primited Mantle.
On the other hand, in the Fumo stream section in the Upper Zone, which is 260 m thick, there is a plagioclase lherzolite with significantly lower MgO and higher Al2O3 and CaO contents than PM and DMM indicating enrichment in basaltic components (Kogure et al., 2021). Especially, this feature is remarkable in the plagioclase lherzolite around the mafic layer, suggesting that the melt that formed the mafic layer percolated and re-fertilized the surrounding rocks into the melt component. To confirm whether this is a universal feature of the Upper Zone of the Horoman peridotite, we investigated the composition of plagioclase lherzolite in the Upper Zone exposed in the Fudo stream section. The results of microscopic observations of thin section indicate that the plagioclase lherzolite with fertile composition tends to be enriched in plagioclase and pyroxene. The plagioclase lherzolite of the Fudo section shows similar characteristics, with large-grained plagioclase distributed among other mineral grains. Comparison of peridotites from the Lower Zone with those from the Upper Zone shows that the plagioclase lherzolite in the Upper Zone tends to have a higher proportion of plagioclase. In this study, we focus on whole-rock composition of peridotites from the Upper Zone and its correlation with the mineralogical and modal compositions, and examine the scale of re-fertilization in the entire Upper Zone of the Horoman peridotite.

Keywords: Upper Mantle, Partial melting, Refertilization, Peridotite

