The origin of fertile plagioclase lherzolite in the Upper Zone of the Horoman peridotite complex

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The Horoman periodite complex is a 2,800m thick orogenic lherzolite complex inter-layered along the Hidaka Main Thrust. Although much research has been done on the Horoman complex, the origin of the layered structure is still being discussed. The Upper Zone structurally occupies the upper 800-meter-thick section and has recorded a thermal history about max 200˚C higher than the Lower Zone [1]. In the Horoman peridotite complex, small amounts of mafic layers of a centimeter to a meter thick are often found in peridotites. Relatively thick mafic layers (tens of centimeters to a meter) are thought to have formed as cumulates that crystallized from melts at various depths (i.e., garnet- or plagioclase-stability field) [2] [3]. On the other hand, the plagioclase lherzolite is often accompanied by a thin mafic layer of a few centimeters. Malaviarachchi et al. (2010) [4] concluded that the thin mafic layers alternated with thin peridotites in the Horoman river have been formed from a Pacific-type MORB melt of about 300 Ma. Investigating the origin of the other thin mafic layers is important in studying the layered structure of the Horoman complex. Therefore, we selected a continuous section in the Upper Zone (Fumo section) for this study and examined variations of whole rock major and trace element compositions along lithological sequences.

The Fumo section has a thickness of 263m, which is about one third of the thickness of the Upper Zone and consists of plagioclase lherzolite (51%) and harzburgite (49%) with minor amount of mafic rocks. The lower 190 meters are dominated by plagioclase lherzolite and locally form banding with harzburgites of several centimeters to several meters thick. The upper 73 meters consist of 70 m thick single harzburgite layer and become plagioclase lherzolite at the top. In the Fumo section, 1 to 3 centimeters-thick mafic layer appears locally concentrated in plagioclase lherzolite. Amphibole is included in the mafic layer and its surrounding plagioclase lherzolite, but not in plagioclase lherzolite and harzburgite far from the mafic layers. In many cases, plagioclase and spinel form fine-grained granular seams, whereas in the neighbor of the mafic layer, lenticular shaped plagioclase-rich pools with a thickness of several centimeters are also observed.

The plagioclase lherzolite and harzburgite show a linear trend in the whole rock major elements vs. MgO diagrams, and the mafic layer is plotted on this extension, suggesting the possibility of mixing two end members. Among the plagioclase lherzolites, those with lower MgO and enrichments in melt components such as Al, Ca, Na than DMM [5] are distributed near the mafic layer in the Fumo section. Thus, the melt infiltrated to peridotite to form both mafic layer and fertile plagioclase lherzolite. The presence of amphiboles only in the mafic layer and its surrounding plagioclase lherzolite suggests that the melt forming the mafic layer may have been a hydrous melt.

On the other hand, plagioclase lherzolites, which are located far from the mafic layer in the Fumo section, have composition similar to DMM or more depleted in melt components. They may have the original composition of peridotite before the intrusion of mafic layer-forming melt. The plagioclase lherzolites near the boundary with harzburgite is depleted in melt components relative to other plagioclace lherzolites, and their composition is comparable to that of the lower zone lherzolite. Since the Upper Zone has a higher temperature history than the Lower Zone, it indicates that the subsolidus reaction in which spinel, Opx and Cpx become plagioclase and olivine was promoted in the Upper Zone even with the same composition. This suggests that there were two different origins of plagioclase in the Upper Zone.

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Keywords: Horoman Peridotite, mantle, mafic layer, orogenic lherzolite, Hidaka Metamorphic Belt

