

Evidence for diffusion and folding process from the Mg# profile in the Horoman mantle peridotite complex

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The Horoman peridotite complex, Hokkaido, Japan exhibits a conspicuous parallel layered structure, which has a characteristic symmetry in the alignment of lithological layers at the northern ridge of Mt. Apoi peak, suggesting that the layering is formed by folding or streamline mixing in mantle entraining crustal components. The symmetrical sequence of layers is mafic layer (3cm) -depleted peridotite (1cm) -mafic layer (6cm) -peridotite (4cm; center of symmetry) - mafic layer (5cm) -depleted peridotite (1cm) -mafic layer (2.5cm). In this study, we examine the chemical profile of minerals in the symmetrical layers. We carry out the chemical analysis by SEM-EDS and EPMA-WDS in order to determine the chemical compositions of the mafic minerals (olivine, opx, cpx) as functions of distance from the symmetry center. As a result, we find the different Mg# profiles of mafic minerals between peridotite and mafic layer. Namely, the Mg# of mafic minerals in a mafic layer abruptly decreases from the contact surface between peridotite and mafic layer to the center of the mafic layer, whereas the Mg# in the adjoining peridotite layer varies gradually. In addition, the Mg# takes wider range in mafic layer (82-89) whereas the Mg# of peridotite dose narrower range (89-91, 88, 84.5 in each layer). A pair of same lithological layers displaying symmetry has the nearly same Mg# profile, indicating that the lithological symmetry accompanies the chemical symmetry. On the basis of the chemical signature and the spatially homogeneous mineral distribution in each layer, we propose that the key process of the cryptic layering in mineral chemistry is a diffusion process between peridotite and mafic layer after the layers are contacted. The different chemical profile between peridotite and mafic layer can be explained by the different diffusivities due to the effect of the different modal abundance of mafic minerals on the diffusion path. Namely peridotite layers have relatively faster diffusive velocities than mafic layers because they include larger volume fraction of mafic minerals than mafic layers. So D_p (diffusion coefficient in peridotite) must be considerably larger than D_m (diffusion coefficient in mafic rock) by at least one order of magnitude. In fact numerical calculations show the most similar Mg# profile in the case of $D_p/D_m=20$, assuming the realistic symmetrical layer alignments. This supports the idea that diffusion process to generate the Mg# profile takes place after the folding process to construct symmetrical layered structure during upwelling from the upper mantle. From the diffusion profile of Mg#, we estimate the time scale during which the diffusion process effectively operates as 0.87 Myr at 1200 centigrade.