Remelting of oceanic lithospheric mantle observed in the mantle section of the northern Fizh Block, the Oman ophiolite

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We report the evidence for remelting of oceanic lithospheric mantle on the basis of mineral and whole rock major and trace element compositions from the mantle section of the northern Fizh block, the Oman ophiolite. The northern Fizh block consists of harzburgite, dunite and minor amount of lherozlite. We have analyzed 278 harzburgite samples for mineral chemistry by EPMA and 101 samples for whole rock chemistry by XRF and ICP-MS.

The Fo content of olivine ranges in narrow range from 90 to 92 but Cr# [=Cr/[Cr+Al]] ratio of spinel widely ranges from 24.2 to 77.6. Although compositions of spinel with Cr# less than 60 are similar to those for abyssal peridotites but we found many harzburgites and dunites with spinel Cr# more than 60 from the northern Fizh block. This indicates that those peridotites have experienced higher degree of melting than abyssal peridotites formed at mid-ocean ridge. Al2O3 and Cr2O3 contents of opx and cpx show positive correlation with spinel Cr# indicating residues after partial melting.

We plotted spinel Cr# on the map of northern Fizh block and found that the harzburgites with spinel Cr# more than 70 linearly distribute in the western side of NW-SE oriented shear zone that extends from Moho to the inside of mantle section. Spinel Cr# increases both from basal thrust and Moho toward the shear zone. This indicates that higher degree of melting occurred in the region with high Cr# spinel. We infer that H2O rich fluid flew into this region decreasing the solidus temperature thereby causing remelting of residual harzburgite and dunite.

In whole rock REE-Yb diagrams abundances of MREE [Nd, Sm, Eu] have two trends corresponding to the spinel Cr#. First is considered as residual trend by melting at mid-ocean ridge white other may have formed by remelting of residual peridotites. It is also confirmed that abundances of whole rock HREE are lowest in the western side of shear zone. Abundance of LREE in whole rocks are the most enriched in the north-western region near basal thrust and decrease toward the Moho. It indicates that the LREE-enriched fluid flew from the basal thrust through shear zone into the mantle section. On the other hand, the peridotites near Moho and inside of shear zone have linear REE patterns with positive Eu anomaly indicating refertilization by addition of melt.

On the basis of above observations we propose that the mantle section of the northern Fizh block evolved through two stages. First, asthenospheric mantle ascent and melted beneath mid-ocean ridge forming a residual mantle column with more depleted peridotite on the top. Second, in the stage of oceanic thrusting, LREE-enriched fluid was derived by dehydration of metamorphic sole and flew into the mantle section through shear zone. Migration of fluid decreased solidus temperature of residual harzburgite. As a result, spinel with Cr# more than 60 formed after remelting of such peridotites. Moreover, the reaction with LREE-enriched fluid produced LREE-enriched patterns in peridotites. Near the Moho, small amount of trapped melt caused refertilization of uppermost mantle.