Petrology of two lherzolite types found in the base of the northern Oman ophiolite

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We report two distinctive lherzolite types (Type I and Type II) found on the base of mantle section in the northern Oman Ophiolite. Type I lherzolite shows porphyroclastic texture while Type II is mylonitized and forms banding with harzburgite and dunite. Compared to Type I lherzolite, Type II is characterized by greater Na2O and TiO2 contents in whole rock and cpx. Chemical variations from Type I lherzolite to harzburgite are consistent with residual origin produced by different extent of melt extraction from a MORB source mantle in the spinel-stability field. However, the formation of Type II lherzolite may require (1) fragment of subcontinental mantle, (2) enrichment of Type I lherzolite in Na and Ti by mantle/melt reaction or (3) refertilization of harzburgite by pyroxene impregnation.

Harzburgite-type ophiolites commonly have local lherzolite zone or patch in the base of mantle section. For example, in the Oman Ophiolite, Lippard et al. (1986) reported the presence of basal lherzolite in the bottom of mantle section. Compared to harzburgite, the lherzolite in ophiolites has been considered as a residual product due to smaller extent of melt extraction beneath mid-ocean ridge. However, Ishiwatari (1985) also reported some ophiolite lherzolites which have chemical characteristics similar to subcontinental mantle. In this study, we report two distinctive lherzolite types found in the base of mantle section in the northern Oman ophiolite. On the basis of their field occurrence and major element composition we classify lherzolites into two types. Both types are located in the field just a few hundred meters apart each other. The first type (Type I lherzolite, hereafter) was found in Wadi Sarfah a few hundred meters above the bottom of the mantle section whereas the second type (Type II, hereafter) was found at Wadi Sarfah and Wadi Rayy near the contact between mantle section and metamorphic sole.

Type I lherzolite appears massive and homogeneous in the outcrop scale associated with well-developed foliation plane and shows porphyroclastic texture. The extent of serpentinization is about 25 vol.%. The reconstructed modal proportion using mass balance between whole rock and mineral compositions with least squares fit is olivine 57-63 wt.%, opx 30-37 wt.%, cpx ~6 wt.% and spinel ~1 wt.%. On the other hand, Type II lherzolite shows banding structure (several meters in thickness) associated with harzburgite and dunite layers parallel to the foliation plane. In the microscopic scale, it shows mylonitized texture indicating strong shear deformation. Opx and rarely cpx porphyroclasts distribute in the fine-grained neoblasts consisting of olivine, opx, cpx and spinel. The extent of serpentinization is about ~30 vol.%. The reconstructed modal proportion is olivine 62-64 wt.%, opx ~27 wt.%, cpx 8-10 wt.% and spinel ~1 wt.%.

Relative to Type I, Type II lherzolite is chemically characterized by greater Na2O and TiO2 contents in their whole rock and cpx compositions: i.e., cpx from Type I have Na2O ~0.1 wt.% and TiO2 <0.1 wt.% whereas cpx from Type II have Na2O ~1.2-1.4 wt.% and TiO2 ~0.3-0.4 wt.%. Fo contents of olivine from both types vary within a range of 90.6-91.1. Cr/(Cr+Al) atomic ratio of spinel in Type I varies from 0.26 to 0.30 while that of Type II from 0.14 to 0.16. Compositions of olivine and spinel from both types are included in the compositional range for abyssal peridotites (Arai, 1994) in the olivine-spinel mantle array (Arai, 1987). Although both Type I and II lherzolites are very similar in whole rock MgO contents, Type II is markedly greater in whole rock Na2O and TiO2 contents than Type I: i.e., Na2O and TiO2 contents of Type I are 0.01-0.02 wt.% and 0.02 wt.%, respectively, whereas those of Type II are 0.11-0.12 wt.% and 0.06-0.07 wt.%, respectively.

On the basis of their chemical variation the two lherzolite types found in the northern Oman Ophiolite cannot be interpret as a series of residual peridotites produced by different extent of melt extraction from a depleted MORB source mantle. Variation of major element contents from Type I lherzolite to harzburgite are rather consistent with residual trend formed by melt extraction in the spinel-stability field. However, the formation of Type II lherzolite may require either model such as (1) fragment of subcontinental mantle possibly related with the Neo-Tethys rift, (2) enrichment of Type I lherzolite in Na2O and TiO2 by mantle/melt reaction, or (3) refertilization of harzburgite due to impregnation of pyroxene from basaltic melt.