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Hydration processes in the mantle wedge peridotite; an example from the Ust-Belaya ophiolite, Far East Russia

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The Ust'-Belaya ophiolite is exposed in the 80 km x 40 km area on the south of Ust'-Belaya (N65 30', E173 17'), Far East Russia (Sokolov et al., 2003 Geol. Soc. London, Spec. Publ. 218, 619-664). The associated limestone suggests Devonian or older age of this ophiolite. The ultramafic rocks of the Ust'-Belaya ophiolite are mainly composed of fertile lherzolite, lherzolite/harzburgite with small amount of dunite, pyroxenite and chromitite. Those are characterized by significant hydration, which caused formation of secondary minerals. Here we describe hydration process of the mantle peridotite.

Mantle peridotite of the Ust'-Belaya ophiolite is divided into hydrated peridotite and antigorite-bearing serpentinite based on mineral assemblage. In both types, primary spinel is often rimed by chlorite. In some cases, primary spinel completely breaks down to aggregate of chlorite and magnetite/ferritchromite. Hydrated peridotite is composed of olivine, amphibole, chlorite and/or talc and/or secondary clinopyroxene. Amphibole and talc occur as pseudomorph after primary pyroxenes. Antigorite-bearing serpentinite is composed of olivine, amphibole, and/or talc and/or secondary clinopyroxene. Olivine often shows apparent partings similar to cleavage, i.e., the so-called "cleavable olivine". Primary pyroxenes are basically replaced by aggregate of secondary olivine, amphibole and serpentine.

Olivine compositions in both mineral assemblages are often heterogeneous even in a single mineral grain and/or within sample because of chemical modification related to hydration events. Olivine along with amphibole shows low Fo (= 100 x Mg/[Mg+Fe] = 85~89) and poor in NiO (= 0.15~0.40 wt.%) if compared with primary olivine (Fo=90~92; NiO = 0.35~0.45 wt.%). Meanwhile olivine which is along with antigorite in antigorite-serpentinite also show low Fo contents (= ~90) but resemble to primary olivine in NiO content. This compositional modification suggests introduction of Fe during hydration.

Amphiboles show different compositional trend corresponding to the mineral assemblage. Amphiboles in hydrated peridotite are calcic amphiboles, showing a pargasite/edenite-tremolite trend, on the other hand amphiboles in antigorite-bearing serpentinite show a richterite-tremolite trend with some pargasite. Several amphiboles in antigorite-bearing serpentinite show zoning composed of pargasitic core, tremolitic mantle and richiteritic rim. This zoning indicates multiple stage addition of Na2O with Fluid. Trace element patterns of edenitic/pargasitic amphibole are similar to those of primary clinopyroxene. On the other hand, those of Na-rich tremolite and richteritic amphibole show low abundance with pronounced positive anomaly of Sr. These chemical data indicate introduction of Na and Sr during serpentinization. The reports of Na-rich tremolite and richterite in ultramafic rock are relatively rare and most of them are associated with antigorite. This may mean that formation of such amphibole requires a specific condition during antigorite formation.

The unsystematic spatial distribution of hydrated peridotite and antigorite-bearing serpentinite may mean that they represent effectively cooled part by hydrous fluids in the mantle wedge.

Keywords: mantle wedge, hydration, metasomatism, serpentinization, antigorite, Ust'-Belaya ophiolite