Geochemistry of Ochiai-Hokubo peridotite complex: an analogue of metasomatized mantle by water rich fluid from the slab

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The most essential feature of the sub-arc mantle is a metasomatism by H2O-rich fluid from the slab. Partial melting of the metasomatized mantle generates arc magmas, which are enriched with LILE, LREE relative to HFSE. To know the arc magma genesis, the behavior of trace elements in the metasomatized mantle is important, although it has not been fully understood. As an analogue of mantle-slab interaction, we analyzed the trace-element behavior in serpentinized peridotite (lherzolite origin) from Ochiai-Hokubo peridotite complex surrounded by the Sangun high-P/T metamorphic rocks.

Ochiai-Hokubo peridotite complex

The Ochiai-Hokubo peridotite complex, the Sangun zone, southwestern Japan, is composed of several alternating layers of dunite-wherlite and lherzolite-hartzburgite. Oyama (1983) classified this complex into three concentric mineral zones (from core to rim of the complex; tremolite-olivine-antigolite, diopside-olivine-antigolite, brucite-olivine-antigolite) on the basis of mineral assemblage of lherzolite. Tremolite is Na-rich and sub-calcic. Mafic and pelitic schist of greenschist facis enclose this complex. Water from the schists had promoted serpentinization of the peridotite inward: the degree of serpentinization basically decreases inward.

Rock samples

We selected 4 samples of serpentinized lherzolite from the tremolite- and diopside-zones. The rock samples are as follows from the interior outward.

OH550 (tremolite zone); Orthopyroxene is partly converted to tremolite, and serpentine is minor in amount.
OH515 (diopside zone); Tremolite is partly changed to secondary clinopyroxene.
OH470 (diopside zone); Secondary clinopyroxene is larger in amount than OH515.
OH415 (diopside zone); Orthopyroxene and tremolite disappears.
Serpentine increases in amount from OH550 to OH470. All samples contain spinel with double chlorite coronas.

Whole-rock chemistry

The chondrite normalized REE patterns of all samples show that LREE, La (N) = 0.02~0.1, is depleted relative to HREE, Yb (N) = 1, and is equivalent to a slightly depleted lherzolite. The REE concentrations of OH550 are lower than in other samples, which is a primary character determined by the differences of degree of partial melting. Cs and Rb concentrations are, on the other hand, increasing from rim to core of the complex.

Mineral chemistry

We analyzed primary clinopyroxene, secondary clinopyroxene, tremolite, serpentine, and chlorite (both inner and outer coronas). The chondrite normalized REE patterns of primary clinopyroxene from all samples show that the LREE depletion relative to HREE, and are the same as those for the whole-rock samples. Tremolite has higher Cs and Rb concentrations than the other minerals. Chlorite from the outer corona around spinel sometimes contain appreciable amounts of Cs and Rb. Secondary clinopyroxene, serpentine and inner part of chlorite are very low in the trace-element concentrations.

Hydration has not altered the primary REE concentration of the peridotite, but has disturbed the Cs and Rb. Tremolite is a reservoir of Cs and Rb, and is coincident with its highly Na-rich character.

The mantle wedge metasomatized by water-rich fluid from slab forms amphibole and results in LILE enrichment without LREE enrichment at relatively low temperatures (= greenschist facis). The LREE enrichment that products LREE-rich characteristics of arc magma may be caused by the higher-temperature metamorphism at depth.