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北西太平洋湯川海丘から見つかった深部海洋リソスフェアの欠片
Fragments of deep oceanic lithosphere from the Yukawa knoll in NW Pacific

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Chemical and physical structures of oceanic lithosphere have been generally inferred based on comparative examinations using the seismic profiles, dredged or drilled samples of young rocks at mid-oceanic ridges and exposed sections of ophiolites. However, direct observations of the constituent materials are limited to the shallowest part (up to 20 km depth) and, therefore, a large part of old oceanic lithosphere, especially of its deeper part, is petrologically still unknown. It is known that the NW Pacific plate is accompanied with young monogenetic volcanoes originating at depths just below the bottom of the lithosphere. Lithospheric fragments entrapped by the alkaline magmas are able to shed light on the whole structure across the plate. In this study, we examined dredged samples (D07&8 during Kairei KR04-08 Cruise) from the youngest volcano (0-1 Ma), Yukawa knoll, at the eastern slope of the outer rise in the NW Pacific plate. They include mm-scale xenocrysts and xenoliths of crustal and mantle origins. Here we report the petrological nature of these valuable pieces that test models of oceanic plate.

We found hundreds of xenocrysts: olivine, Cpx, Opx, plagioclase and xenoliths (consisting of more than 2 grains) of spinel-bearing lherzolite, harzburgite, pyroxenite, troctolite, olivine-bearing anorthosite, gabbronorite and non-alkaline basalt with medium- and fine-grained plagioclase. Mineral chemistry of the crustal fragments is plotted in the range of seafloor samples and ophiolites. However, mafic minerals forming xenocrysts and those in spinel-bearing lherzolite have distinctive compositions. Olivine, Opx and Cpx imply a Fe-rich nature of lithospheric mantle compared to residual peridotite in ophiolite. Cr# of spinel in the lherzolite is 0.16. Cpx has an extremely high Na2O content up to 2.3 wt% whereas the Al2O3 content (3-7 wt%) is comparable to the oceanic samples. The Cpx is enriched in REE (C1 normalized value of Sm = 10) but relatively low in HREE implying it has coexisted with garnet.

Geothermobarometry for the pyroxenes with the garnet signatures gives results consistent with their origins at pressures of 1.5-2.3 GPa (45-70km depth) and temperatures of 750-1000 oC. These conditions lie on a conductive geotherm with heat flow of 60-80 mWm and are expected for the 130 Myr old Pacific plate. The REE patterns of the pyroxenes in the spinel lherzolite from the Yukawa knoll are very similar to those in cratonic garnet peridotite. Na2O in the Cpx and the spinel Cr# are close to Na-rich source mantle, partial melting of which can explain a large part of residual abyssal peridotite. Our finding of the Na-rich pieces from the NW Pacific implies that deeper parts of the oceanic mantle are occupied by such fertile peridotite that is comparable to sub-cratonic mantle.

Keywords: oceanic lithosphere, xenolith, mantle