Deformation and hydrothermal alteration processes of basal peridotites in the Palawan Ophiolite, Philippines

*Hiyori Abe[1], Ken-ichi Hirauchi[2]

1. Graduate School of Integrated Science and Technology, Shizuoka University, 2. Department of Geosciences, Faculty of Science, Shizuoka University

Supra-subduction zone ophiolites record processes associated with the initiation of intra-oceanic plate subduction (Prigent et al., 2018). To understand effects of deformation and hydrothermal alteration at the base of the juvenile mantle wedge on subduction initiation, we conducted structural analysis of the basal peridotites in the Palawan ophiolite, Philippines. Keenan et al. (2016) have shown that forced subduction occurred near the mid-ocean ridge axis at about 34 Ma based on U-Pb zircon ages of ophiolitic and metamorphic sole rocks. The amphibolite as the metamorphic sole is in fault contact with the basal mantle peridotite (Keenan et al., 2016), and is characterized by peak metamorphic pressure-temperature conditions of 1.3 GPa and 700 °C (Valera et al., 2021).

The basal peridotites collected in this study are composed of dunite, harzburgite, and lherzolite, and display various degrees of dynamic recrystallization of olivine over a width of at least about 2 km. Electron back-scatter diffraction analysis shows that most of coarse (>1 mm in size) olivine grains exhibit a strong crystal-preferred orientation (CPO) indicative of {0kl}[100] (D type) or (010)[100] (A type) slip system, suggesting that the olivine CPOs formed under relatively low water content (Karato et al., 2008). On the other hand, fine (< 200 μm in size) olivine grains show random CPOs, suggesting the operation of diffusion creep. The fine-grained basal peridotites underwent silica and calcium metasomatism to form talc and tremolite via dissolution-precipitation processes. Talc has a distinct CPO and forms anastomosing networks wrapping around olivine grains.

These results suggest that the basal peridotites above the slab initially deformed via dislocation creep at relatively high-temperatures and dry conditions, and then grain size reduction by dynamic recrystallization causes a transition in deformation mechanism from dislocation creep to diffusion creep. Afterwards, the addition of SiO_2 and CaO-rich fluids, which are possibly derived from the slab, into the adjacent basal peridotites result in the development of anastomosing talc-rich shear zones at relatively low temperatures. We suggest that both olivine diffusion creep and talc friction act to reduce the strength of the basal peridotites, which would have promoted continuous subduction initiation of the oceanic plate.

References: Karato et al. (2008), *Annual Review of Earth and Planetary Sciences*, **36**, 59-95. Keenan et al. (2016), *Proceedings of the National Academy of Sciences*, **113**, 7379-7366. Prigent et al. (2018), *Journal of Geophysical Research: Solid Earth*, **123**, 7529-7549. Valera et al. (2021), *Journal of Metamorphic Geology*, **40**, 717-749.

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