Unraveling the oceanic serpentinization reaction from aluminum-zoning in mesh textures

*Ryosuke Oyanagi[1], Atsushi Okamoto[1], Yumiko Harigane[2], Noriyoshi Tsuchiya[1]

1. Graduate School of Environmental Studies, Tohoku University, 2. Geological Survey of Japan National Institute of Advanced Industrial Science and Technology (AIST)

Serpentinization (hydration of mantle peridotite) gives significant changes to both chemical and physical properties of lithosphere. Mesh texture was usually observed in serpentinized peridotite, and is a key to understand the dynamics of oceanic lithosphere. Serpentine minerals in mesh texture commonly contain subtle amounts of aluminum, but the influences of Al on kinetics of serpentinization is poorly understood.

In this study, we conducted hydrothermal experiments in olivine (Ol)–plagioclase (Pl)–H_2O system at 230 ° C and a vapor-saturated pressure of 2.80 MPa for understanding the effect of Al on the mechanism of olivine replacement. By using unique tube-in-tube type hydrothermal experiments vessel (e.g., Oyanagi et al., 2015), spatial and temporal data were obtained.

We found the systematic difference in olivine replacement textures between Al–metasomatic zone near the Ol–Pl contact and isochemical zone far from the contact. In the isochemical zone, lizardite + brucite + magnetite was formed and original olivine outline was not clear. In contrast, in the metasomatic zone, Al–rich serpentine + Ca-Saponite aggregate replaced olivine with forming a characteristic zoning of core, mantle, and rim parts. Microstructual observations revealed that this zoning was produced by initial formation of mantle part at Al–free solution, subsequent to simultaneous progress of pseudomorphic replacement at olivine front (core part) and overgrowth (rim part) with migration of Al metasomatic front. Similar Al zonings of olivine mesh texture were observed in partly serpentinized harzburgite and Pl-bearing wehrite, suggesting that local mass transfer plays an essential role on replacement progress and texture development with volume expansions during serpentinization of oceanic lithosphere by onset of beak down of Al–bearing minerals.

References

Oyanagi, R., Okamoto, A., Hirano, N., and Tsuchiya, N., 2015, Competitive hydration and dehydration at olivine–quartz boundary revealed by hydrothermal experiments: Implications for silica metasomatism at the crust–mantle boundary: Earth and Planetary Science Letters, v. 425, p. 44–54, doi: 10.1016/j.epsl.2015.05.046.

Keywords: Serpentinization, Mesh texture, Hydrothermal experiment, Serpentine

