Silica-rich aqueous fluids from dehydrating serpentine to form talc as lubricant for slab-mantle interfaces

RYO NISHIZAKI [1], TATSUHIKO KAWAMOTO [2]

[1] Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto Univ., Japan, ryo.nishizaki@gmail.com

[2] Institute for Geothermal Sciences, Graduate School of Sci, Kyoto Univ., Japan, kawamoto@bep.vgs.kyoto-u.ac.jp

Serpentine minerals have anhydrous compositions between those of olivine and enstatite and contain about 13 wt.% H_2O in their chemical structure. Hydration of mantle peridotite results in the formation of serpentinite, a rock composed of serpentine minerals. Antigorite ($Mg_{48}Si_{34}O_{85}(OH)_{62}$, Wunder and Schreyer, 1997, Lithos) is a polymorph of serpentine minerals that is stable at the highest pressure conditions, and plays an important role in transporting H_2O to the deep mantle during subduction. It is also an important phase geophysically, since its dehydration can trigger subduction-zone magmatism and earthquakes. In order to obtain an accurate understanding of the dehydration reaction, in-situ observation of antigorite surrounded by aqueous fluids is carried out at 0.17–0.64 GPa and 550–612°C using a Bassett-type hydrothermal diamond anvil cell and Raman microscopy. Beyond the dehydration reaction of antigorite (Evans et al., 1976, Schweizerische Mineralogische und Petrographische Mitteilungen), tiny crystals of forsterite nucleate from the aqueous fluids and grow with time until antigorite dissolves and talc starts to crystallize. Antigorite dissolves into the aqueous fluids, from which forsterite crystallizes. Such dissolution and growth indicate incongruent dissolution of antigorite into silica-rich fluids and forsterite during the dehydration reaction of antigorite. The results allows us to formulate a scheme in which antigorite at the base of the mantle wedge is dragged down and dehydrates to produce aqueous fluids at dehydration front. Such aqueous fluids together with aqueous fluids expelled by the underlying subducting slab may flush through the overlying layers, dissolving antigorite incongruently to form silica-rich fluids and forsterite. These silica-rich fluids can migrate upward along the plate boundary to form talc layers in serpentinites through the reaction antigorite + SiO_2 in aqueous fluids = talc + H_2O at pressures lower than 2.5 GPa. The formation of talc layers may be responsible for the mechanical decoupling at the plate boundaries that are commonly found at depths around 75 km in numerical modeling (Wada et al., 2008, J Geophs Res).