Dehydration kinetics of talc in the system $MgO-SiO_2-H_2O$ probed in-situ by vibrational spectroscopy at high pressure and high temperature

*山下 茂[1]
*Shigeru Yamashita[1]

1. 岡山大学惑星物質研究所
1. Institute for Planetary Materials, Okayama University

Dehydration kinetics of talc is important to understand transport of H_2O into the mantle wedge during subduction processes. Experimental results from in-situ observation of talc dehydration at 2.4 GPa and 800 ˚C under the presence of excess amount of forsterite are presented.

A 50/50 mixture (in weight proportion) of natural, stoichiometric-pure Mg-talc (<38 μm grain size) and synthetic forsterite together with distilled H_2O was loaded in the sample chamber of an externally heated hydrothermal diamond anvil cell (HDAC) fitted to micro-FTIR and confocal micro-Raman spectrometers. Pressure in the HDAC was monitored with the pressure- and temperature-dependent Raman shift of the fundamental Si-O stretch vibration of forsterite (˜857 cm^{-1} at ambient condition, Gillet et al., 1991; Wang et al., 1993). To ensure the highest precision of the Raman shift, the 557 nm Kr line was acquired simultaneously as reference. Temperature was controlled to ±1 ˚C with chromel-alumel thermocouples in contact with the anvils near the sample chamber. Near infrared (NIR) bands assigned to the combination modes of the fundamental Mg-O-H bending + stretch vibrations (˜4200 to ˜4400 cm^{-1}, Madejova et al., 2011) and Raman band assigned to the fundamental Mg-O-H bending (˜678 cm-1, Madejova et al., 2011) were continuously recorded as a scale of the talc abundance.

At 2.4 GPa and 800 ˚C, the talc NIR and Raman bands all decrease in the intensity with time while Raman bands due to the fundamental Si-O stretch of enstatite (˜665, ˜687, ˜1013, and ˜1037 cm^{-1}, Huang et al., 2000) appeared and grew. No phase other than talc, forsterite, enstatite, and H_2O fluid was observed during the experiment, which means that the dehydration reaction, talc + forsterite = 5 enstatite + H_2O, was successfully monitored. The time decay of the talc NIR bands intensity was adequately fitted by an Avrami-type sigmoidal curve with the exponent of 2 and the rate constant of 2.1 ±0.2 x 10^{-5} min^{-2}. This translates into a half-lifetime of ˜180 min for the talc (half of the talc disappears in that time). This half-lifetime is more than two-fold longer than those obtained by previous works for the forsterite-deficient reaction, talc = 3 enstatite + quartz + H_2O (e.g., Chollet et al., 2009), yet far shorter than the Maxwell relaxation time of the upper mantle materials (months to years). Thus, brittle fracturing associated with talc dehydration is likely in the mantle wedge.

References: Chollet et al., Earth Planet. Sci. Lett., 284, 57-64, 2009; Gillet et al., J. Geophys. Res. Lett., 96, 11,805-11,816, 1991; Huang, et al., Amer. Mineral., 85, 473-470, 2000; Madejova et al., EMU Notes, Mineral., 9, 171-226, 2011; Wang et al., Amer. Mineral., 78, 469-476, 1993.

キーワード：その場観察、タルク、脱水分解
Keywords: in-situ observation, talc, dehydration