

Hydration breakdown of lizardite under cold subduction geotherm

Heehyeon Sim

Crystallography Lab.

Dept. of Earth System Science, Yonsei University

Stability of serpentine minerals are of importance to typify subduction zone lithology and related geochemical cycling. In this study, we conducted in-situ high-pressure and temperature X-ray powder diffraction experiments on lizardite ($\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$), one of the representative serpentine minerals, using a resistively-heated diamond anvil cell (RH-DAC) under two-contrasting subduction geotherm conditions. Under cold subduction geotherm with sufficient water content, lizardite undergoes previously unknown hydration breakdown to the 3.65 Å phase and phase E assembly above ca. 9.5 GPa and 500 °C, equivalent to ca. 285 km depth, leading to the following reaction; $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4 + 3\text{H}_2\text{O} \rightarrow \text{MgSi}(\text{OH})_6 + \text{Mg}_2\text{SiO}_2(\text{OH})_4$. In contrast, under warm subduction conditions, such a breakdown reaction does not occur but lizardite is decomposed to the previously known phase assemblage of forsterite and enstatite above ca. 6 GPa and 530 °C, equivalent to ca. 180 km depth, as summarized by the following dehydration reaction; $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4 \rightarrow \text{MgSiO}_3 + \text{Mg}_2\text{SiO}_4 + 2\text{H}_2\text{O}$. The newly observed breakdown into DHMS (dense hydrous magnesium silicate) minerals thus appears to be specific for a wet and cold subduction environment and manifests a new type of metamorphic reaction, which will enhance water transport capacity of a subducting slab into deeper mantle.