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OH group behavior and pressure-induced amorphization of antigorite examined under high pressure and temperature using synchrotron infrared spectroscopy

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Abstract

Infrared (IR) absorption spectra of antigorite were measured up to 27 GPa and 320 °C using synchrotron IR radiation to elucidate OH group behavior under high-pressure (HP) and high-temperature (HT) conditions. The absorption bands attributable to the OH stretching modes of outer OH groups (OH_{outer}) and inner OH groups (OH_{inner}) show positive pressure dependencies. The shift rate of the OH_{inner} band is almost constant at all pressure ranges. In contrast, that of the OH_{outer} band increases slightly at about 6 GPa. This discontinuous change of the shift rate is consistent with the anomalous behavior of the OH_{outer} upon compression, which was predicted in the previous first-principle calculation study. Specifically, the pressure dependence of the OH_{outer} band shows that the hydrogen ion of an OH_{outer} interacts not only with the nearest basal oxygen ion of the SiO_4 tetrahedron but also with the second nearest two basal oxygen ions upon compression. The latter interaction becomes dominant over the former interaction at about 6 GPa.

Pressure-induced amorphization was indicated from IR spectra measured at 300 °C and 25.6 GPa. This *P-T* condition is out of the thermodynamic stability field of antigorite. A broad absorption band, which is close to the broad band attributable to natural hydrous silicate glass, appeared after amorphization, which suggests that the pressure-induced amorphization of antigorite does not induce dehydration. Hydrogen atoms are retained in amorphized antigorite as OH groups.

Keywords: Antigorite, high pressure, pressure-induced amorphization, synchrotron infrared spectroscopy, high-temperature diamond-anvil cell (HT-DAC)