

In-situ infrared spectroscopic studies of hydroxyl in amphiboles at high pressure

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ABSTRACT

Oceanic plates contain numerous hydrous phases including amphiboles, which are important carriers of water into subduction zones. The hydroxyl bound within the crystalline structure of hydrous minerals, as well as changes in hydrogen bond symmetry, can impact the bulk properties of these minerals. In this study, 12 natural amphibole samples spanning a range of 10 compositions were probed with synchrotron infrared spectroscopy at room temperature and pressures up to 60 GPa. Infrared spectra were collected at atmospheric pressure and at regular intervals during compression, allowing for the collection of spectra centered on the typical O-H stretching region at 3600–3700 cm⁻¹ as they evolved with pressure for each composition. The number of O-H bands within each sample was found to vary with composition, but the pressure dependence of O-H frequency shifting more closely correlated with mode frequency at ambient pressure than with composition. Combined with earlier results, these data reveal a linear relationship between mode frequency at ambient pressure and the pressure dependence of O-H stretching modes in amphiboles and sheet silicates.

Two sample preparation methods utilized in this study allowed for direct comparison between quasi-hydrostatic neon-loaded sample conditions and the conditions achieved with a KBr pressure medium. Samples loaded in neon preserved sharper peaks, allowing greater spectral resolution, especially at higher pressures when peaks are most likely to broaden or disappear due to crystalline disorder and pressure gradients across the sample. This new quasi-hydrostatic loading method proved valuable to tracing O-H stretching behavior in amphiboles to higher pressures than previously obtained and will lend itself to future study of O-H stretching pressure dependence in a wide range of hydrous minerals.

Keywords: Infrared, high pressure, diamond-anvil cell, hydroxyl, amphiboles