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Structural insights and elasticity of single-crystal antigorite from high-pressure Raman and Brillouin spectroscopy measured in the (010) plane

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Abstract

We report high-pressure Raman and Brillouin spectroscopy results measured in the (010) plane of a natural antigorite single crystal. We find that structural changes at >6 GPa lead to (1) an intensity crossover between Raman modes of the Si-O-Si bending vibrations, (2) changes of the compression behavior of Raman modes related to the SiO_4 tetrahedra, (3) changes of the pressure derivative of the Raman shifts associated with OH stretching vibrations, (4) the emergence of a new Raman band in the OH spectral region, (5) a softening of the elastic constants c_{33} and c_{11}, and (6) a directional change of the slowest compressional wave velocity in the **a-c** plane. In addition to the structural insights at high-pressure, the unique characteristics of our single-crystal sample allows for first direct measurements of the acoustic velocity anisotropy in a plane perpendicular to the basal **a-b** plane. Comparison to previously published data indicates that the elastic anisotropy of antigorite strongly depends on the FeO and/or Al_2O_3 content. In contrast, it seems not to be affected by increasing temperature as inferred from an additional high-temperature experiment performed in our study. These constraints are important for the interpretation of seismic anisotropy observations in subduction zone environments.

Keywords: Antigorite, serpentine, elasticity, Brillouin, Raman, seismic anisotropy