High-pressure Raman spectroscopic studies of hydrous wadsleyite II

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ABSTRACT

Raman spectra in the range 80 to 4000 cm^{-1} of wadsleyite II (Fo$_{90}$ with 2.0 wt% H$_2$O and Fo$_{88}$ with 2.7 wt% H$_2$O) have been measured in a diamond-anvil cell with solid rare-gas pressure-transmitting media to 51.4 GPa at room temperature. The ambient Raman spectrum of wadsleyite II is closely similar to wadsleyite modified with bands in frequency regions where the SiO$_4$ tetrahedral and OH stretching vibrations of hydrous ringwoodite occur. The most intense, characteristic wadsleyite II modes at 709 and 911 cm^{-1} (Si$_2$O$_7$ and SiO$_3$ symmetric stretching vibrations, respectively) shift continuously to 51.4 GPa showing no evidence for a change in the crystal structure. A striking feature in the high-pressure Raman spectra of wadsleyite II is a significant growth in intensity in the mid-frequency range (300–650 cm^{-1} at 10^{-4} GPa and 400–750 cm^{-1} at 51.4 GPa) under compression accompanied by the appearance of new Raman modes near 40 GPa, perhaps a result of resonance electronic Raman scattering. In the OH stretching frequency range, the Raman spectrum of wadsleyite II exhibits at least six modes and their high-pressure behavior agrees with that of Fo$_{90}$ hydrous wadsleyite: OH stretching modes above 3530 cm^{-1} remain approximately constant up to at least 21.8 GPa whereas OH modes at frequencies <3530 cm^{-1} decrease with increasing pressure. The OH stretching modes are consistent with protonation of the non-silicate oxygen O2 and the O atoms surrounding the partially vacant tetrahedral site Si2, as suggested from X-ray diffraction data.

Keywords: Hydrous wadsleyite II, Raman spectroscopy, diamond-anvil cell, transition zone, high pressure