

The effect of pressure upon hydrogen bonding in chlorite: A Raman spectroscopic study of clinochlore to 26.5 GPa

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ABSTRACT

The effect of pressure upon hydrogen bonding in synthetic end-member clinochlore, $(\text{Mg}_5\text{Al})(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$, has been studied in situ by high-pressure micro-Raman spectroscopy in a moissanite-anvil cell to 26.5 GPa at 300 K. The ambient spectrum consists of three OH-stretching bands between 3400 and 3650 cm^{-1} , attributed to the hydrogen-bonded interlayer OH, and a narrow band at 3679 cm^{-1} that is assigned to the non-hydrogen-bonded OH groups of the talc-like 2:1 layer. The pressure dependence of the OH modes is linear up to 6 GPa. Near 9 GPa a major discontinuity occurs in the pressure dependence of the interlayer OH-stretching modes. It involves frequency increases $>100 \text{ cm}^{-1}$ that indicate major changes in hydrogen bonding. The OH mode of the 2:1 layer does not show discontinuous behavior at 9 GPa. A further discontinuity occurs at ~ 16 GPa. This discontinuity affects both interlayer and 2:1 OH, and is likely to be associated with a change in the overall compression mechanism of clinochlore. The spectroscopic behavior is a completely reversible function of pressure. Predictions based upon recent high-pressure diffraction studies of hydrogen bonding and compression of clinochlore suggest that the 9 GPa transition is associated with attainment of an $\text{O}^{2-}\text{-O}^{2-}$ -contact distance of 2.7 Å.