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Compression of synthetic hydroxylclinohumite [$Mg_9Si_4O_{16}(OH)_2$] and hydroxylchondrodite [$Mg_5Si_2O_8(OH)_2$]

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ABSTRACT

The isothermal equations of state (EoS) of synthetic hydroxylclinohumite, $Mg_9Si_4O_{16}(OH)_2$, and synthetic hydroxylchondrodite, $Mg_5Si_2O_8(OH)_2$, have been determined using high-pressure single-crystal X-ray diffraction, carried out in a diamond anvil cell under hydrostatic conditions. Both humites are monoclinic (space group $P2_1/b$ with a unique): a = 4.7490(3) Å, b = 10.2861(4) Å, c = 13.6991(11) Å and α = 100.649(6)° for hydroxylclinohumite, and a = 4.7449(2) Å, b = 10.3464(2) Å, c = 7.8990(6) Å, and α = 108.681(3)° for hydroxylchondrodite. A third-order Birch-Murnaghan EoS was determined from unit-cell volume data to 8.1 GPa for hydroxylclinohumite: V_0 = 657.69(5) Å^3, K_T = 119.4(7) GPa and K' = 4.8(2). A similar analysis of hydroxylchondrodite for data collected to 7.8 GPa resulted in V_0 = 367.36(3) Å^3, K_T = 115.7(8) GPa and K' = 4.9(2). Axial compression is anisotropic with the direction perpendicular to the close-packed anion layer, i.e., the **a** axis, being the least compressible. Axial moduli and their pressure derivatives are: K_a = 162(1) GPa, K_a' = 6.7(3), K_b = 97.9(5) GPa, K_b' = 4.0(1), K_c = 111.1(7) GPa and K_c' = 4.2(2) for hydroxylclinohumite. For hydroxylchondrodite: K_a = 149(1) GPa, K_a' = 6.8(3), K_b = 101.3(4) GPa, K_b' = 4.3(1), K_c = 102.4(6) GPa, and K_c' = 4.1(2). Comparison of the bulk moduli of these phases with other phases along the Mg_2SiO_4–$Mg(OH)_2$ join shows that the bulk modulus increases systematically with density (ρ) and can be approximated by, K_T (GPa) = 97(6) × ρ – 186(17). The bulk modulus also decreases systematically with water content: K_T (GPa) = 127.9 (16) – 2.75 (11) × wt% H_2O.