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Volume behavior of the 10 Å phase at high pressures and temperatures, with implications for H_2O content

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Abstract

The 10 Å phase is a high-pressure hydrous magnesium silicate whose composition appears to depend on synthesis conditions. We have measured the compressibility to 10.5 GPa and thermal expansivity to 400 °C of samples of 10 Å phase synthesized in long experiments (400 and 169 h, respectively) designed to maximize compositional equilibrium. The structure was refined using a metrically trigonal unit cell. Compression is highly anisotropic, especially over the first 2 GPa of compression, indicating weak bonding across the interlayer. There is an inflection in the compression curve of c at 8 GPa, suggesting a change in compression mechanism or the onset of non-hydrostaticity in the pressure medium. Fitting the compression data collected below 8 GPa to a Murnaghan equation-of-state gives $V_0 = 734.8(7)$ Å^3, $K_0 = 25(1)$ GPa, $K' = 18(1)$. Thermal expansion is also strongly anisotropic: coefficients for data up to 200 °C are $\alpha_a = 0.15(5) \times 10^{-5}$ K^{-1}, $\alpha_c = 3.1(2) \times 10^{-5}$ K^{-1}, $\alpha_V = 3.4(2) \times 10^{-5}$ K^{-1}. Above 200 °C, the expansivity of c decreased, and all parameters showed a contraction after the experiment, suggesting partial dehydration at high temperatures. Comparison of our compressibility data with those of previous studies suggests that 10 Å phase synthesized in short experiments does not retain all of its interlayer H_2O during quenching and decompression. In contrast, samples annealed for many hours at high pressure and temperature are stabilized by small amounts of hydrogarnet-type substitution and consequent hydrogen bond strengthening.

Keywords: 10 Å phase, equation of state, compressibility, expansivity