

## Thermal expansion of Mg<sub>2</sub>SiO<sub>4</sub> ringwoodite at high pressures

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Unit cell volumes of Mg<sub>2</sub>SiO<sub>4</sub> ringwoodite have been measured at temperatures to 2000 K and pressure of 15 to 24 GPa, and at temperature of 300 K and pressure of 0 to 21 GPa, using a Kawai-type multi anvil apparatus that is equipped with an oscillation system to obtain high-quality diffraction pattern against grain growth. We obtained the following parameters describing the P-V-T relations of Mg<sub>2</sub>SiO<sub>4</sub> ringwoodite. Volume at 0 GPa and 300 K is 524.8(1) Å<sup>3</sup>. By assuming the isothermal bulk modulus of 182 GPa, its pressure derivative is 4.6(2). Thermal expansion coefficient at 300 K and its logarithmic volume dependence, Anderson-Grüneisen parameter, are  $2.57(9) \times 10^{-5} + 1.42(8) \times 10^{-8} (T-300) / K$ , where T is absolute temperature in K, and 6.9(4). The temperature derivative of isothermal bulk modulus is -0.029(1) GPa/K. The Debye temperature is 846(26) K. The Grüneisen parameter and its volume dependence are 1.93(3) and 3.5(3). The adiabatic temperature gradient in the mantle is largely temperature dependent: it increases from 0.29 to 0.40 K/km with increasing temperature from 1600 to 2000 K.