American Mineralogist, Volume 83, pages 1030–1036, 1998

Volume measurements of zoisite at simultaneously elevated pressure and temperature

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ABSTRACT

Unit-cell parameters of zoisite, $Ca_2Al_3Si_3O_{12}(OH)$, have been measured at simultaneously high pressures and temperatures (up to 6.1 GPa and 800 °C) in a Walker-style multi-anvil apparatus at the synchrotron radiation source at Daresbury Laboratory, U.K. Measurements were made in a series of heating cycles at increasing loads. Sample pressure, measured using an internal NaCl standard, increased during heating. Cell parameters vary smoothly with pressure and temperature; individual expansivities and compressibilities vary in the order $c > b > a$. Isothermal bulk moduli were calculated from the volumes measured at 30, 200, 400, 600, and 800 °C by fitting the Murnaghan equation of state to each isothermal data set. This assumes $K' = 4$. Ambient-pressure volumes calculated from previous measurements of thermal expansivity of zoisite were included in the Murnaghan fits. A linear fit of the bulk moduli with temperature gave values for the bulk modulus at 298 K, $K_{298} = 125(3)$ GPa, and its variation with temperature, $\partial K_T/\partial T = -0.029(6)$ GPa K^{-1}. K_{298} is slightly higher than the recent value for a single crystal in a diamond-anvil cell, indicating a lower maximum pressure stability of zoisite than would be calculated using that value. Our data allow zoisite volumes to be calculated at *P-T* conditions relevant to the Earth and show that, in a typical subduction zone, zoisite becomes more dense as subduction proceeds, helping to stabilize it to high pressures.