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Thermoelastic properties of zircon: Implications for geothermobarometry

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Abstract

A thermal-pressure equation of state has been determined for zircon ($ZrSiO_4$) that characterizes its thermoelastic behavior at metamorphic conditions. New pressure-volume (*P*-*V*) data from a "Mud Tank" zircon have been collected from 1 bar to 8.47(1) GPa using X-ray diffraction, and elastic moduli were measured from room temperature up to 1172 K by resonance ultrasound spectroscopy. These data were fitted simultaneously with temperature-volume (*T*-*V*) data from the literature in EosFit7c using a new scaling technique. The parameters of a third-order Birch-Murnaghan EoS with a Mie-Grüneisen-Debye model for thermal pressure have compressional EoS parameters $K_{0T} = 224.5(1.2)$ GPa, $K'_{0T} = 4.90(31)$ with a fixed initial molar volume $V_0 = 39.26$ cm^3/mol and thermal parameters $\gamma_0 = 0.868(15)$, $q = 2.37(80)$, and $\Theta_D = 848(38)$ K. EoS parameters that describe the variation of unit-cell parameters with pressure and temperature were determined using an isothermal-type EoS. This new EoS confirms that zircons are stiffer than garnets and exhibit a much lower thermal expansion. This results in steep isomekes between zircon and garnets, which makes zircon trapped as inclusions in garnets at metamorphic conditions a good piezothermometer.

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