American Mineralogist, Volume 96, pages 828–832, 2011

PVT equation of state of epsilon iron and its densities at inner core conditions

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Abstract

The first comprehensive *PVT* description of ε-Fe is presented by collecting the complete data set of previous experiments on ε iron, covering a pressure and temperature range of 6–306 GPa and 293–2255 K, respectively. A single set of equation of state parameters, which is able to cover the entire pressure and temperature range has been determined. The root mean square misfit of the residuals is 1.17 GPa for the *PVT* version of the Birch-Murnaghan equation of state. The equation of state uses an absolute reference frame ($T = 0$ K and $P = 0$ GPa) and follows a $T = 0 \overset{P=0}{\Rightarrow} T = T$ and then $P = 0 \overset{T=T}{\Rightarrow} P = P$ path, which eliminates the pressure effect on the volume coefficient of thermal expansion and the temperature effect on the pressure derivative of the bulk modulus.

The calculated temperatures, which reproduce the PREM density, bulk modulus, and bulk seismic velocities at the inner core boundary, are 4640, 4070, and 3980 (±230) K, respectively, indicating that no light elements are necessary in the inner core. The calculated density deficit for the outer core at 4000–4600 K ICB temperatures is 4.4–3.5%.

Keywords: Equation of state, epsilon iron, inner core density, temperature in the core, light elements in the inner core