High pressure, high temperature equation of state for Fe_2SiO_4 ringwoodite and implications for the Earth's transition zone

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(work performed at GSECARS)

We measured the density of iron-ringwoodite and its pressure and temperature dependence at conditions of the mantle transition zone using the laser-heated diamond anvil cell in conjunction with X-ray diffraction. Our new data combined with previous measurements constrain the thermoelastic properties of ringwoodite as a function of pressure and temperature throughout the transition zone. Our best fit Mie-Grüneisen-Debye equation of state parameters for Fe end-member ringwoodite are V_0 = 42.03 cm^3/mol, K_0 = 202 (4) GPa, K' = 4, g_0 = 1.08 (6), q = 2, and q_D = 685 K. This new equation of state revises calculated densities of the Fe end-member at transition zone conditions upwards by ~0.6% compared with previous formulations. We use this revised equation of state to make predictions of the effect of compositional (iron) and thermal anomalies on the bulk properties of the transition zone.

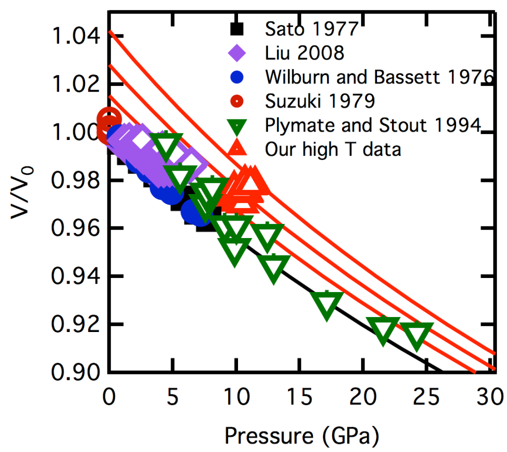

Figure 1. Plot of normalized volume versus pressure for data used in the linear least squares regression. Open and closed symbols refer to high temperature and room temperature measurements respectively. The best fit room-temperature equation of state is shown in black and high temperature contours are plotted in red at 1000, 1500, and 2000 K.

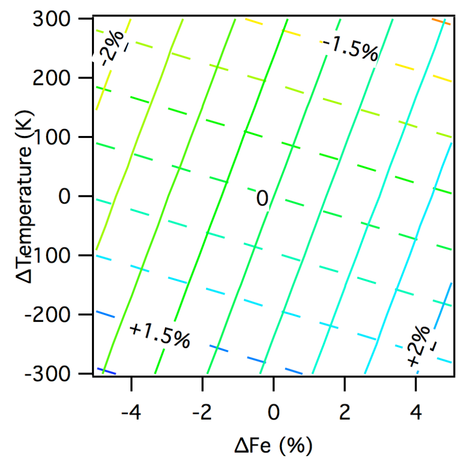

Figure 2. Schematic representation of the effect of changes in composition and temperature on ringwoodite's density (solid) and bulk sound velocity (dashed). Contours of density and bulk sound velocity are plotted in increments of 0.5% difference from 410 km reference values. Different combinations of thermal and compositional anomalies have distinct seismic signature.

References

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