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Constraints on the *P-V-T* equation of state of $MgSiO_3$ perovskite

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ABSTRACT

Equation of state fits to experimental *P,V,T* data were examined by the inversion of synthetic data sets using the thermoelastic parameters of $MgSiO_3$ perovskite. Our results show that by extending the pressure and temperature range to 130 GPa and 2500 K, the volume dependence of the Grüneisen parameter, q (=$\partial \ln\gamma/\partial \ln V$), could be resolved to ~10% under the best circumstances. However, simulations also showed strong correlation between the bulk modulus, K_{T0}, and its pressure derivative, K'_{T0}, and q within the currently accepted uncertainty of elastic parameters for $MgSiO_3$ perovskite. We considered the effect of random error based on the reported uncertainty for different measurement techniques. Even though the laser heated diamond-anvil cell (LHDAC) technique has significantly larger temperature uncertainty, the ability to extend the pressure and temperature ranges allows for improved resolution of higher order thermodynamic parameters. However, systematic error from temperature inhomogeneity in the LHDAC sample could result in overestimation of q. We also performed Birch-Murhanghan-Debye (BMD) equation of state (EOS) fits for currently available data sets. Consistent with the simulation results, combining recent LHDAC (Fiquet et al. 1998) and resistance heated diamond-anvil cell (RHDAC) (Saxena et al. 1999) with lower *P-T* measurements (Ross and Hazen 1989; Wang et al. 1994; Utsumi et al. 1995; Funamori et al. 1996) we obtained q = 2.0(3) and γ_0 = 1.42(4). The difference between q = 2.0(3) and the normally assumed value of q =1 strongly affects calculated values for higher order thermoelastic parameters [e.g., α, $(\partial K_T/\partial T)_P$] as well as first order parameters, such as density and bulk modulus at lower mantle conditions. However, possible systematic error sources need to be further investigated and measurements at higher *P-T* conditions promise to yield better constraints on the thermoelastic parameters of $MgSiO_3$ perovskite.