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Anelasticity in the lower mantle: influence on the temperature dependence of seismic velocities

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There is little agreement regarding the importance of anelastic contributions to the temperature dependence of seismic wave velocities. Some studies consider the anelastic contribution to be negligible, whereas others argue that it may be as important as the purely elastic contribution. In order to evaluate these claims, we review physically plausible models for mantle relaxation processes and construct a model of activation enthalpy based on solid state physics as well as on recent experimental results. We then deduce self-consistent 1-D Q profiles and evaluate the anelastic contribution to the temperature dependence of V_s and V_p. The calculated anelastic corrections increase with depth and are as large as 30% of the purely elastic value at 2700 km. This suggests that the anelastic enhancement of temperature derivatives of seismic velocities must be taken into account in interpretations of tomographic data. We also compute the values of $R_{s/p}$, $R_{\phi/s}$, and $R_{\rho/s}$. We find that anelasticity can either increase or decrease $R_{s/p}$, but the magnitude of the correction, of the order of 15 %, is smaller than the uncertainty in the elastic value. Anelasticity cannot change the sign of $R_{\phi/s}$ and $R_{\rho/s}$, but it can decrease their values by as much as 50%. However, given current uncertainties in seismic and mineral data, the effects of anelasticity on the dimensionless parameters are of no practical consequence to their role as constraints on lateral variations of temperature, chemical composition and/or mineral phase.