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# Elasticity of Mantle Minerals at High Pressures and Temperatures: Implications for Mantle Composition and Heterogeity

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Measurements of elastic wave velocities and elastic moduli are now possible at the high pressure and temperature conditions of the deep interior. We have performed Brillouin scattering elasticity measurements at pressures corresponding to those in Earth's transition zone on ringwoodite and majorite, which are two of the most abundant constituents in this region of the mantle. Ringwoodite is especially important because phase transitions involving this phase are thought to be responsible for seismic discontinuities at 670 and 520km depth. These same phases have been studied at high temperatures using a resistance heater of our own design in which the temperature is accurately known. Significantly, our experiments were carried out on materials with iron contents representative of those thought to exist in the mantle. These results allow us to calculate the compressional (Vp) and shear (Vs) elastic wave velocities expected for different mineral assemblages under transition zone conditions, with more certainty than has previously been possible. Our results show that the presence of Fe increases the impedence contrast resulting from high pressure phase transformations in olivine. The phase transformation from wadsleyite to ringwoodite is accompanied by a larger increase in Vp and Vs than implied from previous data on Fe-free samples. This transformation should be clearly detectable using seismological methods if the mantle is composed primarily of olivine. Moreover, the seismological velocity increases at 400, 520, and 660 km depth are not consistent with a single olivine content for the mantle. Combined with our results on garnet-structured majorite (which bears on the velocity gradients in the transition zone), the available data cast significant doubt on the likelihood that the mantle is homogeneous in composition.