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Mantle composition and thermal structure from joint inversion of P-to-S converted waves and Rayleigh wave dispersion curves

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P-to-S waves converted at the 410- and 660-km discontinuities and surface wave dispersion curves can be used to map variations in velocity gradients associated with the lithosphere-asthenosphere boundary, upper mantle, and transition zone (TZ). These gradients reflect phase transitions of major mantle minerals providing valuable insight on mantle thermo-chemical structure. In this work, we jointly invert P-to-S receiver function (RF) waveforms and Rayleigh wave phase velocities for 42 high-quality worldwide distributed permanent seismic stations to directly map global variations in mantle temperature and composition. This is achieved by interfacing the geophysical inversion with self-consistent mineral phase equilibria calculations from which rock mineralogy and its elastic properties are predicted as a function of pressure, temperature, and bulk composition (parameterized in terms of the basalt fraction in a basalt-harzburgite mixture). This approach anchors temperatures, composition, seismic properties, and discontinuities that are in mineral physics data, while permitting the simultaneous use of geophysical inverse methods to optimize models of seismic properties to match RF waveforms and Rayleigh wave dispersion curves. Preliminary results suggest that only data from stations located in stable continental regions can be explained by a compositionally uniform and adiabatic mantle. Furthermore, global TZ temperature variations span over ∼300–400 °C and relatively little lateral variability in mantle composition (basalt fraction∼0.07–0.25) is observed.