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SEISMIC CONSTRAINTS ON THE THERMAL STRUCTURE OF CONTINENTAL LITHOSPHERE

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Most information on lithospheric thermal structure has been obtained from the downward extrapolation of surface heat flow data along steady state conductive geotherms. Geothermobarometry of xenoliths provides complementary information about conditions directly at depth, but only in a few regions. Seismic velocity anomalies have the advantage that they are mapped at depth and (with variable resolution) globally and their interpretation does not hinge on steady state or conductive thermal conditions. Forward calculations of seismic velocities based on mineral physics data show that in the shallow mantle (Moho-top of the transition zone), the effect of reasonable temperature variations on seismic velocities is an order of magnitude larger than the effect of reasonable variations in composition (excluding the effect of fluids). Comparison of temperature estimates from P-, S-velocities, seismic attenuation and surface heat flow corroborates the dominant influence of temperature on lateral variations in seismic velocity. Important for interpreting seismic velocities in terms of physical state is the availability of well-resolved absolute velocity models, and taking into account the effect of strongly temperature-dependent anelasticity. Seismically constrained temperatures at 50 km depth range from 400 to 1300oC and correlate well with surface tectonics and tectonothermal age. The maximum thickness of the lithosphere, defined as the depth down to which seismic velocities correlate with tectonics, is 200-250 km. The wide range of seismically determined temperatures is consistent with the continental steady state conductive geotherm model generally used in interpreting heat flow data, where crustal heat production and residual (mantle) heat flow are coupled and each contribute around 50% to surface heat flow.