A Lithospheric Thermal Model from Seismic Fields

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Conventional inverse modeling techniques combined with seismic data and mineral-physics considerations can constrain lithospheric thermal regimes. Here we compare geotherms derived from different observations, including plate cooling models, Pn seismic velocity, and depth to a negative shear wave velocity gradient (NVG), to test assumptions regarding the physical properties and geodynamic processes responsible for heat transfer in the Earth. Using a thermal modeling inversion schema that integrates multiple seismic properties with mineral physics, we create a global lithospheric geotherm model, integrating multiple observables through an inversion that estimates temperatures for various depth layers. Geotherms derived from each observable are used to guide calculations. Such methods help address observational gaps and highlight thermal anomalies unique to each methodology. Model outputs reveal a strong correlation between Moho temperatures derived using various Pn tomography models, and high temperature residuals when comparing Pn tomography models to models that assign an isotherm to NVG depth, implying the seismic definition of LAB is not tied to an isotherm. The thermal structure of oceanic lithosphere as derived from plate ages is used as a baseline to evaluate the reliability of seismic model predictions and assess whether oceanic geotherm models can be improved with seismic constraints. Geodynamic simulations with independent geophysical constraint of the thermal field, as achieved through this project, provide a more accurate depiction of Earth's geophysical state. This modeling provides insight into deformation patterns over a broad range of spatiotemporal scales, better resolves lithospheric thermal structures, and leads to a better understanding of when assumptions of conductive thermal transfer are incomplete due to the thermal influence of melt, volatile flux, and reaction thermodynamics. This research is driven by the demand for improved techniques to realistically represent global lithospheric geotherms. Resultant global geotherms will form the basis for 3D conductive lithospheric temperatures in ASPECT.