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Non-thermal origin of seismic heterogeneity of the continental upper mantle

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Global seismic tomography models as well as mantle gravity anomalies reflect large-scale compositional variations in the mantle; however they are substanňtially masked by temperature anomalies. Data on the thermal regime of stable continental lithosphere provides an exceptional information on lithospheric properties as it permits to separate thermal and non-thermal effects in global geophysical models. Global seismic tomography model based on Rayleigh waves (Shapiro and Ritzwoller, 2002) is analyzed jointly with thermal model for the upper 150 km of the continental mantle. Both seismic and thermal models for the continental upper mantle outline the same regions of thick continental lithosphere and indicates large variations in lithospheric thickness on the continents. Thermal model is used next to calculate "synthetic" model of seismic velocities at depths between 50 and 200 km: based on laboratory data, mantle temperatures are converted into velocities with account for anelasticity effects. Significant difference between "synthetic" and observed seismic velocities can be attributed to large-scale compositional and structural heterogeneity of the continental upper mantle. In agreement with xenolith data, strong mantle depletion is clearly seen for all of the cratons; however it shows strong lateral variations in the amplitude. The results are compared with the residual mantle gravity anomalies, which represent compositional density anomalies in continental lithospheric mantle after the effect of thermal expansion being excluded (Kaban et al., EPSL, 2003).