Geophysical Research Abstracts
Vol. 15, EGU2013-8275, 2013
EGU General Assembly 2013

Lithospheric structure and deformation of the North American continent

Magdala Tesauro (1), Mikhail Kaban (1), Sierd Cloetingh (2), and Walter Mooney (3)

(1) GFZ, Earth Modelling, Potsdam, Germany (magdala@gfz-potsdam.de, +49 (331) 288 1959), (2) Department of Earth Sciences, Utrecht University, The Netherlands, (3) USGS, Menlo Park, USA

We estimate the integrated strength and elastic thickness (Te) of the North American lithosphere based on thermal, density and structural (seismic) models of the crust and upper mantle. The temperature distribution in the lithosphere is estimated considering for the first time the effect of composition as a result of the integrative approach based on a joint analysis of seismic and gravity data. We do this via an iterative adjustment of the model. The upper mantle temperatures are initially estimated from the NA07 tomography model of Bedle and Van der Lee (2009) using mineral physics equations. This thermal model, obtained for a uniform composition, is used to estimate the gravity effect and to remove it from the total mantle gravity anomalies, which are controlled by both temperature and compositional variations. Therefore, we can predict compositional variations from the residual gravity anomalies and use them to correct the initial thermal model. The corrected thermal model is employed again in the gravity calculations. The loop is repeated until convergence is reached. The results demonstrate that the lithospheric mantle is characterized by strong compositional heterogeneity, which is consistent with xenolith data. Seismic data from the USGS database allow to define P-wave velocity and thickness of each crustal layer of the North American geological provinces. The use of these seismic data and of the new compositional and thermal models gives us the chance to estimate lateral variation of rheology of the main lithospheric layers and to evaluate coupling-decoupling conditions at the layers' boundaries. In the North American Cordillera the strength is mainly localized in the crust, which is decoupled from the mantle lithosphere. In the cratons the strength is chiefly controlled by the mantle lithosphere and all the layers are generally coupled. These results contribute to the long debates on applicability of the "crème brulée" or "jelly-sandwich" models for the lithosphere structure. Intraplate earthquakes (USGS database) occur mainly in the weak regions, such as the Appalachians, and in the transition zones from low to high strength surrounding the craton. The obtained 3D strength model is used to compute Te of the North American lithosphere. This parameter is derived from the thermo-rheological model using new equations that consider variations of the Young's Modulus in the lithosphere. It shows large variability within the cratons, ranging from 70 km to >100km, while it drops to <30 km in the young Phanerozoic regions. The new crustal model is also used to compute the lateral pressure gradient (LPG) that can initiate horizontal ductile flow in the crust. In general, the crustal flow is directed away from the orogens towards adjacent weaker areas. The results show that the effects of the channel flow superimposed with the regional tectonic forces might result in additional significant horizontal and vertical movements associated with zones of compression or extension.