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## Arduino Lecture

# Lithospheric Structure of the North American Plate

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Aula Arduino

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### Abstract:

Seismic data on the North American continent are unevenly distributed and in some cases discrepancies exist between published models. In order to construct a consistent 3D crustal model with three layers in the crystalline crust, the following sequence of steps have been implemented: 1. Definition of the geometry of the main tectonic provinces of North America; 2. Selection and evaluation of the reliability of seismic crustal models in the database; 3. Estimation of the P-wave seismic velocity and thickness of the upper, middle and lower crust for each tectonic province; 4. Estimation of the interpolated Pn velocity distribution. In comparison with the global crustal model CRUST 1.0, the new crustal model, NACr14, is more heterogeneous, showing a larger spatial variability of the thickness and average velocities of the crustal layers. The largest velocities of the crystalline crust ( $>6.6$  km/s) reflect the presence of a 7.x layer ( $>7.0$  km/s) in the lowermost part of the crust. Using NACr2014, a regional (NA07) and a global (SL201sv) seismic tomography model, and gravity data, an iterative technique, which jointly interprets seismic tomography and gravity data, to estimate temperature and compositional variations in the NA upper mantle has been applied. The results obtained demonstrate that temperature of the cratonic mantle is up to  $150^{\circ}\text{C}$  higher than when using a uniform compositional model. The differences between the two tomography models influence the results more strongly than possible changes of the depth distribution of compositional variations. Strong negative compositional density anomalies, corresponding to Mg #  $>92$ , characterize the upper mantle of the northwestern part of the Superior craton and the central part of the Slave and Churchill craton. The Proterozoic upper mantle of the western and more deformed part of the NA cratons, appears weakly depleted (Mg#  $\sim 91$ ) when NA07 is used, in agreement with the results based on the interpretation of xenolith data. When SL2013sv is used, the same areas are locally characterized by high density bodies, which might be interpreted as the effect due to fragments of subducted slabs, as those close to the suture of the Appalachians and Grenville province.

The two thermal models have been used to estimate the integrated strength and effective elastic thickness ( $T_e$ ) of the lithosphere. In the peripheral parts of the cratons, as the Proterozoic Canadian Platform and Grenville, the integrated strength for model NA07 is ten times larger than in model SL2013sv, due to a model-dependent temperature difference of  $>200^{\circ}\text{C}$  in the uppermost mantle. In both models, Proterozoic regions reactivated by Meso-Cenozoic tectonics (e.g., Rocky Mountains and the Mississippi Embayment) show a weak lithosphere due to the absence of the mechanically strong part of the mantle lithospheric layer. Intraplate earthquakes are distributed along the edges of the cratons, characterized by a weak lithosphere or pronounced variations in integrated lithospheric strength and  $T_e$ . In addition, the sum of the seismic moments shows that most of the energy is released by the weak lithosphere. These results suggest that the edges of the cratons are more prone to accumulation of tectonic stress and subsequent release by earthquakes, in comparison with the stable cratonic regions which resist deformation.

**Proponenti:** Alessandro Caporali e Manuele Faccenda