Mantle structure of the North American continent inferred from transdimensional inversions of long and short period seismic data

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Different approaches have been used to image crust and lithospheric structure at continental scales, and in particular in North America (NA). At long periods (20-250 s), surface wave tomography provides resolution of volumetric heterogeneity of ~500 km laterally and ~50 km in depth, down to ~300 km. However, surface waves cannot uniquely resolve sharp interfaces, such as the Moho, the Lithosphere-Asthenosphere Boundary (LAB) or the possible presence of Mid-Lithospheric Discontinuities (MLD's). In order to image such discontinuities, methods based on the analysis of converted phases at crust and upper mantle interfaces (e.g. the receiver functions) have been developed. Since surface wave data and receiver functions provide complementary constraints on the Lithosphere, several studies showed the possibility to combine them to obtain more robust models of the crust and uppermost mantle.
Here we propose a trans-dimensional MCMC technique [1] that allows us to combine fundamental mode Love and Rayleigh wave dispersion curves and P-to-s converted phase data to retrieve 1D radially anisotropic layered models beneath a set of stations in NA.
Results at 30 stations deployed on the NA continent show that the tectonically active region west of the Rocky Mountain Front is marked by a Lithospheric Asthenosphere Boundary (LAB) and a Lehmann Discontinuity occurring at relatively shallow depths (60-150 km and 100-200 km, respectively), whereas further east, in the stable and old craton, these discontinuities are deeper (170-200 km and 200-250 km, respectively). In addition, in the stable part of the continent, at least two Mid Lithospheric Discontinuities (MLD's) are present at intermediate depths, suggesting the existence of strong lithospheric layering, and the possible presence of more layers, as lithospheric thickness increases with increasing cratonic age. The Moho across the continent as well as mid-crustal discontinuities in the craton are also imaged, and are generally in agreement with independent studies.

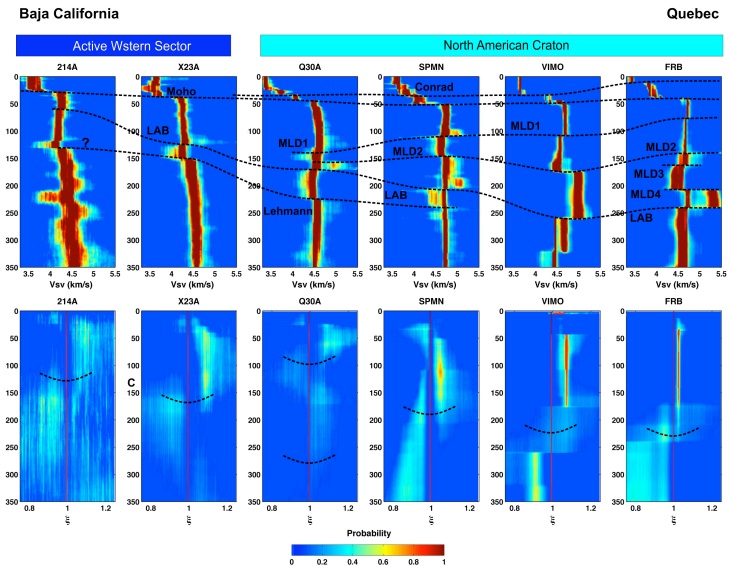

Figure 1. 1D Posterior Density Distributions of V_{sv} (top) and ξ (bottom) at stations aligned along a profile approximately oriented SW-NE. Dashed lines in V_{sv} connect the main variations in depth observed on the models and discussed in the text. Dashed lines in PPD of ξ roughly indicate the depth of change from $\xi>1$ to $\xi<1$.

References

[1] Green, P. *Reversible jump MCMC computation and Bayesian model selection*, Biometrika, 82, 711-732, (1995)