Long memory: seismological evidence of lithospheric deformation 1 billion years ago.

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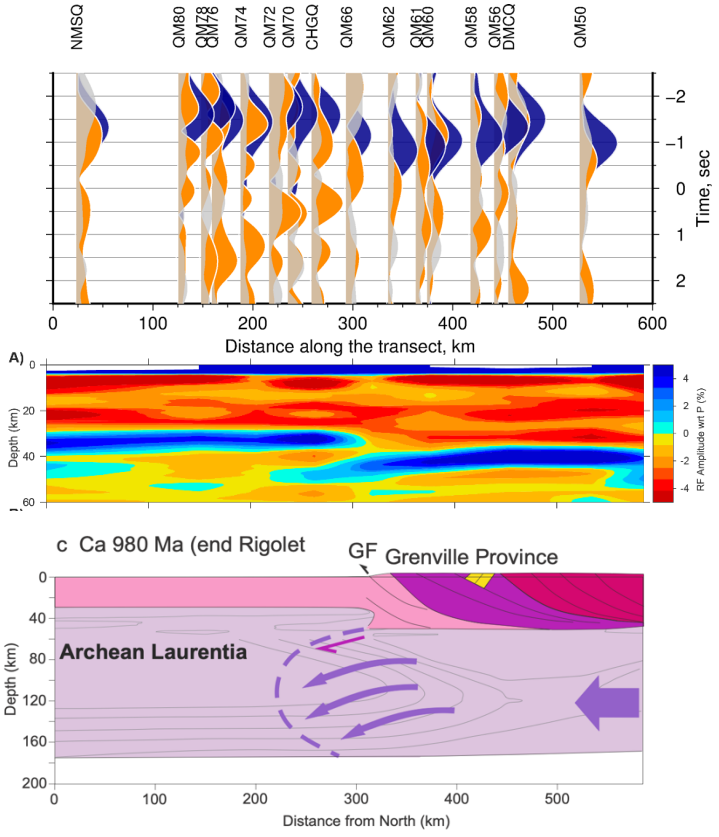
The history of Earth's development is preserved in the rock formations making up its continents. The Grenville Front (GF) of eastern North America is among the clearest of records of past tectonic upheaval. The Archean-age cratonic core of North America lies to the north and west of it, while to its south and east are rocks of the Grenville Province that were substantially affected by the ~1 Ga orogeny during the final stage of assembly of the supercontinent Rodinia. The area adjacent to the GF has not experienced any more tectonic episodes, preserving the record of continental lithosphere formation for nearly a billion years. This study makes use of the data collected by an array set up astride the GF and applies two advanced variants of receiver function (RF) methodology, CCP stacking and harmonic decomposition, that yield complementary constraints on layering of seismic properties in the lithosphere. We find a major difference in the crustal thickness (6-10 km over 50-100 km) across the GF and document a prominent boundary dipping from the GF northward beneath the Archean craton. The vertical contrast in seismic properties associated with this dipping boundary is directionally variable and displays a characteristic pattern of seismically anisotropic material with near-horizontal symmetry axis. The unexpected geometry and the anisotropic signature of the boundary require an explanation in terms of intra-lithospheric deformation that we believe is related to the multi-stage Grenvillian Orogeny between 1080 and 980 Ma ago.



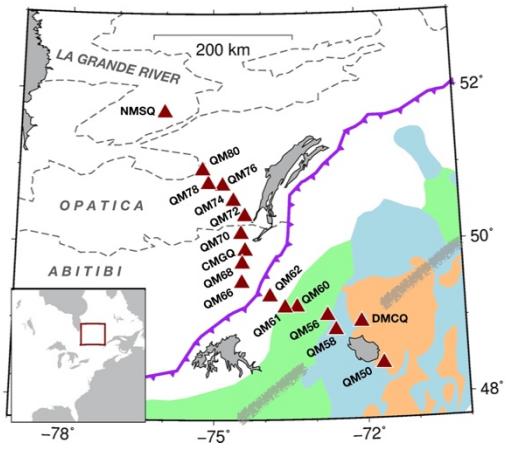


Figure caption: (top left) Directionally invariant (blue) and 180°-periodic (orange) receiver functions; (middle left) Cumulative amplitude of P-SV converted waves (positive – blue); (lower panel) Schematic cartoon of preferred tectonic scenario; (above) Tectonic units and seismic stations. Archean rocks – white, Proterozoic – colors, age in Ga: green – 1.69-1.65; blue – 1.55-1.35; orange – 1.3 -0.95; Purple line – Grenville Front.