A Sharp Edge of the Cratonic Lithosphere of North America

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Using teleseismic travel time delays, we develop a tomographic model of the lithosphere beneath northeastern North America, from the shore of James Bay in Quebec to the Atlantic coast of New England and to a depth of 300 km. Three major terranes lie within this cratonic margin: the 2.7 Ga Superior province, the 1 Ga Grenville orogenic belt and the 0.3-0.4 Ga Appalachian terranes, which are bounded by the Grenville Front (GF) and Appalachian Front (AF), respectively. Additionally, the 0.8 Ga Avalon terrain was accreted to coastal New England by strike-skip faulting during the Appalachian orogeny. Our tomographic model uses earthquake seismograms recorded by permanent US and Canadian stations, the Transportable Array and the temporary QMIII deployment. All data were corrected for instrument response and record sections were examined visually to identify gross errors in response and timing. Differential arrival times of P and PKP waves were determined by cross-correlation and have a maximum amplitude of about ±1 second. In our model, lithospheric boundaries do not correlate well with geological boundaries, nor do they strike parallel to them. The seismically-fast (by 5% relative to AK135) cratonic lithosphere of North America is much thicker than that of the younger terranes, extending to 200 km or more depth but with a sharp east-dipping eastern edge located (at Moho depths) 100-250 km northwest of the GF. The lithosphere beneath the Grenville and Appalachian terranes, which were affected by subduction during the Grenville and Appalachian orogenies, is slower (by 4%). A sliver of seismically-fast lithosphere, extending to ~150 km depth, occurs along the Atlantic coast and is interpreted as the Avalonian lithosphere.