Regional scale constraints on seismic lithosphere thickness beneath eastern North America

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This paper infers the depth of the base of the seismically-fast lithosphere beneath two broadband, continuously recording seismic stations located in eastern North America. 24 three-component teleseismic earthquake waveform records of high signal-to-noise ratios at Peaks-Kenney State Park (ME, USA), a station in the US National Seismic Network, were processed alongside 71 similarly constrained waveforms recorded at Schefferville, Quebec, Canada, a station in the Canadian National Seismic Network. The Maine station is located on the Paleozoic Appalachian orogen, and the Canadian station is sited on the late-Archean Superior Province that forms part of the North American craton. Surface-wave tomography predicts an increase in S-wave velocity (at 100 km) and thickening of the lithosphere from Maine to north-eastern Canada. Receiver function analysis using multi-taper codes (MTC) developed by Park and Levin (2000) was applied to the collected waveform data. The resulting receiver function plots binned events by epicentral distance (every 10 degrees) and by back-azimuth (every 10 degrees) and plotted the timing of arriving P-to-S (Ps) converted phases allegedly originating at the various structural discontinuities located within the crust and upper-mantle. Forward modeling using the continental structure, seismic-velocity global reference model AK135 made possible the identification of consistent Ps phase arrivals that identify the base of the crust for the Maine station at 33 km and for the Canadian station at 48 km. An opposite polarity Ps arrival with the expected dependence on incident wave epicentral distance is taken to have originated at a plane-layered discontinuity 81 km beneath the Maine station and 103 km beneath the Canadian station. Results by Rychert and Shearer (2009) for a similar procedure at the Canadian station match those found in this study. Therefore, the imaged upper-mantle discontinuities may correspond to the lithosphere-asthenosphere boundary (LAB) beneath the respective station at a regional lateral scale. Expected thickening of the lithosphere from Maine to eastern Canada and its proposed positive correlation with crustal age further corroborate these results. Finally, the reproducibility confirmed for the Canadian station validates the technique employed in this study and, therefore, the results for the Maine station, which are the first to be published.