Low Seismic Attenuation in Southern New England Lithosphere Implies Little Heating by the Upwelling Asthenosphere

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The Northern Appalachian Anomaly (NAA) is a patch of the asthenosphere in southern New England that is unusually hot given its passive margin setting. Previous research has detected large seismic wave delays that imply a temperature of ~770 deg C higher than the mantle below the adjacent craton at the same depth. A key outstanding issue is whether the NAA interacts with the lithosphere above it (e.g. by heating it up). We study this issue using Po and So waves from two magnitude >5.5 earthquakes near the Puerto Rico Trench. These waves, propagating in the cold oceanic lithosphere at near Moho speeds, deliver high frequency energy to the shallow continental lithosphere. We hypothesized that: (1) once within the continental lithosphere, Po and So experience attenuation with distance that can be quantified by a quality factor Q, and that (2) any heating of the lithosphere above the NAA would lead to a higher Q than in regions further north or south along the continental margin. Corresponding Po and So velocities would also be lower. The decay rates of Po and So are estimated using least-squares applied to RMS coda amplitudes measured from digital seismograms from stations in northeastern North America, corrected for instrument response. A roughly log-linear decrease in amplitude is observed, corresponding to P and S wave quality factors in the range of 394-1500 and 727-6847, respectively. Measurements are made for four margin-perpendicular geographical bands, with one band overlapping the NAA. We detect no effect on these amplitudes by the NAA; 95% confidence bounds overlap in every case; Furthermore, all quality factors are much higher than the ~100 predicted by lab experiments for near-solidus mantle rocks. These results suggest that the NAA is not causing significant heating of the lithosphere above it. The shear velocities, however, are about ~10% slower above the NAA – an effect that may be fossil, reflecting processes that occurred millions of years ago.