Lithospheric Structure at the NAA from Ekstrom's [2017] Rayleigh Wave Velocities

Bill Menke, August 20, 2017

Ekstrom's [2017] maps indicate that Rayleigh wave phase velocity is 5% slow in the vicinity of the Northern Appalachian Anomaly (NAA) at 40s period and 0% slow at 20s (and shorter) periods. We use these observations to constrain the shear velocity of the NAA lithosphere.

We have good reason to think that the NAA asthenosphere is, on average, about 10% slow. Because velocities anomalies tend to be largest in the shallow asthenosphere, I model the shear velocity anomaly as changing linearly from -5% at 400 km depth to -15% at the lithosphere-asthenosphere boundary (LAB) at 100 km depth. This asthenospheric anomaly produces only about a 2.5% reduction in the 40s Rayleigh wave phase velocity, since Rayleigh waves at that period are mostly sensitive to shallower structure (peak sensitivity is at about 75 km). It produces no reduction in the 20s Rayleigh wave phase velocity, whose peak sensitivity is even shallower. The asthenospheric part of the NAA cannot match the 40s data; slow velocities must extend into the lithosphere.

The 40s data can be matched by adding a -5% velocity anomaly that is distributed over the entire mantle lithosphere (60-100 km depth). However, the low velocities in the shallow lithosphere lower the 20s phase velocity by about 1.5%, which is not observed.

If instead, a -10% anomaly is added to just the lower half of the mantle lithosphere, then both the 40s and 20s phase velocities are matched.

I conclude that Ekstrom's [2017] require a reduction in shear velocity in the lower part of the lithosphere.

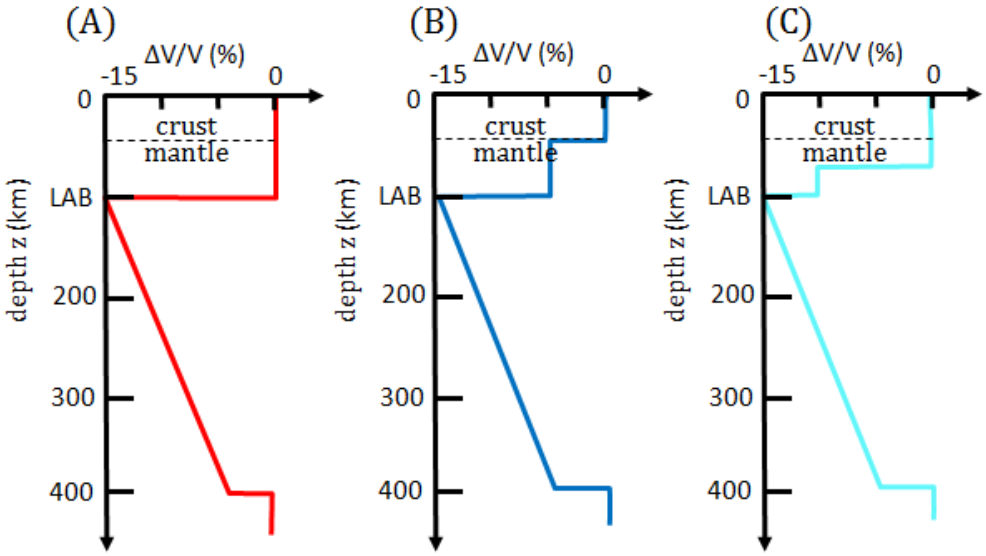

Figure 1. The three shear velocity vs. depth profiles considered.

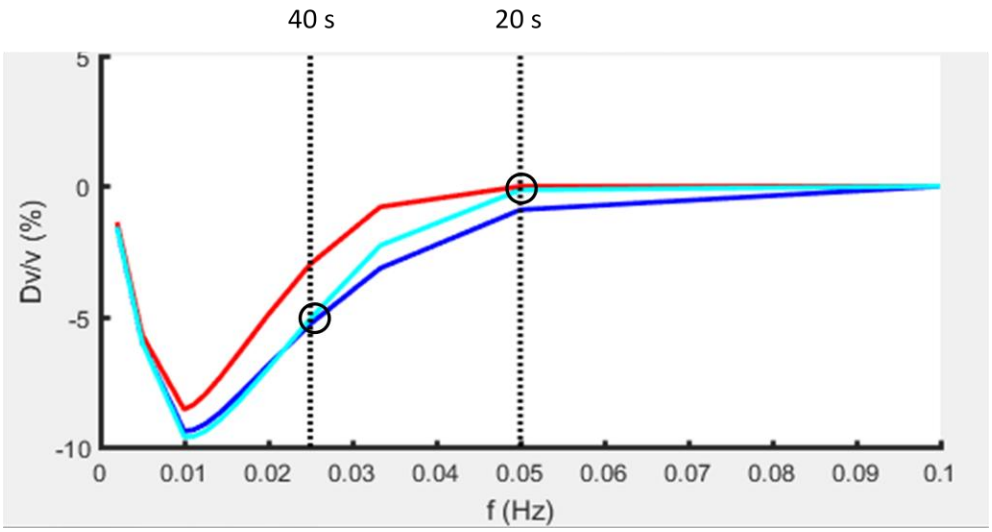

Figure 2. Phase velocity vs. frequency for the three models in Figure 1. Ekstron's [2017] 40s and 20s observations are shown with circles.

Reference:

Ekstron, G., Short-period surface-wave phase velocities across the conterminous United States, Physics of the Earth and Planetary Interiors 270, 168–175, 2017.