Seismic Anomalies in the Southeastern North American Asthenosphere as Characterized with Body Waves Travel Times from High Qualities Teleseisms

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Previously published tomographic maps of compressional and shear wave velocities beneath North America show seismic low velocity anomalies in the asthenosphere along the Southeastern margin of the continent, especially around 200 km depth, which are not yet fully-understood. Some of these anomalies, such as the Northern Appalachian Anomaly (NAA, in New England), the Central Appalachian Anomaly (CAA, in Virginia) and the Northern Gulf Anomaly (NGA, along Texas-Louisiana coast), have been shown to be thermal anomalies associated with mantle upwelling. Our study characterizes the seismic structure of the asthenosphere from Georgia to Virginia and develops evidence for the presence of low seismic velocities (and high temperatures) in that region. The research is based on high-quality maps of P and S wave differential travel time anomalies of several magnitude>6 teleseisms observed on the EarthScope Transport Array, along with forward modeling in a three-dimensional Earth model with simply-shaped heterogeneities. The differential travel time between pairs of stations was calculated by cross-correlation, after correcting seismograms for instrument response and filtering them. Anomalies were calculated with respect to the arrival time of each seismic phase as predicted by the AK135 Earth model. Additionally, the ratio of S to P differential wave travel time anomalies were computed using least-squares and used to infer whether the observed anomalies are thermal or chemical in origin. One major seismic slow velocity anomaly, here named South Coastal Anomaly (SCA), was identified. It appears on several previously-published maps and extends along the coast from the Georgia-South Carolina border to Northern Virginia. The SCA is about 600 km long in its north-south dimension and at least 400 km wide in its east-west dimension (its eastern edge is not image), and its western edge strikes north-south. Parallax measured from two different earthquakes from opposing directions is clearly observed and indicates that the anomaly is centered at about 200 km depth. The ratio of P-to-S wave differential travel time anomalies was found to be 3.84 ± 0.10 (95% confidence), a value that is close to the value of 3.24 predicted for a thermal anomaly and very different from the value of 1.84 predicted for a compositional anomaly. Its P and S wave travel time anomalies are 1.09 seconds and 4.20 seconds, respectively, relative to the Laurentian craton, which correspond to a temperature difference of about 620-730 °C. Although the SCA is a thermal anomaly like the NAA and CAA, it does not fit into the sequence of thermal anomalies along the eastern margin of North America, because is much larger in area, less intense and further east of the Appalachian Mountains than these others. Some published tomographic maps do show a low-velocity anomaly in the northwestern corner of Georgia, here called Southern Appalachian Anomaly (SAA), which is more consistent with the overall spatial sequence. However, our data show that the SAA does not exist. The SCA is a spatially-large thermal anomaly along the

southeastern coast of North America that might fit into a picture of ongoing upwelling along the eastern margin of North America. While the pattern of this upwelling is not yet understood, the difference in shape and intensity between the NGA and NAA suggest that several modes of convection might be occurring.