Lithospheric and Asthenospheric Structure Beneath Alaska Using Travel Time Anomalies from Teleseismic P and S Waves

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We derive high-quality P and S wave differential travel time delay maps for Alaska using Transportable Array data, magnitude >6 teleseisms and waveform cross-correlation techniques applied to the vertical and radial components, respectively. P wave and S wave anomalies between stations observing a common event are as much as +/-2 s and +/-6 s, respectively. The footprint of the fast Cook Inlet (CI) anomaly is about 800 by 100 km, with its long axis extending inland, striking NNE. Following Berg et al. (2020), we identify it as the descending slab of the Alaska subduction zone. It is brightest and narrowest, with a strike of N28E. For earthquakes from the SW, implying rays are coming up-dip through the slab. The slow Cape Yakataga (CY) anomaly is about 100 by 250 km, with its long axis parallel to the coast. The slow the Central Brooks Range (CBR) anomaly is about 200 km by 330 km, with an EW long axis. While Berg et al. (2020) identifies an intensely slow anomaly beneath the Seward Peninsula, our delay maps are only moderately slow in that region. S anomalies generally follows the of the pattern P wave anomalies, except in the Yukon Delta region, where S is systematically late. We measure parallax of anomalies by comparing their geographical position on delay maps from teleseisms with opposing back-azimuths. The northern end of the fast CI anomaly shifts about 440 km for opposing northerly and southerly back-azimuths. The slow CY anomaly appears only for S and SW back-azimuths, presumably because parallax moves it >200 km, to an offshore position for opposing directions. The slow CBR anomaly shifts about 240 km between northwesterly and southeasterly back azimuths. These shifts of 200-440 km are consistent with the anomalies being most intense in the mid to lower asthenosphere. The ratio of the P wave S differential travel time anomalies, for all station pairs observing a common event, varies from 2.4 to 4.4, with a strong azimuthal variation about an average ratio of 3.067 +/0.146 (95%). This ratio is typical of a thermal anomaly. The one-theta pattern peaks at an azimuth of N283E degrees and the two-theta pattern at N209E. These patterns are approximately parallel and perpendicular, respectively, to North American – Pacific plate motion and may be due to the dip of the subduction zone and strain-induced seismic anisotropy, respectively.