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Imaging the Upper Plate Lithosphere and Asthenosphere beneath Alaska with Sp Converted Waves

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To resolve the signatures of subduction zone processes in the mantle wedge, and how subduction has interacted with the upper plate, we imaged seismic velocity gradients beneath the US state of Alaska with Sp receiver function common conversion point (CCP) stacking. Pacific plate lithosphere, and lithosphere bearing the thicker crust of the Yakutat terrane, subduct to the northwest beneath the southern margin of Alaska. We employed data from hundreds of stations of the US NSF EarthScope Transportable Array, as well as other portable arrays and permanent networks. We calculated waveform components using a free-surface transform with improved estimates of free-surface velocities that were determined from P and SV particle motions. Sp receiver functions were calculated with time-domain deconvolution, and the CCP stack was generated with weighting functions that incorporate the properties of Sp scattering kernels. The CCP stack shows a clear interface between the North American and underthrust Yakutat crust, as well as Yakutat Moho depths of up to 60 km. Sp phases from the negative velocity gradient at the base of the upper plate are strongest in west-central Alaska, where lithosphere-asthenosphere boundary (LAB) depths lie at 65-100 km. In west-central Alaska, joint inversions of Sp data at single stations with Rayleigh phase velocities show comparable LAB depths as well as low asthenospheric velocities. This zone includes active magmatism and the upper plate appears to have been thinned by mantle wedge volatiles, melt, and flow. The LAB phase deepens to the north, reaching depths of ~120 km beneath the northern Arctic Alaska terrane. This increase in the depth of the LAB phase from the arc to the back-arc is consistent with the sculpting of the upper plate by subduction-related processes. Sp phases also delineate a prominent positive velocity gradient that represents the base of a low-velocity asthenospheric layer at depths of 100-130 km. The positive velocity gradient is consistent with the onset of partial melting in the asthenosphere.