Mapping out spatial variability in the subduction plate interface properties using high frequency P-to-S mode conversions

The subducting plate interface has properties that vary along strike and with depth posing significant constraints on earthquake processes. However, imaging this heterogeneity is limited using current seismic imaging techniques, which tradeoff between image resolution and the spatial and depth extent of the image. To solve this, we use P-to-S mode converted arrivals from local in-slab earthquakes (> 50 km deep) to image the plate interface at a high resolution across the subduction zone. We focus on 38 broadband stations active in southcentral Alaska between 2007 and 2008 (15 km spacing), which extend from the great 1964 earthquake rupture zone into slow slip and tremor regions downdip. The mode converted arrivals (X phase) start as a P wave, travel up the slab, and convert to S at an interface. A comparison between the observed X minus P travel time and those calculated using 3D ray-tracing indicates the converting interface is the top of the low velocity zone of the subducting slab recorded in receiver function images. The amplitude of the X phase varies along strike but is independent of earthquake location and minimally affected by the station. Therefore, the X phase amplitude depends on the characteristics at the conversion point. Mapping the X/P amplitude ratio, which removes the effect of moment and geometric spreading, at the conversion point elucidates variability along strike at the scale of 10s of kms. This variability maps out changes in the plate interface properties, which vary in a complex way with frequency. The X phase amplitude is controlled by the impedance contrast across the interface, indicating changes in lithology or fluid content along strike. Overall, using the X phase has proved to be a powerful way to map out changes in the subducting plate interface properties along strike at a higher resolution than typical passive source seismic studies.