Title: Structural constraints on non-volcanic tremor along the Cascadia margin

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Lateral variations in the seismic properties of the Cascadia margin are fundamentally tied to fluid-mediated processes like non-volcanic tremor, intermediate-depth seismicity, and volcanism. Using a recently developed 3D shear wave velocity model, we apply timing corrections to the migration of P-wave receiver functions to create a 3D model of the discontinuity structure along the Cascadia margin. Using this model, we investigate the relationships between non-volcanic tremor distribution, low frequency earthquakes, and the seismic structure of the subduction margin.

We find that the spatial extent of non-volcanic tremor and low frequency earthquakes is mainly constrained to depths where the downgoing oceanic crust is in contact with the overriding crust, terminating near where the subducting slab underthrusts below the forearc mantle (i.e., the “mantle wedge corner”). This indicates that the overriding crust of the Cascadia margin is relatively impermeable, enabling non-volcanic tremor through the build-up of fluid pressure near the plate interface. The crust of the forearc is also characterized by high attenuation and very low shear wave velocities at depth, likely caused by the transient infiltration of fluids derived from metamorphic dehydration reactions into underthrusting sedimentary material. Only minor amounts of tremor occur where the slab underthrusts the forearc mantle, perhaps because peridotite may react quickly to form serpentinite if fluids are present and/or may be too permeable to allow fluid pressures to reach the near-lithostatic conditions necessary to cause non-volcanic tremor. Outboard of the forearc mantle corner, velocity contrasts across the Moho and uppermost mantle shear wave velocities indicate much of the forearc mantle is serpentinized to various extents, consistent with previous studies.