3-D seismic anisotropy structure of the Cascadia subduction zone

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We determine the first P-wave tomography of 3-D azimuthal and radial anisotropy of the Cascadia subduction zone by inverting a great number of arrival-time data of local and teleseismic events. Fast-velocity directions (FVDs) of azimuthal anisotropy in the crust are generally trench-parallel, reflecting N-S compression along the Cascadia margin. Radial anisotropy (RAN) is negative (i.e., Vpv > Vph) in the crust and upper-mantle wedge beneath the Cascadia volcanoes and back-arc area, reflecting hot and wet upwelling flows associated with fluids from dehydration reactions of the young and warm Juan de Fuca plate that is subducting toward the northeast. Trench-parallel FVDs occur in the subducting slab under the forearc, suggesting that the gently-dipping slab may still keep its original anisotropy produced at the mid-ocean ridge and modified at the outer-rise before subduction. The slab and subslab mantle exhibit the same RAN pattern: positive RAN in the Cascadia forearc whereas negative RAN under the Cascadia volcanoes and the back-arc. This feature suggests that the slab and the subslab asthenosphere are strongly coupled, and subslab mantle flow is formed by entrainment of the asthenosphere with the overriding slab. In northern Cascadia, NE-SW FVDs occur in a prominent subslab low-velocity zone that also exhibits negative RAN, reflecting thermally buoyant mantle materials derived from nearby oceanic hotspots, which flow toward the northeast and gradually accumulate under northern Cascadia, resulting in decompression melting.

Reference

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