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Shoreline-crossing shear-velocity structure of the Juan de Fuca plate and Cascadia subduction zone from surface waves and receiver functions

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The Cascadia subduction zone (CSZ) is the site of the onshore-offshore Cascadia Initiative, which deployed seismometers extending from the Juan de Fuca ridge to the subduction zone and onshore beyond the volcanic arc. This array allows the unique opportunity to seismically image the evolution and along-strike variation of the crust and mantle of the entire CSZ. We compare teleseismic receiver functions, ambient-noise Rayleigh-wave phase velocities in the 10-20 s period band, and earthquake-source Rayleigh-wave phase velocities from 20-100 s, to determine shear-velocity structure in the upper ∼200 km. Receiver functions from both onshore and shallow-water offshore sites provide constraints on crustal and plate interface structure. Spectral-domain fitting of ambient-noise empirical Green's functions constrains shear velocity of the crust and shallow mantle. An automated multi-channel cross-correlation analysis of teleseismic Rayleigh waves provides deeper lithosphere and asthenosphere constraints. The amphibious nature of the array means it is essential to examine the effect of noise variability on data quality. Ocean bottom seismometers (OBS) are affected by tilt and compliance noise. Removal of this noise from the vertical components of the OBS is essential for the teleseismic Rayleigh waves; this stabilizes the output phase velocity maps particularly along the coastline where observations are predominately from shallow water OBS. Our noise-corrected phase velocity maps reflect major structures and tectonic transitions including the transition from high-velocity oceanic lithosphere to low-velocity continental lithosphere, high velocities associated with the subducting slab, and low velocities beneath the ridge and arc. We interpret the resulting shear-velocity model in the context of temperature and compositional variation in the incoming plate and along the strike of the CSZ.