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A 2-D Tomographic Model of the Juan de Fuca Plate from Accretion at Axial Seamount to Subduction at the Cascadia Margin from an Active Source OBS survey

Details

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Abstract

The subduction of the Juan de Fuca plate in Cascadia, with an age of the plate at the trench from 6-9 Ma, is considered an end-member example of a young lithosphere subduction zone. The state of hydration of the Juan de Fuca plate is currently poorly constrained and while the expectation for a young-warm lithosphere is for low hydration, numerous observations suggest the presence of abundant water in the subduction zone. Due to the location of the Juan de Fuca Ridge (JdFR) in relatively close proximity (<500km) to the trench, it is feasible to investigate the evolution of the Juan de Fuca plate, from accretion at the ridge to subduction beneath Cascadia. In June-July 2012 we conducted an active-source seismic experiment consisting of multi-channel seismic (MCS) reflection and wide-angle ocean bottom seismometer (OBS) profiles onboard the R/V Langseth and R/V Oceanus. Here we present results from a plate transect extending from Axial Seamount at the JdFR to Hydrate Ridge off the Oregon margin. Twenty-seven ocean bottom seismometers (OBSs), with an approximate inter-instrument spacing of 16km, recorded nearly 10,000 air-gun shots. In the OBS records we have identified and picked 2990 sedimentary P-wave travel times (Ps), 3417 crustal refractions (Pg), 1105 Moho reflections (PmP), and 1335 upper mantle refractions (Pn). These arrivals are observed up to maximum source-receiver offsets of 15 km (Ps), 87km (Pg), 70km (PmP), and 113km (Pn). These observations are being used to create a 2D tomography P-wave velocity model of the plate. The Ps travel times, in conjunction with poststack-migrated MCS reflection images, constrain a sedimentary cover that progressively increases in thickness as the plate ages from essentially zero km at a distance of 50km from the ridge axis up to 2.7km at the Cascadia deformation front off Central Oregon. Our results will allow us to address whether hydration of the plate is restricted to the sediments and upper crust, or if hydration extends down into the lower crust and uppermost mantle. This model will also help constraining where/when during the evolution of the plate does hydration take place, whether it be near-axis, at the outer trench rise, or in an intraplate setting. This improved view of the structure of the Juan de Fuca plate will be a critical piece of information currently missing for understanding subduction zone processes at Cascadia.

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