The evolution of the hydration state of the Juan de Fuca plate from Ridge to Trench offshore Washington State

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We conduct a two-dimensional travel time tomography study of a cross-plate, 300-km long, ocean bottom seismometer (OBS) transect collected as part of the Ridge to Trench (R2T) program to investigate the structure, evolution and state of hydration of the Juan de Fuca (JdF) plate from the ridge axis to subduction at the Cascadia margin offshore Washington. Our study employs the methodology of Korenaga et al. (2000) to derive a P-wave velocity model using wide-angle data from 15 OBSs spaced on average 15 km apart along the Washington Transect, spanning from the Endeavour segment of the JdF ridge to the Cascadia accretionary prism. Previous studies provide a well-resolved multi-channel seismic (MCS) reflection image of this transect (Han et al., 2016), affording good constraints of the location of basement and Moho reflectors while allowing for comparison of the relationship between velocities and crustal structure. MCS results along this transect suggest evidence of little bending faulting confined to the sediment and upper-middle crust. Seismic velocities are compared to predicted velocities for crustal and mantle lithologies at temperatures estimated from a plate-cooling model and are used to provide constraints on water contents in these layers.

Our velocity model results show values consistently less than predicted velocities at all crustal ages, which indicates some level of fractured and hydrated crust. We present comparisons to previously published analysis of Oregon Transect data (Horning et al., 2016) supporting MCS inferences of more prevalent bend faulting and increased hydration offshore Oregon as compared to the Washington transect. We further present evidence of varying velocity structure across the plate interior at timescales associated with known changes in crustal formation, suggesting that hydration potential may be dependent on ridge processes.