T42C-02: Dry Juan de Fuca slab revealed by quantification of water entering Cascadia subduction zone

Thursday, 14 December 2017
10:35 - 10:50
New Orleans Ernest N. Morial Convention Center - 210

Water is carried by subducting slabs as a pore fluid and in structurally bound minerals, yet no comprehensive quantification of water content and how it is stored and distributed at depth within incoming plates exists for any segment of the global subduction system. Here we use controlled-source seismic data collected in 2012 as part of the Ridge-to-Trench seismic experiment to quantify the amount of pore and structurally bound water in the Juan de Fuca plate entering the Cascadia subduction zone. We use wide-angle OBS seismic data along a ~400-km-long margin-parallel profile ~10-15 km seaward from the Cascadia deformation front to obtain P-wave tomography models of the sediments, crust, and uppermost mantle, and effective medium theory combined with a stochastic description of crustal properties (e.g., temperature, alteration assemblages, porosity, pore aspect ratio), to analyze the pore fluid and structurally bound water reservoirs in the sediments, crust and lithospheric mantle, and their variations along the Cascadia margin. Our results demonstrate that the Juan de Fuca lower crust and mantle are much drier than at any other subducting plate, with most of the water stored in the sediments and upper crust. Previously documented, variable but limited bend faulting along the margin, which correlates with degree of plate locking, limits slab access to water, and a warm thermal structure resulting from a thick sediment cover and young plate age prevents significant serpentinization of the mantle. Our results have important implications for a number of subduction processes at Cascadia, such as: (1) the dryness of the lower crust and mantle indicates that fluids that facilitate episodic tremor and slip must be sourced from the subducted upper crust; (2) decompression rather than hydrous melting must dominate arc magmatism in northern-central Cascadia; and (3) dry subducted lower crust and mantle can explain the low levels of intermediate-depth seismicity in the Juan de Fuca slab.

Plain Language Summary

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