Title:
Basement Outcrops as Pathways for Seawater Circulation at the Southern Chilean Trench

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Abstract

Hydrothermal circulation and faulting in fast-spreading oceanic lithosphere are typically confined to the upper crust, but subduction-related outer-rise bending significantly alters this hydrogeologic regime. We investigate the seismic structure and crustal hydration of the incoming Nazca plate offshore southern Chile (42º-44°S), where sediment thickness reaches up to 2.5 km near the deformation front. Utilizing joint traveltime tomography from wide-angle and multi-channel seismic reflection profiles constrained by P-wave and S-wave (Vp/Vs) data, we evaluate fluid percolation and structural modification across the oceanic crust. Elevated Vp/Vs ratios in layers 2A and 2B indicate high upper-crustal porosity, confirming that fracturing and fluid penetration extend through layer 2A and into layer 2B. Basement outcrops piercing the thick sedimentary blanket act as essential primary conduits, governing active cold seawater infiltration and creating highly heterogeneous Vp/Vs distributions that mark localized regions of fluid inflow and outflow. Conversely, the lower crust exhibits minimal Vp/Vs anomalies, showing significant velocity reductions only in the immediate vicinity of the trench. These findings demonstrate that bending-related faulting and outcropping basement pathways primarily drive extensive fracturing and fluid circulation within the upper oceanic crust prior to subduction.