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Seismic imaging of water distribution in subduction zones

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Subduction zones transport water into the Earth's interior. The subsequent release of this water through dehydration reactions may trigger intraslab earthquakes and arc volcanism, regulate slip on the plate interface, control plate buoyancy, and regulate the long-term budget of water on the planet's surface. Here, we show how water distribution in these systems can be inferred through high-resolution seismic imaging. We present examples of seismic profiles across subduction zones in Cascadia, Alaska, and Greece, which were obtained by 2-D inversion of teleseismic scattered waves recorded at dense broadband arrays. In conjunction with constraints from geodynamic models and petrological data, these seismic profiles provide direct insight into the depth range over which the downgoing plate undergoes dehydration and the degree of hydration-serpentinization of the mantle wedge. We find that the depth at which the oceanic crust transforms from hydrated metabasalts into eclogite is highly dependent on the age of the subducted slab, with the youngest crust in Cascadia undergoing eclogitization at 40 km depth whereas the older ones in Alaska and Greece eclogitize at depths greater than 100 km, as expected from thermal models.