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Relationship between oceanic-plate hydration at trenches and intra-slab seismicity beneath arcs

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Growing evidence indicates that oceanic plates are strongly hydrated by processes linked to bending-related deformation at trenches just before subduction. During oceanic plate bending flexural stresses are partially relieved by normal faulting. Seismic images show that bend-faults cut across the oceanic crust into the mantle. Coincident p-wave seismic velocities of the uppermost mantle are ˜7-7.5 km/s and modeling of gravity data is compatible with a ˜20 km thick upper mantle layer with average density of 3.15 g/cm3. The low velocities and densities indicate ˜15% mantle serpentinization probably caused by water percolating along the bend-faults. Low velocities are also observed in the oceanic crust but cracking may cause part of the velocity reduction and potential hydration is difficult to quantify. To learn about the fate of chemically-bound water in the subducting slab we compared the patterns of bend-faults with patterns of intra-slab earthquakes in Middle America and Chile subduction zones, where there is geophysical evidence of ongoing plate hydration at the trench. In these two regions the pattens of hydrated bend-faults at the trench and the patterns of fault-plane solutions of intra-slab seismicity underneath volcanic arcs in the corresponding slab show a striking similarity. The similarity of the two groups of patterns indicates that bend-faults are reactivated during intra-slab seismicity. Faults are reactivated probably by pore pressure increase, due to the release of chemically-bound water by dehydration reactions during progressive metamorphism of the slab. The data supports that most oceanic plate hydration occurs at the trench and that much of that chemically-bound water in the slab is released into the mantle wedge under volcanic arcs associated to intra-slab seismicity.