Water recycling in subduction zones and the role of rehydration in the generation of intermediate-depth seismicity and the nature of the cold fore-arc mantle

PETER VAN KEKEN[1], GEOFF ABERS[2], BRAD HACKER[3], JUNICHI NAKAJIMA[4], SAEKO KITA[5], MARC SPIEGELMAN[6], AND CIAN WILSON[6]

[1]Carnegie Institution of Science, Washington DC, USA, pvankeken@carnegiescience.edu
[2]Cornell University, Ithaca, NY, USA, abers@cornell.edu.
[3]University of California at Santa Barbara, CA, USA, hacker@geol.ucsb.edu.
[4]Tokyo Institute of Technology, Japan, nakajima@geo.titech.ac.jp.
[5]Hiroshima University, Japan, saeko@hiroshima-u.ac.jp.
[6]LDEO, Columbia University, New York, NY, USA, mspieg@ldeo.columbia.edu, cwilson@ldeo.columbia.edu.

Significant amounts of water enter the world's subduction zones in the form of free and mineralogically-bound water. While the free water likely disappears nearly completely at shallow levels, the water bound in rock is released at depth through a series of metamorphic dehydration reactions. Water can move past the volcanic front and be recycled to the deeper Earth particularly in the colder subduction zones.

Geodynamical predictions show that water that is released from the slab travels towards the arc and triggers wet melting in the warm mantle wedge. The released water can also travel back up the slab through the crust and slab wedge. Comparisons with well-determined hypocenters and low-velocity crustal channels in a number of subduction zones suggest the rehydration of the crust and mantle by fluids released from deeper dehydration reactions is likely the cause for intermediate-depth seismicity in these regions by 'rehydration embrittlement'.

These results indicate the importance of hydrological flow in subduction zone processes with potentially significant flow back up the slab. The extent to which these fluids rehydrate the cold fore-arc region of the mantle wedge is still unclear. Seismological observation of this region suggest that in most cases the amount of rehydration and associated serpentinization is modest at best.