Importance of serpentine as a lubricant in subduction dynamics

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Subduction zones processes are key to understanding geodynamics and material transportation-fractionation within the Earth, e.g., earthquakes, magmatism, metamorphism, orogeny, continental growth and mantle convection. Thermal and flow structure of the subducting slab and the overlying mantle wedge is one of the important factors that govern or affect the various phenomena mentioned above, yet it remains to be constrained. In subduction zones, thermal structure, flow structure and water distribution interplay, and they need to be solved consistently. Consequently, the numerical modeling should include generation and migration of aqueous fluid, and its reaction with the convecting solid. The results of such numerical models show that an aqueous fluid released from the subducting oceanic crust forms a serpentinite layer in the mantle wedge just above the subducting slab. This layer acts as a lubricant between the subducting slab and the overlying mantle wedge, and greatly affects the thermal and flow structure to contribute to water transportation to the deep mantle. An increase in thickness or a decrease in effective viscosity of this lubricant layer results in deeper water transportation. Seismic studies support existence of such a hydrous layer just above the subducting slab (e.g., Kawakatsu and Watada, 2007; Tonegawa et al., 2008). Even after the completion of dehydration of major hydrous mineral phases in the subducting materials, especially at the base of the mantle wedge just above the subducting slab, nominally anhydrous phases can carry a significant amount of H_2O (1.1 to $7.8x10^{11}$ kg/yr) into the deep mantle (Iwamori, 2007). This water and the associated components may be accumulated in the deep mantle to develop unique isotopic character reflecting aqueous fluid-rock reaction, and could be the source of one of the two independent components that have recently been found in the isotopic compositional space of oceanic basalts (Iwamori and Albarede, 2008).