On a reversely-dipping low-velocity layer in the Tohoku-slab beneath the forearc: unbending induced fluid pathway?

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Kawakatsu & Kim (2018, SSJ) have recently updated the receiver function reflectivity images beneath the Japanese islands reported earlier in a series of papers by Kawakatsu and others(e.g., Kawakatsu & Watada, 2007, Science). We collected data from recent 14 years (April 2004 to April 2018) of Hi-net recordings; the resulting new dataset is 2.4, 6.4 and 4.8 times larger in terms of the time period, the number of earthquakes, and the number of RF waveforms compared to the earlier works. New images obtained are generally consistent with the previous ones; as the data quantity increases, the covered area widens and images tend to be clearer and smoother. One exception is that there is a glimpse of reversely-dipping low-velocity layer (LVL) within the slab beneath the forearc region dipping toward the Japan trench. When compared with the recent tomographic model that incorporates data from a seafloor cable seismic network S-net, the LVL appears to correspond to a strong P-wave LVL dipping also toward the trench that is imaged from the slab surface at around a depth of 40km to at least 60km. As this LVL is observed along the entire Tohoku Japan arc, it might be a representation of some mechanical process associated with subduction, unless some systematic bias is introduced in tomography (e.g., mis-location of off-shore earthquake depths). We speculate that this structure may continue to the bottom of the slab as imaged by the tomography though not resolved, and be related with the slab unbending that straightens the slab in the mantle (e.g., Kawakatsu, 1986, JGR). Tensile stress caused by unbending near the slab bottom may open a pathway for the sub-slab fluid to migrate upwards all the way to the slab top to further supply fluids around the slab surface, as well as to hydrate the lower-layer of the double seismic zone as suggested by Seno & Yamanaka (1996, AGU Monograph). Geophysical and geochemical consequences of this hypothesis that might be testable via various ways may be discussed.

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