Geophysical Research Abstracts
Vol. 13, EGU2011-9576, 2011
EGU General Assembly 2011

Seismological constrains on dual plate subduction beneath Kanto, Japan: Role of hydrated oceanic crust and serpentinized mantle in seismicity

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The Kanto district in central Japan, which surrounds the Tokyo metropolitan area, is known as a unique region in the world in terms of plate tectonics. This region is located behind a trench-trench-trench (TTT) triple junction with two obliquely subducting oceanic plates. The Philippine Sea (PHS) plate is subducting beneath the continental plate, and the older Pacific (PAC) plate is subduting beneath the both plates. As a result of dual plate subduction, many disastrous M$\sim$8 and numerous M$\sim$7 earthquakes have repeatedly struck Tokyo. Here we review our recent seismological studies on dual plate subduction and show how it affects seismotectonics (Nakajima et al., 2009, JGR; Nakajima et al., 2009, GRL; Uchida et al., 2009, EPSL, Uchida et al., 2010, JGR; Nakajima and Hasegawa, 2010, JGR). Our result suggests that the PHS slab beneath Kanto is the best natural laboratory to investigate ongoing metamorphism in the slab.

We first determine geometries of the two slabs from the distribution of thrust-type earthquakes and seismic velocity structures inferred from travel-time tomography. Then, an area where the bottom of the PHS slab is in contact with the upper surface of the PAC slab is defined. This slab-slab contact zone has a crucial effect on seismotectonics in the PHS slab in various ways. Detailed seismic velocity structures in the PAC slab shows deep penetration of a thin low-velocity (hence hydrated) crust by 40-70 km only beneath the slab contact zone. This result suggests that the complete overlap of the PHS slab on the PAC slab can prevent the upper surface of the PAC slab from being heated from the hot mantle wedge, resulting in the delay of dehydration in the crust. Our study also reveals two serpentinized areas in the PHS slab: one is a thin serpentinized layer at its bottom (immediately above the PAC slab), and the other is a wedge-shaped high-degree serpentinized mantle at its easternmost part. Interestingly, M7-class intraslab earthquakes appear to have occurred related to the wedge-shaped serpentinization in the PHS slab. Serpentinization may be caused by fluids supplied from the underlying PAC slab.