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New tomographic images of P- , S- wave velocity and Q on the Philippine Sea Slab beneath Tokyo: Implication to seismotectonics and seismic hazard in the Tokyo metropolitan region

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The Central Disaster Management Council of Japan estimates the next great M7+ earthquake in the Tokyo metropolitan region will cause 11,000 fatalities and 112 trillion yen (1 trillion US$) economic loss at worst case if it occur beneath northern Tokyo bay with M7.3. However, the estimate is based on a source fault model by conventional studies about the PSP geometry. To evaluate seismic hazard due to the great quake we need to clarify the geometry of PSP and also the Pacific palate (PAP) that subducs beneath PSP. We identify those plates with use of seismic tomography and available deep seismic reflection profiling and borehole data in southern Kanto area.

We deployed about 300 seismic stations in the greater Tokyo urban region under the Special Project for Earthquake Disaster Mitigation in Tokyo Metropolitan Area. We obtain clear P- and S- wave velocity (Vp and Vs) and Q tomograms which show a clear image of PSP and PAP. A depth to the top of PSP, 20 to 30 kilometer beneath northern part of Tokyo bay, is about 10 km shallower than previous estimates based on the distribution of seismicity (Ishida, 1992). This shallower plate geometry changes estimations of strong ground motion for seismic hazards analysis within the Tokyo region.

Based on elastic wave velocities of rocks and minerals, we interpreted the tomographic images as petrologic images. Tomographic images revealed the presence of two stepwise velocity increase of the top layer of the subducting PSP slab. Rock velocity data reveals that subducting PSP crust transforms from blueschists to amphibolites at depth of 30km and amphibolites to eclogites at depth of 50km, which suggest that dehydration reactions occurs in subducting crust of basaltic compositions during prograde metamorphism and water is released from the subducting PSP crust. Tomograms show evidence for a low-velocity zone (LVZ) beneath the area just north of Tokyo bay. A Q tomogram show a low Q zone in PSP slab. We interpret the LVZ as a serpentinized region in the forearc mantle of Honshu arc, resulting from hydration by water derived from subducting PSP crust. Because strength of the serpentinized preidotite is not large enough for brittle fracture, if the area is smaller than previously estimated, a possible area of the large thrusting fault on the upper surface of PSP can be larger than previously thought.