Slab structure beneath the Japanese Islands and earthquake generation

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A dense nationwide seismic network recently constructed in Japan has been yielding large volumes of high-quality data that have made it possible to investigate the seismic structure in the Japanese subduction zone with unprecedented resolution. We introduce the configuration of the Philippine Sea and Pacific plates subducting beneath the Japanese Islands recently obtained by seismic tomographic imagings, precise earthquake hypocenter determinations and focal mechanism studies. A model for generation of earthquakes and arc magmas is also introduced based on these observations. Seismic tomographic studies show that the Philippine Sea plate subducting beneath southwest Japan is continuous throughout the entire region, from Kanto to Kyushu, without disruption or splitting even beneath the Izu Peninsula. Estimated geometry of the subducted Pacific and Philippine Sea slabs shows a broad contact zone between the two slabs located directly beneath the Kanto plain. It further shows wavy configuration of the Philippine Sea slab subducting beneath the entire region of southwestern Japan. The contact of the Philippine Sea plate with the Pacific plate causes anomalously deep interplate and intraslab earthquake activity in Kanto. Detailed waveform inversion studies have revealed that the asperity model is applicable to interplate earthquakes. High-resolution studies of the spatial variation of intraslab seismicity and the seismic velocity structure of the slab crust strongly support the dehydration embrittlement hypothesis for the generation of intraslab earthquakes. Seismic tomography studies show that water released by dehydration of the slab and secondary convection in the mantle wedge, mechanically induced by slab subduction, are responsible for magma generation in this region. Water of slab origin is also inferred to be responsible for large anelastic local deformation of the arc crust leading to inland crustal earthquakes that return the arc crust to a state of spatially uniform deformation.