Plate Subduction and Generation of Earthquakes in Japan: Recent Observations Based on Nationwide Dense Networks

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Abstract

Dense nationwide seismic and GPS networks recently constructed in Japan have been yielding large volumes of high quality data that have made it possible to investigate the seismic structure and earthquake generation process in the Japanese subduction zone with unprecedented resolution. Seismic studies have shown that the Philippine Sea plate subducting beneath southwest Japan has a wavy configuration and is continuous throughout the entire region of southwest Japan without disruption or splitting even beneath the Izu Peninsula as suggested in the past. The contact of the Philippine Sea plate with the Pacific plate subducting below causes anomalously deep activity of interplate and intraslab earthquakes in Kanto, central Japan. Waveform inversion studies of successive earthquakes in common source area, studies of interplate coupling by GPS data and analyses of small repeating earthquakes have revealed that the asperity model is applicable to the process of seismic and aseismic slips on the plate boundary. Episodic slow slips accompanied by low-frequency tremors/earthquakes on the plate boundary have been found by detailed analyses of dense seismic and GPS network data. These aseismic slips including low-frequency seismic signals are considered to play an important role in stress loading at asperities. Studies of spatial variation of earthquakes and the seismic velocity structure within the slab crust have provided evidence supporting the dehydration embrittlement hypothesis for the generation of intraslab earthquakes. Seismic tomography studies have shown that water released by slab dehydration and corner flow in the mantle wedge are responsible for generation of magmas. Water of this slab origin which attained to the arc crust weakens surrounding crustal rocks and probably causes large anelastic local deformation of the arc crust there, yielding shallow inland earthquakes in order to make the deformation of the arc crust uniform.