Seismic structures beneath the western Pacific Ocean

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Structural heterogeneities of the crust and upper mantle under the entire-arc regions of the subduction zones along the Western Pacific Ocean are investigated in detail for better understanding of the generating mechanisms of the megathrust earthquakes, dehydration of subduction slabs and interplate coupling. In order to accurately relocate the earthquakes occurred in the suboceanic regions of the Pacific Ocean and the Philippine Sea, we present a combined method (master-event location: MEL) that makes use of the sP depth phase data together with the P-wave and S-wave double-difference arrival times. The method was assessed to be an effective way to determine the precise hypocenters of the suboceanic earthquakes that occurred outside of the land-based seismic network. The obtained results confirmed the major features delineated by previous studies and revealed some new features of the structural heterogeneity beneath the entire-arc regions of the subduction zones along the Western Pacific Ocean. The cold subducted Pacific plate in Northeast Japan and the warm Philippine Sea lithosphere are imaged as continuous high-velocity anoamlies. Strong low-velocity anomalies are distributed extensively along the volcanic front and extend to the back arc side in the crust and upper mantle along the West Pacific subduction zones. Such low-velocity anomalies are caused by large quantity of fluids liberated by the dehydration reaction of the subducting slabs. At the shallow depths in the mantle wedge of the subduction zones, fluids related to the serpentinization of the forearc mantle could be released from the subducted Pacific and Philippine Sea slabs. At depths of 70-150 km, the dehydrated fluids mixing with the hot upwelling materials may cause partial melting there due to the high temperature. Such melted materials will weaken the seismogenic layer and finally reach to the surface in the arc or back arc region to form the volcanoes in these subduction zones. Strong lateral heterogeneities are imaged on the upper boundaries of the Pacific and Philippine Sea slabs under the forearc regions, which show a good correlation with the spatial distribution of large interplate earthquakes, i.e., most of the great thrust earthquakes are located within the high-velocity or around the low-velocity areas. These observations indicate that strong coupling sections (or asperities) and weak-coupled or decoupled patches might exist along the upper boundaries of the subducting slabs in Northeast Japan, Southwest Japan and Kyushu. The spatial distribution of the great thrust earthquakes is possibly controlled by lateral heterogeneities, including strongly coupled sections (asperities) and weakly coupled or decoupled sections along the upper slab boundary, which is expected to be a common feature for the megathrust earthquakes in the subduction zones.