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Structural heterogeneity of West-Pacific subduction zones and its implications for interplate megathrust earthquakes

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We have studied 3-D structures of West-Pacific subduction zones especially for the forearc and back-arc areas under the oceanic regions using a large number of high-quality waveform and arrival-time data recorded by the dense Japanese seismic networks. Our results show that strong lateral heterogeneities exist in the interplate megathrust zone under the forearc regions of the West-Pacific subduction zones. We find that large interplate earthquakes (M ≥ 6.0) generally occurred in or around high-velocity (high-V) and low-attenuation (high-Q) patches in the megathrust zone. These high-V and high-Q patches are generally surrounded by significant low-velocity (low-V) and high-attenuation (low-Q) anomalies. We think that the high-V and high-Q patches in the megathrust zone probably represent strongly coupled areas, while the low-V and low-Q anomalies may reflect the weakly coupled portions. We suggest that the high-V and high-Q patches in the megathrust zone may represent asperities formed by subducted oceanic ridges, seamounts or other topographic highs on the upper boundary of the subducting slab. In contrast, the low-V and low-Q anomalies may result from subducted sediments and fluids associated with slab dehydration. The fluids in the megathrust zone may play an important role in the nucleation of megathrust earthquakes at the asperities, in addition to the stress accumulation caused by the plate subduction.

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