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Structural control on the nucleation of Nankai megathrust earthquakes

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Many large interplate earthquakes (M >7) occurred on the megathrust fault of the Nankai subduction zone, where the young Philippine Sea plate is subducting beneath the Eurasian plate along the Nankai Trough. The landward downdip limit of the Nankai megathrust seismogenic zone is located at a depth of ˜30-40 km, marked by the occurrence of episodic tremors and slips. The seaward updip limit is not very distinct, being generally at a depth of ˜10 km and correlated with a suite of diagenetic to low-grade metamorphic processes.

To clarify the causal mechanisms of the Nankai megathrust earthquakes, we studied the detailed three-dimensional P and S wave velocities (V), attenuation (Q), and Poisson's ratio (PR) structures of the southwest Japan forearc, using a large number of high-quality arrival time and t∗data measured precisely from seismograms of local earthquakes. The suboceanic earthquakes used are relocated precisely using sP depth phase and ocean bottom seismometer data. Our results show the existence of two prominent high-V, high-Q, and low-PR patches separated by low-V, low-Q, and high-PR anomalies in the Nankai megathrust zone. Megathrust earthquakes during 1900 to 2013 nucleated in or around the high-V, high-Q, and low-PR patches, which may represent strongly coupled areas (i.e., asperities) in the megathrust zone. Our results indicate that structural heterogeneities in the megathrust zone, such as the subducting seafloor topography and compositional variations, control the nucleation of the Nankai megathrust earthquakes.

Keywords: Nankai arc, Subduction zone, Megathrust earthquake, slab, fluids