Detailed Vp structure of the plate boundary fault revealed by dense OBS survey in Nankai Trough off Cape Muroto

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In the plate subduction zone, various types of fault slip behaviors are observed along the plate boundary. In general, the slip types changes with the depth. The fast slip type that generate regular earthquakes including megathrust are located at an intermediate depth, the area is called as the seismogenic zone. The updip side and the downdip side of the seismogenic zones are transitional zones where slow earthquakes release the strain along the plate boundary, and the outer side of these transitional zones are the stable sliding zone.

The boundary among these zones are mainly determined by the frictional coefficient along the plate boundary, which is affected by various factors such as pressure-temperature condition, pore-fluid pressure and materials along the plate interface, and the geometry of the plate interface. To reveal these potential factors controlling the interplate slip behaviors, detailed seismic structure at around the depth of the plate boundary is critically important.

Nankai Trough is one of the most investigated seismogenic subduction zone in the world. Especially in the central part of the Nankai Trough, detailed seismic activities are always monitored by using a seafloor cable seismic observatory system (DONET), which reveals the distribution of the shallow very low frequency earthquakes (sVLFE). The downdip limit of the sVLFE area is considered as the boundary between the seismogenic zone and the transitional sliding zone, but the factor determines this zone boundary has not been resolved yet.

Since 2018, we, JAMSTEC, has conducted extensive controlled-source seismic surveys in Nankai Trough to reveal the detail seismic structure at around the depth of the plate boundary entire Nankai Trough. In 2019, as a part of this survey campaign, we conducted a wide-angle seismic reflection and refraction survey using a densely aligned OBSs off Cape Muroto crossing the Tosa-bae and Tosa-bae basin. The Tosa-bae is a remarkable topographic high and the Tosa-bae basin is a sharp valley type topographic feature dividing the Tosa-bae into northern and sothern parts. As for the seismic activities, the Tosa-bae basin corresponds to the downdip limit of the sVLFE distribution, possible boundary between the seismogenic zone and transitional sliding zone.

The OBS spacing was 2-km, which enabled us to apply the acoustic, frequency-domain, waveform inversion techniques to develop a detailed P-wave velocity (Vp) model. We succeeded in revealing detailed Vp at around the depth of the plate interface from the trough axis to the area below the Tosa-bae. Our Vp model indicates that low Vp materials exist immediately above the plate interface to the south of the Tosa-bae basin but it suddenly disappears to the north. Together with the sVLFE distribution, our results suggest that the interplate slip behaviors are closely related to the materials immediately above the plate interface.

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