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Segmentation of hypocenters and 3-D velocity structure around the Kii Peninsula

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Around the Kii Peninsula, the rupture boundary of the Tonankai and Nankai earthqueks is located. In addition, there can be seen along-strike segmentations in hypocenters, P-wave anisotropy, low frequency earthquake (LFE) distribution and subduction depth of the Philippine Sea (PHP) Plate. To investigate these segmentations, 3-D velocity structure and hypocenters were determined by using ocean bottom seismometers (OBSs) deployed from 2003 to 2007 and on-land stations.

To begin with, we determined station corrections which compensate travel time delays due to the sediment layers based on traveltime misfits. A double-difference tomography method was adapted to obtain 3-D velocity structures and a grid search method was used to increase the number of determined hypocenters. In addition, we performed calculations of waveform cross-correlation coefficients (CC) in order to improve relative hypocenters and to detect similar event clusters. Waveforms recorded by OBSs are problematic in that their frequencies tend to be monotonic due to the sediment layers. To overcome this problem, a new method was developed which determines thresholds of CC at every station statistically.

As a result, geometry of the PHS Plate was estimated. It has been discovered that Vp/Vs ratio is segmented within the oceanic crust and at the bottom of the overriding plate, which coincides with the LFE distribution. In the western Kii segment, Vp/Vs ratio is low within the oceanic crust and LFE cluster with small amount of cumulative slip is located. It is considered that the pore fluid pressure is relatively low in this segment. In the eastern Kii segment, because no LFEs occur and Vp/Vs ratio is high, the pore fluid pressure must be comparable to the lithostatic pressure, so the plate interface may be at the state of stable slip.

Similar segmentation has also been seen in hypocenters. In the western Kii segment and its west side segment, most earthquakes occur in the oceanic crust and mantle, respectively. In the western Kii segment, fewer earthquakes occur. Moreover, variation of the depth can also be seen where earthquakes do not occur within the oceanic crust, which can be considered to reflect difference of the thermal structure.

As a result of cluster analysis based on waveform similarity, we found a fault sequence in the oceanic mantle and an inter-plate earthquake cluster at the southern tip of the Kii Peninsula. The inter-plate earthquakes occur at the landward edge of the strong plate coupling zone. Long term observations of these inter-plate earthquakes might provide insight into the state of plate coupling during inter-seismic periods.

Keywords: subduction zone, Kii Peninsula, ocean bottom seismometer, hypocenters, 3-D seismic velocity structure, similar event cluster