Geophysical Research Abstracts
Vol. 13, EGU2011-5263, 2011
EGU General Assembly 2011

Crustal structure and segmentation of seismicity around the fault boundary of historical great earthquakes along the Nankai Trough, SW Japan, revealed by long-term ocean bottom seismic observation

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Through the history of great earthquake occurrences along the Nankai Trough, southwest Japan, there appears to be a static fault boundary off the Cape Shionomisaki, Kii Peninsula. The ruptures of the latest 1944 Tonankai and 1946 Nankai M$\sim$8 earthquakes were initiated adjacent to the fault boundary, and propagated away to the east and west, respectively. Understanding the factors producing such prominent fault boundary may help evaluate possible fault sizes of the future great earthquakes in the region. Regular seismic activities around the boundary region as well as the tectonic structure are primary information to infer the fault characteristics. However, the regular seismicity along the Nankai Trough has been extremely low in accord with results from geodetic studies that have indicated almost complete coupling along the plate interface between the overriding Eurasia and subducting Philippine Sea Plates. Therefore, offshore seismicity along the trough has not been well understood by onshore observation. We conducted repeating long-term seismic observations around the fault boundary region using at most 27 newly developed ocean bottom seismometers with a capability of one-year long observation, and collected a total of four year long continuous seismic data. We applied tomographic analysis to $\sim$2000 selected earthquakes with more than four P-wave and one S-wave arrival picks, and obtained 3-D P- and S-wave velocity structure across the fault boundary. Using this velocity structure, we successfully determined $\sim$4700 precise hypocenters. The hypocenter distribution shows along-axis variation of seismicity across the fault boundary. There appears to be a $\sim$50 km wide high-seismicity band continuing landward from the trough axis, the eastern side of which coincides with the fault boundary. Most of these earthquakes within the band have occurred around and within the subducting oceanic crust. There is almost no seismicity in the source region of the Tonankai earthquake to the east of the boundary. To the west of this high-seismicity band, seismicity starts $\sim$50 km landward from the trough axis and extends $\sim$100 km west. Most of these earthquakes occurred around the upper-most part of the oceanic mantle. To the west of the activity in the upper-most mantle, there is almost null seismicity. The boundaries between these seismicity segments are sharp, and appear parallel to the magnetic anomaly lineation over the subducting Philippine Sea Plate. Therefore, it implies that the boundary has its origin in the formation process of the subducting plate. The obtained 3-D velocity structure shows along-trough structural heterogeneity correlating with the intensively downward depressed shape of the subducting plate beneath the Kii Peninsula. The oceanic crust appears the thinnest off the Kii Channel between the Kii Peninsula and Shikoku Island.