Seimic Structure and Interplate Seismicity of the Japan Trench Subduction Zone by Ocean Bottom Seismographic Studies (Extended Abstract)

著者	Hino Ryota, Nishino M, Fujimoto H
雑誌名	The science reports of the Tohoku University. Fifth series, Tohoku geophysical journal
巻	36
号	2
ページ	257-259
発行年	2001-09
URL	http://hdl.handle.net/10097/45394

Tôhoku Geophys. Journ. (Sci. Rep. Tôhoku Univ., Ser. 5), Vol. 36, No. 2, pp. 257-259, 2001

Seimic Structure and Interplate Seismicity of the Japan Trench Subduction Zone by Ocean Bottom Seismographic Studies (Extended Abstract)

RYOTA HINO, M. NISHINO and H. FUJIMOTO

Research Center for Prediction of Earthquakes and Volcanic Eruptions, Graduate School of Science, Tohoku University, Aramaki-Aoba, Sendai 980-8578

(Received November 2, 2000)

The Japan Trench subduction zone, east off the northeastern Japan arc, is characterized by active seismicity accompanied with the underthrusting of the Pacific plate. Most of the earthquakes occurring in this region are considered to be interplate earthquakes with focal mechanisms of a thrust fault type [*e.g.*, Umino *et al.*, 1990; Hasegawa *et al.*, 1994]. The seismicity pattern for more than 20 years revealed by a land seismic network operated by Tohoku University looks temporally invariant, suggesting that the seismic coupling along the plate boundary is inherently heterogeneous affected by heterogeneous crust and mantle structure around the plate boundary. Recent ocean bottom seismic (OBS) observations have greatly improved the seismic structure image of this interplate seismogenic zone and we have obtained several important evidences that the seismic coupling is affected by the structure of the surroundings.

The 1994 Sanriku-oki earthquake (Mw 7.7) is the most recent large interplate event in the Japan trench subduction zone. Aftershock distribution of the earthquake precisely located by using the OBS data defines the geometry of the plate boundary of the entire seismogenic plate boundary (Hino *et al.*, 2000). The obtained geometry of the plate boundary seems to have close relations to the heterogeneous slip distribution of the main rupture and also to the seismic structure around the seismogenic zone. Up to the distance of about 100 km from the trench axis, the dip angle of the plate boundary is nearly constant and less than 10°. The dip angle begins increasing at 100 km, and is about 30° at the landward end of the aftershock area. The dip at the landward end is almost the same as those of the double-planed deep seismic zone beneath the northeastern Japan arc [Hasegawa *et al.*, 1978]. In other words, the subducting Pacific plate starts significant bending at about 100 km landward from the trench axis. Comparing the co-seismic slip distribution of the mainshock [*e.g.*, Sato *et al.*, 1996; Nakayama and Takeo, 1997], and the seismic velocity structure of this area revealed by the offshore seismic explorations [*e.g.*, Ito *et al.*, 2000; Takahashi *et al.*, 2000], it was suggested that such the geometry of the seismogenic plate boundary has a close relationship with the interplate seismic coupling and the difference in the materials of the hanging wall side: On the trenchward side of the bending point, the plate boundary has almost flat with small dip angle (less than 10°), the hanging wall crust and oceanic crust contact each other across the boundary, and the seismic coupling is weak On the landward side of the bending, the subducting slab contacts with the wedge mantle of the northeastern Japan arc with strong seismic coupling along the plate boundary with the increasing dip angle.

Similar seismic structure of the seismogenic plate boundary, the geometry of the subducting plate and the seismic velocity structure of the overriding plate, has also been clarified in the southern part of the Japan subduction zone [Nishino, 1998]. Almost no background seismicity in the trenchward area suggests that weak interplate coupling is expected in the area with low plate boundary dip angle and of crust/crust contact at the plate interface as in the northern part. Such large-scale variations of seismic structure and interplate coupling must be a fundamental nature of the Japan trench seismogenic zone. On the other hand, we also found a correlation between the structure heterogeneity of the subducting oceanic crust and the interplate seismicity in regional scale.

In the northern part of the subduction zone, interesting seismic cluster activity has been revealed by the land network data. In the trenchward half of the seismogenic plate boundary, where weak seismic coupling is expected as described above, almost all the earthquakes, those of background seismicity, large (M>6) events and their aftershocks, exclusively occur within several clusters. In 1992, there was a swarm activity of the clusters, including several M 6 events, and an aftershock observation using an OBS network was made [Hino *et al.*, 1996]. In the region of this swarm activity, we also made extensive seismic surveys, multi-channel seismic (MCS) reflection and OBS refraction surveys, and detailed seismic velocity structure has been revealed [Takahashi *et al.*, 2000 ; Tsuru *et al.*, 2000]. Precisely relocated aftershocks using the OBS data and the obtained seismic velocity model can be directly compared to the MCS reflection profile to see where those aftershocks actually occur. The relocated hypocenters are concentrated almost along the plate boundary imaged by the MCS survey, but looking more in detail, they seem to occur within the subducting oceanic crust, mostly in the oceanic layer 2. The oceanic layer 2 may act as a shear zone of the interplate thrusting.

On the seismic records obtained by the OBS refraction survey, we see evident wide angle reflections from the plate boundary and from the boundary between the oceanic layers 2 and 3 of the subducting oceanic crust [Fujie, 1999]. Such evident reflected arrivals are observed only in the area of less background seismicity while they are not clearly observed in the area of active seismicity. Such locality in the appearance of the reflection arrivals from the plate boundary and the oceanic crust indicates that the seismic velocity structure is quite inhomogeneous and the structure heterogeneity can be correlated to the heterogeneity of the seismicity along the plate boundary.

References

Fujie, G., 1999 : A new traveltime inversion using refracted and reflected arrivals and its application to the estimation of the plate boundary structure off Sanriku, Japan, *D. Sc. Thesis, University of Tokyo*, 118 pp.

Hasegawa, A., N. Umino and A. Takagi, 1978 : Double-planed structure of the deep seismic zone in the Northeastern Japan Arc, *Tectonophysics*, **47**, 43-58.

Hasegawa, A., S. Horiuchi and N. Umino, 1994 : Seismic structure of the northeastern Japan convergent margin : a synthesis, *J. Geophys. Res.*, **99**, 22295-22312.

Hino, R., T. Kanazawa and A. Hasegawa, 1996 : Interplate seismic activity near the northern Japan Trench deduced from ocean bottom and land-based seismic observations, *Phys. Earth Planet. Inter.*, **93**, 37-52.

Hino, R., S. Ito, H. Shiobara, H. Shimamura, T. Sato, T. Kanazawa, J. Kasahara and A. Hasegawa, 2000 : Aftershock distribution of the 1994 Sanriku-oki earthquake (Mw 7.7) revealed by ocean bottom seismographic observation, *J. Geophys. Res.*, **105**, 21697-21710.

Ito, S, R. Hino, S. Matsumoto, H. Shiobara, H. Shimamura, T. Kanazawa, T. Sato, J. Kasahara and A. Hasegawa, 2000: Deep seismic structure of the seismogenic plate boundary in the off-Sanriku region, northeastern Japan, *Tectonophysics*, **319**, 261-274.

Nakayama, W. and M. Takeo, 1997: Slip history of the 1994 Sanriku-Haruka-Oki, Japan, earthquake deduced from strong-motion data, *Bull. Seismol. Soc. Am.*, **87**, 918-931.

Nishino, M., 1998: Seismic structure of the plate boundary zone beneath the off-Fukushima area, *Master Thesis, Tohoku University*, 154 pp.

Sato, T., K. Imanishi and M. Kosuga, 1996: Three-stage rupture process of the 28 December 1994 Sanriku-Oki earthquake, *Geophys. Res., Lett.*, **23**, 33-36.

Takahashi, N., S. Kodaira, T. Tsuru, J-O. Park, T. Kaneda, H. Kinoshita, S. Abe, M. Nishino and R. Hino, 2000: Detailed plate boundary structure off northeastern Japan coast, *Geophys. Res. Lett.*, **27**, 1977-1980.

Tsuru, T., J-O. Park, N. Takahashi, S. Kodaira, Y. Kido, Y. Kaneda and T. Kono, 2000: Tectonic features of the Japan Trench convergent margin off Sanriku, northeastern Japan revealed by multi-channel seismic reflection data, *J. Geophys. Res.*, **105**, 16403-16413.

Umino, N., A. Hasegawa and A. Takagi, 1990: The relationship between seismicity patterns and fracture zones beneath northeastern Japan, *Tohoku Geophys. J.*, **33**, 149-162.