

Tomography of the Northeast Japan forearc region and its implications for interplate seismic coupling

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We have tried to determine the 3-D P and S wave velocity structure of the NE Japan forearc region using the data from 598 earthquakes that occurred under the Pacific Ocean, whose hypocentral locations were well determined with sP depth phases. Our results show that strong lateral heterogeneities exist in V_p , V_s and Poisson's ratio in the forearc region, which may affect the degree and extent of the interplate seismic coupling.

The majority of earthquakes in subduction zones occur along the interplate thrust zone between the subducting oceanic plate and the overriding continental plate. The frequent occurrence of the great thrust earthquakes have caused widespread damages to the coastal areas through strong shakings and tsunamis. Information on the detailed structure of the forearc regions of subduction zones is crucial for our understanding of the initiation of subduction, the interplate seismic coupling and the rupture nucleation of destructive interplate earthquakes. However, such information is very scanty because the forearc regions are generally covered by oceans and so there are few seismic stations available there. Observations with ocean bottom seismometers are very expensive and are limited in both time and space.

In this work, we have attempted to investigate the 3-D P and S wave velocity and Poisson's ratio structures under the Pacific Ocean between the Japan Trench and the Pacific Coast of Northeast Japan. We used two groups of earthquakes. One group consists of 1216 shallow and intermediate-depth earthquakes which occur beneath the NE Japan land area having reliable hypocentral locations. The other group consists of 598 earthquakes that occurred in the NE Japan forearc region, whose hypocentral locations were well determined by Umino et al. (1995) with sP depth phases. The total of 1814 events were recorded by the dense seismic network of Tohoku University that covers the NE Japan land area. The 1216 events under the land area were also recorded by the temporary seismic stations deployed in central Tohoku during 1997-1998. We applied the tomography method of Zhao et al. (1992) to 86,024 P and 47,756 S wave arrival times from the 1814 events. The 1216 events under the land area were relocated in the inversion.

Our preliminary results show that there exist strong lateral heterogeneities in V_p , V_s and Poisson's ratio in the forearc region. Between 39 and 40 degrees north latitude, an east-west oriented low-velocity (low-V) feature is visible from the Pacific coast under Sanriku to the Japan Trench, which roughly coincides with the rupture zone and aftershock area of the 1994 Far Off Sanriku earthquake (M 7.1). A north-south oriented low-V zone of about 30-40 km wide is visible right off the Pacific coast and parallel to the Japan Trench. We compared the tomographic images along the cross sections 5-10 km above the subducting slab boundary with the distribution of large interplate earthquakes (M 6.0-8.5). We found that most of the interplate earthquakes occur outside the low-V zones. Few large earthquakes occur within zones of low velocity and high Poisson's ratio which may represent decoupled areas with fluids. Most of the large interplate earthquakes are located in areas with low Poisson's ratio, which may re

These results suggest that strong heterogeneities (and possibly fluids) exist along the slab boundary, which may control the degree and extent of the interplate seismic ruptures.