P-wave anisotropic tomography of the 2011 Tohoku-oki earthquake area

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On 11 March 2011, the great Tohoku-oki earthquake (Mw 9.0) occurred in the boundary between the subducting Pacific slab and the overlying Okhotsk plate. To clarify the generating mechanism of such a huge earthquake, it is important to study the detailed structure of the subduction zone.

In the crust and mantle, the velocity of seismic waves depends on the direction of wave propagation, which is called seismic anisotropy. A major cause of seismic anisotropy is that the crystal lattice of minerals such as olivine is selectively oriented in a specific direction due to mantle convection. Measuring shear-wave splitting is a good method to study seismic anisotropy, but the measurements have a poor depth resolution. In this work we adopt P-wave azimuthal anisotropy tomography which can determine 3-D variations of seismic anisotropy.

We inverted a large number of high-quality arrival-time data of local earthquakes for P-wave azimuthal anisotropy parameters, and estimated the 3-D velocity structure and azimuthal anisotropy in the 2011 Tohoku-oki Earthquake area beneath the Tohoku forearc. Our study region is in the range of 36N~41N and 139E~145E, and we used 516 seismic stations. The grid interval for the isotropic tomography is 0.3 degrees in the latitude and longitude directions, and the lateral grid interval is 0.4 degrees for the anisotropic tomography. In the subducting Pacific slab, the grid nodes are set up at depths of 5, 25 and 50 km from the slab upper boundary. In the crust and mantle wedge, the grid nodes are set up at depths of 10, 25, 40, 65, 90, 120, 160 and 200 km. We used P-wave arrival-time data selected from the Japan Unified Earthquake Catalogue. The data set used in this study contains many aftershocks of the 2011 Tohoku-oki Earthquake.

The results of this work are summarized as follows.
(1) The predominant FVD (fast velocity direction) is NW-SE in the mantle wedge, which reflects preferred orientation of mantle minerals (such as olivine) caused by the corner flow induced by the subduction of the Pacific plate.
(2) The predominant FVD is nearly N-S in the subducting Pacific slab, which reflects the anisotropy induced by fossil fabric formed at the spreading mid-ocean ridge. This feature of anisotropy is consistent with the previous studies (Wang & Zhao, 2008; Huang et al., 2011).
(3) The interplate megathrust zone exhibits complex FVDs, which may reflect a complex stress field in and around asperities where the interplate plate coupling is strong.

References

Huang, Z., D. Zhao, L. Wang (2011) Seismic heterogeneity and anisotropy of the Honshu arc from the Japan Trench to the Japan Sea. *Geophys. J. Int*. 184, 1428-1444.
Wang, J., D. Zhao (2008) P-wave anisotropic tomography beneath Northeast Japan. *Phys. Earth Planet. Inter*. 170, 115-133.

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