Inhomogeneous structure beneath the source region of the Mid Niigata Prefecture earthquake based on receiver function analysis

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On October 23, 2004, an earthquake with magnitude 6.8 occurred at the central part of Niigata prefecture (the Mid Niigata prefecture earthquake, Chuetsu earthquake). NIED Hi-net stations are located around the source region of Chuetsu earthquake and have been recorded continuously since October, 2000. By using the teleseismic waveforms recorded at the Hi-net stations, we investigate the subsurface structure beneath the Chuetsu region based on the receiver function analysis method.

We select earthquakes that occurred from October 2000 to November 2004 with magnitudes 6.0 or larger and epicentral distances between 30 degree and 90 degree. In this study, we compute the receiver functions using the MAR model method (Shiomi et al., 2004). To avoid the contamination of the surface reflection and other high frequency noises, we choose four Hi-net stations (N.NGOH, N.YNTH, N.KWNH and N.MUIH) in the central part of Niigata Prefecture with sensor depth shallower than 350 m and apply a Gaussian low-pass filter with cut-off frequency of 0.6 Hz. In addition, to remove low-frequency noises, a high-pass filter with corner frequency of 0.1 Hz is applied to raw seismograms with the instrument response correction.

At the N.NGOH and N.KWNH stations, arrival of the initial phase corresponding to the direct P wave clearly delay late and the width of the phase is wider than that estimated at other stations. Moreover, some receiver functions show that the initial phase is split into two peaks and/or that the negative phase arrives just after the initial phase. These characteristics can be theoretically explained with the model structure which has a very low velocity layer on uppermost. The receiver functions estimated at the N.MUIH and N.YNTH stations indicate the azimuth dependence in the width of the initial phase and the time delay of arrival of the secondary negative phase. These features mean that the thickness of the sedimentary layer and the location of the low velocity layer beneath the stations changes with azimuth. Considering the form of the initial pulse, the velocity of the surface layer beneath the N.MUIH and N.YNTH stations is faster than that beneath the N.NGOH and N.KWNH stations. In order to clarify these characteristics, we invert for the seismic velocity structure by using the receiver functions. To reduce the contamination caused by dipping velocity boundary, we classify estimated receiver functions into some groups according to the back azimuth of each station. The seismic velocity structure is estimated for every group of the receiver functions. At N.NGOH station, the S wave velocity of the uppermost layer is about 2.0 km/s with 2 or 3 km in thickness. The Moho discontinuity is found 30 km in depth. At the NE-SW direction of the N.YNTH station, the S wave velocity of the uppermost layer is 2.0 km/s and its thickness is about 4 km. This direction corresponds to the strike of Muikamachi-basin. At the southern part of N.YNTH, the thickness of the uppermost layer is 1 km or less and S wave velocity is 2.5 km/s. Low velocity region is detected at 10 to 20 km in depth beneath the western part of the station. Beneath the N.KWNH station, low velocity sedimentary layer with 8 km in thickness exists. At the SSW of N.KWNH, the uppermost layer exists with 10 km thickness. In this direction, remarkable negative gravity anomaly is located. The depth of the Moho discontinuity beneath the N.KWNH is 30 to 32 km. At the western part of the N.MUIH station, the S wave velocity of the uppermost layer is about 2.5 km/s with 5 km in thickness. This layer does not exist at the southern part of the station. The Moho discontinuity is located around 32 km in depth beneath the N.MUIH station.