

Source Process of the 2004 Mid Niigata Prefecture Earthquake Estimated from the Waveform Inversion of Strong Motion Records

Kimiyuki Asano[1]; Tomotaka Iwata[1]

[1] DPRI, Kyoto Univ.

1. Introduction

The 2004 Mid Niigata Prefecture (Chuetsu) Earthquake on October 23, 2004, brought severe strong ground motions to the near source region. To understand the strong motion generation process of this earthquake, it is necessary to model the source and underground structure based on observed records. As the first step, we estimated a source rupture process of the 2004 Mid Niigata Prefecture Earthquake by the kinematic waveform inversion using strong motion records.

2. Methodology

Based on the preliminary analysis, we could not construct appropriate Green's function by assuming an uniform one-dimensional underground structure model because the underground structure in the target area is rather complicated. We constructed an underground structure at each site by comparing the observed and synthetic waveforms of an aftershock (Mj5.0) which occurred at 4:35 on November 1, 2004 (JST). Green's functions were calculated by the discrete wavenumber method (Bouchon, 1981) with the reflection and transmission matrix (Kennett and Kerry, 1979). To obtain a source model we performed the kinematic linear waveform inversion using multiple time-windows by Sekiguchi et al. (2000). We used the S-wave portion of velocity waveforms that were bandpass-filtered between 0.1 and 1 Hz, and we used 16 strong motion stations of K-NET and KiK-net around the source area. A fault plane is assumed based on the moment tensor solution (Strike 212 deg, Dip 47 deg) by F-net and the aftershock distribution. The length and width of the assumed fault plane are 30 km and 20 km, respectively. The fault plane is divided into sub-faults of 2 km x 2 km. The rupture starting point is fixed at the hypocenter determined by the Japan Meteorological Agency (JMA). The slip time-history at each subfault is expressed by six time-windows. One time window composes a smoothed ramp function having the rise-time of 1.0 s, and time-window interval is 0.5 s. We also include the spatio-temporal smoothing and rake-angle constraint following Sekiguchi et al. (2000). The appropriate smoothing strength is selected based on ABIC.

3. Results

The final slip distribution obtained by the inversion shows that the rupture propagated to shallower part from the rupture starting point. The large slip concentrates in the vicinity of the rupture starting point and other area has smaller slip. Total seismic moment is 1.24×10^{19} Nm (Mw6.7), and maximum slip is 3.8 m. The synthetic waveforms fit the observed ones fairly well. The first time-window front propagates at a velocity of 1.9 km/s, which is almost equal to 55% of the shear-wave velocity assumed in the source region. One possibility is that the rupture could not propagate smoothly and strong short period ground motion radiated from the source. Static stress change was also estimated from the final slip distribution using the methodology developed by Ripperger and Mai (2004). Maximum static stress drop of about 30 MPa was observed in the vicinity of the rupture starting point. It is necessary for understanding the strong motion generation process of this earthquake to include shorter period range in the analysis. We should also try to improve underground structure models.

Acknowledgements: We are appreciating to the K-NET and KiK-net operated by the National Research Institute for Earth Science and Disaster Prevention (NIED) for releasing the strong motion records, to the F-net by the NIED for providing moment tensor solutions, and to the JMA for providing the hypocentral information.