Source rupture process during the 2007 Noto Hanto earthquake (M6.9) estimated by using the broadband inversion technique

Yoshiaki Shiba[1]

[1] CRIEPI

During the 2007 Noto Hanto earthquake (M6.9) string motion data were obtained on and around the source area, though a part of fault plane lies below sea area. Therefore this is considered to be an appropriate event to investigate the detailed source rupture process generating broadband strong ground motions. In this article I apply the source inversion scheme composed of the empirical Green's function method and simulated annealing to broadband strong-motion data from the 2007 Noto Hanto earthquake and separately estimate the spatio-temporal distributions of the seismic moment and effective stress on the fault.

The source inversion algorithm proposed by Shiba and Irikura (2005) is modified by introducing smoothing constraints for spatial distributions of search parameters. In this procedure the empirical Green's function method is used as forward process and very fast simulated annealing is employed for search algorithm of an optimal solution. Consequently our proposed method is possible to evaluate strong motions in the higher frequency range compared with other conventional methods. Since there are many kinds of source parameters controlling generation of strong motions, Shiba and Irikura (2005) inverted the displacement waveforms first to estimate seismic moment, rise time and rupture time at each sub-fault. Next velocity waveform inversion is performed to search the effective stress with fixed rise time distribution. Furthermore Shiba (2006) proposed a new idea that posterior marginal distribution of rupture times inferred from the displacement inversion is used as the prior distribution for the velocity inversion to fully utilize information obtained from both inversions. Here I apply this inversion scheme to the strong-motion dataset of the 2007 Noto Hanto earthquake. Smoothing constraints for the seismic moment and effective stress are added to the inversion algorithm and weighting factors for these constraints are determined by calculating ABIC. Only the causality law is taken into consideration for estimation of the rupture times.

Strong-motion records of two horizontal components from eleven stations, which are nine K-NET and two KiK-net surface stations are used for the inversion. A moderate event of Mj4.6 occurring on March 28, 2007 is chosen as the empirical Green's function. For an initial fault model we assume the rectangular fault of 36 km long and 22 km wide following aftershock distribution obtained during 24 hours after the main shock, and it is divided into sub-faults of 1.9 km long and wide. Rupture starts from the center of the fault plane, and the correction of the radiation patterns based on the fault mechanisms of the target and the element event. The frequency range in the displacement inversion is from 0.1 to 2 Hz, and the upper limit of the high frequency range is stretched to 5 Hz in the velocity inversion.

The optimal solution in the displacement inversion shows that the asperity area where the moment release rate is high concentrates near the hypocenter, and which is about 15 km long and 10 km wide. Total seismic moment is estimated to be 1.79E+19 Nm and the moment magnitude is 6.8. The average rupture velocity is 2.5km/s, which is about 0.7 times the S-wave velocity in the source region.

I will further construct the optimal source model which describes the generation of the broadband strong motions by using both results from the displacement and the velocity inversions, and estimate the strong motion levels during the main shock just on the source area with records from the temporally installed aftershock observation station.