アイソクロン・バックプロジェクション法による2007新潟中越沖地震の震源過程

Rupture process of the Niigata Chuetsu-oki Earthquake (2007/7/16), by using an Isochrones Back-projection Method and Strong motion data (preliminary version)

(Nelson Pulido, 19/7/2007)

1- Fault Model

We estimated the source process of the 2007/7/16 Niigata Chuetsu-oki earthquake (latitude 37.5386, longitude 136.6240 and depth 15km, Hi-net solution) by using an Isochron Backprojection Method (IBM) and K-NET, KiK-net waveforms. We use a fault model corresponding to the F-net solution (strike 49 degrees and dip 42 degrees), and assume the starting point of the rupture at the Hi-net hypocenter solution. The fault length is set to 42 km and the fault width to 26 km.

2- Method

The IBM method differs from conventional earthquake source inversion approaches, in that the calculation of Green's functions is not required. The idea of the procedure is to directly back-project amplitudes of seismograms envelopes around the source into a space image of the earthquake rupture (Pulido et al. 2007).

The method requires the calculation of theoretical travel times between a set of grids points distributed across the fault plane, and every station. For this purpose and for simplicity we assume a multi-layered 1D model. All travel times are adjusted by a station correction factor, calculated by taking the difference between observed and theoretical travel times at each station. Next we calculate the rupture time of every grid within the fault plane by assuming some arbitrary constant rupture velocity value, and obtain the isochrones distribution across the fault plane by adding subfaults rupture times and the corresponding travel times for every station. We select waveforms that have clear P and S wavelets, which means stations located approximately between 40 km and 100km from the epicenter. We extract P-wave windows between the origin time of the earthquake and the theoretical arrival of the S-wave, and taper 1s of the waveforms at the end. We band-pass filter the data between 1Hz and 30Hz, and calculate the waveforms envelopes using the root-mean-square of the original waveforms and their Hilbert transform. We calculate a grid "brigthness" by adding all the envelope amplitudes corresponding to every grid isochron time for all stations. The final result is a distribution of the brightness across the fault plane, which gives us an idea of the location of asperities within the fault plane.

3- Data

To estimate the fault brigthness we choose 28 K-NET and 22 KiK-net stations of NIED, with distances ranging from 40km to 100km from the epicentre (Figure 1). For the calculation of travel times we used a velocity model developed for the Kanto region (Ukawa et al. 1984).

4- Results

We obtained an image of the brigthness distribution across the fault plane of the Niigata Chuetsu-oki earthquake (Figure 3). Our results show that the grids with the largest brightness within the fault plane, corresponds to a region 12 km above the hypocenter along the dip direction (Figure 2). We obtained that a rupture velocity of 3.0 km/s maximizes the total fault plane brigthness for the Niigata Chuetsu-oki earthquake (Figure 3). Envelopes of EW components of K-NET and KiK-net stations used for source imaging are shown in Figure 4.

5- References

Pulido, N., S. Aoi, and H. Fujiwara, 2007. Rupture process of the 2007 Notohanto Earthquake by using an Isochrones Back-projection Method and K-NET and KiK-net data, (submitted).

Ukawa, M., M. Ishida, S. Matsumura, and K. Kasahara, 1984. Hypocenter Determination Method of the Kanto-Tokai Observational Network for Microearthquakes, Research Notes of the National Research Center for Disaster Prevention No. 53.

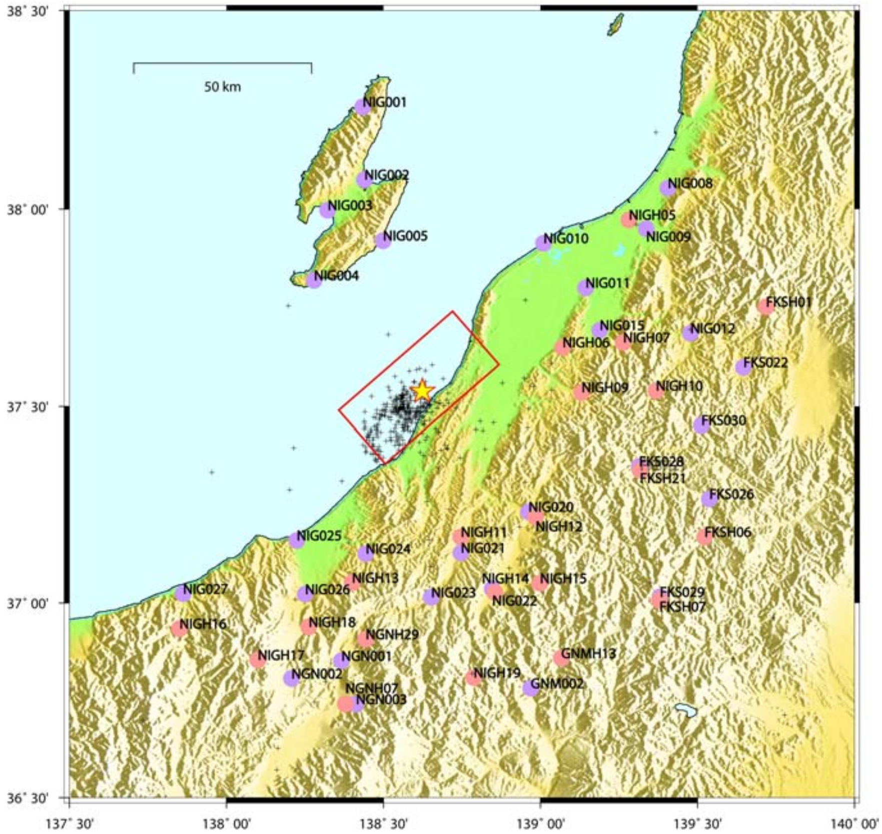

Figure 1. KiK-net and K-NET stations used for the source imaging of the 2007/7/16 Niigata Chuetsu-oki earthquake. The assumed fault plane is shown by a red rectangle. The star represents the Hi-net hypocenter. The crosses represent the first day of aftershocks, with magnitude larger than 2.

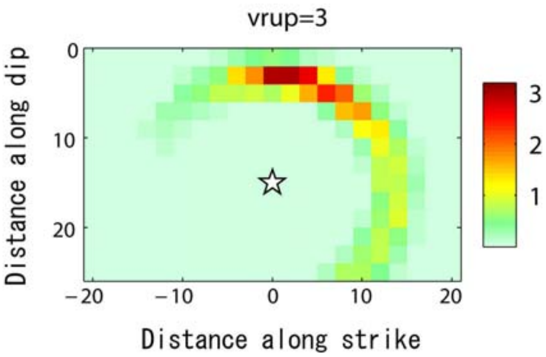

Figure 2. Total brigthness of the 2007/7/16 Niigata Chuetsu-oki earthquake. The assumed fault length is 42 km and the fault width is 26 km. The star represents the Hi-net hypocenter.

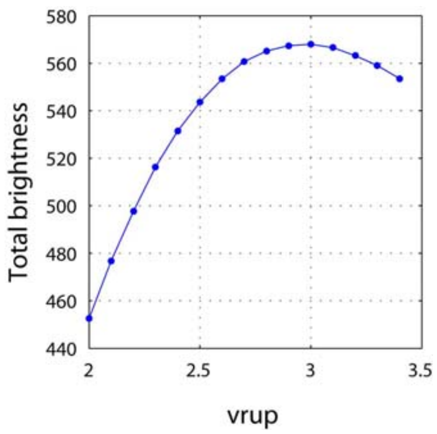

Figure 3. Total fault plane brightness during the 2007/7/16 Niigata Chuetsu-oki earthquake, obtained by the Isochrons Backprojection Method for different rupture velocities. The total brightness is maximum for a rupture velocity of 3.0 km/s

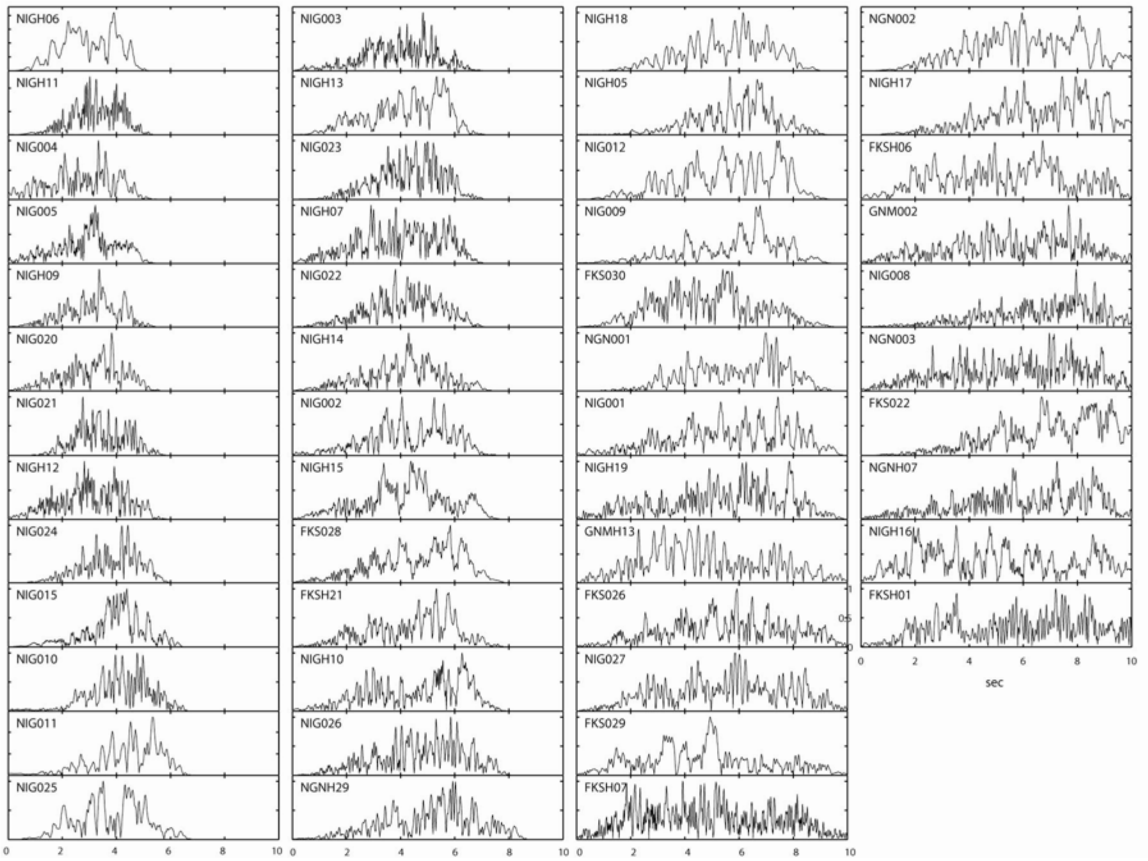

Figure 4. Normalized EW component of velocity envelopes at K-NET and KiK-net sites used for source imaging of the 2007/7/16 Niigata Chuetsu-oki earthquake. The envelopes are aligned at the P-wave onset and ordered by increasing arrivals.