アイソクロン・バクプロジェクション法による２００５年福岡県西方沖の震源過程のイメージング

Rupture process of the 2005 Fukuoka-ken Seiho Oki Earthquake by using an Isochrones Back-projection Method

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Conventional approaches to investigate the source rupture process of earthquakes are based on inversion of near-fault ground motions. Because these methods rely on the calculation of a large number of Green's functions, slip images of the earthquake are obtained only after several days after the earthquake occurrence.

In this study we introduce a technique for imaging the rupture process of an earthquake shortly after the records from the earthquake become available. We study the source process of the 2005 Fukuoka-ken Seiho Oki Earthquake by using an Isochrons Back-Projection Method (IBM). The idea of the procedure is to back-project amplitudes of seismograms envelopes around the source into a time-space image of the earthquake rupture. Our method is a variation of the Source-Scanning Algorithm (Kao and Shan 2007) by making use of isochron times. We set a grid of possible sources across the fault plane of the Fukuoka earthquake and calculate the theoretical travel times from every grid to every station. We assume a rupture initiation point, that in this case corresponds to the Hi-net hypocenter location, and calculate the rupture time of every grid within the fault plane by assuming some arbitrary rupture velocity value. Then we obtain the isochrones distribution within the fault plane for every station. We choose 55 stations (KiK-net boreholes and K-NET) with distances ranging from 40km to 100km from the epicenter. We calculate the waveforms envelopes using the root-mean-square of the original waveforms and their Hilbert transform and start them at the origin time.

We calculate a grid " luminosity " by adding all the envelope amplitudes corresponding to every grid isochron time for all stations. In this way we scan for all possible isochrons time contributions to the grid luminosities from the shortest to the longest possible isochrons time values.

We obtain an image of the total luminosity at every grid within the fault plane. We also search for an optimum rupture velocity by exploring the model with the largest total grid luminosity within the fault plane. We obtained that a rupture velocity of 2.1 km/s maximizes the total fault plane luminosity for the Fukuoka earthquake. Our results show that the grids with the largest luminosity correspond to a region approximately 8 km above and slightly to the south of the hypocenter. This high luminosity region corresponds approximately to the large slip region (asperity) obtained by a kinematic inversion of the Fukuoka earthquake (Sekiguchi et. al. 2006). Our results show so far that the IBM has the capability to identify asperities within the fault plane.

The present method has the advantage that it does not require calculation of Green's functions and therefore is able to identify asperities within the fault plane, soon after the earthquake. This capability makes IBM particularly interesting for a rapid estimation of earthquake damage for large cities, and could be easily implemented as an element of the city earthquake disaster response system. Future developments of the method will address the issue of how to relate the outputs of the model with quantitative images of fault slip, as well as extending the search domain to a volume around the hypocenter in order to study the capability of IBM to identify the causative fault plane without any a-priori constraint.