広帯域地震波形を用いた断層面の決定：2007 年中越沖地震への適用

Determination of fault plane using regional broadband waveforms: The 2007 Chuetsu-Oki earthquake

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There had been a long discussion on which fault slipped during the 2007 Chuetsu-Oki, Niigata, earthquake (Mw6.6) because of insufficient accuracy of hypocentral depths of aftershocks as well as insufficient coverage of geodetic observation because this earthquake occurred off the coast of Niigata basin covered with very thick sediment. Therefore, the routine analyses included significant uncertainties, which prevented us from the determination of the fault plane.

Here I propose a technique to determine the fault plane from two possible ones using broadband waveforms at regional distances. I used the waveforms longer than 20 seconds observed at 100-200km away from the epicenter. In this period range, the waveforms are insensitive to the heterogeneous shallow velocity structure. In addition, they are very sensitive to its focal depth. Therefore, by summing up the corresponding Green's functions in the rectangular fault area assuming different hypocenter locations and rupture velocity, we can extract the source information. I grid-searched the best-fit fault model that maximizes the variance reduction of waveforms.

To confirm the validity and reliability of this method, I first applied it to the 2007 Noto-Hanto earthquake (Mw6.7). The Noto-Hanto earthquake has a similar magnitude and focal mechanism occurring not far away from the Chuetsu-Oki earthquake. Its fault plane is well determined by the aftershock distribution as well as the modeling of geodetic data. I obtained the result that the rupture propagated from southwest to northwest on the southeast-dipping fault plane (strike, dip, rake) = (50, 63, 124) at a velocity of 2.8km/s, which is consistent with corresponding results already published.

Then I applied this technique to the 2007 Chuetsu-Oki earthquake. The result was that the rupture propagated from northeast to southwest on the southeast-dipping fault plane (strike, dip, rake) = (36,47,84) with a rupture velocity of 2.5km/s. This result supports the aftershock distribution (although fault image was not clear enough) as well as the crustal deformation modeling (although the misfit to the geodetic data was tiny).

Since this technique is quite simple and can determine the fault plane with only mainshock waveforms, it is suitable for the early-warning purpose.