Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SSS025-P04 Room:Convention Hall Time:May 27 10:30-13:00

The Source Process of the 2010 Canterbury, New Zealand, Earthquake

Sunhe Yun[1*], Yosuke Aoki[1], Yusuke Yokota[1], Yasuyuki Kawazoe[1], Satoko Oki[1], Kazuki Koketsu[1]

[1]ERI, Univ. of Tokyo

In the Canterbury region of New Zealand's South Island, a moment magnitude (Mw) 7.1 earthquake occurred at 4:35 a.m. local time (16:35 p.m. on November 5 UT) on November 6th, 2010. The hypocenter located by GNS was at (43.55S, 172.18E) and a depth of 10 km. Although the Mw is quite large and the epicenter is only about 40 kilometers west of Christchurch whose population is about 400,000, no deaths were reported according to CNN. In the south of the hypocenter, fault traces were found on the ground surface, and the rupture offset locally reached more than 4m [Quigley, 2010].

We first performed point source inversions of W-phase and P-wave waveforms using the methods developed by Kanamori and Rivera [2008] and Kikuchi and Kanamori [1991], respectively, to derive the focal mechanism of the earthquake. The strike, dip, and rake angles obtained from the W-phase and the P-wave waveforms are (85, 68, 169) and (268, 70, -175) in degree, respectively. Both of the derived solutions suggest focal mechanisms of right-lateral strike slip on an almost vertical fault planes. However, they have different dip directions, and we cannot determine which fault plane is collect from the waveform data. This confusion is also seen from source fault models derived by various institutes. To identify the actual fault plane, we plotted aftershocks occurring in the first 24 hours, but no significant plane was defined. We then took an advantage of the surface fault traces considering their relative location to the surface extensions of the fault planes. In the result, the fault plane derived by the P-wave waveforms is selected.

Interferometric synthetic aperture radar (InSAR) data from both Japanese and European satellites provided high quality maps of surface displacements by this earthquake. According to these results, there observed very large right lateral displacements in the south of the hypocenter followed by a 3km^2-area of little displacement at the western edge. And a northwest-southeast displacement in relatively large area was located in the 10km west of the hypocenter, implying a reverse fault.

Based on the aftershock distribution, surface fault traces and the InSAR image, we set two faults. One includes the hypocenter (fault1), and the other in the western area with NW-SE displacements (fault2). For the fault parameters of each fault, we used the ones from the P-wave focal mechanism and the aftershock distribution in the first 1-week. We next performed a finite source inversion of teleseismic waveform data and strong motion data using this source fault model and the method of Yoshida et al. [1996]. We adopted the CRUST 2.0 model for the crustal structure and used the rigidity based on this model. For the smoothness constraint of the slip distribution and the weight of the constraint, we used a discrete Laplacian in space and Akaike's Baysian Information Criterion (ABIC)[Akaike, 1980], respectively.

The resultant slip distribution is in good agreement with surface fault traces and the InSAR observation. The slip distribution close to the surface fault traces showed large eastward slips. In addition, there derived NW-SE slips in the west and southeast of faults 1 and 2, which are also consistent with the InSAR observation.

In summary, we first derived the focal mechanisms by the waveform inversions. Additionally to the focal mechanisms, we then used the observed data by InSAR and surface fault traces to determine the appropriate fault plane. The obtained slip distribution is in good agreement with the surface fault traces, and the displacements derived from the InSAR image. This study indicates the usefulness of the field fault observation and the InSAR data when it is difficult to identify the appropriate fault parameters only by waveform inversion.

Keywords: source process, inversion, InSAR, focal mechanism, slip distribution, surface fault traces