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# A deep revers outer-rise earthquake triggered a shallow normal outer-rise earthquake - The 2012 Off-Sanriku earthquake -

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The Dec. 7, 2012 Off-Sanriku outer-rise earthquake (Mj7.4) had two successive sub-events, the first sub-event was a deep reverse event (Event 1) and the second one was a shallow normal event (Event 2), as revealed by the teleseismic body-wave analysis (Kikuchi and Kanamori, 2003). The estimated coseismic slip distributions show that Event 1 had a relatively simple circular slip distribution and Event 2 had two large slips. Calculated static changes in the Coulomb Failure Function (dCFF) due to Event 1 shows positive values around the Event 2' s rupture area, indicating that Event 2 was induced by Event 1.

After the 2011 Tohoku earthquake of M 9.0, many outer-rise earthquakes have occurred near the Japan Trench and the Dec. 7, 2012 Off-Sanriku (Mj 7.4) was one of such outer-rise events. In this study, we estimated mechanism solution for this event by using the Kikuchi and Knanamori (2003)'s teleseismic body-wave analysis programs. We used UD-component of P-waveforms recorded at 73 stations with distance from 30 to 90 degree and assumed two triangles as source time functions. The result shows that the 2012 Off-Sanriku earthquake had two successive sub-events, the first event was a deep reverse event (Event 1; depth: 56 km, strike: 171.8 deg., dip: 57.3 deg., rake: 68.5 deg.) and the second event was a shallow normal event and it took place 20 sec. later at 20 km from Event 1 in the N25deg.E direction (Event 2; depth: 6 km, strike: 23.7 deg., dip: 76.3 deg., rake: -94.5 deg.). Seismic moments of Event 1 and 2 are 5.9∗10^19 Nm (Mw7.1) and 7.8∗10^19 Nm (Mw7.2), respectively, and 8.8∗10^19 Nm (Mw7.2) in total. According to the Quick CMT Catalog, the reverse earthquake of Mw7.2 occurred at 144.09 deg. E, 38.01deg. N, and 58 km in depth, and normal earthquake of Mw7.2 followed 12 sec. after at 143.83 deg. E, 37.77 deg. N and 20 km in depth.

We then estimated coseismic slip distributions of Event 1 and 2 by the teleseismic body-wave inversion. The mechanism solutions and the point source locations estimated in the previous analysis were used for the initial mechanism and the rupture points, respectively, of both events. The coseismic slip of Event 1 is concentrated around the initial rupture point, with the maximum slip and average slip of 2.52 m and 0.43 m, respectively. As for Event 2, we used the residual waveforms that the synthetic waveforms from the slip distribution of Event 1 are subtracted from the observed waveforms. The slip distribution has two large slips. The maximum slip and average slip are 2.35 m and 0.82 m, respectively.

Finally, we calculated the static changes in the Coulomb Failure Function (dCFF) due to Event 1's slip distribution on steep nodal plane by using the Okada (1992)'s program. The positive dCFF is distributed in the shallow part of outer-rise region including the rupture area of Event 2. Therefore, we conclude that Event 2 was triggered by Event 1.

Keywords: outer-rise earthquake, tele-seismic body-wave analysis, coseismic slip distribution, dCFF