Rupture processes of large Fukushima-Oki Earthquakes in 1938

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A large earthquake of M7 occurred on May 23,1938 off Fukushima. Six months later, there occurred four large earthquakes of M7 class within two days. In this area, no other earthquakes of M7 class are known to have occurred for last 800 years. In this study, we investigate the detailed source rupture process of these earthquakes using strong motion seismograms in Japan.

We used records of strong motion seismographs at JMA stations and Tokyo Univ. station with epicentral distance between 80km and 280km. Using the data for a recent earthquake near the source area of the 1938 events, we determine an effective structure model consisting of horizontal layers. Also we relocated the epicenters using the P-wave arrival time of the 14 stations near the source area. Then we constructed the grid scheme for the fault plane by taking the initial break at the hypocenter, the fault strike and the dip from the P-wave first motion solution. We divided the fault plane into subfaults with a span of 10km, and the unknown parameters of slip rate function at each subfault is expanded in a series of 5 triangular functions with a rise time of 1.0 sec.

The results for three events show that the rupture propagated to shallow direction along the subducting plate boundary, and asperities didn't overlap each other. The region of each asperity may be characterized by a lower seismicity and small b-value. This indicates that we can estimate the location of an asperity by the distributions of seismicity and b-value.

In the off-Fukushima area, the backslip of overriding plate is estimated to be 6cm/yr by Nishimura(2000), while a co-seismic slip estimated in the present study is about 4m on the largest asperity. Thus, if seismic coupling rate were 100%, a large earthquake of the same magnitude would repeatedly occur about every 60 years. Actually it is not the case. Therefore there should have been a considerable aseismic slip even at asperities. Recent GPS observation near the source region by Tohoku University supports this idea.