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Generation mechanism of shallow earthquakes near Choshi after 2011 Off Tohoku earthquake

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After 2011 Off Tohoku earthquake, numerous earthquakes have occurred near Choshi, eastern Kanto. Especially, two M6-class earthquakes (March 16, 2011 Mw5.8 and March 14, 2012 Mw5.8 from NIED AQUA) occurred at region shallower than 20 km, though small number of earthquakes occurred before the Off Tohoku earthquake. To study generation mechanism of these earthquakes, I determined detailed hypocenters and compared it with other data.

Earthquakes from January 1, 2009 to April 1, 2012 were relocated by Double Difference (DD) method (Waldhauser and Ellsworth, 2000) using arrival time data and relative traveltime difference based on seismic data acquired by NIED Hi-net and other networks. Centroid moment tensor (CMT) solutions were determined by using NIED F-net data based on CMT analyzing method by Matsumura et al. (2006).

Significant seismic cluster can be seen at a region shallower than 20 km in the obtained result. CMT solutions in this cluster are almost normal fault types with E-W tension. At region from 25 to 30 km depth, seismic plane dipping northwestward direction can be seen. This can be regarded as the eastward extension of the upper plane of the Philippine Sea plate (PHS) identified base on small repeating earthquakes (Kimura et al. 2006). CMT solutions in this seismic plane are consistent with slip direction on the PHS. At region from 35 to 50 km, seismic clusters are distributed along a plane dipping westward. These clusters correspond to the Pacific plate and CMT solutions are consistent. Small repeating earthquakes are distributed along this plane, too.

Aftershocks wihitn 24 hours (hereinafter, aftershocks) from the earthquake on March 14, 2012 (hereinafter, mainshock) are composed of a group of most aftershocks along a plane dipping eastward with dip angle of about 40 degree at a depth from 10 to 15 km and a group of few earthquakes sparsely distributed above the seismic plane. The mainshock is located at the deep extension of the seismic plane and it is likely that this plane corresponds to the fault. In association with the mainshock, small crustal deformations were observed by Geospatial Information Authority of Japan (GSI) GEONET stations. Based on an inversion analysis of the rectangle fault model confinied close to the seismic plane, a tentative fault model with width of 6 km, length of 15 km, and slip amount of 45 cm was obtained. This model can explain the observed horizontal displacements well. The CMT solution of the mainshock is a normal fault type with E-W tension and eastward dipping nodal plane is consistent with aftershock distribution. Before the Off Tohoku earthquake, small number of earthquakes also occurred at a shallow region and they are also normal fault types with E-W tension.

These results indicate that earthquakes shallower than 20 km near Choshi occurred above the interface of interplate shearing on the PHS. E-W tension is dominant at this region before the Off Tohoku earthquake, and it was strengthened after the Off Tohoku earthquake, resulting in numerous earthquakes.

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