Geophysical Research Abstracts
Vol. 13, EGU2011-7657, 2011
EGU General Assembly 2011

Inversion structure constraining the focal area of the Iwate-Miyagi Nairiku Earthquake in 2008, northeast Honshu, Japan

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The Iwate-Miyagi Nairiku Earthquake in 2008 (M 7.2, 8 km depth) occurred in an eastern area of the Ou Backbone Range, northeast Honshu, Japan. The mainshock focal mechanism shows thrust faulting with west-northwest to east-southeast compression axis. The earthquake ruptured about 8 km of an almost continuous surface fault and caused aftershocks over a north-northeast to south-southwest trending area 15 km wide by 55 km long. Any active faults had been reported in this focal area until the earthquake occurred and seismogenic source faults are poorly understood, although the area was a part of northern Honshu rift-system during early to middle Miocene and has been uplifted since at least Pleistocene.

Two-dimensional gravity modeling is applied to the northern and central focal areas, along survey lines, 50 km and 11 km long, respectively. The modeling as well as seismic profiling, P-wave velocity tomography, surface geology and borehole data reveals west-dipping normal faults and associated half grabens in both areas. In the northern area, four listric faults with half grabens are developed, western two of which has been inverted as reverse faults. The most western fault, reported as on of the source faults of the earthquake, has total-inversion structure and shows large amount of reverse displacement. The fault bounds the range on the east, and Cretaceous granitic rocks and lower to middle Miocene formations are exposed west to the fault. These grabens are inferred to be filled with lower to middle Miocene sedimentary rocks. In the southern area, three faults are developed, at least two of which were reactivated as reverse faults at the time of the eaarthquake and caused surface ruptures.

Parts of the aftershocks in the northern and southern marginal focal area form linear trending zones to northwest (named as NW zone), perpendicular to the trend of the dominant aftershock distribution. Most of the aftershocks have distributed between these two NW zones. In the NW zones, many of focal mechanisms of the aftershocks shows strike-slip faulting rather than thrust faulting, which is dominant in other area. Contour maps of regional Bouguer anomaly (Geological Survey of Japan, AIST, 2004) show some large gradient zones with a trend of north to south or north-northeast to south-southwest in and around the focal area, some of which correspond to the normal faults mentioned above. However, these large gradient zones have been divided into shorter segments by the NW zones. The NW zones constrained the extent of the focal area, that is , the magnitude of the earthquake. And the zones has been tear faults since the normal faults were formed in early to middle Miocene, segmentalizing these faults.