Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SCG088-22 Room: 302 Time: May 28 16:15-16:30

Relationship between fault-segmentation boundaries and seismicity in the High-Strain-Rate Zone of Japan

Tetsuya Takeda[1*], Hiroshi Sato[2], Kazushige Obara[1], Bogdan Enescu[1]

[1]NIED, [2]ERI, univ. of Tokyo

In the high-strain-rate zone of Japan, located in the eastern margin of the Sea of Japan, large earthquakes of magnitudes up to 7.5 have often took place. Recently, two M6.8 earthquakes occurred in 2004 and 2007, showing reverse fault mechanisms, with a NW-SE compression. The aftershock distributions of both mainshocks are oriented in a NE-SW direction, and seem to have a sharp cut-off boundary at the northeastern edges, implying the existence of a structural boundary. Revealing structural constraints on fault segmentation is important not only for strong motion prediction and earthquake hazard assessment, but also for understanding the tectonic formation processes of the high-strain-rate zone. In a previous presentation (Takeda et al., 2009 SSJ fall meeting) we showed that NW-SE trending linear alignments exist, and one of them plays the role of a northern fault-segmentation boundary of the 1828 Sanjo earthquake. We here expand the area of study to the 2004 Chuetsu and the 2007 Chuetsu-oki aftershock regions, and investigate the boundaries that control the segmentation of faults using accurately located earthquake hypocenters and their focal mechanism.

We assess the accurate spatial distribution of hypocenters in the target area. Earthquakes determined by Hi-net from Jan, 2001 to Nov, 2009 are used for the analysis. Since the seismic velocity in the high-strain-rate zone has a large lateral heterogeneity, we first estimated the three dimensional velocity structure. We then determined the hypocenters of 41,790 earthquakes using the obtained 3D velocity structure. Next we accurately relocated the hypocenters using waveform cross-correlations and a double-difference method (Waldhauser and Ellsworth, 2000). Finally we carefully examined the relocated hypocenters and classify the focal mechanism of earthquakes using the criterion of Frohlich (1992).

The relocated hypocenters delineate the detailed distributions of the aftershocks of the 2004 Chuetsu and the 2007 Chuetsu-oki earthquakes. A close examination reveals a NW-SE linear alignment of hypocenters in the aftershock area of the 2004 Chuetsu earthquake. The distribution extends for about 5 km in the horizontal direction, and dips southwestward at a high angle (mostly subvertically). The earthquakes have focal mechanisms of normal or strike-slip fault type, striking in a NW-SE direction. This alignment located the northern boundary of the 2004 Chuetsu earthquake fault plane.

The 2004 Chuetsu earthquake has five M5-class aftershocks, implying the existence of fault segments other than the mainshock fault. The alignment we discussed above locates between the mainshock and one of five aftershock areas, and became activated after the 2004 Chuetsu earthquake. This suggests that a transfer fault, connecting each fault plane, exists, and became activated.

This result indicates that more fault-segmentations exist in the high-strain-rate zone. In the high-strain-rate zone, normal faults, which were formed in the Sea of Japan opening, are reactivated as reverse faults under the present compressional regime (the inversion tectonics, Sato, 1994). Structural units formed in the extensional regime, become activated and play a role as high-angle faults. Therefore the boundary of these units may form fault-segmention boundaries.

Keywords: High-Strain-Rate Zone, fault-segmentation boundaries, seismicity