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

SCG088-P15 Room: Convention Hall Time: May 27 17:15-18:45

Easterly-dipping remarkable belt-shaped microearthquake distribution along the eastern margin of Sado Basin

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We relocated the remarkable belt-shaped microearthquake distribution extending for about 40 km in the NNE direction from the aftershock area of the 2007 Niigata-ken Chuetsu-oki earthquake (Mj 6.8), by considering station corrections seriously in order to reflect complicated velocity structure in this region. This is to improve our previous study (Harada and Ishibashi, 2009, 2010) which showed that the belt-shaped hypocenter distribution was extending along the Eastern-boundary fault of Sado Basin (Watanabe et al., 2007, 2009), and to reveal the three-dimensional shape of the hypocenter distribution.

The relocated earthquakes are 7,433 in all, which occurred from October 1, 1997 to December 31, 2009 in and around Sado Basin. We used data from the integrated hypocenter database of Japan Meteorological Agency (JMA), the JMA's one-dimensional velocity structure and stations within epicentral distances of around 60 km. We pay special attention to the main shock of the Chuetsu-oki earthquake not to be located too deep.

First, we estimated tentative station corrections by referring the Chuetsu-oki main shock. Since its focal depth by JMA (16.8 km) is considered too deep, we fixed it at 8 km following Yukutake et al. (2007) and Koketsu (2009) (between 7 and 9 km). We also fixed the JMA's epicenter. Then, we calculated theoretical P-wave travel times at all stations for JMA's velocity structure, and estimated P-wave O-Cs by comparing them with JMA's observed travel times. The pattern of the obtained O-C distribution basically resembles that by Shibutani et al. (2005). As for S-wave O-Cs we assumed them to be 1.73 times of P-wave O-Cs (Vp/Vs = 1.73), because S-wave readings at many stations seemed to contain considerable errors.
As the result of hypocenter relocation using above-mentioned P-wave and S-wave O-Cs, the 2007 aftershocks were located at depths shallower than 20 km and their vertical distribution clearly showed easterly-dipping, which is in harmony with presently widely-accepted fault model of the 20 07 Chuetsu-oki earthquake. In addition, the belt-shaped seismicity was located about 5 km shallower than our previous result, and the hypocenter distribution near the 2007 aftershock area showed easterly-dipping. However, events distant from the 2007 aftershock area tended to cluster suggesting that the tentative station corrections were not appropriate enough.

Then, as the second step, we modified inappropriate O-Cs at stations distant from the 2007 main shock (in the northern part of the Nagaoka plain), such as negative or very small O-Cs at stations in the plain. As the result of hypocenter recalculation using these revised O-Cs as new station corrections, the belt-shaped hypocenters were relocated shallower than 15 km in depth, and their vertical distribution clearly showed easterly-dipping in the northern part as well. The hypocenter depths are in agreement with those by Shinohara et al. (2008) and the easterly-dipping distribution harmonizes with the 2007 aftershock distribution.

In conclusion, the station corrections that we adopted to hypocenter relocation of the belt-shaped seismicity are considered basically appropriate although they need further revision in detail, and the relocated hypocenter distribution is more appropriate than those by JMA and Harada and Ishibashi (2009, 2010). The clear easterly-dipping distribution of hypocenters beneath the continental slope along the eastern margin of Sado Basin strongly supports the existence of the Eastern-boundary fault of Sado Basin as an active fault.

We used the hypocenter location program by Hirata and Matsu'ura (1987) and the seismic observation data in the integrated hypocenter database of JMA. We thank all the persons concerned.

Keywords: microearthquake distribution, eastern margin of Sado Basin, hypocenter relocation, station correction, easterly-dipping