

Seismotectonics of the 2007 Chuetsu-oki, Niigata, earthquake and its northern area: Where are major seismogenic zones?

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We discuss the seismotectonics of the region including the rupture zone of the 2007 Niigata-ken Chuetsu-oki earthquake (Mj 6.8) and its northern adjacencies, in the Japan Sea's eastern margin mobile belt, central Japan, based on the fault model of the Chuetsu-oki earthquake, historical earthquakes, active faults and recent microearthquake distribution. In the study area, there are apparent seismic gaps between the source regions of the 2007 earthquake and the 2004 Niigata-ken Chuetsu earthquake (Mj 6.8) in the south and that of the 1964 Niigata earthquake (Mj 7.5) in the north. Therefore, it is important to reveal where are major seismogenic zones in the study area.

Ishibashi et al. (2008a, b) interpreted that the 2007 earthquake was rupture of the southern half of the Sado-kaibon toen fault (Eastern-boundary fault of Sado Basin; STF), an easterly-dipping reverse fault as long as 50 km or more (Watanabe et al. 2007, 2009), based on the static fault model of this earthquake, distribution of uplifted coastal terraces, and others. They claimed that STF had seismic potential of M 7.5-class earthquake and its northern half (plus its northern extension) was a seismic gap. On the other hand, Earthquake Research Committee (2004) made a long-term evaluation that the Nagaoka-heiya Seien fault zone (Western-margin fault zone of the Nagaoka plain; NSF) was an active fault zone as long as 83 km, west-side-up reverse fault, having seismic potential of M 8.0 or so. These two faults run almost in parallel with each other with about 20 km separation, so we should understand each tectonic meaning and their relationship.

Regarding the Kakuda-Yahiko fault, the northern segment of NSF, it should be noted that the late Quaternary geomorphological feature is obscure and Mt. Kakuda on its hanging-wall side has scarcely been uplifted since ca. 8 Ma judging from the distribution of volcanic sediments. On the contrary, the Nagaoka (or Echigo, or Niigata) plain on its foot-wall side has been remarkably subsided since ca. 3 Ma. Therefore, it is probable that the Kakuda-Yahiko fault was originally a normal fault dipping steeply toward the east and has changed its geometry into westward-steeply-dipping feature due to the east-west contraction in the shallower crust (Ishibashi and Harada, 2009). So, the conventional view that NSF is a large-scale active reverse fault as long as 83 km having seismic potential of M 8 seems doubtful.

As for the present microseismicity, it is very important that a remarkable belt-shaped hypocenter distribution which shows clear eastward-dipping is extending for about 40 km in the NNE direction from the aftershock area of the 2007 Chuetsu-oki earthquake, beneath the continental slope of the eastern margin of Sado Basin (Harada and Ishibashi, 2010, this session). This is a strong evidence of the existence of STF.

Concerning historical destructive earthquakes in the study area, the 1670 Echigo earthquake (M[~]6.7) and the 1828 Sanjo earthquake (M[~]6.9) are known. Yata and Urabe (2009) proposed that the source region of the latter was under the Higashiyama Hill, to the east of the Nagaoka plain and

on the north of the 2004 rupture zone. The 1670 source may have been the northern adjacency of the 1828 one.

In conclusion, one of major seismogenic zones in the study area is considered not to be NSF but STF. According to the integrated hypocenter database of Japan Meteorological Agency, there seems to exist another microearthquake belt to the north of the 2004 aftershock area extending northward toward Awashima Island in the source region of the 1964 Niigata earthquake. This may be another important seismogenic zone in this area including the source regions of the 2004, 1828, 1670 and 1964 destructive earthquakes from south to north, and there may be a seismic gap on the south of the 1964 rupture zone.

Keywords: 2007 Niigata-ken Chuetsu-oki earthquake, Sado-kaibon Toen fault, Nagaoka-heiya Seien fault system, microearthquake distribution, 1964 Niigata earthquake, seismic gap