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2011 Yamagata-Fukuhsima Border Earthquake Swarm and Tanakura Tectonic Line

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An active earthquake swarm occured in the Yamagata-Fukushima border induced by the 2011 Thohoku-Oki earthquake. Hypocenters were relocated precisely by temporary stations, which clearly showed hypocenter migration (Okada et al., 2014). The migration has been estimated to be related with the flow of fluid which reduced the mechanical strength. This study examined the relation between seismicity and geologic structures.

The focal area locates on the mountainous region with 1000-2000m of altitude in the Yamagata and Fukushima border to the west of Azuma Volcano and to the north of Bandai Volcano. In the geologic view, the focal area is passed through with north-south trend by Tanakura Tectonic Line, which is estimated to be formed by sinistral strike slip fault movement in late Creataceous (100-80 Ma) [?] along the eastern margin of Asian Continent. The Tanakura Tectonic Line is major tectonic line in the Japanese Island Arcs and bounds northeast and southwest Japan. The west of Tanakura Tectonic Line is composed by Ashio Belt of Jurassic accreationary complex with the intrution of Asahi Paleogene granits and the east with Abukuma Creatacous granits. Ashio Belt is eastern extend from Mino and Tamba Belts in southwest Japan.

The epicenters do not fit to the active volanos and subsiding area in Yonezawa Basin of north and Kitakata Basin of southwest.

The geology of the focal area is summarized as follow;

1) pre-rifting stage: Jurassic accretionary complex, Abukua Creataceous granits (100-85Ma), Asahi Paleogene granits (65-54Ma) along eastern margin of Asian Continent,

2) rifting stage [concentric bent slab started to fall into lower mantle] : overlaid terrestrial sediments on rifting continental margin (20-16 Ma),

3) Japan Sea opening stage [slab falled into lower mantle]: marine sediments with so called green tuff (15-14 Ma),

4) peak of transgressive and sinking stage [collapse of slab]: pelagic sediments (13-12 Ma),

5) regressive stage [break and falling down of slab and subduction of next slab]: terrestrial volcanic efusives of caldera (8-5 Ma),

6) dacitic volcanism.

Jurassic accretionary complex intruded by Asahi Plaeogene granits exposes in the west and Abukuma Creataceous granits in the east of the focal area, which indicates for Tanakura Tectionic Line to pass between them.

The focal area is located at a caldera (5) and dacitic (6) volcanisms. It suggests the magma reservoir of the volcanisms relating to the earthquake swarm. The earthquake swarm initiated from the central part of the dacitic volcanism (6) where thick dyke for the main vent exposes after the uplift and erosion of the volcanic body. It is estimated that decrease of the east-west compressional stress by the Tohoku-Oki earthquake induced uplift of fluid into the upper crust which reduced mechanical strength of the upper crust and induced those earthquakes.

In the early stage, hypocenters migrated up westward along eastward dipping plane in the central part of the focal area. Then, changing the direction, hypocenters migrated eastward along the main westward dipping plane. It is not easy to correlate the westward dipping plane with the surface geology, because the hypocenter depths range 8-10 km. However the westward dipping nodal planes of focal mechanisms trend along this westward dipping plane. Thus we can use the intersection of the nodal planes with the surface for the correlation. Because the intersections are paralleled to the unconformity of overlaid terrestrial sediments (2) on Abukuma Creataceous granits (1) along Tanakura Tectionic Line, the westward dipping plane can be correlated with Takankura Tectonic Line. The migration of hypocenter can be estimated with flow of the fluid along Tanakura Tectonic Line.

In the later stage, hypocenters migrated westward without significant differences of depth, which may relates to fractures on the hanging wall of magma reservoir

Keywords: Yamagata-Fukushima border, Tanakura Tectonic Line, distribution of hypocenters, migration of hypocenter, nodal plane, geologic structure