

Possible pathway of geofluid suggested by deep low-frequency earthquakes, scattered phase, and migration of earthquakes

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Migration of seismicity, reflected phase, and anomalous deep low-frequency earthquakes are possible seismic evidence of geofluid in the crust. All of these phenomena are observed near the Moriyoshi-zan volcano in Akita Prefecture located to the west of the volcanic front of northeastern Japan. Seismic activity around the volcano became quite high after the occurrence of the great 2011 Off the Pacific coast of Tohoku (Tohoku-oki) Earthquake. Among some earthquake clusters the one to the north of volcano has been the most active from May 2011 to date. The size of this cluster is about 3 km both horizontally and vertically. Since there is only one nearby seismic station to the west of volcano, we deployed temporary stations above the most active cluster on September 2012. Relocated hypocenters using data of temporal observation shows increased depth accuracy by the concentration of hypocenters around a depth of 7 km, whereas the depth of catalog location by the JMA spans from 8 to 10 km. Seismic activity in the most active cluster exhibits clear migration, however, the direction and speed are variable. The activity started near the center in the horizontal location, then migrated to the northeast, and jumped to the west, and migrated again to the south and to the north. This complex pattern suggests repeated injection of geofluid below the cluster, however, the temporal rate of migration is not clear due to insufficient accuracy of hypocenter location for the period before the temporal observation.

A prominent feature of the seismogram is a reflected/scattered phase observed at the station to the west of volcano. The time interval between this later phase and S wave depends on the hypocenter location, suggesting gently dipping zone of scatterers to the west. This zone probably corresponds to a plane of reflection estimated previously from the 1982 earthquake swarm.

The Moriyoshi-zan area is one of the source areas of deep low-frequency earthquakes occurring mainly beneath active volcanoes in the northeastern Japan. The low-frequency earthquakes that occur well below the elastic plastic boundary are interpreted as the events generated by the activity of geofluid. The westward bottom of reflector/scatterers is close to the upper limit of low-frequency earthquakes and the eastward top seems to reach the bottom of earthquake cluster. From this we can image a pathway of geofluid from the upper mantle to the source of cluster. However, to verify this idea, we need to estimate the location and temporal change of reflector/scatterers accurately using arrival times and waveform characteristics of the later phase.

Acknowledgement: We used hypocentral parameters and arrival time data of the JMA catalog that was prepared by the JMA and the Ministry of Education, Culture, Sports, Science and Technology in Japan. I thank the National Research Institute for Earth Science and Disaster Prevention (NIED) and Tohoku University for providing waveform data. This work was supported by JSPS KAKENHI Grant Number 21109002.

Keywords: geofluid, seismic activity, migration, scattering, low-frequency earthquakes