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Seismic activity near the Moriyoshi-zan volcano in northeastern Japan: Implications for geofluid migration

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The 2011 Off the Pacific coast of Tohoku (Tohoku-oki) Earthquake caused increased seismicity in many inland areas. A seismic cluster that occurred north of the Moriyoshi-zan volcano in the Akita prefecture of the Tohoku District is of interest in light of contribution of geofluids to seismic activity. We observed a seismic cluster characterized by the migration of seismicity, reflected/scattered phases, and deep low-frequency earthquakes. We relocated hypocenters by using the data of temporal observation and by using the Double-Difference location technique, which increased the depth accuracy. We interpreted the spatiotemporal variation of the hypocenters in the most active cluster by estimating the migration of pore fluid pressure. The hydraulic diffusivity of the cluster was in the range of 0.01?1.0 m2/s, and increased with time, implying that the migration of hypocenters accelerated after a pathway for fluids was formed by the fracturing of the wallrock that produced the initial stage of seismic activity. A prominent feature of the seismograms is a reflected/scattered phase observed at stations around the volcano. We have interpreted the phase as S-to-S scattered waves and estimated the location of scatterers using a back-projection method. The scatterers are located about 5 km northwest of the Moriyoshi-zan volcano and at an approximate depth of 13 km. The Moriyoshi-zan area is one of the source areas of deep low-frequency earthquakes that have previously been interpreted as events generated by the migration of geofluids. The depth of scatterers is close to the upper limit of the depth at which low-frequency earthquakes occur. Thus, we regard the observed scatterers to be a reservoir of geofluid that came from the uppermost mantle accompanying contemporaneous low-frequency earthquakes. The geofluid reservoir is the probable source of overpressurized fluid that induces the migration of seismicity in the upper crust. A time delay in seismic activity from the Tohoku-oki Earthquake was considered as the time needed to migrate across a gap between the reservoir and the earthquake cluster with a hydraulic diffusivity comparable to that observed for the initial stage of seismicity, i.e., fracturing of the wallrock.

Keywords: The 2011 Off the Pacific coast of Tohoku Earthquake, triggered seismicity, hypocenter migration, scattering, geofluid