S-wave reflectors beneath the earthquake swarm in the Yonezawa-Kitakata area, NE Japan

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Research on reflected S wave around volcanic regions and inland earthquake faults has been conducted throughout Japan. Mizoue et al. (1982) showed the spatial distribution of S wave reflection points in Nikko-Ashio area, and the amplitude ratio of SxP wave and SxS wave was explained by layered partially melt. In the Tohoku region, reflected S wave is from reflector contains fluid which was released during the cooling process of the melt suggested by Umino et al. (2002) and Hori et al. (2004). It is pointed out that the dehydrated fluid is involved in the mechanism of the occurrence of an inland earthquake [e.g., Hasegawa et al., 2005], and it is important to understand the behavior of the fluid in the crust in the Tohoku region in more details.

In the Yonezawa - Kitakata area, NE Japan, which is the target area of this research, it is thought that a swarm earthquake occurred 7 days after the 2011 Tohoku Region Pacific Offshore Earthquake, and the cause is the decrease in strength due to increase in fluid pressure [eg, Okada et al., 2015]. The focal region is located in and around the Otoge caldera [Yamamoto et al., 1994] which formed in the Miocene, and the possibility of existence of the fluid dehydrated from the melt as described above is sufficient. Since S wave reflected waves in Yonezawa - Kitakata area have already been discovered by Hasemi et al. (2016), this study aims to obtain the spatial distribution of the S wave reflector. In this area, temporary stations are deployed densely by Group of the aftershock observations of 2011 off the Pacific coast of Tohoku Earthquake. In this research, seismic waveform data at these temporal stations and the permanent stations by Hi-net is used. In order to accurately obtain the spatial distribution of the S wave reflector, we use the hypocenters determined by the Double Difference method using the temporary observation data.

First of all, I carefully read the travel time of the S wave reflected wave visually. For ten observation stations/clusters pairs which were able to confirm the S wave reflected wave remarkably, the travel time of the seismic waveform was converted to the depth as in Inamori et al. (1992). As a result, 16 reflectors in the northeast clusters, 14 in the center, and 3 in the southwest were read.

Next, using the read travel time, the mirror observation stations were calculated by grid search [e.g., Horiuchi et al., 1988]. We assume that the reflector is a single plane, and the wave ray path is a straight line with a uniform velocity structure of 3.4 km/s. We will find the reflector with minimum of the least squared square root between observed and calculated traveling times. From the equation of the reflector obtained by the above process, the strike/dip and the position of the reflection point with respect to each epicenter were obtained.

As a result, the reflectors are located from the lower part of the source region to the depth of 10 - 20 km below it. The strike seems to be drawing a circle or an arc, and the dips are smaller beneath the source region. Comparing this reflector distribution with the seamless geological map [AIST], for the reflectors just beneath the Otoge caldera their strikes seems to be along the edge of the caldera, and for the

reflector in the western part, their strikes follows the western marginal fault zone of Aizu Basin and the boundaries of geological structure. Comparing this with the seismic velocity structure, the reflectors are located at the periphery of the low velocity zone, being consistent with the results obtained by Umino et al. (2002) and Hori et al. (2004). By this reason, fluids promoting swarm earthquakes in the Yonezawa - Kitakata area may be migrated from the melt below the epicenter area and may have passed boundary of the existing geological structure.

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