Imaging of S wave reflector in the crust obtained from a dense seismic array at the southern part of Abukuma Plateau

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The 2011 Tohoku-Oki earthquake (Mw9.0) occurred off the Pacific coast of Japan, on March 11, 2011. The seismic activity in Japan changed after the Tohoku-Oki earthquake. It is considered that the stress field in the inland fault zones has changed due to the slip of the main shock and the after slip. Especially in the southern part of Abukuma Plateau (the southern part of Fukushima Prefecture and the northern part of Ibaraki Prefecture), so many earthquakes within the crust has occurred. The largest earthquake in this region is the Fukushima Hamadori earthquake (M7.0), which caused severe damage. In this region, the seismic zone within the crust is divided into two groups. The shallower group earthquakes occurred at a depth of shallower than 15km. The other group earthquakes occurred at a depth rage of 15 km - 25 km. We don’ t know the clear reason that the seismicity is split into two groups.
Earthquake Research Institute, Universities, and other organizations deployed a temporary dense seismic array with 63 seismic stations in this area. We analyzed the 123 earthquakes (Mj2.5~4.0) observed by the array from January, 2012 to December, 2012. We applied AGC (Automatic gain control) to the waveform data. We found two clear later phases after the S wave. In order to clarify the nature of these later phases, we analyzed the particle motion and amplitude of the later phases. The two later phases were reflected wave of the S wave. We estimated the locations of reflection points using reversed VSP (Vertical Seismic Profile) method which is used for seismic exploration. We converted travel time to depth using the velocity structure of JMA (Ueno et al., 2002), and estimated locations of S wave reflection boundary in the crust. As a result, it was found that the two later phases are reflected waves from velocity boundaries located at depths of (1) 15-23km and (2) 27-33km in the crust. The reflection boundary (2), which was located at a depth of 27-33km, was found to be the Moho discontinuity by comparing with previous studies in this region. We compared the location between the reflection boundary (1) and the earthquakes. It was found that the reflection boundary (1) was located just under the hypocenters. The seismic activity in this region started to occur just above the reflection boundary (1). To explain further, this reflection boundary (1) is well consistent with the focal area at the depth of 15-20km which is one of the characteristics of seismic activity in the region. It is suggested that the reflection boundary (1) is significantly related to the cause of the earthquakes occurring at this depth range. The amplitude of the reflected waves from the reflection boundary (1) in the crust is large. The location of the reflection boundary (1) is well consistent with that of the crustal fluids suggested by some previous studies in this region. It is possible that the reflected waves are from the layer including the crustal fluids. In the future, we will estimate the more precise location of the reflection boundary taking into account the migration and the velocity structure estimated in this region. We declare the cause of the earthquakes in this region.

Keywords: Iwaki area, seismic array observation, S wave reflector, crustal structure

