Active source seismic experiment in Zao Volcano, Japan

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Zao volcano is a Quaternary stratovolcano located in the central part of the volcanic front of the northeastern Japan. The most recent activity of Zao volcano began at ca. 35 ka at the central part of the volcano, and many historic eruptive activities including occurrence of lahar from the crater lake named Okama have been documented. After the occurrence of the 2011 Tohoku Earthquake, the activities of both deep low-frequency earthquakes and shallow long-period events beneath Zao volcano become higher, and it is thus important to reveal the subsurface structure and fluid distribution to prepare against possible future eruptive activities. With this point of view, as a part of MEXT 'Earthquake and Volcano Hazards Observation and Research Program', we conducted an active source experiment in October, 2015.
In the experiment, 132 temporal seismic stations were deployed on and around the volcano by 21 researchers from 8 universities and JMA, and seismic waves excited by two underground dynamite shots whose charges were 200 kg and 300 kg were recorded at a sampling frequency of 500 Hz. The configuration of seismic network was designed for refraction and fan-shooting analyses. In addition to these underground shots, to enhance the resolution of shallowmost structure, we also utilized a dynamite shot at a nearby quarrying plant, which generate surface waves suitable for the surface wave dispersion analysis.
As the first step of our analysis, we manually pick the arrival time of first onset at each station, and estimate velocity and depth of the basement layer by analyzing the obtained travel-time curves. By applying the time-term method, the P wave velocity of the basement is estimated as 5.2-5.5 km/s. An interesting point of this analysis is that the depth of the basement is quite shallow and at a depth of around 0.5 km from the ground surface. Although the uncertainty of this depth is still remaining, the result of surface wave dispersion analysis also supports the existence of basement at a shallow depth. We then apply the fan-shooting analysis to elucidate the distribution and extent of shallow hydrothermal system. From this analysis, we reveal that an attenuative zone seems to exist beneath slightly northeast of Okama at a depth of around 1 km.
In the previous studies, the subsurface structure of Zao volcano has been discussed mainly based on the geological observations. The results of the active seismic experiment such as the existence of shallow basement are consistent with these previous studies, and provide more detailed images of the subsurface structure beneath the volcano. Further studies including the relocation of volcanic earthquakes and elucidation of hydrothermal system may contribute to a better understanding of volcanic activities at Zao volcano.

Keywords: Zao Volcano, Active seismic experiment, Volcanic structure

