Imaging of reflectors beneath Unzen Volcano using vibratory sources

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A seismic experiment using vibratory sources was conducted at Unzen volcano in December 2001 in order to detect the conduit of Unzen Volcano, being conducted as part of Unzen volcano Scientific Drilling Project. The experiment was reflection and fan-shooting exploration using three large vibrators. A profile of the exploration was performed along about 12km line crossing Unzen graben and passed through 2km west from lava dome of last eruption. The survey line was composed of 201 sweep points along the profile. 589 sites of receivers were deployed on the line. Since the vibrators can generate only weak energy, signals were stacked 34 times for each sweep point to improve the S/N ratio of the data. Ordinary seismic reflection analysis was applied to the data set at survey line.

In this study, we try to detect reflectors beneath Unzen Volcano using vibration signals observed at seismic stations of Kyushu University in Shimabara peninsula. A seismograph with natural frequency of 1 Hz is installed in the seismic station, and it is recorded with sampling of 100 Hz.

From reciprocity, the common receiver gather from the vibrators on the survey line observed at the station is equivalent to common shot gather observed at the profile for a source locating at the station. This kind of observation is useful in the mountain area where artificial sources cannot set up.

We stacked data containing sweep signal, which cut out from continuous record. After taking cross correlation to stacked data with original sweep signal, we found some phases after 1 to 3 seconds from first P wave arrival. These phases are identical to those found in the reflection profile. Therefore, we can detect reflectors with similar or higher sensitivity by using this kind of fan-shooting data. In the ordinary reflection analysis, there is no obvious phase after 3 seconds in two-way travel time. On the other hand, we found phases at 4 and 8 seconds in two-way travel time in many stations. These phases are presumed reflection waves from 6 and 16 km in depth respectively. The pressure sources were estimated from geodetic data at 7 km (C source) and 15 km (D source) in depth. It seems that depths of the reflectors correspond to those of pressure sources. This suggests that a relation between reflectors and shape of pressure sources.