Seismic exploration of Usu volcano with active sources in 2001: Three dimensional P-wave velocity structure

Shin'ya Onizawa[1], Hiromitsu Oshima[2], Hiroshi Aoyama[1], Hitoshi, Y. Mori[3], Tokumitsu Maekawa[4], Atsuo Suzuki[4], Hiromu Okada[5], Tomoki Tsutsui[6], Norimichi Matsuwo[7], Jun Oikawa[8], Takao Ohminato[9], Keigo Yamamoto[10], Takehiko Mori[11], Taka'aki Taira[12], Hiroki Miyamachi[13]

[1] ISV, Hokkaido Univ., [2] Usu Volcano Observatory, Hokkaido Univ, [3] Inst. Seismolgy and Volcanology, Hokkaido Univ., [4] Inst. Seismology and Volcanology, Hokkaido Univ., [5] UVO - Inst. Seism. Volcan., Hokkaido University, [6] Akita Univ., [7] Shimabara Earthq. and Volcano Observatory, Kyushu Univ, [8] ERI, Univ. of Tokyo, [9] ERI, [10] D.P.R.I., Kyoto Univ., [11] KSVO, [12] Earth and Planetary Sci., Hokkaido Univ., [13] Earth and Environmental Sci., Kagoshima Univ.

Mt. Usu is one of the most active volcano in Japan, and 8 eruptive events have been recorded since 1663. Location of eruptions varied from a summit to eastern, western and northern flanks. There is location dependence of eruption styles such that Plinian - Sub-Plinian explosive magmatic eruptions occur in the case of summit eruptions, while such eruptions do not occur in flank areas. These variety of eruptive location and location dependence of eruption styles must be largely affected by shallower subsurface structure.

An seismic exploration using active sources was conducted around Usu volcano in November, 2001 to investigate shallower seismic structure. In this paper we show preliminary result of P-wave velocity analyses.

(1) Basement velocity inferred from traveltime curve
First, we constructed a traveltime curve using whole traveltime data set to estimate a basement velocity. The traveltime curve can be approximated as a linear line for data which epicentral distance is greater than 8-10 km. From a slope of the linear line, P-wave velocity of the basement layer is estimated as 6.0-6.1 km/s.

(2) Basement velocity and depths inferred from the time term method
In order to investigate basement depths beneath whole survey area, the time term method is applied. In the method, a basement velocity can be treated as unknown as well as time terms. An inferred basement velocity is 5.6-5.7 km/s, when we use traveltime data which epicentral distance is greater than 8-10 km. The basement velocities inferred from the traveltime curve and the time term method are similar to values obtained by previous studies, such as refraction survey in southwestern Hokkaido, artificial seismic survey around Usu volcano and lake Toya, and core samples.

A velocity of a surface layer must be given in order to translate to basement depths from the time terms. Since precise estimate of the surface layer velocity have not been carried out, uncertainty of the depths is still remaining. However, a general pattern can be recognized. Characteristics of the pattern are (1) deepening of the depth from southern coast of lake Toya to Uchiura Bay, (2)
shallowing to eastern range, which are consistent with a previous gravity analysis.

(3) Three-dimensional velocity structure
In order to investigate three-dimensional velocity structure beneath Usu volcano, the velocity inversion is performed. An initial structure is constructed from the result of the time term method, in case that surface and basement velocities are 3.6 and 5.7 km/s, respectively. From the result of the checker board test, we can recognize that the model can be resolved from the surface to a depth of 2 km b.s.l., when grids are set as 1 and 2 km intervals in vertical and horizontal direction, respectively. As a result of the inversion, local velocity anomalies are detected, such as (1) high velocity region at a depth of 0 km, (2) low velocity at a depth of 2 km, beneath Usu volcano.