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Estimation of Vs Using one 3-Component Seismometer with P-wave Reflection Profiling - Application to a Survey in Saitama

Toshiki Ohtaki[1*], Naomi Kano[1], Takanobu Yokokura[1]

[1]GSJ, AIST

We developed a new method to obtain S-wave velocity in a shallow depth during P-wave reflection profiling (Ohtaki et al., 2011). This method requires only one additional 3-component seismograph, which was installed on the profiling. P-to-SV reflected waves generated by the reflection source will be observed on station gather of radial component of this seismograph. We picked P-to-SV reflected waves on the station gather, and adjusted theoretical travel-time curves to the observed waves at the seismometer. When travel times are calculated, velocities of P-wave and depths of layer boundaries are fixed to the result of P-wave reflection profiling, and variables are the mean ratio of Vp to Vs from the surface to the reflector. The reflected depth is determined from slowness of the wave, and then S-wave velocity from traveltimes. The ratio for well-matched theoretical time is considered as the mean ratio of vertical travel times of S-wave to P-wave from the surface to the reflected layer. Shear-wave velocity for each layer, even if a reflected wave is not observed from the layer, is thus calculated from the ratio.

In the previous paper (Ohtaki et al., 2011), we also assessed a validity of this method with synthetic tests for simple horizontal layer models and dipping layer models. We also applied this method to a previous real seismic reflection survey with 3-component seismometers. This survey was designed for converted-wave reflection profiling and P- and S-wave velocity profiles was obtained to 2-km depth. Another velocity profile near the site was also obtained by using VSP method. S-wave velocity profile that we obtained is consistent with the profiles of these studies to 2-km depth. Our results show that this method provides adequate shear-wave velocity profile with little additional cost to P-wave reflection profiling.

The survey we analyzed in the paper was designed for P-S converted wave processing. Thus its specification may be different from that of P-wave reflection processing. We then examine another on-site testing by using P-wave reflection survey data in this paper. We have installed one 3-component seismometer on several previous P-wave surveys. Among these surveys, we selected a survey at Konosu city, Saitama prefecture on November 2006 (Yokokura et al., 2007).

The survey area is in a gap between the Fukaya Fault and the Ayasegawa Fault. The survey line is a 10 km long from Sekishinden in Konosu city to Yoshimi hill. The source is one large vibrator except near the center of the line. The 10-Hz up-down component seismometers were installed at every 10 m. The total channel number is 192. A 3-component seismometer was installed near recorders. These are the specification for one expansion. Five expansions were totally conducted. Five 3-component record sections were thus obtained. Among them, we selected one station gather that has a largest data set. The station is located in the northeast part of the line. The maximum offset of the records is about 1 km. The record length is 4 s, which is the same as the length of up-down component records. Our preliminary analysis suggests that several P-to-SV reflected waves were observed in the station gather and that S-wave velocity will obtained to about 1 km depth. We will show S-wave velocity structure beneath the site. Note that Vp and depths of reflectors were fixed to the result of the P-wave reflection profiling by Yokokura et al. (2007).