

Development of hypocenter location method using envelopes: Application to B-type earthquakes at Miyakejima volcano

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B-type earthquakes are frequently observed in active volcanoes, but it is difficult to locate them by using traditional phase picking methods because most of B-types show emergent onsets of P- and S-waves. We applied the envelope correlation method of Obara (2002) to B-type earthquakes at Miyakejima volcano, but the located hypocenters shifted towards the south-east by 0.5 - 1 km compared to those determined by phase picking method. Such systematic difference is caused by some assumptions such as that the envelope waveforms at each station are all the same. Actually, the envelope waveform broadens as hypocentral distance increases because of the scattering, or the waveform strongly depends on the site condition. In this study, therefore, we develop a new envelope correlation method in which a small number of the B-type earthquakes whose S-wave arrival times are manually picked are used as reference events. The method estimates S-wave arrival times by taking cross-correlations between envelopes of reference events and that of target event at each station. To find appropriate reference events effectively, we use the similarity of concatenated envelopes: the envelopes of all stations are connected in order keeping the amplitude ratios and time differences of envelopes between stations. The similarity of the concatenated envelopes means that the hypocenters and path effects on the envelope waveform at each station are almost the same with those of the reference events. By applying this method to B-type earthquakes at Miyakejima volcano observed from August 2010 to April 2011, we determine 71 % of the observed ones in an automated way. The B-type earthquakes are located within a 1 km diameter centered on the southern part of the summit caldera, where continuous gas emission occurs. On the other hand, A-type earthquakes, which show clear onsets of P- and S-waves, are distributed from southern part to western part of the summit caldera. To check the reliability, we also compare the result to the hypocenters located by picking P- and S-onset times, and there is no systematic difference between them as seen in the comparison to the result of Obara (2002) method. Our new method is applicable to volcanic earthquakes recorded at other seismic networks that consist of at least several stations surrounding hypocenter regions, which will help us to monitor and understand volcanic activity.

Keywords: hypocenter determination, envelope correlation, Miyakejima volcano