Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC46-P13 Room:Convention Hall Time:May 25 18:15-19:30

Relative hypocenter determination of eruption earthquakes using deconvolution: Application to Stromboli volcano

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Eruption earthquakes are repeatedly observed with intervals of several minutes, hours or days associated with Strombolian or Vulcanian explosions. These eruption earthquakes generally have obscure onsets of P or S phases, which disables us to use general hypocenter determination methods using the arrival times of these waves. In this study, we determine relative hypocenter locations of eruption earthquakes associated with repetitive eruption, using deconvolution filter and master event method.

We use records of three tilt meters that are deployed near the active crater of Stromboli volcano since May 2014. We analyze tilt signals of eruption earthquakes that are recorded with a sampling frequency of 100Hz. We relate arrival time difference between a master event and slave event at each station with differences of hypocenter parameters. We use deconvolution filter to obtain arrival time difference because eruption earthquakes observed at each station have similar waveforms. However, since the origin time of the master event is not known, we further calculate time differences of the arrival time differences between two stations to eliminate the origin time difference.

We analyze 31 eruption earthquakes occuring from 0:00 a.m. to 3:00 a.m., July 1of 2014, whose amplitudes are more than 20 micro radian at all the stations. We define the first event as a master event. Assuming the epicenter at NE crater, the depth of 100m for master event, and the wave velocity of 800m/s, we determine relative depths of slave events using least squares methods. The results show that the relative depths are estimated to be from 70 to 225m.

Deconvolution filter enables us to automatically read the time differences of arrival time differences between two stations. By analyzing large number of data, we will be able to monitor the spatio-temporal change of the source locations of repetitive eruptions.

Keywords: hypocenter determination, eruption earthquake, master event method, deconvolution, Stromboli volcano