

Time evolution of seismic wavefield from active sources around the Iwate Volcano, northeastern Japan

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1. Introduction

Since February 1998 the Iwate volcano became highly active associated with both volcano-tectonic and low-frequency earthquakes, volcanic tremors, very long period events, and crustal deformation. To clarify a three-dimensional velocity structure of volcano, an active survey was carried out under the National Project for the Prediction of Volcanic Eruptions (Tanaka et al., 2002a). This survey was extensive with nine explosions observed by more than 300 stations around the volcano and a small-aperture seismographic array. In this paper we investigate the characteristics of seismic wavefield around the volcanoes by using the data from both the dense stations and the array.

2. Data

The seismic survey was conducted in October 2000 with nine chemical explosions using dynamite charges of 200-250 kg. 330 temporary seismic stations recorded the seismic signal picked up by a vertical short-period seismometer with a natural frequency of 2 Hz. The sampling frequency and resolution are 250 Hz and 16 bit, respectively. For the survey we deployed an L-shaped small-aperture seismographic array on the northern flank of volcano. The array consists of 27 stations with an average spacing of 50 m.

3. Visualization of wave propagation

We investigate the characteristics of wavefield by means of band-pass filtered and root-mean-squared (rms) seismograms. We calculate the rms amplitude for sliding time windows with a length of twice the center period of filter and with a time increment equal to the period. We visualize the time evolution of wavefield by plotting rms amplitude on maps. First we measure average amplitude of rms trace for each sliding time window with a length of 1 s and a time increment of 0.5 s. Next, we spatially interpolate the amplitude data to display amplitude maps for each time step.

The general feature of wavefield is a circular spread of wavefront from the explosion and gradual decay of coda amplitudes. A significant variation from the general trend in 4 Hz band are summarized as follows. At 7 s the shape of wavefront is markedly distorted from the circular shape so that a shadow zone is formed from the summit of volcano to the direction opposite to the explosion. At a time window of 15 s, there remains significant seismic energy at areas including the explosions and the summit. This is particularly evident for the explosions located close to the summit. A semblance analysis using array data for this event shows most coda waves arrive incoherently from the direction of explosion with large slowness. Thus the main part of coda waves is composed of scattered surface waves generated and trapped in a shallow part around the explosion.

A three-dimensional P-wave velocity structure of the Iwate volcano was estimated by applying a seismic tomography method to the arrival time data from the same survey as this paper. The summit and eastern flank of the volcano are covered with very low-velocity (LV) material, which is interpreted as relatively younger volcanic edifices that reflect the evolutionary history of volcano (Tanaka et al., 2003b). The above observation of coda localization suggests an effective excitation and entrapment of surface waves from the explosions fired on the LV material.

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