Small seismic array and continuous video observation of gas emission activity at Iwo-yama Volcano, Kirishimayama

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Introduction

Hypocenter determination of volcanic tremor showing consecutive vibrations is difficult because of unclear phases. Volcanic tremor is considered to be generated by the oscillation of volcanic fluid in magma chamber and/or conduit, but its mechanism is not well known. At Iwo-yama, Kirishimayama, hot water in a pouring basin is continuously blown up to several meters high by volcanic gas emission. The amount of hot water in the pouring basin is almost kept constantly during such activity and the system of gas emission is relatively simple. In this study, we carried out seismic array observation of the continuous tremors and visual observation of the gas emission at Iwo-yama volcano to understand the shallow hydrothermal system.

Observation

A seismic array was deployed on a flat area several tens of meters to the southwest of the vent called Y2-a that is located on the southern part of the Iwo-yama volcano. Six vertical seismometers (2Hz, L-22D, Sercel) were deployed at the vertices of a triangle with a side length of about 30 m and at the midpoints of each side. The signals of the seismometers were recorded on site with a sampling frequency of 200 Hz and an A/D resolution of 24 bit by two low-power data loggers (HKS-9550, Keisoku Giken). The data were acquired continuously from October 28, 2021, to February 15, 2022. In addition, a video camera had been deployed on the crater edge to the south of the vent to continuously record the gas emission activity. We also use the precipitation records at Japan Meteorological Agency observation point, Ebinokogen.

Analysis results

Our video camera shows that the amount of hot water in the pouring basin increases after precipitation, and the water level decreases during the period without precipitation. Running spectrum of the tremor shows large amplitudes at around 2 Hz and 4-10 Hz. The spectrum amplitude at 2 Hz was correlated with the amount of spring water in the pouring basin: the amplitude increased when the amount of water increased. On the other hand, the amplitude of 4-10 Hz was relatively stable over the observation period.
We applied frequency-wavenumber analysis to the tremor records. The propagation direction and apparent velocity of seismic waves are divided in to four groups: the first, second and third groups comes from the vent with apparent velocity (Va) of less than 500 m/s, about 1000 m/s, and greater than 2000 m/s, respectively, and the fourth group showvarious propagation directions and apparent velocity.
For most of the periods when the water volume increased due to precipitation, the number of the second group with (Va= 1000 m/s) was dominant and the spectral amplitude at 2 Hz increased. On the other hand, during the period when the water volume decreased, the number of this group decreased, and the spectral amplitude at 2 Hz decreased.

Discussion and Summary

We found three tremor sources that are associated with the gas emission activity at Iwo-yama. Assuming the S-wave velocity with 1000 m/s at the observation area, we infer that the seismic waves with Va of less than 500 m/s are the waves coupled with infrasounds, the seismic waves with Va around 1000 m/s are S-wave or surface wave generated by the gas emission activity at the shallow vents, because the frequency of that group is correlated with the amount of hot water, the group with Va of greater than 2000 m/s are the waves generated at a depth of about 100 m below the vents which may represent hydrothermal activities underground.

Keywords: Iwo-yama volcano, Kirishima volcano complex, Volcanic tremor, gas emission activity, hydrothermal system

