Temporal evolution of a hydrothermal system in Kusatsu-Shirane Volcano inferred from complex frequencies of long-period events

Hiroyuki Kumagai[1], Bernard Chouet[2], Masaru Nakano[3]

[1] NIED, [2] USGS, [3] Architecture., Nagoya Univ

We present a detailed description of temporal variations in the complex frequencies of long-period (LP) events observed at Kusatsu-Shirane Volcano in the period between August, 1992 and February, 1993. To explain the temporal variations, we estimate the acoustic properties of a crack containing hydrothermal fluids. We find that such temporal variations can be consistently explained by the dynamic responses of a hydrothermal crack to a magmatic heat pulse.

We present a detailed description of temporal variations in the complex frequencies of long-period (LP) events observed at Kusatsu-Shirane Volcano in the period between August, 1992 and February, 1993. We use the Sompi method to determine the complex frequencies of the most dominant mode from the tails of the LP waveforms. The observed temporal variations in the complex frequencies can be divided into three periods. During the first period, before September 3, the frequency rapidly decreases from 5 to 1 Hz, and Q remains roughly constant with an average value near 100. During the second period, between September 3 and November 18, the frequency gradually increases up to 3 Hz, and Q gradually decreases from 160 to 30. During the third period, after November 18, the frequency increases more rapidly from 3 to 5 Hz, and Q shows an abrupt increase at the beginning of this period and then remains roughly constant with an average value near 100. To explain these variations, we estimate the acoustic properties of a crack containing hydrothermal fluids. We find that such temporal variations can be consistently explained by the dynamic responses of a hydrothermal crack to a magmatic heat pulse. During the first period, crack growth occurs in response to the overall pressure increase caused by the heat pulse. During this time of crack formation, the crack may be filled either with a wet misty gas or a water foam. Once crack formation is complete, heat gradually changes the fluid in the crack from a wet misty gas to a dry gas during the second period. As heating of the hydrothermal system gradually subsides, the overall pressure in this system starts to decrease, causing the collapse of the crack and allowing cooler water to seep in from the surrounding region during the third period. This influx of colder water changes the fluid in the crack from a dry gas to a wet misty gas or a water foam.