Temporal change of a hydrothermal system beneath Azuma volcano inferred from the Analysis of N-type events

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1. Introduction
Understanding a hydrothermal system beneath volcano is a key to predict volcanic activities because surface volcanic phenomena are strongly controlled by the physical state of subsurface hydrothermal system. For that purpose, the analysis of N-type events, which are considered to be a resonance of underground fractures, may be a suitable way to estimate the physical properties of fluids inside the fractures (e.g., Kumagai and Chouet, 2000). At Mt. Azuma, N-type events are frequently observed around the time of appearance of a new fumarole on November 11, 2008, and these events have also been observed in recent years. In this study, we analyzed spectral characteristics of N-type events to infer the temporal evolution of hydrothermal system beneath Mt Azuma.
2. Data and Methods
We used vertical-component waveform data recorded at permanent stations TU.AZM (Tohoku Univ.) and V.AZJD (JMA), and apply the Sompi method (e.g., Kumazawa et al, 1990) to estimate four parameters (frequency, damping factor, initial amplitude, initial phase) characterizing each observed waveform. In this study, we mainly examine the time variation of frequencies, quality factors, and spectrum ratios of dominant namiso (wave elements) estimated by the Sompi method to interpret temporal variation of physical parameters of volcanic fluids.
3. Result and Discussions
The temporal variations of oscillatory characteristics of N-type events during two representative time periods from August, 2008 to November, 2008 (Period I) and from October, 2009 to December 2009 (Period II) are summarized as follows: During Period I, dominant frequency gradually shift from 4.0 Hz to 3.0 Hz, while the corresponding Q factors are almost constant. The spectrum ratios between lower mode and higher modes becomes larger as time passes. During Period II, dominant frequency becomes lower in the former part of the period, and settles down to 1.0 Hz. Quality factors and spectrum ratios during this period is almost constant.
These temporal variations of oscillatory characteristics of N-type events are interpreted in terms of temporal evolution of hydrothermal system as follows: During the Period I, the density ratio between fluid inside fractures and surrounding rock becomes larger while the velocity ratio is almost unchanged. This implies that the fluid inside fractures is a mixture of liquid and gas components, and the fraction of gas component becomes smaller during this period. During the Period II, the physical properties of fluid are at stable conditions and it implies steady supply of fluids into the crack.
The fact that the frequencies of most dominant mode in the period I is around 3 Hz while that of the period II is around 1 Hz also indicates that the gas fraction in the hydrothermal fluid during the Period I is larger than that of the Period II, and suggests a long-term variation of hydrothermal system.

Keywords: Azuma, fracture, hydrothermal system, N-type events

