Evaluation of total masses in volcanic clouds using video records: Application to the eruption of Asama volcano on 6 February 2003

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[Introduction]

Asama volcano is one of the most active volcanoes in Japan. From September 2000, intense earthquake swarms occurred followed by vigorous steam emission from the main vent. Since October 2001, temperature at the bottom of the main vent has rose gradually and SO2 flux has increased episodically. From February to April 2003, four small eruptions occurred. Although magnitudes of these eruptions were much smaller than those that had occurred before 1973, it is important to reveal the mechanism of these eruptions. This is because Asama volcano has been most active in these decades. Unfortunately, we have few observations about these eruptions except for seismic data near the main vent (Kobayashi, et al, 2003).

During these eruptions, ascent processes of volcanic clouds were automatically recorded by video cameras. Using these records, we can measure the maximum heights of volcanic clouds to evaluate the magnitude of eruption. But in small volcanic clouds, their maximum heights are not useful, because they are likely to be effected by conditions of ambient atmosphere (Woods, 1993).

In this study, we have developed simple models of dynamics of volcanic clouds to evaluate their masses. We synthesize above analysis, seismic and geological to discuss the mechanism of these eruptions.

[Features of volcanic cloud]

For the above analysis, we revealed the features of ascent processes of volcanic clouds. The camera records of the volcanic cloud emitted on 2 Feb. 2003 revealed that the volcanic cloud had mostly spherical shape and its convection pattern was like vortex ring. Camera records also revealed that the volcanic cloud was expanded linearly as it ascended. These features are consistent with the character of a thermal, which is well known for experiments and dimension analyses (Scorer, 1957).

[Analysis]

On the basis of thermal assumption we have developed simple 1D models for volcanic clouds. In this model, volcanic cloud is composed of ash and real gas, driven only by the buoyancy. Any fall-out of particles was ignored. Using above models, we show the ascent velocity as a function of mean temperature and mass of ash in volcanic cloud.

We compare predictions of the models with the video records of the volcanic cloud emitted on 6 February 2003. From this analysis we deduced that the volcanic cloud had ash of less than 300 ton.

[Discussion]

We found new craters at the bottom of the main vent. Volume of the most prominent crater is consistent with the estimate derived from the analysis. The source of tremor associated with ash emission located at the shallow depth under the main vent (Kobayashi et al., 2003). Chemical compositions of the emitted materials are unlike essential magma, but are consistent with those of Maekake stage which is one of the youngest products of Asama volcano, suggesting. that emitted ash were derived from shallow part of volcanic edifice. It is interpreted that small explosion occurred at the shallow part beneath the main vent. We proposed that small explosion was responsible for the intense gas supply that caused development of the new vent.