Intensity of volcanic eruption estimated from infrasonic and seismic waves

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For real-time monitoring of volcanic eruption, Japan Meteorological Agency (JMA) installed visual cameras and infrasonic microphones at active volcanoes. When volcanic eruption is detected, JMA immediately issues Volcanic Ash Advisory and other information. In the case of Sakurajima and other volcanoes, where volcanic eruptions have frequently observed, JMA identifies occurrence of volcanic eruptions using infrasonic and seismic data without visual data. In historical big eruptions at some volcanoes, small eruptions preceded the big eruptions, therefore, the real-time monitoring of eruption is important also for the prediction of volcanic eruptions.

JMA has observed infrasonic signals from volcanic eruptions at 7 active volcanoes. These signals have some common natures.

(1) Impulsive infrasonic wave

Impulsive signals are observed associated with explosive eruptions. These start with compressive phase followed by long period later phase and are of the most familiar type. In some case, impulsive signals successively occur. Explosion earthquake is observed associated with eruption of this type but volcanic tremor is observed when the interval time of infrasounds is short.

(2) Continuous infrasonic wave

When the duration of eruption is rather long, infrasonic signal shows continuous waveform. Infrasounds of this type are observed at Sakurajima, Miyakejima and Hokkaido-Komagadake volcano. Volcanic tremors are observed associated with these eruptions. At Miyakejima volcano, continuous infrasounds were observed in the eruptive stage in 2000 and the following period. The amplitudes of infrasonic and seismic signals are correlative to the volcanic smoke heights and JMA used the criteria determined from this relation for the monitoring of volcanic activity of Miyakejima. At the small phreatic eruption at Hokkaido-Komagadake in 2000, infrasounds of the same type were observed but their amplitudes and durations were less than those at Miyakejima.

The relation between seismic and infrasonic amplitudes of signals is almost common for eruptions at various volcanoes. It seems from common process in the excitation of infrasonic and seismic energy at explosions in the conduit. As the infrasonic energy release rate seems correlative to intensity of volcanic eruption and their duration might be also important, continuous infrasonic signal with large amplitude and with long duration needs caution in the monitoring of volcanic eruption.

There are some infrasonic events that don't belong to the two types and they show different relationship in seismic and infrasonic amplitudes from the above-mentioned relationship. One of them is low frequency earthquake with infrasonic signal at Miyakejima, of which the mechanism might not explosions in the conduit (e.g., Fujiwara et al., in preparation) and corresponding eruptions (small ash emissions) might be accidental phenomena.

On the other hand, infrasonic signal was not observed at small eruptions (e.g., Meakandake 2006). It is also important to know the noise level and the detection capability of each low frequency microphone.