Radio wave emission phenomenon due to rock fracture and its application to volcano research and hazard mitigation

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Volcanic activity is associated with rock fracture in a crater and inside a mountain. Fumes eruption, where radio wave at low frequency was observed (1), is an assembly of small-scale rock crashes. On the other hand, the microwave emission due to rock fracture was formerly found at the higher frequencies of 300 MHz to 22 GHz (2). Recently, we have studied the phenomenon experimentally in various fracture modes. Rocks of quartzite, gabbro, granite, and basalt were used as a specimine.

This paper describes the measurement system and experimental results. Then, we discuss the availability of the obtained results to the research of volcanoes.

The measuring system hanndles 1 MHz-, 300 MHz-, 2GHz- and 18 GHz-bands. We calibtae the measuring system beforehand so that we can estimate the received power from the received waveform. In the modes of fast fracture, signals at all bands were recorded in pulse shapes. The radio wave component is included inside the pulse. There is hardy difference of the signal power level among gabbro, granite, and basalt. In the modes of slow fracture and with moisture existence, the waveform was almost the same as the fast fracture mode.

Application of radio wave measurement on a volcano offers the following advantages:

(a) Remote sensing is safer and more stable than mechanical means of measuement,

(b) Frequency- sensitive features can be extracted through a particular frequency,

(c) Modern technologies can be diverted.

Our measurement showed radio wave emission from basalt which is popular in volcanic areas, and which contains no piezo-electric material.

In volcanic activities, we can conceive several cases of radio wave emission. The radio wave due to collapse of crater cliff was confirmed in the field experiment on Miyake-jima (3). Eruption of fumes can be observed at higher fequncies with grater advantages than a low fequency, because interferences can be eliminated by virtue of a sharp directivity of an antenna.

Rock fracture due to undergraound magma is not verified through radio waves yet, but has a lot of capability. Even if a rock coexists with underground water, we can obtain the same signal power, as indicated experimentally. It was revealed that a radio wave can propagate underground in a gap of several wavelengths (4). Therefore, a shorter wavelength or a higher frequency is preferred for this application.

References

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