Cliff collapse and maicrowave emission around Miyakejima crater

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An earthquake means a shake of the ground so that its detection or prediction is quite important and of urgent need for the sake of social security. But the pursuit of the ground shake or deformation of the ground only may probably be insufficient to realize an effective countermeasure. Luckily, the change of a crust is associated with many physical phenomena. For example, there were reports on electromagnetic effects in earthquakes such as the anomaly of ground potential, the propagation anomaly or generation of radio wave at several Hz to several tens kHz, and also the propagation anomaly or generation of FM radio wave at several tens MHz. The changes of radon gas density in the air and components in the underground water were also reported. Among those means, we have to select effective and secure ones to eventually put it to practical means to cope with earthquakes.

On the other hand, microwave emission due to rock fracture was found for the first time in the experiments in our laboratory. Formerly, electro-magnetic signal at lower frequencies and light were reported in rock fracture. The mechanism of signal generation has been proposed to be piezoelectricity, the potential difference in contact, micro cracks, and charge accumulation due to exo-electrons.

This phenomenon could be applied to the detection of an earthquake and volcanic eruption as the fraction or friction of rock can be considered on the occasion of such disasters. Moreover, the method can cover a wider area than mechanical a sensor so that a global measurement system using satellites deserves investigation.

It is important to verify and show the phenomena associated with rock fracture in the natural field. If we select an earthquake as a test target in the field, there is a difficulty to know when and where it occurs. On the other hand, the measurement of a volcano has no ambiguity in the location and time to be advantageous from the viewpoint of the experimental security and the effect versus cost. Therefore, we compared several volcanoes from the viewpoints of volcanic activity and infrastructure, and determined to measure the volcano of Oyama at Miyake-jima with microwaves. Rock fractures are expected to be association with volcanic activities on the following occasions:

(1) Quake of a crust including a volcano, or earthquake,
(2) Eruption from a crater
(3) Collapse of a crater cliff

This paper presents the constitution of the measuring system, observation site, and obtained data with analytical explanation. The microwave signals at three frequency bands of 300 MHz-, 2GHz- and 18GHz are received by the assigned antennas and receivers. The antennas are placed to point the rock cliff of the volcano crater in correspondence to the occasion (3).

The observation has been carried out from November 2007 with several interruptions due to troubles. We studied the correlation of microwaves with several factors: lightening, artificial interferences and ground quakes. The contamination of microwaves due to lightening was not observed in the concerned period of data. Interferences with artificial radio waves are recognized at particular frequencies, but can be are filtered out by post processing.

For the correlation between the microwaves and ground quakes, we can use video and photo data of the crater and the seismometer data. The ground quake including tremor may be generated in the above-mentioned three cases. The analysis result has shown the significant correlation. Accordingly, we can conclude that the microwaves are emitted from the above-mentioned rock fractures.

The sensors for microwave detection may be applied to early warning systems for natural hazards on satellites in orbits. That is because the microwave due to rock fracture can penetrate the ionosphere to reach a satellite at a strong enough level of reception. But the relation between a rock fracture and quakes has not been clarified at all, and is left to the future research.