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SSS30-P04 Room:Convention Hall Time:May 20 18:15-19:30

# Radio wave emission due to rock fracture in various modes and its application to earthquake/volcanic activity detection

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1. Introduction

Formerly, the microwave emission due to rock fracture was found at the frequency of 300 MHz to 22 GHz [1]. Later, we studied the radio wave emission phenomenon experimentally changing the destruction condition: destruction speed, moisture, and the existence of a thermally shrinkable tube.

This paper describes the measurement system and experimental results. Then, we discuss the availability of the obtained results to the detection of earthquakes and volcanic activities.

2. Measuring system

The measuring system handles 1 MHz-, 300 MHz-, 2GHz-, and 18 GHz-bands. For each frequency band, an antenna, a low noise amplifier and a filter are installed.

We calibrated the measuring system beforehand so that we can estimate the received power from the received waveform height. The 1 MHz receiving system was calibrated as a whole by receiving a broadcasting signal [2]. The phenomenon of a target is instantaneous so that a special recorder and a triggering system to activate a main memory are inevitable.

3. Measured results

In the reference status, a rock is destroyed abruptly in a short time less than 1 sec. The trigger signal was obtained from the highest frequency of 18 GHz with the discrimination level slightly higher than the noise level.

By virtue of this contrivance, the 18 GHz signal was successfully recorded as well as the other frequencies. In the total observation time of 20 msec, signal pulses exist. After expansion, we can see that the radio wave component is included inside the envelope of a pulse shape. There is hardy difference among gabbro, granite, and basalt.

In slow destruction, a rock is destroyed slowly in a long time of several minutes. The obtained waveforms are shown in Fig. 1. In the coarse time scale, we can see a fewer pulses than the reference status. However, more pulses were probably distributed after the recorded time. The pulse height is almost the same as the reference status. The expanded waveform is similar to the case of the reference status.

For dstruction with moisture existence, we immersed a rock in water, and then wiped off droplets to use it as an experiment material. There existed hardly a difference from the reference status, but the pulse number is rather increased.

When a rock was destroyed with a thermally shrinkable tube, the signal was received, but weaker than the reference status.

4. Applicability to the detection of earthquakes and volcanic activities

In an earthquake, rock is destroyed around a plate boundary, a fault area, or an asperity. The power of emitted radio wave in a slow destruction was close to the reference status. Therefore, instantaneous power level in an earthquake may be close to the reference status though the average power level is decreased due to a longer destruction time. Accordingly, a sensor to detect radio wave should have an integration capability matched to signal emission circumstance.

A rock is esteemed to coexist with underground water. However, we can obtain the same signal power if the radio wave is generated in the inside of a rock, as indicated experimentally. It was revealed that a radio wave could propagate underground in a gap of several wavelengths [3]. Therefore, a shorter wavelength or a higher frequency is preferred for this application.

5. References

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Keywords: Radio wave emission, rock fracture, various modes, earthquake, volcanic activity, detection application

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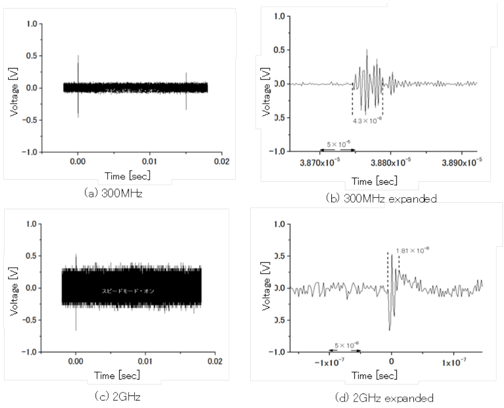


Fig. 1 Measured results in slow destruction of basalt. The trigger signal is from 2GHz channel with a discrimination level of 500 mV. The sampling frequency is 500 MS/s.