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Fundamentals of Microwave Detection in Association with Rock Fracture and Experimental Data for Various Rocks

Tadashi Takano (1,2), Ken-ichiro Maki (3), Eriko Soma (1), Katsumi Hattori (4), and Takashi Maeda (1)

(1) Japan Aerospace Exploration Agency, Sagamihara, Japan (ttakano@ac.jaxa.jp), (2) Nihon University, College of Science and Technology, Department of Electronics and Computer Science, Funabashi, Japan (takano@ecs.cst.nihon-u.ac.jp), (3) Riken, (4) Chiba University

Microwave emission due to rock fracture is a newly found phenomenon, and esteemed as a novel tool for geology, seismology, and volcanology. It was shown through laboratory experiments and theoretical considerations by the current authors that microwaves are generated by micro-discharge across micro cracks in a rock. In the nature, micro cracks are considered to be formed in rupture or frictional process. Therefore, we expect that microwave is emitted in earthquake of volcanic activity, as is verified in our field test at a volcano. Concerning the propagation of the microwave underground, the propagation loss is quite small if cracks sufficiently larger than a wavelength. Therefore, it is possible to detect such natural disasters via microwave, which can be received by a satellite in an orbit, as is shown through the elaborate analysis of a remote sensing satellite data by the current authors.
Nevertheless, the experiment may not be familiar to the scientists of those special fields due to the following reasons:
1. Quite high frequencies should be treated. The ever-tried frequencies are 300 MHz, 2 GHz, and 22 GHz, which are much higher than the frequencies treated in the above-mentioned fields.
2. The phenomena are instantaneous, and lasts typically less than one msec. This fact is more serious than usual microwave measurements. We have to record the signal with accurate triggering device.
3. The obtained signals suggest quite wide frequency band, which exceeds technological capability for only one wide-band receiver to cover the whole band. Therefore, we have to divide the total frequency band to several sub-bands, and use heterodyne receiving technology.
4. As the high frequencies are enclosed in the envelopes, we have to investigate carefully the original signal waveform and power.
5. In order to calibrate the emitted power, special knowledge of waveform of band-limited signal is needed.
In this paper, we first describe the fundamentals of the experiments focusing on the receiving and recording system. Then, the obtained data are introduced for quartzite, granite, gabbro, and basalt. The content of quartz is one of important factors to affect the emitted power, but the other factor should be also considered as gabbro emits more power than granite.