Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SEM031-P01 Room: Convention Hall Time: May 26 17:15-18:45

On the Mechanism of Microwave Emission due to Rock Fracture

tadasi takano[1*], Hirokazu Ikeda[2], Takashi Maeda[2]

[1]Nihon University and JAXA, [2]JAXA

Microwave emission due to rock fracture was found at 300 MHz, 2 GHz, and 22 GHz, and its power was calibrated in laboratory for the first time in the world. The microwave emission phenomena were also observed on occasions of hypervelocity impact, and esteemed as phenomena generally associated with material destruction. Earthquakes and volcanic activities are association with rock fractures so that the microwave is expected to be emitted. In order to show this effect, we planned and executed the field test to detect the microwave due to the collapse of a crater cliff at the volcano of Miyake-jima about 100 km south of Tokyo. As a result, they observed the microwave emission which was strongly correlated with the cliff collapses. Moreover, we analyzed the data of the brightness temperature obtained by a remote sensing satellite. The e emission was confirmed by the data obtained by a satellite which flew over great earthquakes of Wenchuan and Sumatra, and great volcanic eruptions of Reventador and Chanten. Despite of the above-mentioned phenomenological fruits, the reason of the microwave emission is not investigated yet. Formerly, the emission of electro- magnetic signals was reported: the radiation at the low frequency of several hundred kHz or the impulsive noise. And the emission of high frequency of 30 GHz was implied but not verified. As for the cause of the electro- magnetic signals, they considered piezo-electricity, the potential difference in contact, micro-crack, charge accumulation due to exo-electrons, and the movement of charged particles. But these theories cannot explain the fast change in a nano second so that the microwave emission is hard to deduce.
This paper analyzes the obtained data in rock fracture, compare with the research results in material destruction due to hypervelocity impacts, and investigate the mechanism of microwave emission. Prior to the analysis, we confirmed the microwave emission due to the collision of metals without apparent destruction, though faint. Next, we will explain some conceivable mechanisms of microwave emission. For simplification purpose, material of single kind atoms is considered. The electrons confined around the atoms are supplied with kinetic energy of abrupt compression or puling so that they are excited to be free from the atom, and eventually are recombined with the remaining ion atom with radiation. For this procedure, the excitation energy should be larger than the work function of material. For example, the work function of Al is 4.3 eV which is equivalent to infrared and does not radiate microwave frequency. Unless electrons do not go out of the realm of an atom, the voltage distribution in space may be made by electron excitation to reach the discharge. Let us consider that micro cracks are generated in a material before destruction. The electrons bound to atoms which face to the micro-cracks change their energy states from the quantized level around an atom in crystal to the level of a surface atom or an isolated atom. The gap of a micro crack is assumed to be 0.1 nm at minimum, because adjacent atoms are considered isolated with the separation larger than the atom's radius. As the voltage changes across such a narrow gap, the discharge may happen. In the third model, we consider that an assembly of atoms is excited mechanically in the way described above, and drop to the lower energy state to radiate the emission. Namely, fragments with molecule quantity larger than several tens thousand or even more make rotational or linear movement. The movements are quantized and the emitted energy is equal to the energy difference between the states. As the molecule is quite large, the energy states exist almost continuous. Based on the above-mentioned models, we investigate the

mechanism of the microwave emission considering the emission characteristics in the material destruction due to compression or impact.

Keywords: compression fracture, impact fracture, earthquake detection, volcanic activity monitoring, electron excitation, discharge