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Features of Changing Microwave Radiation from Loaded Rock in Elastic Phase

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Since the discovery of satellite infrared anomaly occurred before some earthquake by Russian geo-scientists in 1980's, both satellite remote sensing on seismic activities and experimental infrared detection on rock physics in process of rock loading were undertaken in many counties including China, Japan, Europe nations and United States. Infrared imager and spectrum instruments were applied to detect the changed infrared radiation from loaded rock to fracturing, which lead to the development of Remote Sensing Rock Mechanics. However, the change of microwave radiation from loaded rock was not so much studied, even if abnormal changes of microwave brightness temperature (MBT) preceding some large earthquakes were observed by satellite sensors such as AMSR-E on boarded Aqua. To monitor rock hazards, seismic activities, and to make earthquake precautions by via of microwave detection or microwave remote sensing, it is fairly demanded to explore the laws of microwave radiation variation with changed stress and to uncover the rock physics.

We developed a large scale rock loading system with capability of 500 tons and 10 tons of load, respectively, at two horizontal loading head, and designed a group of microwave detectors in C, K, and Ka bands. To investigate the changed microwave radiation from loaded granite and sandstone in its elastics deformation phase, the first horizontal stress was circularly applied on rock samples of size $10\times30\times60$cm3 at a constant second horizontal stress, and the changes microwave radiation was detected by the detectors hanged overhead the rock sample. The experiments were conducted outdoor at nighttime to keep off environmental radiation and to simulate the satellite observation conditions in background of cool sky. The first horizontal stress and the microwave radiations were synchronically detected and recorded. After reducing the random noise of detected microwave signals with wavelet method, we found the MBT increase with stress rising and decrease with stress dropping, and the correlation factor (R2) of MBT-stress reached 0.88. The experiments and results revealed an important rock physical phenomenon of rock dielectric property changing with stress, which leads to detectable MBT variation.