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Stress Stimulated Currents. From fracture processes to earthquake physics in view of complexity theory.

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The possibility of electrical earthquake precursors (EEP) has long been appreciated, but it is still a debate on the theoretical mechanism explained their generation and expected characteristics, or proven techniques to identify and discriminate true precursors from noise. To this end, a large number of laboratory experiments have been conducted, which have demonstrated the generation of transient electric potential prior to rupture in both dry and wet rock specimens. The principal mechanisms proposed to explain these observations are the piezoelectric and electrokinetic effects. The piezoelectric effect, often quoted in the literature as the principal generator of EEP, cannot explain why non-piezoelectric rock specimens also generate precursory electric phenomena. Streaming potential can be generated in many kinds of saturated rocks, but the fracturing of dry rocks also produces transient electric effects. Therefore, these two mechanisms may not be the basic contributors to the precursory phenomena observed in the laboratory (and to possible EEP signals). A series of laboratory experiments on the microfracturing electrification of dry marble samples under stress, and their possible relationship to field observations of purported EEP proposed the last ten years.

Geomaterials were subjected to uniaxial compression, at constant and variable stress-rates, in both the elastic and the plastic domains. During the experiments, stress stimulated currents were observed. The emitted current appears very intense and non-linear just prior to failure. The dependence of the emitted stress stimulated currents on the stress rate and the Young modulus of the material demonstrated. Explanation of these observations was attempted with a theoretical model involving microfracturing and the Motion of Charged edge Dislocations (MCD) as the primary electrification mechanism. The stress stimulated currents waveforms and mode of appearance accord with the predictions of the MCD model and it appears that if this process could scale up to the size of seismogenic zones, it would yield observable EEP. The MCD model also makes specific predictions of the waveforms of the expected EEP signals.

Furthermore some resent results based on the statistical description of stress stimulated currents from rock fracture experiments along with observed acoustic emissions obtained from samples of calcite are presented in view of complexity theory. The resulting scaling functions for stress stimulated currents , and acoustic emissions and earthquakes are similar strongly suggesting a universality in the manifestation of fracture processes and derivative effects.

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