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Electric signal emissions from rock samples used as failure predictors

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The electric signals emitted during the application of mechanical uniaxial compressive stress upon rock samples (amphibolites and marbles), are observed and studied in this work. These signals are known as Pressure Stimulated Currents (PSC) and the technique associated with their investigation is termed PSC technique. In this work PSC signals are detected and studied when rock specimens are excited through a stepwise pressure increase from a low level σ_{L} to a high level σ_{H}, at a fast rate and consequently the specimen remains for a long time at the high pressure regime. This technique is characterized by the term "abrupt rate step stress" (ARSS) technique. The choice of proper values for the quantities σ_{L} and σ_{H} enables the appearance and comparison of PSC signals representing all regions of the mechanical behavior of the material.

Based on the experimental data, during transition from an initial stress level to a higher stress level using the ARSS technique procedure, an abrupt bulge of the PSC signal is observed with the appearance of a current peak (PSC_{max}), followed by a signal relaxation process at a lower level (PSC_{min}). In the initial time that elapses after pressure stabilization at σ_{H}, the PSC signal obeys an exponential decrease law: PSC $\propto \exp(-t/\tau)$, where τ is a relaxation constant. The experimental results indicate that the PSC relaxation process after a previous stress-step has intense differentiations directly associated with the final level value σ_{H} of the step. The macroscopic characteristics of the PSC signal as the value of PSC_{max} and its relaxation parameters (τ and PSC_{min}) give clear information about the relationship of the σ_{H} level neighbourhood with the fracture limit σ_{F} of the material sample.

Finally, during PSC signal relaxation when the σ_{H}stress level is in the neighbourhood of the fracture limit σ_{F} of the material sample, suddenly PSC bulges appear. It is experimentally proven that the appearance of such peaks is associated with the evident evolution of the strain rate that may be observed in the temporal display of strain. The appearance of such PSC peaks under a constant stress regime and after a previous stepwise stressing predicts an upcoming sample failure.