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Temporal power-law change in rock magnetization prior to failure

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We study the changes in rock magnetization associated with deformation (i.e., damage evolution) prior to its failure. An analysis of creep experimental data reveals that the change in remanence intensity under uniaxial creep follows a temporal power-law of time-to-failure. This result is investigated in terms of irreversible thermodynamics. In this theory, the Gibbs free energy is prescribed by the macroscopic stress-strain relation, remanent magnetization and internal state variables (generalized coordinates). The dynamics of the internal state variables represent the microscopic damage evolution such as microcracking or local plastic straining. A large number of internal states have each characteristic relaxation time, while the collective dynamics of internal states shows temporal power-law behaviour. This condition corresponds to stress power-law behaviour of strain-rate associated with time-scale invariant evolution of microscopic damage. Moreover, in the Gibbs free energy, the Maxwell's relation can be defined between the magnetization and internal state variables. This relation explains that the microscopic damage evolution causes temporal power-law change in the rock magnetization prior to the failure. This theory contributes also to an interpretation of the seismo-electromagnetic radiation prior to rock failure or large earthquakes.