Geophysical Research Abstracts
Vol. 13, EGU2011-10588, 2011
EGU General Assembly 2011

A first principles approach to understand the physics of precursory accelerating seismicity

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January 11, 2011

Observational studies from rock fracture to earthquakes indicate that fracture along with many large earthquakes are preceded by accelerating seismic release rates (Accelerated Seismic Deformation), characterized by a cumulative Benioff strain following a power law time -to failure relation of the form $\epsilon(t) = K + A(T_f - t)^m$, where T_f is the failure time of the large event and m of the order of $0.2 - 0.4$. More recent theoretical studies relate the behaviour of seismicity prior to a large earthquake to the excitation in proximity of a spinodal instability and show that the power-law activation associated with the spinodal instability is essentially identical to the power-law acceleration of Benioff strain observed prior to earthquakes, with $m = 0.25 - 0.3$. In the present work, we follow the Wackentrapp-Hergarten-Neugebauer model for mode I propagation and concentration of microcracks in brittle solids due to remote stresses. This is a coupled system of the equlibrium equation for the stress tensor and an evolution equation for the crack density integral. The equilibrium equation allows us to estimate the stress tensor in terms of the crack density integral -through the Nash-Moser iterative method. These estimates imply via the evolution equation that the crack density integral blows-up in finite time in a $(T_f - t)^{-0.3}$ -law, with an agreement with the observational results.

Acknowledgements F.V. acknowledges support from EU grant PIEF-GA-2009-235433 "NEXT EARTH"