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Thresholds for Transport and Fracture: Implications for Earthquakes precursors

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Percolation models of critical phenomena in heterogeneous solids predict the existence of critical points or percolation transitions in various properties of the material. At these transitions various properties of the material change dramatically. Examples of these transitions are metal/dielectric, gel/sol, permeable/impermeable and consolidated/unconsolidated. Such transitions are associated with so-called generalized conductivities or transport-related properties of materials, which depend critically on the conductivity of transport channels. In many cases the percolation thresholds for various properties are the same, which means that these transport processes have the same geometrical support. At the same time it is evident that an impermeable/permeable percolation transition, for example, does not necessarily mean that a 3-dimensinal system becomes mechanically unconsolidated. A consolidated/unconsolidated transition demands a much larger concentration of voids for division of a 3-d material into two or more parts. The percolation thresholds become quite variable in dynamical models (where the interaction range of particles (site, poles) depends on the external field, e.g. electrical or mechanical) as well as in anisotropically correlated models. This variability of the percolation threshold for various generalized conductivities can explain the empirically observed difference in the lead times for various earthquake precursors, at least insofar as the seismic process can be considered as a critical transition from a consolidated to an unconsolidated state. In this paper we apply a percolation model approach to the observed difference in precursor times of electromagnetic signals before strong earthquakes. Our treatment is mostly qualitative and is aimed at constructing a consistent qualitative model of processes that can explain some uncommon experimental evidences obtained by monitoring electromagnetic fields in seismoactive areas.