Geophysical Research Abstracts
Vol. 17, EGU2015-15258, 2015
EGU General Assembly 2015
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On the critical or geometrical nature of the observed scaling laws associated with the fracture and faulting processes

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One of the largest controversial issues of the materials science community is the interpretation of scaling laws associated with the fracture and faulting processes. Especially, an important open question is whether the spatial and temporal complexity of earthquakes and fault structures, above all the interpretation of the observed scaling laws, emerge from geometrical and material built-in heterogeneities or from the critical behavior inherent to the nonlinear equations governing the earthquake dynamics. Crack propagation is the basic mechanism of material's failure. A number of laboratory studies carried out on a wide range of materials have revealed the existence of EMEs during fracture experiments, while these emissions are ranging in a wide frequency spectrum, i.e. from the kHz to the MHz bands. A crucial feature observed on the laboratory scale is that the MHz EME systematically precedes the corresponding kHz one. The aforementioned crucial feature is observed in geophysical scale, as well. The remarkable asynchronous appearance of these two EMEs both on the laboratory and the geophysical scale implies that they refer to different final stages of faulting process. Accumulated laboratory, theoretical and numerical evidence supports the hypothesis that the MHz EME is emitted during the fracture of process of heterogeneous medium surrounding the family of strong entities (asperities) distributed along the fault sustaining the system. The kHz EME is attributed to the family of asperities themselves. We argue in terms of the fracture induced pre-seismic MHz-kHz EMEs that the scaling laws associated with the fracture of heterogeneous materials emerge from the critical behavior inherent to the nonlinear equations governing their dynamics (second-order phase transition), while the scaling laws associated with the fracture of family of asperities have geometric nature, namely, are rooted in the fractal nature of the population of asperities.