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Preseismic electromagnetic emissions: demystifying the features of the last stages of fracture process

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In recent years, the wind prevailing in the scientific community does not appear to be favorable for earthquake (EQ) prediction research, in particular for the research of short term prediction. Sometimes the arguments were extended to the extreme claim that any precursory activity is impossible. Importantly, negative views originate from certain systematically observed features, currently considered as "paradoxes".
Fracture-induced electromagnetic emissions (EME) in a wide range of frequency bands are sensitive to the micro-structural chances. Thus, their study constitutes a nondestructive method for the monitoring of the evolution of damage process at the laboratory scale. It has been suggested that fracture induced MHz-kHz electromagnetic (EM) emissions, which emerge from a few days up to a few hours before the main seismic shock occurrence permit a real time monitoring of the damage process during the last stages of earthquake preparation, as it happens at the laboratory scale. Despite fairly abundant evidence, EM precursors have not been adequately accepted as credible physical quantities. These negative views are enhanced by the fact that certain "puzzling features" are consistently observed in candidate pre-seismic EM emissions. More precisely: (i) EM silence in all frequency bands appears before the main seismic shock occurrence, as well as during the aftershock period. (ii) Absence of strong strain changes is observed during the emergence of EM precursors.
We argue that experiments by means of EME at the large, geophysical, scale would probably reveal features of the last stages of failure process not clearly observable at the small, laboratory, scale, allowing thus the monitoring in real-time and step-by-step of the EQ generation. The observed EM precursors have been interpreted through a shift in thinking towards the basic science. Strict criteria have been established for the definition of an emerged EM anomaly as a pre-seismic one by means of a proposed three stages model of EQ generation which is supported by recent laboratory and numerical studies of granular packings, micron-scale plastic flow, and concepts drawn from phase transitions, criticality, interface depinning, fracture size effects, self-affine notion of fracture and faulting process, and universal features of fracture surfaces. Precursory EM features, which have been considered as paradoxes, are explained.