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Fracture induced electromagnetic emissions: extending laboratory findings by observations at the geophysical scale

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Under natural conditions, it is practically impossible to install an experimental network on the geophysical scale using the same instrumentations as in laboratory experiments for understanding, through the states of stress and strain and their time variation, the laws that govern the friction during the last stages of EQ generation, or to monitor (much less to control) the principal characteristics of a fracture process.

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. Since the EME are produced both in the case of the laboratory scale fracture and the EQ preparation process (geophysical scale fracture) they should present similar characteristics in these two scales. Therefore, both the laboratory experimenting scientists and the experimental scientists studying the pre-earthquake EME could benefit from each- other's results.

Importantly, it is noted that when studying the fracture process by means of laboratory experiments, the fault growth process normally occurs violently in a fraction of a second. However, a major difference between the laboratory and natural processes is the order-of-magnitude differences in scale (in space and time), allowing the possibility of experimental observation at the geophysical scale for a range of physical processes which are not observable at the laboratory scale. Therefore, the study of fracture-induced EME is expected to reveal more information, especially for the last stages of the fracture process, when it is conducted at the geophysical scale. As a characteristic example, we discuss about the case of electromagnetic silence before the global rupture that was first observed in preseismic EME and recently was also observed in the EME measured during laboratory fracture experiments, completely revising the earlier views about the fracture-induced electromagnetic emissions.