Energy budget of laboratory earthquakes: a comparison between linear elastic fracture mechanics approach and experimental approach.

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Earthquakes correspond to a sudden release of elastic energy stored during inter-seismic period by tectonic loading around fault. The earthquake energy budget consists of four non-independent terms: the energy release rate (by unit crack length), the fracture energy, the heat term and finally the radiated energy. These terms depend on the rupture and sliding velocities, the amount of slip and the stress drop. Because of the impossibility to access to stress and strain conditions at depth, the earthquake energy budget cannot be fully constrained from seismological data, limiting our understanding of its influence on rupture propagation.

To address this issue, we conducted stick-slip experiments with large samples in a biaxial configuration apparatus. By imposing constant normal load and increasing shear load, seismic events were produced on a 20 cm long fault, for which the energy budget was estimated using different methods.

Fracture energy was estimated by recording the strain field around the crack tip through high frequency (2 MHz) strain gage rosettes array and comparing it to the theoretical LEFM strain field predictions obtained for same conditions (i.e. rupture velocity, distance from the fault). Fracture energies were then inverted and found to range in between 1 and 10 J/m^2. At the same time the energy partitioning was estimated through stress-slip evolution during rupture. The fracture energies obtained from this method are almost one order of magnitude larger than the ones inverted from LEFM and range in between 1 and 90 J/m^2. Moreover, the energy partitioning shows the radiated energy ranging between 80 and 300 J/m^2 and finally the heat/thermal energy as the largest fraction of the energy partitioning with values ranging from 200 to 2500 J/m^2. Our preliminary results highlight the importance of understanding the contribution of heat energy in frictional processes, since this term cannot be estimated from seismological data.