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Frictional heating processes during laboratory earthquakes

Jérôme Aubry (1), François-Xavier Passelègue (2), Damien Deldicque (1), Frédéric Girault (3), Samson Marty (1), Abdeltif Lahfid (4), Harsha Bhat (1), Javier Escartin (3), and Alexandre Schubnel (1)

(1) École Normale Supérieure, Laboratoire de Géologie, Paris, France , (2) Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, (3) Institut de Physique du Globe de Paris, Paris, France, (4) Bureau de Recherches Géologiques et Minières, Orléans, France

During an earthquake, part of the released elastic strain energy is dissipated within the slip zone by frictional and fracturing processes, the rest being radiated away via elastic waves. While frictional heating plays a key role in the energy budget of earthquakes, it could not be resolved by seismological data up to now. Here we investigate the dynamics of laboratory earthquakes by measuring frictional heat dissipated during the propagation of shear instabilities at stress conditions typical of seismogenic depths.

We estimate the complete energy budget of earthquake rupture and demonstrate that the radiation efficiency increases with thermal-frictional weakening. Using carbon properties and Raman spectroscopy, we map spatial heat heterogeneities on the fault surface. We show that an increase in fault strength corresponds to a transition from a weak fault with multiple strong asperities and little overall radiation, to a highly radiative fault behaving as a single strong asperity.