INSIGHTS INTO RUPTURE PHYSICS FROM INDUCED SEISMICITY

Martin GALIS [1,2], ***Jean-Paul AMPUERO*** [3,4], ***P. Martin MAI*** [5], ***Jozef KRISTEK*** [1,2]

[1] Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovakia

[2] Earth Science Institute, Slovak Academy of Sciences, Bratislava, Slovakia

[3] California Institute of Technology, Pasadena, USA

[4] GeoAzur, University Côte d'Azur, Valbonne, France

[5] KAUST-King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

Better understanding of the conditions controlling nucleation and size of earthquakes is of critical importance. Although injection-induced earthquakes pose a serious seismic hazard, they also offer an opportunity to gain insight into rupture physics.

Galis et al. (2015) derived fracture-mechanics-based relations between the area and overstress of overstressed asperity and the ability of ruptures to either stop spontaneously (arrested ruptures) or runaway (super-critical ruptures). These relations were verified via extensive 3D dynamic rupture simulations on faults governed by linear slip-weakening friction. Later, Galis et al. (2017), extended previous results and derived estimate of the size of arrested ruptures nucleated by localized stress perturbations. Fluid-injection induced earthquakes are triggered by pore-pressure concentrations that can be reasonably constrained using pore-pressure diffusion models and information about volume of injected fluids. Utilizing this fact, they developed a theoretical scaling relation between the largest magnitude of self-arrested earthquakes and the injected volume. They find it consistent with observed maximum magnitudes of injection-induced earthquakes over a broad range of injected volumes, suggesting that, although runaway ruptures are possible, most injection-induced events have been self-arrested ruptures. Recently, we investigated impact of elongated overstressed asperities on rupture nucleation and arrest and we found that the ruptures are dominantly controlled by area of asperity, even for elongated asperities.