Geophysical Research Abstracts
Vol. 20, EGU2018-6572, 2018
EGU General Assembly 2018


# Simulating fluid flow in complex natural fault zones: towards a tool for predicting natural and human-induced earthquake nucleation.

Thomas Snell (1), Nicola De Paola (1), Jeroen van Hunen (1), Stefan Nielsen (1), and Cristiano Collettini (2)

(1) Durham University, Department of Earth Sciences, United Kingdom (thomas.snell@durham.ac.uk), (2) Sapienza Università di Roma, Dipartimento di Scienze della Terra

Both natural and human-induced subsurface fluid flow can generate supra-hydrostatic fluid pressure gradients, which control the effective normal stress and static frictional strength of faults. Although many current numerical simulation techniques model the role of fluid flow in faulting processes and seismicity, only a few simulations have investigated the control exerted on fluid flow by realistic, complex fault zones architecture and its implications on earthquake nucleation processes.

Here, we model overpressured, supercritical $CO_2$ fluid flow in natural seismic fault zones with complex, realistic architecture (e.g. Mw 6.0 1997-98 Colfiorito and Mw 6.5 2016 Norcia earthquakes), where permeability in the fault core and surrounding damage zones depends on mode of failure (e.g. brittle vs. ductile), fabric anisotropy, effective pressure and shear strain, as parameterised after laboratory experiments. Modelled fluid flow is then used to investigate the effects of pore fluid pressure during the nucleation phase that precedes an earthquake.

The results obtained show that the occurrence, timing and distribution of localised brittle or ductile failure within the different fault zone domains significantly affects pore pressure diffusion. Our simulations show that these factors control the duration of the earthquake recurrence interval (decreasing from 360 years to as low as 250 years), the size of the nucleation patch and the duration of the nucleation phase.

Our results have implications for short and long term earthquake forecasting, as crustal fluid migration during the interseismic period may control earthquake recurrence intervals. The results could inform earthquake early warning systems, as any significant extension of the duration of the nucleation phase and size of the nucleation patch can increase the likelihood of early premonitory signal detection.