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Comparison of fracture roughness and acoustic emissions statistics from triaxial deformation of rocks

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Fracture roughness has been shown to be a very robust parameter in fracture mechanics with little sensitivity on the material properties, fracture modes, loading conditions and scales. Indeed, a self-affine scaling invariance has been show to be a very good geometrical model of the fracture surface geometry in many configurations. However some hints of departure from this general rule seem to exist in some specific cases.

To re-explore this observation, we have performed a large set of triaxial tests on six different rocks, with contrasting physical properties: Etna basalt, Westerly granite, Crab Orchard sandstone, Darley Dale sandstone, Bentheim sandstone and Solnhofen limestone. All tests were performed under the same conditions: an effective confining pressure of 30MPa (50MPa confining pressure and a 20MPa pore fluid pressure), at a constant strain rate of 1.0 x 10^{-5} s^{-1}, room temperature and under drained conditions. Crack damage evolution was monitored throughout each experiment by measuring the independent damage proxies of axial strain, pore volume change and output of acoustic emission (AE) energy. Immediately after macroscopic failure, samples were slowly unloaded and pressures slowly reduced to ambient conditions, in order to carefully preserve the fault plane and fault gouge.

Each of the resultant fault planes were then precisely mapped using a high resolution laser profiler (resolution of a few micro-meters) to investigate the differences in fracture roughness between the different lithologies. Moreover, extended 3D maps of fracture morphology allow to tackle the possible anisotropy of the surface with respect to the fracture slip. We finally complete our analysis by investigating the link between fracture morphogenesis and the recorded AE.