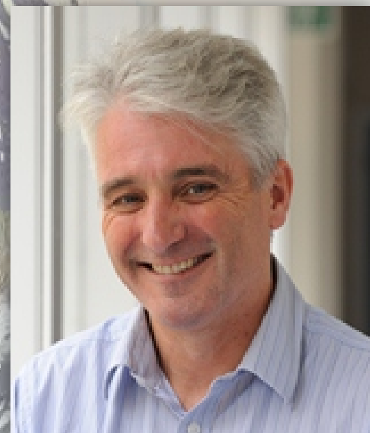
Squashing the Digital Rock



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The spontaneous emergence of localized cooperative deformation is an important phenomenon in the development of shear faults and brittle rheology in porous media. Here we investigate the evolution of damage and fragmentation leading up to and including system-sized failure in a numerical model of a porous rock, using discrete element simulations of the strain- controlled uniaxial compression of cylindrical samples of different finite size, in comparison with those observed in natural experiments and in the Earth. As the system approaches catastrophic failure the number of fractures and the energy release rate both increase as a time-reversed Omori law, with scaling constants for the frequency-size distribution and the inter-event time, including their temporal evolution, that closely resemble those of laboratory experiments. Initially-distributed damage progressively localizes in a narrow shear band, ultimately producing a fault ’gouge’ containing a large number of poorly-sorted, non-cohesive fragments on a broad bandwidth of scales, with properties similar to those of natural and experimental faults. The position and orientation of the central fault plane, the width of the deformation band and the spatial and mass distribution of fragments resemble those in real deformation experiments. Overall the results are important in identifying the key ingredients for localisation, scaling and the onset of catastrophic rupture, and identifying a realistic basis for evaluating the predictability of such systems in nature.

15 September 2017

2:30 p.m.

Conference Room, 3/F,
Mong Man Wai Building

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