Geophysical Research Abstracts
Vol. 21, EGU2019-5058, 2019
EGU General Assembly 2019

In situ dynamic X-ray microtomography reveals the evolving energy budget of faults within continental crust

Jessica McBeck (1), Benoit Cordonnier (1), Karen Mair (1), Francois Renard (1,2)

(1) University of Oslo, Physics of Geological Processes, Dept of Geosciences, Oslo, Norway (jmcbeck@gmail.com), (2) University Grenoble Alpes, University Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, Grenoble, France

We investigate the evolving distribution of strain associated with a sliding fault within crystalline rock, and the energetics of deformation that occurs both on- and off-fault. We slid centimeter-scale precut faults of differing roughness oriented at 45° to the maximum compression while acquiring in situ synchrotron X-ray microtomograms. Digital volume correlation of these time series of 3D local density fields provide estimates of the 3D displacement and strain fields. Our novel representation and sampling of the strain tensor field reveal that the differing fault roughnesses produced distinct slip behavior, degree of strain localization and accumulation, and energy budget partitioning. The rougher fault slipped more episodically, hosted a wider and more asymmetric damage zone, and accommodated less normal and shear strain. In addition, the rougher fault consumed more energy in off-fault deformation (Wint) per volume and more energy in frictional slip (Wfric) as portions of the total energy input to the system (Wext) than the smoother fault. In both experiments, Wfric consumed the largest portion of the energy budget (50-100%), while Wint consumed smaller percentages (5-20%). As the damage zones thickened with slip, the rate at which they consumed Wfric increased, even as the overall fault length remained constant. Tracking the variability of total energy budget and energy partitioning through time reveals how evolving fault architecture determined the energetic dominance of various deformational processes. This analysis predicts the dominance of frictional work relative to internal work in mature crustal fault zones. However, in younger fault systems with more off-fault deformation, internal work may comprise a larger portion of the deformational energy budget.