INDUCED SLIP ON A LARGE-SCALE FRICTIONAL DISCONTINUITY: COUPLED FLOW AND GEOMECHANICS

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Access via a DUSEL to large-scale frictional discontinuities such as faults and bedding interfaces will create unprecedented opportunities for long-term experiments into coupled frictional slip and flow, with potential application to earthquake mechanics. Laboratory-scale experiments conducted at Purdue University indicate that slip initiation along a pre-existing frictional discontinuity can be predicted by fracture mechanics theory. However, the critical energy release rate, an indicator for slip initiation, is not a material property but depends strongly on the applied normal stress, on the frictional properties of the slip surface, and on the slip required to decrease the frictional strength from peak to residual. Numerical experiments indicate that mode II loading (slip) in undrained conditions decreases the compressive and tensile stresses ahead of the fault tip, while shear stresses remain unchanged, thus favoring mode II propagation over mode I. These observations have been made at the laboratory scale, and while we are confident that the fundamental mechanisms for slip initiation and pore pressure response to external loading have been well identified, validation at a large scale is required.

DUSEL offers unique opportunities to compare laboratory observations with field measurements and to incorporate scale effects in a theoretical framework. We propose to investigate coupled flow and mechanical effects related to slip initiation along selected large-scale (persistent) discontinuities. Faults are especially interesting because they are shear discontinuities with potential importance to earthquake engineering and geophysics. We propose to induce slip by: (1) decreasing the stress field through excavation of additional drifts; and (2) injection of fluid inside the discontinuity. The coupled process will be monitored by mechanical systems (extensometers, pressure transducers) and by acoustic emission. The goals of the research are: (1) validate laboratory experiments; (2) quantify scale effects; (3) determine effects of slip on flow of fluids (and vice versa); and (3) provide a theoretical framework for slip along frictional discontinuities.