**Title:** A LARGE BLOCK [PILLAR] TEST TO STUDY THE FAILURE OF ROCK – APPLICATION TO ROCK-STRENGTH AND EARTHQUAKE MECHANICS

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**Space:** Large block at >4800 ft. Access around block 5m _ 5m _ 5m.

**URL:** http://www.phys.vt.edu/~dusel/workshop/abs/5.pdf
http://www.phys.vt.edu/%7Edusel/workshop/DUSEL/elsworth_large_block_test.ppt

**Objective:** The energetic failure of rock bears importantly on the potential success of a Deep Underground Science and Engineering Laboratory. The construction of large cavities that may span 60 m at a depth of 2000 m pose unprecedented engineering challenges and will require careful site investigation, design, and extensive stability monitoring – issues of stress-control and the protection from rock bursting will be important considerations. The hazard of rock bursts is a ubiquitous problem in deep mining, worldwide. For example, the Creighton Mine (Ontario), that houses the SNO lab and now reaches to ~2400 m, sustains a few M>3 events annually with the largest event recording M=4 (1984). These events pose a significant safety hazard, but offer scientific challenges in the improved understanding of rupture mechanisms that relate to length scales from nanometers to kilometers, and timescales that span milliseconds to thousands of years. This is the principal focus of this proposed study.

**Approach:** We propose fundamental engineering and scientific studies of rupture mechanics via the physical (seismic, stress, fluid pressure, deformation) and chemical (reactant fluxes and compositions) monitoring of a test that will isolate and fail a large deep block of rock, *in situ*. This heavily instrumented test would both complement, and be complemented by, the process understanding of rock failure gained by the monitoring of the observatory site by geophones and other instrumentation, and concentrated around critical caverns.

**Expected Outcomes:** The observations provided by the failing of a large block of rock, under deep controlled stresses and geometry, and triggered by energetic and reactive fluids would illuminate important contemporary issues in earthquake mechanics and seismicity. The physics of earthquake nucleation and rupture is not yet well-described because of the impossibility of near-field access to fault zones. For example, understanding shear zone formation (i.e. how a zone of freshly-fractured rock accumulates displacement and eventually forms a friction-controlled fault) would contribute critical knowledge toward understanding earthquake processes. A natural laboratory would also lend itself to other studies that would contribute to the knowledge of earthquake failure mechanics, such as quantification of the critical slip event (the smallest size frictional slip event as predicted by the rate-and state-dependent friction laws), understanding the mechanisms of triggering across short distances and timescales, mechanisms of strength-gain and fault-healing promoted by reactive fluids and other agents, and the respective roles of velocity weakening and energy surplus effects in defining the transition between quiescent rupture and energetic failure.

The observations would contribute to the constraint of Rate and State friction constitutive laws that have emerged as powerful tools for investigating the mechanics of earthquakes and faulting. Although these laws are capable of reproducing virtually the entire range of observed seismic and interseismic fault behaviors, ranging from preseismic slip and earthquake nucleation to coseismic rupture and earthquake afterslip, our understanding of key parameters in these laws remains poor. A major limitation in developing process-based models of these parameters is the scaling problem associated with applying laboratory-sized samples. Numerical models are available to apply laboratory-based friction laws to problems such as earthquake triggering and fault interaction. However, the natural scale laboratory data necessary to carry out such studies do not exist. These data are needed to understand the role of fault roughness and gouge on frictional properties and stability. The proposed underground laboratory will allow detailed studies of frictional strength and stability, including resonant behavior and shear destabilization. The observations will constrain theoretical models based on friction constitutive laws.

Importantly DUSEL offers this unique opportunity for long-occupancy of a site with a prescribed dense coverage of observations, access to an unusually large block of rock, and the application of high stresses at depth. Consequently the proposed underground laboratory will provide an important link between the laboratory and natural tectonic events, which has so far only been possible by studying mining-induced seismicity and by borehole recordings.