# THE INFLUENCE OF FRICTIONAL MELT ON EARTHQUAKE DYNAMICS AND THE SEISMIC CYCLE: EXPERIMENTS ON ANALOG MATERIALS

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**ABSTRACT**

Here we present data from tests conducted using the University of Texas Rock Deformation Lab's rotary shear Apparatus on polymethyl methacrylate glass (PMMA). During each experiment, we measured the normal load, torque, rotational displacement, and internal and external interfacial temperature. We recorded the experiment with a high-speed camera capable of recording at 960 frames per second. In addition, we acquired acoustic emissions data that provide the means to link our results with seismograms from natural earthquakes. Experiments were conducted at a normal stress of ~3.6 MPa and an initial spring loading rate (SLR) of ~2 RPM (~0.15 MPa/s). During this phase, we observed constant frequency and amplitude stick-slip events. The SLR was then increased to ~19 RPM (~1.5 MPa/s), initiating a transition period exhibiting higher frequency events causing the slipping zone temperature to increase until a continuous melt layer was formed. The melted PMMA cooled and bonded the slip interface during the interseismic period. This process led to a positive feedback loop in which melt generation and cooling led to larger events which in turn increased the amount of melt generated. The corresponding thermal and shear stress runaway continued until a rupture occurred that was large enough to create a continuous patch of melt across the surface, and a phase of stable sliding was initiated. We analyzed these results in terms of coseismic energy budgets and characteristic acoustic emissions to provide insight into earthquake processes across scales. At the scale of a single event, we observe multiple strengthening and weakening mechanisms, including flash heating, melt lubrication, and viscous braking/strengthening. At a broader scale, we observe cycles of stick-slip to stable sliding that draws parallels to observations of natural earthquakes. Additional analyses presented here investigate the earthquake nucleation process. We extract spatial data from high frame rate recordings and correlate them with mechanical data and acoustic emissions. We show that the rupture modes leading to earthquake nucleation may be associated with characteristic AE signals.