# Towards a physics-based rock friction constitutive law

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Experiments measuring friction at a variety of sliding velocities find that the value of the friction coefficient varies widely: friction is high and behaves according to the rate and state constitutive law during slow sliding, yet markedly weakens as the sliding velocity approaches seismic slip speeds. We introduce a physics-based theory to explain this behavior. Using conventional microphysics of creep, we calculate the velocity and temperature dependence of contact stresses during sliding, including the thermal effects of shear heating. Contacts are assumed to reach a coupled thermal and mechanical steady-state, and friction is calculated for steady sliding. Results from theory provide good fits to the reported experimental results for calcite and quartz friction at all velocity ranges and at varying ambient temperatures, see figure 1.

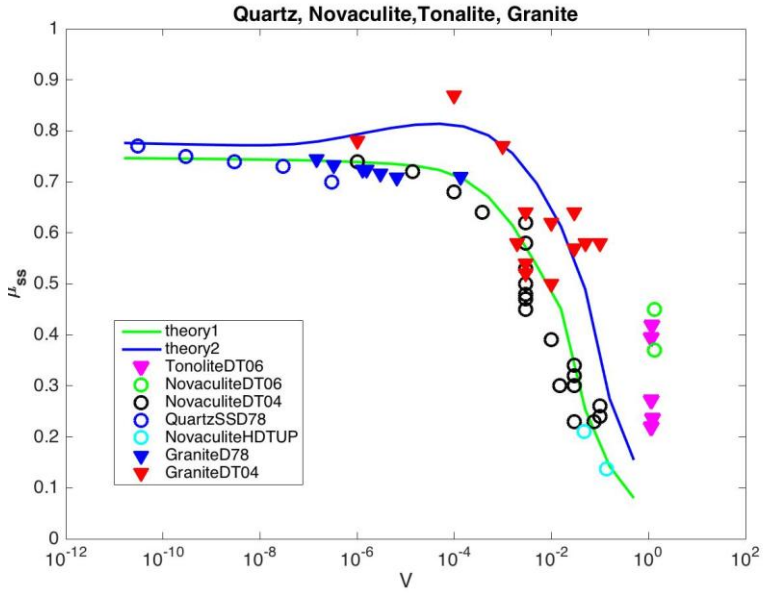


**Figure 1.** Experimental observations of steady-state friction from DiToro et al, 2006, 2004, and Dieterich 1978 (symbols) and our theory using 2 different parameter sets (lines), showing good fit across many orders of magnitude in velocity.