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Using Temperature to Measure Fault Stress
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Knowledge of the shear stress on a fault during slip is necessary for any first principle understanding of earthquake mechanics, yet measuring the shear stress on the fault during an earthquake has been an elusive goal of earthquake mechanics for decades. The slip of the recent Tohoku earthquake to through the nominally rate-strengthening regime highlights the need for better observational constraints on this key quantity. Temperature measurements immediately after an earthquake record the energy dissipated by this stress. A major goal of the JFAST expedition is to measure the temperature on the fault. There are only two extant similar measurement projects: the Taiwan Continental Drilling Project (TCDP) and the Wenchuan Fault Scientific Drilling (WFSD). Both TCDP and WFSD have apparent temperature anomalies consistent with extraordinarily small effective coefficient of friction. In particular, in WFSD a 0.02oC temperature anomaly was observed from 1.5 years to ˜3 years after the earthquake. It appears to be advecting vertically ˜5 m/year and is consistent with a shear stress of ˜0.2 MPa at a vertical depth of 578 m. Assuming Andersonian mechanics for the long-term normal stress on the fault, the stress is equivalent to a coefficient of friction of 0.02, which is a factor of 50 below the canonical static value and less than the current generation of high-speed laboratory results. In particular, here we synthesize those results with what is known from preliminary data of JFAST.

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