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Possible transient creep events in a brittle-ductile continental crust: observations, experiments and potential models.

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In a given tectonic province and over thousands to millions of years, slip on faults is believed to be constant and approximately equal to the local tectonic rate in agreement with rigid plate tectonic theory. In this model the ductile lower crust flows in response to this steady plate motion. Moreover brittle and ductile behaviors interact only at a sharp boundary defined as the brittle ductile transition (BDT). However in the continental lithosphere brittle and ductile behavior may coexist over a large range of pressure and temperature conditions for different mineral compositions. This generates heterogeneities in the brittle and ductile crust that are often ignored in models of shear zones. We hypothesize that the interaction between brittle (elastic) and ductile (viscous) behavior may cause deviations from steady-state slip and generates transient creep events on shear zones that release many meters of creep over years to thousands of years marked by a single period of tectonic activity followed by quiescence.

We present a set of numerical and analytical models, analogue experiments as well as some observations in nature that may support this hypothesis. In this presentation we extend an analytic formulation to model creep events within shear zones at the transition between brittle and ductile behavior in the crust. We assume that creep events are triggered by a set of interconnected fractures modeled as propagating dislocations. The amount of connectivity controls the nature and the intensity of the transient creep events. The shear zone behaves as a forced damped oscillator that can release strain accumulated during jammed/locked periods. The creep can be over-, critically-, or under-damped. The time scale of the events may vary between seconds to thousands of years depending on the viscous, elastic and plastic (fractures) properties of the shear zone.