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Seismo-thermo-mechanical modeling of mature and immature transform faults

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Transform faults (TF) are subdivided into continental and oceanic ones due to their markedly different tectonic position, structure, surface expression, dynamics and seismicity. Both continental and oceanic TFs are zones of rheological weakness, which is a pre-requisite for their existence and long-term stability. Compared to subduction zones, TFs are typically characterized by smaller earthquake magnitudes as both their potential seismogenic width and length are reduced. However, a few very large magnitude (Mw>8) strike-slip events were documented, which are presumably related to the generation of new transform boundaries and/or sudden reactivation of pre-existing fossil structures. In particular, the 11 April 2012 Sumatra Mw 8.6 earthquake is challenging the general concept that such high magnitude events only occur at megathrusts. Hence, the processes of TF nucleation, propagation and their direct relation to the seismic cycle and long-term deformation at both oceanic and continental transforms needs to be investigated jointly to overcome the restricted direct observations in time and space.

To gain fundamental understanding of involved physical processes the numerical seismo-thermo-mechanical (STM) modeling approach, validated in a subduction zone setting (Van Dinther et al. 2013), will be adapted for TFs. A simple 2D plane view model geometry using visco-elasto-plastic material behavior will be adopted. We will study and compare seismicity patterns and evolution in two end member TF setups, each with strain-dependent and rate-dependent brittle-plastic weakening processes:
(1) A single weak and mature transform fault separating two strong plates (e.g., in between oceanic ridges) and
(2) A nucleating or evolving (continental) TF system with disconnected predefined faults within a plate subjected to simple shear deformation (e.g., San Andreas Fault system).

The modeling of TFs provides a first tool to establish the STM model approach for transform faults in a more general case.