Geophysical Research Abstracts,
Vol. 11, EGU2009-2912, 2009
EGU General Assembly 2009

Strength and depth extent of a continental strike-slip fault system

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The strength of both secondary faults and of master faults like the San Andreas has been controversial for decades. We use a the global finite-element code SHELLS with a variable-resolution grid and mantle-derived driving forces to determine whether the effective friction $\mu*$ on the San Andreas fault is high ($\mu*$ = 0.6 - 1), intermediate ($\mu*$ = 0.3 – 0.1) or low ($\mu* < 0.1$), whether a single value of $\mu*$ can be used for all mapped faults within the region, and whether weakening of the ductile lower crust associated with faulting is important, i.e. whether these faults extend down into the upper mantle. We compare our model results with existing data on fault slip-rates, GPS velocity field, stress field, and depth of earthquakes. This comparison indicates that all faults are weak ($\mu* \leq 0.1$), and that slip-dependent weakening is important. All viable models show that weakening of major faults in the lower crust is necessary to avoid excessive weakening in the brittle crust and therefore unrealistic depths to the brittle-ductile transition. The strongest faults in California have $\mu*$ in the range 0.1 - 0.03. The San Andreas fault is a very weak fault among weak faults, with $\mu*$ values of $\tilde{0}.01$.