Geophysical Research Abstracts, Vol. 9, 10201, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10201

Slip-Rate-and-State friction law in a thick gouge friction experiment

J. Schmittbuhl (1), G. Chambon (2), A. Cordir (3) and Y. Messen (3)

(1) EOST - IPGS, Strasbourg, France (Jean.Schmittbuhl@eost.u-strasbg.fr), (2) CEMAGREF, Grenoble, France, (3) CERMES, Marne-la-Vallée, France

On the basis of experimental results [1], we propose a new friction law aiming at describing the mechanical behavior of thick gouge layers. The dominant effect to take into account is a significant slip-weakening process active over decimetric slip distances. This slip-weakening is strongly non-linear and, formerly, does not involve any characteristic length scale. The decrease of the gouge friction coefficient μ with imposed slip δ is well modeled by a power law [2]: $\mu = \mu_0 + \alpha\delta^{-\beta}$, with $\beta = 0.4$ and can be expressed as a fractional derivative of the slip history. On this major trend are superimposed second-order velocity-weakening and time-strengthening effects. These effects can be described using classical rate- and state-dependent friction (RSF) laws, and are associated with a small length scale $d_c \approx 100$ μm. Consistent with the general RSF framework, we combine slip-weakening and second-order effects in a Slip, Rate, and State (SRS) friction law with two state variables. We then compute the fracture (or breakdown) energy G_c and the apparent weakening distance D_c^{app} associated with the slip-weakening process. Once extrapolated to realistic "geophysical" confining pressures, the obtained values are in excellent agreement with those inferred from real earthquakes: $G_c \approx 5 \times 10^6$ J.m^{-2} and $D_c^{app} \approx 20$ cm. We also find that fracture energy scales with imposed slip in our experiments: $G_c \sim \delta^{0.6}$. Extension of the experimental results to non dry gouge material is explored.

[1] G. Chambon, J. Schmittbuhl, and A. Corfdir. Frictional response of a thick gouge core: 1. mechanical measurements and microstructures. J. Geophys. Res., 111:10.1029/2003JB002731, 2006.

[2] G. Chambon, J. Schmittbuhl, and A. Corfdir. Frictional response of a thick gouge core: 2. friction laws and implications for faults. J. Geophys. Res.,

111:10.1029/2004JB003339, 2006