Geophysical Research Abstracts, Vol. 7, 02104, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02104

Fault strength from wedge tapers

J. Suppe

Department Geosciences, Princeton University, Princeton NJ 08544 USA
(suppe@princeton.edu)

The existence of thin intact thrust sheets as long as 250 km imply very weak detachments relative to their internal strength, which is the classic thrust-fault problem addressed by Hubbert & Rubey (1959). Low-taper critical-taper wedges also require weak detachments relative to wedge strength (Davis et al. 1983). However the causes and absolute magnitudes of such apparent fault weakness remain controversial and this controversy extends to wrench faults such as the San Andreas and Sumatran faults and to low-angle normal faults. A central problem is that we have limited knowledge of in-situ conditions and theories contain a number of parameters that are difficult to observe. In the face of such difficulties, it is remarkable that in the special case of homogenous critical-taper wedges of variable detachment dip β we can determine absolute detachment and wedge strengths directly from the associated linear variation in topographic slope $\alpha = -s\beta + \alpha_{(\beta=0)}$, where s and $\alpha_{(\beta=0)}$ are the regression slope and intercept of a homogeneous set of data. Starting from the narrow-taper theory of Dahlen (1990 eq. 99), the combined pressure-dependent and non-pressure-dependent basal resistance $R = \mu_b(1 - \lambda_b) + (S_b/\rho g H)$ in this special case reduces to a simple function of the regression slope and intercept $R = \alpha_{(\beta=0)}/(1 - s)$ and the corresponding internal combined strength of the wedge is $W = s/(1 - s)$. The ratio of basal resistence to wedge strength is then just $R/W = \alpha_{(\beta=0)}/s$. We apply this result across the active Taiwan mountain belt whose detachment is illuminated by microseismicity and obtain a basal resistance of 0.09 in the depth range 8-15 km (Carena et al. 2002). Taper data for the Niger delta (Bilotti & Shaw submitted) yield a basal resistance of 0.04 in the depth range 6-9 km. Other constraints are required to test the many hypotheses for such extreme fault weakness. For example a related analysis in the Nankai trough Japan yields a similarly weak detachment where the ambient fluid pressures are low ($\lambda_b = 0.7$) based on ODP borehole logging, which implies that the Hubbert-Rubey hypothesis of static excess fluid pressures is insuffi-

cient cause of the weak Nankai detachment. Similarly, fluid pressures in and on the base of the Chelungpu thrust sheet that slipped in the 1999 Chi-Chi earthquake are hydrostatic ($\lambda_b \approx 0.4$, Yue & Suppe 2004), therefore the static Hubbert-Rubey mechanism does not dominate this Taiwan case. Low intrinsic friction of clays ($\mu_b \approx 0.2$) may dominate in Nankai (Brown et al. 2003) but more generally a wide variety of largely untested dynamical and material mechanisms have been proposed for fault weakness.