Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)


SCG65-02 Room:201A Time:May 19 11:15-11:30

# Determination of effective friction coefficient by optimizing slip tendencies on fault plane orientation distribution

Katsushi Sato[1]*

[1]Div. Earth Planet. Sci., Kyoto Univ.

Friction coefficient (mu) on fault is one of the most crucial parameters to evaluate the risk of faulting and to modeling tectonic phenomena. It is difficult to estimate the coefficient especially of underground faults and of ancient geological faults. This paper proposes a stochastic method to determine the effective friction coefficient from a distribution of fault surface orientations.

The geological faults and observed seismicities are definite proofs of (ancient) slippage. They are expected to provide information on frictional properties in the earth's crust. Stress tensor inversion techniques applied to such meso-scale faults and seismic focal mechanisms usually determine a reduced stress tensor composed of three principal stress orientations and a stress ratio. Angelier (1989) tried to determine all six independent components of stress tensor including magnitudes of principal stresses, assuming that the normal stress (Sn) and shear stress (Ss) on observed fault surfaces satisfies Ss/Sn >= mu. In his analysis, the friction coefficient can be determined graphically on Mohr's diagram, although there remains an ambiguity to recognize the straight line Ss/Sn = mu that bounds the distribution of points showing stresses on faults. The purpose of this study is to remove this ambiguity during the determination of friction coefficient.

The new method proposed by this study utilizes the slip tendency (Morris et al., 1996), which was introduced to quantify the tendencies of reactivations of faults in fractured rock masses. This parameter is strongly related to the friction coefficient since it is defined as the simple ratio between normal and shear stresses (Ss/Sn) on a fault surface. Slip tendency calculation has been applied to both geological faults and present seismicities (e.g., Collettini and Trippetta, 2007; McFarland et al., 2012), and it was confirmed that the natural frequency of fault orientations appears to obey the slip tendency (Lisle and Srivastava, 2004). This study presumes that the frequency of fault orientations is a monotonously-decreasing function of the reciprocal of slip tendency (Sn/Ss). Then we can compose an inversion method for fitting the shape of the function to observed distribution of fault orientations. If the optimized frequency distribution function has a sudden decrease to zero at a certain value of slip tendency, the value can be interpreted as the desired friction coefficient. Note that what can be determined is an effective friction coefficient under the influence of pore fluid pressure.

The new method was applied to 122 meso-scale fault-slip data gathered from the Pleistocene Kazusa Group, eastern Boso peninsula. N-S striking normal faults dominate the data set, and a single-phase E-W tensional stress was detected by a stress inversion analysis. As the result, the internal friction coefficient was determined to be 0.45 +0.34/-0.09. The precision estimated by bootstrap analysis was large because the shape of the optimized frequency distribution function was unfortunately convex. The friction coefficient around 0.45 is slightly small but appears to be reasonable for a young sedimentary rock.

References

Angelier, J., 1989, Jour. Struct. Geol., 11, 37-50.
Collettini, C. and Trippetta, F. 2007, Earth Planet. Sci. Lett., 255, 402-413.
McFarland, J.M., Morris, A.P., Ferrill, D.A., 2012, Comp. Geosci., 41, 40-46.
Morris, A., Ferrill, D.A. and Henderson, D.B., 1996, Geology, 24, 275-278.
Lisle, R.J. and Srivastava, D.C., 2004, Geology, 32, 569-572.

Keywords: stress tensor inversion, effective friction coefficient, slip tendency, orientation distribution, fault-slip analysis