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Friction coefficient of faults inferred from earthquake focal mechanisms

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In earthquake mechanics and structural geology the static friction coefficient is usually assumed to have the laboratory value (μ = 0.6–0.8) according to the Coulomb-Byerlee's law. Estimates from deep boreholes and/or natural faults generally confirm this hypothesis but in some cases friction coefficients can be significantly lower, suggesting the existence of weak faults able to be activated by lower effective stress than theoretically expected.

We apply a modified version of the method proposed by Yin and Ranalli (1995, Journal of Structural Geology, vol. 17, pp. 1327–1335), where the average friction coefficient of a set of n faults is estimated. This method is based on minimization of the sum of squares of the misfit ratios, where the misfit ratio of each fault is given dividing the misfit stress difference (i.e. the misfit between normalized stress difference and average normalized stress difference) by the average normalized stress difference. The normalized stress difference is defined as the critical stress difference divided by the effective overburden pressure, while the average stress difference is obtained considering the entire fault dataset. Input data are (i) the orientation of faults, (ii) the stress field orientation, and (iii) the stress ratio. The latter two must be independently estimated. A uniform stress field and a similar normalized critical stress difference for the fault dataset are assumed.

The procedure has been extended to apply to fault plane solutions by considering both nodal planes of a set of n focal mechanisms and estimating the range of acceptable average friction coefficients from all possible combination of planes (2^n number of combinations). The amount of calculation can be considerably reduced if independent information makes it possible to select which one of the nodal planes of each focal mechanism is the true fault plane (for example when aftershocks delineate the fault geometry at depth), resulting in only n combinations.

We present an initial application of this method by applying it to a set of focal mechanisms from the Giudicarie region in northern Italy, and analyzing various subsets. The data were obtained from literature data and earthquake fault plane solutions computed by seismological agencies. Preliminary results show that best-fitting average friction coefficients are sometimes within the expected range, but occasionally well below it (μ about 0.4 or less).