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Orientation distribution analysis of fault planes for constraining friction coefficient

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Static friction coefficients along faults control the brittle strength of the earth's upper crust, which are rather difficult to estimate especially in the case of ancient geological faults since fault rocks do not preserve their physical properties. Several previous studies provided methods to determine the static friction coefficient of meso-scale faults from their orientation distribution. Fault-slip analysis through stress tensor inversion techniques (e.g., Angelier, 1979) gives principal stress axes and a stress ratio, which allows us to draw a normalized Mohr's circle. Angelier (1989) employed the assumption that a fault slips when the ratio of shear stress to normal stress on it exceeds the static friction coefficient. Then, the distribution of points corresponding to faults on the normalized Mohr diagram should have a linear lower boundary (friction envelope). The slope of the friction envelope provides the static friction coefficient.

However, this method has a difficulty in graphical and manual recognition of the linear boundary. This study succeeded in automating the determination of friction coefficient by considering the fluctuations of fluid pressure and differential stress. These unknown factors are expected to make difference in frequency of faults according to their orientations and the static friction coefficient. Therefore, we can optimize the static friction coefficient in order to explain the observed orientation distribution of fault planes.

This method was applied to two examples of natural meso-scale faults. One is from a forearc basin fill and the other is from an accretionary complex along the southwest Japan arc. The first example resulted in a friction coefficient of 0.6-0.7 which is typical for sedimentary rocks. The second example yielded a value of 0.1-0.2, which is quite small but is also expected for clay minerals located at the base of accretionary prism along subduction plate boundary.

References

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