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Use of non-fault fractures in stress tensor reconstruction using the Mohr Circle with the Win-tensor program

Damien Delvaux
Royal Museum for Central Africa, Earth Sciences, Brussels, Belgium (damien.delvaux@africamuseum.be)

Paleostress inversion of geological fault-slip data is usually done using the directional part of the applied stress tensor on a slip plane and comparing it with the observed slip lines. However, this method do not fully exploit the brittle data sets as those are composed of shear and tension fractures, in addition to faults. Brittle deformation can be decomposed in two steps. An initial fracture/failure in previously intact rock generate extension/tensile fractures or shear fractures, both without visible opening or displacement. This first step may or not be followed by fracture opening to form tension joints, frictional shearing to form shear faults, or a combination of opening and shearing which produces hybrid fractures.

Fractured rock outcrop contain information of the stress conditions that acted during both brittle deformation steps. The purpose here is to investigate how the fracture pattern generated during the initial fracture/failure step might be used in paleostress reconstruction. Each fracture is represented on the Mohr Circle by its resolved normal and shear stress magnitudes. We consider the typical domains on the Mohr circle where the different types de fractures nucleate (tension, hybrid, shear and compression fractures), as well the domain which contain reactivated fractures (faults reactivating an initial fracture plane). In function of the fracture type defined in the field, a "distance" is computed on the Mohr circle between each point and its expected corresponding nucleation/reactivation domain. This "Mohr Distance" is then used as function to minimize during the inversion.

We implemented this new function in the Win-Tensor program, and tested it with natural and synthetic data sets from different stress regimes. It can be used alone using only the Mohr Distance on each plane (function F10), or combined with the angular misfit between observed striae and resolved shear directions (composite function F11). When used alone (F10), only the 3 stress axes can be determined and the stress ratio R (sigma 2-3)/sigma1-3) has to be pre-determined. With the combined function (F11), it provide an additional constrain to the classical angular misfit. With data sets composed of a majority of neoformed fractures, stress inversion using the Mohr Distance F10 function provide a good approximation of the 3 stress axes (using only the fracture data) as compared with the results of the F11 composite function (using also the observed slip lines).

Tensor program is available at (http://www.damiendelvaux.be/Tensor/tensor-index.html).