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Stress inversion assumptions review

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Wallace (1951) and Bott (1959) were the first to introduce the idea that the slip on each fault surface has the same direction and sense as the maximum shear stress resolved on that surface. This hypothesis are based on the assumptions that (i) faults are planar, (ii) blocks are rigid, (iii) neither stress perturbations nor block rotations along fault surfaces occur and (iv), the applied stress state is uniform. However, this simplified hypothesis is questionable since complex fault geometries, heterogeneous fault slip directions, evidences of stress perturbations in microstructures and block rotations along fault surfaces were reported in the literature. Earlier numerical geomechanical models confirmed that the striation lines (slip vectors) are not necessarily parallel to the maximum shear stress vector but is consistent with local stress perturbations. This leads us to ask as to what extent the Wallace and Bott simplifications are reliable as a basis hypothesis for stress inversion. In this presentation, a geomechanical multi-parametric study using 3D boundary element method (BEM), covering (i) fault geometries such as intersected faults or corrugated fault surfaces, (ii) the full range of Andersonian state of stress, (iii) fault friction, (iv) half space effect and (v), rock properties, is performed in order to understand the effect of each parameter on the angular misfit between geomechanical slip vectors and the resolved shear stresses. It is shown that significant angular misfits can be found under specific configurations and therefore we conclude that stress inversions based on the Wallace-Bott hypothesis might sometime give results that should be interpreted with care. Major observations are that (i) applying optimum tectonic stress conditions on complex fault geometries can increase the angular misfit, (ii) elastic material properties, combined to half-space effect, can enhance this effect, and (iii) an increase of the sliding friction leads to a reduction of this misfit.