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Plastic stress field in the Alps region: comparison of modelling and WSM data

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Modelling of stresses in tectonic plates is usually based on the elastic assumption. However, stress-states in some regions of the crust, in particular in mountain areas, can be better described on the basis of limiting equilibrium theories.
The current study is aimed to investigate whether plastic Mohr-Coulomb models can be applied for a part of the Eurasian tectonic plate between the lakes Geneva and Constance (the Alps). For this purpose, patterns of stress trajectories are calculated and compared with the WSM data (release 2008) on stress orientations.
The problem of stress identification is solved by employing a variant of the Stress Trajectories Element Method (STEM) that also uses the WSM data on stress orientations. Stress magnitudes remain unknown prior to the solution, which differs this research from the conventional approaches. Firstly, discrete data on stress orientations (scattered in the whole region between the two lakes) have been converted into continuous one along a chosen boundary. This is necessary in order to specify boundary conditions that are formulated on an open contour in terms of stress orientations and their normal derivatives. The proposed variant of the STEM deals with finite difference formulations for two Cauchy's boundary value problems for identification of the slip lines and the stress trajectories within characteristic triangles. The method also introduces the concept of alternations of the Cauchy's problems for stress trajectories and slip lines, which allows covering a larger area.
For given strength parameters (friction angles and cohesion) a unique pattern of stress trajectories is determined. This field is further compared against the WSM data available inside the region. The comparisons are made for different strength parameters, which allow the best fit to the data. Moreover, because of the fact that the maximum shear stress is governed by the Mohr-Coulomb criterion, the complete stress tensor is found with accuracy of one additive constant.

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