3D Modeling of the in-Situ Stress Field in Nordland, Northern Norway

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Abstract

Investigating the unusual neotectonic activity in northern Norway provides a number of challenges since both far-field and near-field stresses need to be considered. The far-field background stress strongly controls the overall stress regime. The regional stress field stems from the additional interaction of ridge push and GIA (glacial isostatic adjustment); the local stress field mainly results from gravitational stresses as well as the flexural effects of relatively rapid sediment erosion and re-deposition.
We develop a 3D finite element numerical model of crustal scale, using the Structural Mechanics Module of COMSOL Multiphysics® and constraining its geometry with results from previous geophysical studies. Internal body forces (e.g. variations in topography) already yield significant deviatoric stresses, which are often omitted in stress models. Whereas linear elastic material properties are most suited to model tectonic stresses, they cannot reproduce the background stress, and a two-stage model setup is needed. We apply the far-field stress fields (GIA, ridge-push, sediment redistribution) as effective force boundary conditions to the sides or base of the model. This way, we can account for all stress sources at once, but can also vary them separately in order to examine their relative contributions to the observed stress and strain rate fields. We constrain a best-fit model using the different seismological and geodetic data sets collected and compiled within the last few years. Major faults can be included as pre-existing weakness zones. Their effects on stress localization are studied in connection to observed clusters of enhanced seismic activity.