The SpannEnD Project - Numerical modelling of the 3D stress state of Germany

Steffen Ahlers¹, Luisa Röckel², Andreas Henk¹, Karsten Reiter¹, Tobias Hergert¹, Birgit Müller², Frank Schilling², Oliver Heidbach³, Sophia Morawietz³, Magdalena Scheck-Wenderoth³, and Denis Anikiev³

¹TU Darmstadt, Institute of Applied Geosciences, Darmstadt, Germany (ahlers@geo.tu-darmstadt.de)
²KIT, Institute of Applied Geosciences, Karlsruhe, Germany
³GFZ German Research Centre for Geosciences, Potsdam, Germany

One important criterion for the characterization of a potential nuclear waste repository is the crustal stress field. However, stress data are sparse and usually incomplete regarding the six independent components of the stress tensor. The World Stress Map (WSM) is a valuable compilation of stress data, but it does not include information about stress magnitudes as only the orientation of the maximum horizontal stress (S_Hmax) is provided. To receive a comprehensive and continuous 3D description of the stress field in a particular area, geomechanical-numerical modelling is required. Key objectives of the SpannEnD project (Spannungsmodell Endlagerung Deutschland) is to provide such a model for Germany and to develop methods for robust stress predictions at the local scale.

The SpannEnD model is based on finite element techniques and comprises a 3D lithosphere-scale structural model of Germany. The lateral extent of the model covers a pentagon-shaped area of Central Europe with dimensions of 1000 x 1250 km². The model has been chosen significantly larger than Germany to reduce boundary effects in the study area. Furthermore, on the base of the observed stress orientation pattern, the boundaries have been defined parallel or perpendicular to the known orientation of S_Hmax to simplify the definition of the boundary conditions. The vertical extent of the model is from the surface to a depth of 100 km, incorporating several sedimentary layers, several basement units and the Mohorovičić discontinuity. The mesh is laterally homogenous with a resolution of about 4 km and vertically inhomogeneous with a decreasing resolution with increasing depth, to provide the finest mesh in the layers of the greatest interest, near the surface. These units also provide the most stress data measurements to calibrate the model. Furthermore, a selected number of important faults is implemented in the model. This structural model is discretized into about 4 million elements. For the calibration of the model we use a new compilation of stress magnitude data. We present the workflow, the model geometry, and some first results.