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SpannEnD – Prediction of the recent crustal stress state of Germany using a 3D geomechnical-numerical model

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For the safe usage of the subsurface the stress state is of great importance, e.g., for borehole stability, mitigation of induced seismicity or the search and long-term safety of a high-level nuclear waste deposit. However, the state of knowledge concerning the stress state in Germany is limited as only unevenly distributed stress measurements are available which frequently provide only one component of the stress tensor. The SpannEnD (**Spann**ungsmodell **En**dlagerung **D**eutschland) project aims to improve this knowledge with the help of a 3D geomechanical-numerical model. The model is calibrated on available stress magnitudes and enables a continuum-mechanics based prediction of the stress state and its local variability for Germany.

The 3D geomechanical-numerical model comprises the upper lithosphere and contains 22 lithological units parametrized with individual mechanical properties (Young's modulus and Poisson's ratio) and densities. Linear elasticity is assumed and the finite element method (FEM) is used to solve the equilibrium of forces. Overall, the model contains about 11 million hexahedral elements resulting in a lateral resolution of 2.5 x 2.5 km^2 and a vertical resolution of up to 250 m. The model is calibrated by adaptation of displacement boundary conditions with magnitudes of the minimum (S_{hmin}) and maximum horizontal stresses (S_{Hmax}). The model results show an overall good fit with these stress magnitudes used for calibration indicated by a mean of the absolute stress differences of 4.6 MPa for S_{hmin} and 6.4 MPa for S_{Hmax}. Furthermore, the results agree well with additional data sets excluded from calibration but used for validation, e.g., with a mean of the absolute stress differences of 1.1 MPa for vertical stress magnitudes and an absolute mean deviation of the orientation of S_{Hmax} with regard to World Stress Map data of 11.9°.