Geophysical Research Abstracts
Vol. 21, EGU2019-10819, 2019
EGU General Assembly 2019

Lithosphere rheology of the Upper Rhine Graben

Judith Bott, Magdalena Scheck-Wenderoth, and Mauro Cacace
GFZ German Research Centre for Geosciences, 4.5 Basin Modeling, Potsdam, Germany (judith.bott@gfz-potsdam.de)

It has been widely proposed that seismic activity in the crust increases downwards to a peak that indicates the brittle ductile transition. We test this hypothesis and examine its implications by means of data-based numerical 3D models of the Upper Rhine Graben.
The Upper Rhine Graben is part of the European Cenozoic Rift System. As a tectonically active zone and a region of exploration for georesources, it is well covered by geological and geophysical data. As a result, the lithological variability of the sedimentary graben fill and the crustal basement are well known from boreholes as well as reflection and refraction seismic data. Furthermore, seismological models provide information about the variability of lithospheric mantle thickness across the region. In a previous project, these different types of data have been integrated with observed gravity anomalies into a lithospheric-scale 3D density model. This model differentiates fourteen sedimentary cover units, seven upper crustal units, the lower crust and two units for the lithospheric mantle. By using this subdivision for assigning unit-specific thermal rock properties, conductive heat transport was modelled to derive the corresponding steady-state thermal field. Building upon the assessed density and temperature configuration of the entire lithosphere, we have extended this approach and parameterized the model units with mechanical properties to derive predictions for the graben-wide rheological configuration.
We have calculated the maximum differential stress that the model rocks are able to resist without experiencing either brittle or ductile deformation under the given pressure and temperature conditions. Thereby, brittle behavior is modelled by Byerlee's empirical law and ductile deformation by power-law rheology functions. With this contribution we present the resulting yield strength envelopes for different sub-domains of the graben system as well as graben-wide maps of the integrated crustal and lithospheric strength. The predicted spatial configuration of strength and weakness zones is compared to the observed distribution of seismicity in the region. For different sub-areas, we find remarkable consistencies between the modelled brittle-ductile transition in the crust and the observed peak seismicity depth. This analysis reveals insights into the interaction of different deformation-controlling factors across an entire rift and brings up for discussion the predictive capability of this type of data-integrative models.