EGU22-5134
https://doi.org/10.5194/egusphere-egu22-5134
EGU General Assembly 2022

Structural development and heat storage potentials in the east-central Upper Rhine Graben (SW Germany): Constraints from 3D-seismic and borehole data

Florian Bauer, Jens Carsten Grimmer, Ulrich Steiner, Dominik Gudelius, Lars Houpt, Thomas Hertweck, and Eva Schill
Karlsruhe Institute of Technology, Germany

The Upper Rhine Graben (URG) has shown multiple geopotentials during the past century: hydrocarbons have been produced mainly from porous, but also from fractured Cenozoic-Mesozoic reservoirs. Fractured Mesozoic and Paleozoic rocks comprise important geothermal reservoirs that are currently exploited in the URG. Heat storage is a new geopotential under consideration for the KIT Campus North, approximately 10 km north of the city of Karlsruhe, south-west Germany. For spatio-temporal structural analysis, volume calculation, well-path planning and thermo-hydraulic modelling the 3D-structure of the subsurface down to a depth of about 4 km is crucial. We used available 3D-seismic and borehole data for structural analysis, quantification of formation thicknesses and the geometry of sedimentary successions. Significant fault shadows occur at depths greater than 1.5 km in the footwall of major faults and reduce the reliability of their location but still give a good image of faults and their respective displacements.

Sandstone-bearing Cenozoic graben-filling sedimentary successions that previously were exploited for hydrocarbons are currently investigated for their heat storage potential of excess heat. Additionally, fractured Mesozoic and Paleozoic rocks are considered for deep geothermal heat supply. Cenozoic reservoir rocks dip approximately 5° to the East. The studied area is dominated by the two major (N)NE-(S)SW-striking Leopoldshafen and Stutensee growth faults showing displacements of several hundred meters. Major syndepositional normal faulting along the Leopoldshafen fault occurred during early Miocene (Hydrobia beds, Landau Formation). Increase of syn-tectonic sedimentary thicknesses from East to West indicate graben-interior migration of fault activity with time. In the hanging wall of the Stutensee fault shallow-rooted, ENE-dipping en-echelon normal faults, linked by relay ramps, and small NNW-striking graben structures displace Cenozoic strata by several tens of meters, but apparently do not cut the respective major fault, indicating that both minor and major faults were either concomitantly active or that major faults postdate minor fault activity. While the minor faults root in older Tertiary successions, both the Stutensee and the Leopoldshafen Fault are rooting in the crystalline basement of yet unknown petrographic composition. A slip and dilatation tendency analysis was performed to reduce the risk of induced seismicity for well-path planning on basis of published stress models, drilling induced tensile fracture analysis, and borehole breakouts of deep borehole data comprising Mesozoic strata and on borehole breakouts in the Cenozoic successions. The maximum horizontal stress direction (S_H) trends N-S, resulting in a relatively high potential for both (oblique) normal fault slip and dilation and hence for relatively high geothermal potentials in the deep subsurface.