3D Geological Model of the Crystalline Basement in the Northern Upper Rhine Graben Region

Authors: Matthiis Frey[a], Sebastian Weinert[a,b], Kristian Bär[a], Jeroen van der Vaart[a], Chrystel Dezayes[c], Philippe Calcagno[c], Ingo Sass[a,b],

a … Technical University of Darmstadt, Institute of Applied Geosciences, Department of Geothermal Science and Technology, Schnittspahnstraße 9, 64287 Darmstadt, Germany

b … Darmstadt Graduate School of Excellence Energy Science and Engineering, Otto-Berndt-Straße 3, 64287 Darmstadt, Germany

c … BRGM, 3, avenue Claude Guillemin, BP36009, 45060 Orléans cedex, France

Abstract
The crystalline basement is one of the main targets for geothermal exploration in the Upper Rhine Graben (URG) region due to the favorable temperatures in this reservoir. Therefore, it is already utilized at several sites along the rift basin, e.g. in Soultz-sous-Forêts, Rittershoffen, Landau and Insheim, but the technical potential is yet only exploited to a small extend. To significantly reduce the uncertainties future geothermal projects are facing, we developed the so far most detailed 3D model of the basement in the northern URG within the Interreg NWE DGE-ROLLOUT Project. The geometry of the sedimentary horizons was compiled from existing structural models, in particular the Hessen 3D 2.0 and GeORG models (Sokol et al. 2013; Bär et al. 2016). Since only a few wells completely penetrate the thick sediment cover and reach the basement, we made additionally use of magnetic and gravity data which provides valuable constraints on the geometry of deep horizons. To interpret the Bouguer anomalies reasonably with respect to the crystalline basement, we subtracted the regional gravity field and sedimentary effect from the observed data. For the model parametrization, existing petrophysical databases of the region have been used (Bär et al. 2020; Frey et al. 2020; Weinert et al. 2020). We then performed a stochastic joint inversion of the gravity and magnetic anomalies that utilizes the principles of a Monte-Carlo-Markov-Chain simulation and allows a quantification of model uncertainties. A detailed description of the input data, methods and results is presented in Frey et al. (2021, in review).

We provide here the results of this joint inversion in form of high-resolution voxel models as ASCII, Gocad SGrid, CSV Voxel and VTK rectilinear grid files. The whole model has an extend of 90 km in x-, 130 km in y- and 26 km in z-direction. The given coordinates are in UTM Zone
32N and refer to the midpoint of each voxel. While the voxel size is constant in x- and y-direction (1km), it varies in z-direction (50m above sea level, below sea level the voxel height increases from approx. 500 at the top to approx. 1500 at the bottom). A short description of the individual parameters is given in the following:

x, y, z ... coordinates of the voxel midpoints
Entropy ... measure for the uncertainty of the inverted lithology
ChangeCount ... how often did the lithology of one voxel change during inversion
MeanDensity ... average inverted density
StdDevDensity ... standard deviation of the inverted density
MeanSusceptibility ... average inverted magnetic susceptibility
StdDevSusceptibility ... standard deviation of the inverted magnetic susceptibility
MostProbable ... inverted lithology distribution (each number corresponds to one geological unit)
MostProbableThreshold ... most probable lithology distribution with a threshold of 90 %
Prob_[unit] ... Probability of individual model units/lithologies
Voxel_height ... size of each voxel in z-direction

**Model Units/Lithologies:**
0 ... Reference ('Above Topo')
1 ... Lower Crust
2 ... Rhenohercynian Zone
3 ... Northern Phyllite Zone
4 ... Northwestern Mid-German Crystalline High
5 ... Magnetic Albersweiler Body
6 ... Northern Granitoids
7 ... Frankenstein Complex
8 ... Flasergranitoid Zones
9 ... Southern Odenwald Plutons
10 ... Böllstein Odenwald
11 ... Saxothuringian Zone
12 ... Sedimentary Cover
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References

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