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Stochastic approach for estimating the geothermal potential of the Perth Basin, Australia

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The sedimentary Perth Basin is a north-south elongated trough at the continental border of south west Australia, filled with Permian to Cenozoic sediments. Great effort has been taken to explore the geothermal potential of the Perth Basin, especially in order to use it for direct heat technologies (Regenauer-Lieb et al., 2009). As the conditions in the subsurface, regarding structure, lithology and petrophysical parameters, are usually not known precisely, suitable and reliable models are needed in order to explore if a reservoir is suited for geothermal exploitation.

An integrated 3D – structural model of the Perth basin with focus on the Perth Metropolitan Area (PMA) is constructed using the modeling software "3D Geomodeller" and data of various artesian and petroleum wells. The model comprises an area of about 10 500 km^2 and focuses on adequate representation of the major aquifers in the Perth geothermal system and of faults intersecting these aquifers. The main target for deep geothermal use is the Yarragadee – Formation, comprising sediments of > 1500 m thickness in the target area. Free hydrothermal convection is expected to occur within the formation.

Histograms of petrophysical parameters, e.g. porosity and permeability distributions are compiled from two petroleum wells situated in the modeled area. Continuous porosity and permeability logs were derived from borehole measurements and calibrated with corresponding core data. By using these histograms and characteristic spatial correlation lengths, Monte Carlo hydrothermal simulations are carried out on a 2D-section of the constructed 3D model. Model ensembles with stochastically varying permeability distribution in the Yarragadee – Formation are generated and the transient variability of temperature gradient, hydrothermal fluid flux and hydrothermal convection pattern are investigated by numerical modelling.
We study in particular to which extent aquifer geometry controls the formation of convection cells in case of stochastic permeability distribution.

Reference

Regenauer-Lieb, K., Chua, H. T., Wang, X. , Horowitz, F. G. & Wellman, J., 2009. Direct heat geothermal applications in the Perth Basin of Western Australia, Proc. 34th Annual Stanford Workshop on Geothermal Engineering, 14, Stanford University, California.