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Soultz-sous-Forêts – What can inverse simulations contribute to the knowledge of hydro-geothermal system at the European EGS demonstration site?

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The European Enhanced Geothermal System (EGS) research project is located at Soultz-sous-Forêts at the western border of the Rhine rift valley. Three wells were drilled into the deep reservoir (4000 – 5000 m) within the granitic basement. Hydraulic stimulations produced additional mechanically damaged zones in the vicinity of the wells. In July 2005, a tracer was injected into the injector well GPK3 for 19 hours at a rate of 0.015 m^3 s^{-1} and a concentration of 0.389 mol m^{-3}. Tracer concentration was measured in the production wells over the following 5 months, while the produced water was re-injected into GPK3. This experiment demonstrated a good hydraulic connection between GPK3 and one of the production wells, GPK2, but only a very low connectivity was observed in the other one. In the following we concentrate on the high productivity connection between GPK3 and GPK2.

Based on general knowledge of the geological setup we constructed simplified three-dimensional heterogeneous models in order to explain the tracer concentration observed in GPK2 during this experiment. To quantify porosity, permeability, and dispersivity of predefined property zones, we applied a full-physics Bayesian inversion.

Numerical experiments with different models show that an excellent fit can be obtained with several models of different complexities and parameterizations. Rough estimates indicate that less than 4 parameters may be estimated from tracer data alone. As expected, a high-permeability low-porosity zone (main fracture) is required in all models, though the numerical value depends on the spatial extent of the zone and the properties of the immediate surrounding rocks. Most of the tracer is transported near the main flow zone, and an additional circulation path of large spatial extent is not required by the data. Though explaining tracer concentrations equally well, all these models will imply a different behavior of bottom hole pressures and temperatures, which were not available for inversion. Additionally, there is considerable uncertainty in details of the experimental setup. To move from these conceptual studies to model identification and calibration, independent constraints on model geometry are necessary, as well as more observed data.

We will present new results based on a more complete data set, including bottom hole pressures, temperatures and pumping schedules. To take into account the high salinity of the reservoir fluids an appropriate model for thermophysical properties was implemented in the inverse code.