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Can streaming potential data improve permeability estimates in EGS reservoirs?

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We study the capability of streaming potential data to improve the estimation of permeability in fractured geothermal systems. To this end, we simulate a tracer experiment numerically carried out at the Enhanced Geothermal System (EGS) at Soultz-sous-Forêts, France, in 2005. The EGS is located in the Lower Rhine Graben. Here, at approximately 5000 m depth an engineered reservoir was established.
The tracer circulation test provides information on hydraulic connectivity between the injection borehole GPK3 and the two production boreholes GPK2 and GPK4.
Vogt et al. (2011) performed stochastic inversion approaches to estimate heterogeneous permeability at Soultz in an equivalent porous medium approach and studied the non-uniqueness of the possible pathways in the reservoir. They identified three different possible groups of pathway configurations between GPK2 and GPK3 and corresponding hydraulic properties.
Using the Ensemble Kalman Fitler, Vogt et al. (2012) estimated permeability by updating sequentially an ensemble of heterogeneous Monte Carlo reservoir models. Additionally, this approach quantifies the heterogeneously distributed uncertainty.
Here, we study whether considering hypothetical streaming potential (SP) data during the stochastic inversion can improve the determination of the hydraulic reservoir properties. In particular, we study whether the three groups are characterized uniquely by their corresponding SP signals along the boreholes and whether the Ensemble Kalman Filter fit could be improved by joint inversion of SP and tracer data.
During the actual tracer test, no SP data were recorded. Therefore, this study is based on synthetic data.
We find that SP data predominantly yields information on the near field of permeability around the wells. Therefore, SP observations along wells will not help to characterize large-scale reservoir flow paths.
However, we investigate whether additional passive SP monitoring from deviated wells around the injection and production wells can improve the permeability estimate. In addition, we study the impact of different coupling approaches: constant coupling of pressure head and SP as well as coupling depending on permeability.

References

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