Project Fact Sheet

Technische Hochschule Ingolstadt
Institute of new Energy Systems

Project Title	**Stochastic characterization of discrete fractures in rock by hydraulic and tracer tomography**
Keywords	Discrete fracture network (DFN), Hydraulic tomography, Tracer tomography, Bayesian inference

Project Details

Project Start	2018	**Duration**	3 Years
Grant Scheme		**Project ID**	401048478
Funding Authority	Deutsche Forschungsgemeinschaft (DFG)		
Project Budget	274.932€		
Contact Person	Prof. Dr. Peter Bayer (Project Leader) Dr. Ingo Dressel		
Project Partners			

Description

Fractured rocks host productive aquifers and they are the target for enhanced geothermal systems (EGS). A major challenge shared by these subjects is the appropriate characterization of structural features or fracture systems that are relevant for flow and transport processes. The more accurate the characterization, the more reliable the processes can be simulated by numerical models. Recent developments in numerical modelling techniques are impressive, with growing capabilities in computationally efficient, realistic, high-resolution and coupled simulation. Still, the associated data hunger of numerical models is barely fed by available field measurements. Especially features unique for each site, such as fracture geometries, require attuned site investigation techniques. And even if a site is well investigated, methods are needed for integrating measured data in a model. This project proposes the use of tomographic borehole tests with water and tracer injection to identify and characterize fractures relevant for flow and transport. By combining the insight from cross well multi-level tests in several boreholes, the reconstruction of fracture geometries is facilitated. A major novel element is the inversion of recorded tomographic signals by a versatile Bayesian approach that adjusts iteratively fracture orientations, lengths and fracture density (inverse model). This is combined with a flexible and fast numerical implementation and simulation of the discrete fracture network (forward model). Motivated by promising preliminary results, the proposed tomographic discrete fracture inversion approach is here further developed for robust estimation of fracture probabilities in two- (2D) and three-dimensional (3D) systems. It is elaborated and demonstrated utilizing synthetic data from virtual borehole tests, as well as by means of pressure and heat tracer data from in-situ experiments in fractured rock.