Stress-based tomography: potential, open-questions and future developments

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Fracture network characterization is critical for many subsurface engineering problems in petroleum, mining, nuclear waste disposal and Enhanced Geothermal Systems (EGS). Due to limited exposure, direct measurement of fracture network properties at great depth is not possible and geophysical imaging techniques cannot resolve the fractures. Therefore, tomographic imaging techniques have been proposed and applied to reconstruct the structural discontinuities of rock mass. Stress-based tomography is a novel concept aiming at probabilistic imaging of the fracture network using the stress perturbations along deep boreholes. Currently, this approach has only been successfully tested on two-dimensional fracture networks. However, its great potential to unravel the heterogeneous structure of fractured rocks at great depth motivates further scientific effort. Here, we present the potential, open questions, current challenges and necessary future developments in order to apply this methodology to image three-dimensional multiscale structure of the rock mass in the field. Other tomographic approaches such as tracer and hydraulic tomography invert tracer breakthrough curves (BTCs) and pressure response in an observational well. We suggest a joint and comparative tomographic analysis in a Bayesian inversion framework to reconstruct Discrete Fracture Networks (DFN). This is expected to provide a new view of the strengths of each tomographic variant.