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Fracture network characterization constrained with information on the in-situ stress heterogeneities

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Enhanced Geothermal System (EGS) development requires a comprehensive geological model, which includes a proper representation of the natural fracture systems. Our knowledge about the fracture network in the early stages of reservoir creation is restricted to borehole images that only provide the location and orientation of fractures on the borehole wall. Reconstructing the fracture network of a reservoir from the fractures intersecting one borehole remains unresolved due to the insufficient information about the fracture length distributions. On the other hand, the analysis of wellbore failure on borehole images provides information on some components of the stress state and its heterogeneity. It is assumed that these stress heterogeneities (both in orientation and in magnitude) are strongly controlled by the natural fractures and their geometrical characteristics. Indeed, natural fractures are weakness planes that can eventually slip and perturb the stress state. Here, we propose to reconstruct the fracture network characteristics using borehole stress measurements using a Bayesian statistical framework. In this study, the final objective is to develop a Markov Chain Monte Carlo algorithm that uses stress orientation and magnitude along a borehole to reconstruct synthetic two-dimensional discrete fracture networks. In this approach a DFN realization with prior information about the network is used to compute the stress state along a given borehole with the Displacement Discontinuity Method (DDM) in a Markov sequence. In each iteration, the DFN is updated through a random alteration of the geometry (random fracture shift or change in orientation). The geomechanical simulator simulates the stress state on the given borehole with the updated DFN. Each updated DFN is evaluated using the Metropolis-Hastings (MH) acceptance criteria and each accepted realization improves the fit to the stress orientation and magnitude observed on the borehole. The Markov sequence keeps iterating and the resulting ensemble of the feasible DFN realizations displays a probability map indicating the possible fracture locations and may extract the length distribution in a given domain.