The impact of different aperture distribution models and critical stress criteria on equivalent permeability in fractured rocks - DTU Orbit (22/12/2018)

The impact of different aperture distribution models and critical stress criteria on equivalent permeability in fractured rocks

Predicting equivalent permeability in fractured reservoirs requires an understanding of the fracture network geometry and apertures. There are different methods for defining aperture, based on outcrop observations (power law scaling), fundamental mechanics (sublinear length-aperture scaling), and experiments (Barton-Bandis conductive shearing). Each method predicts heterogeneous apertures, even along single fractures (i.e., intrafracture variations), but most fractured reservoir models imply constant apertures for single fractures. We compare the relative differences in aperture and permeability predicted by three aperture methods, where permeability is modeled in explicit fracture networks with coupled fracture-matrix flow. Aperture varies along single fractures, and geomechanical relations are used to identify which fractures are critically stressed. The aperture models are applied to real-world large-scale fracture networks. (Sub)linear length scaling predicts the largest average aperture and equivalent permeability. Barton-Bandis aperture is smaller, predicting on average a sixfold increase compared to matrix permeability. Application of critical stress criteria results in a decrease in the fraction of open fractures. For the applied stress conditions, Coulomb predicts that 50% of the network is critically stressed, compared to 80% for Barton-Bandis peak shear. The impact of the fracture network on equivalent permeability depends on the matrix hydraulic properties, as in a low-permeable matrix, intrafracture connectivity, i.e., the opening along a single fracture, controls equivalent permeability, whereas for a more permeable matrix, absolute apertures have a larger impact. Quantification of fracture flow regimes using only the ratio of fracture versus matrix permeability is insufficient, as these regimes also depend on aperture variations within fractures.

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