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How to Build a Fault Zone Permeability Model in Aeolian Sandstone

Simulating fluid flow through faulted sandstone requires that 3-D fault zone permeability models be built. A unique suite of outcrop, petrophysical, geophysical and structural data obtained at the Big Hole Fault (BHF) zone, Utah provides a foundation for estimating the permeability of faulted sandstone across length scales ranging from one decimeter to 5 meters. Three structural features modify the permeability of the undamaged host rock: single low-permeability deformation bands, amalgamated networks of deformation bands (fault core) and slip surface fractures. These features are used to define five characteristic “damage elements” with differing structural and fluid flow properties: fault tip, moderate displacement (< 10 m), high displacement (10 m), step-over and undamaged host rock. A discrete fracture network modeling approach (DFN) is used to estimate the effective permeability tensor of each damage element, while accounting for host rock permeability variation. Probe permeameter measurements of the host rock permeability range from 1 to 5,000 md, whereas the deformation band permeability is on the order of 1 md. The estimated permeability of a slip surface fracture with 1-mm aperture is ~ 50 Darcy. The effective permeability tensors estimated for each damage element are used to populate a detailed 400 m long, 200 m wide and 70 m deep stratigraphic and structural permeability model. A series of fluid flow simulations will be used to assess the impact of fault permeability on reservoir compartmentalization.