Effect of heterogeneity on effective permeability in fractured aquifers

Tolulope Agbaje, Behzad Ghanbarian, and Jeffery D. Hyman

BACKGROUND

- Effective permeability, $k_{eff.}$, is the overall capability of a formation to allow the passage of fluid through it.
- Fractures play a critical role in the effective permeability of a fractured formation.
- Heterogeneity includes aperture, orientation, density, connectivity, etc.

OBJECTIVES

- To generate discrete fracture networks.
- To simulate fluid flow for different fracture densities.
- To investigate the effect of domain size on k_{eff}.

ASSUMPTIONS

- For fractured aquifers, fracture is the primary control on $k_{eff.}$.
- Fracture size follows an exponential distribution.
- Fracture aperture and length are correlated.

NUMERICAL METHODS

- We first generated the discrete fracture network.
- We then called the module dfnGen_meshing and next ran LaGriT to mesh the DFN.
- We simulated flow using PFLOTRAN.

Exponential distribution

$f(x) = \lambda e^{-\lambda x}$

$\lambda = 1/\mu$

$\mu = 3.37m$; $\lambda = 0.29$

$l_{min} = 1m$

$l_{max} = 50m$

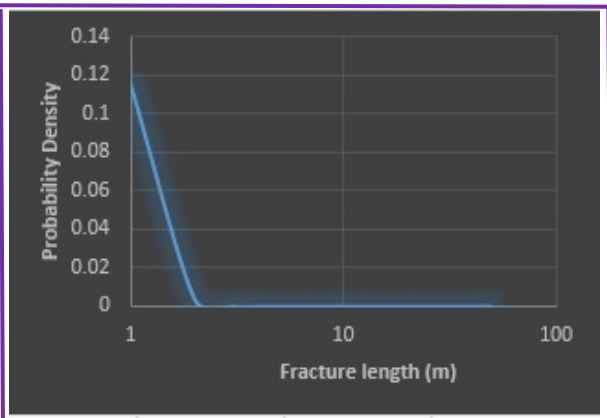
p30 = Fracture Density

p32 = Fracture Intensity

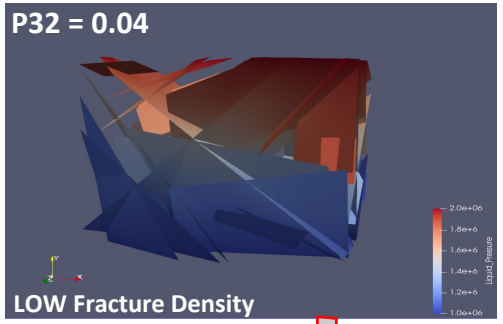
Fisher distribution

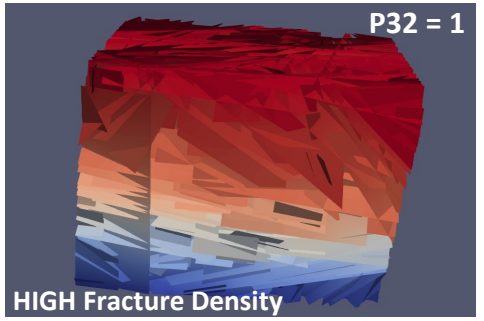
$f(x{:}\mu,k) = k \exp(k\mu^x)/4\pi\sinh(k)$

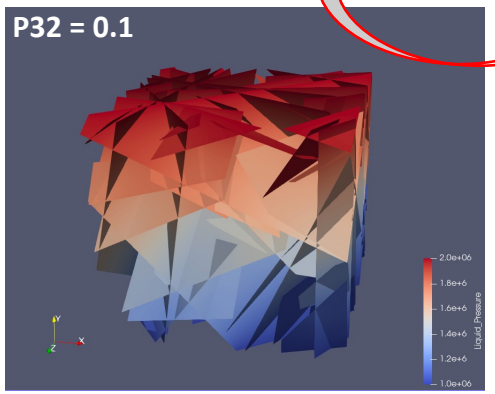
$k_{eff} = - \beta\rho((Q/A)(L/\Delta p)$

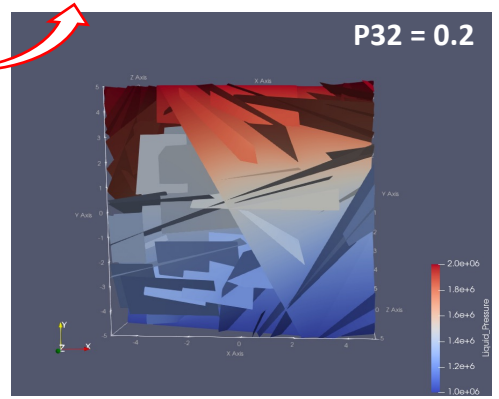


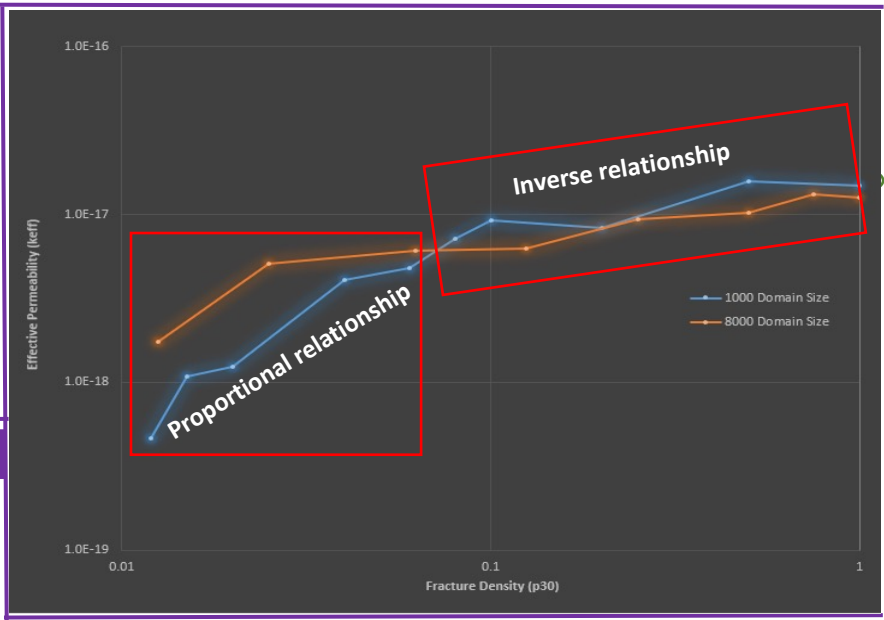
RESULTS











CONCLUSION

- We detected a sigmoidal relationship between effective permeability, $k_{eff.}$, and fracture density, p30.
- We observed a phase transition from low to high effective permeability at some low fracture density.
- We also found an inverse trend between the domain size and the effective permeability at higher fracture densities meaning that as the domain size increased, the value of k_{eff} decreased.

THANK YOU!