Effect of heterogeneity on effective permeability in fractured aquifers

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**BACKGROUND**
- Effective permeability, $k_{\text{eff}}$, 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 $k_{\text{eff}}$.

**ASSUMPTIONS**
- For fractured aquifers, fracture is the primary control on $k_{\text{eff}}$.
- 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.

**RESULTS**

**Exponential distribution**

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

$\lambda = 1/\mu$

$\mu = 3.37\text{m}; \lambda = 0.29$

$l_{\text{min}} = 1\text{m}$

$l_{\text{max}} = 50\text{m}$

$p_{30} = \text{Fracture Density}$

$p_{32} = \text{Fracture Intensity}$

**Fisher distribution**

$f(x;\mu,k) = k \exp(k\mu/4\sinh(k))$

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

**CONCLUSION**

- We detected a sigmoidal relationship between effective permeability, $k_{\text{eff}}$, and fracture density, $p_{30}$.
- 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 $k_{\text{eff}}$ decreased.