SAND2017-5305PE

UPDATE ON MODELING ACTIVITIES FOR DECOVALEX TASK C

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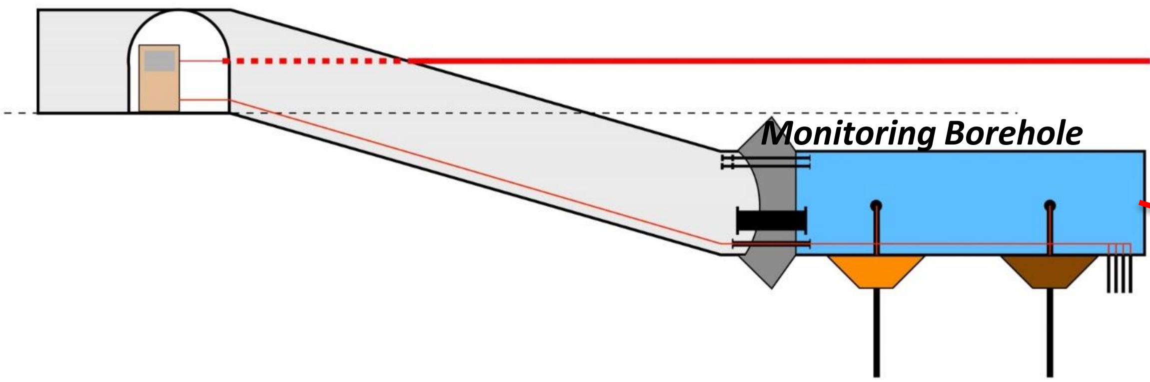
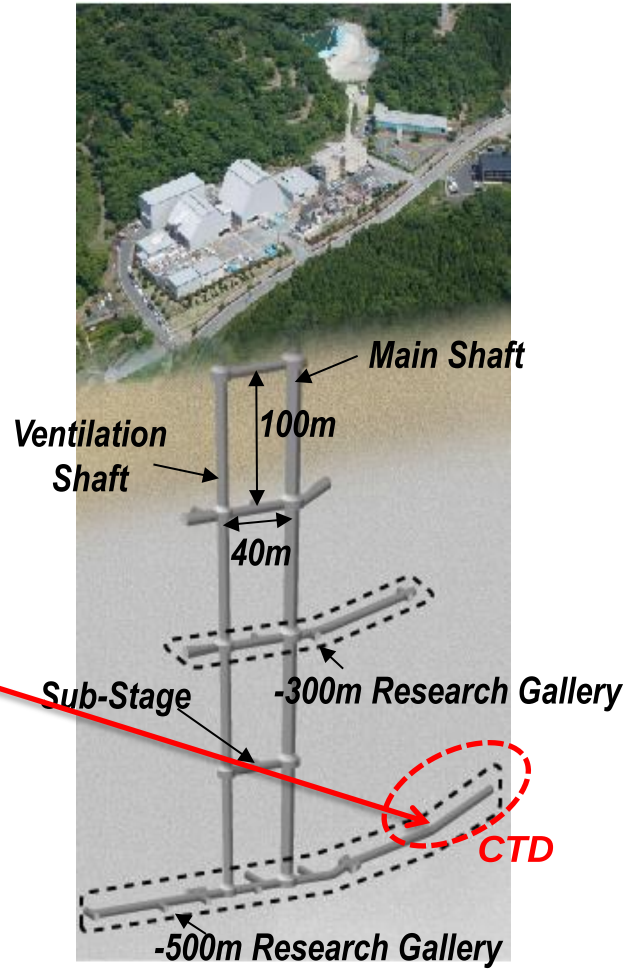
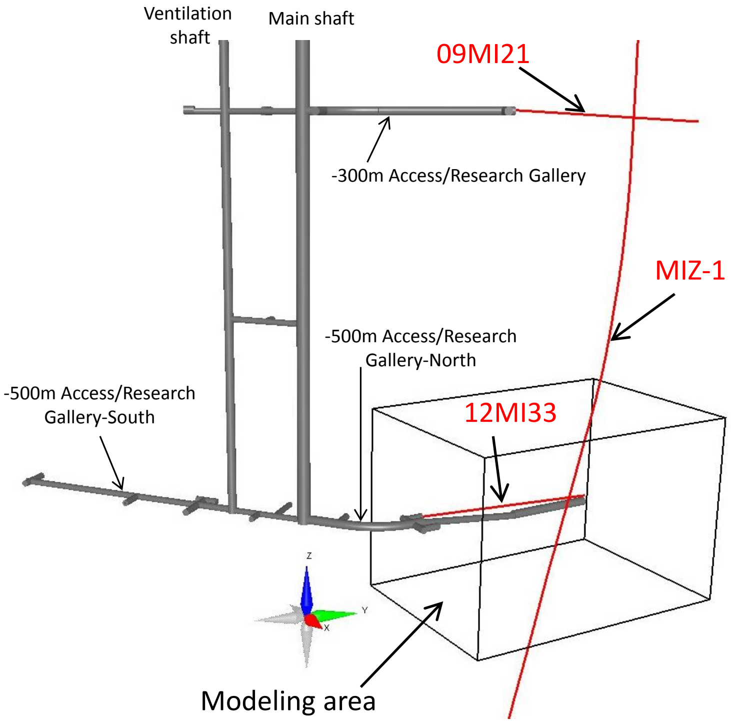
DECOVALEX-19: TASK C

- **Mizunami Underground Research Laboratories for HLW disposal in crystalline rock**
- **GREET(Groundwater REcovery Experiment in Tunnel) : Preliminary test (drift closure and water-filling) in Closure Test Drift (CTD) to estimate the recovery process in granitic rock**





FRACTURE CHARACTERIZATION AND FLOW AND TRANSPORT SIMULATIONS IN CTD-SCALE MODEL



Sandia Tasks:

- *Fracture models using field data.*
- *Inflow rate into CTD*

Modeling domain: 150 m x 100 m x 100 m

CTD: L 46.5m x W5.0m x H4.5m

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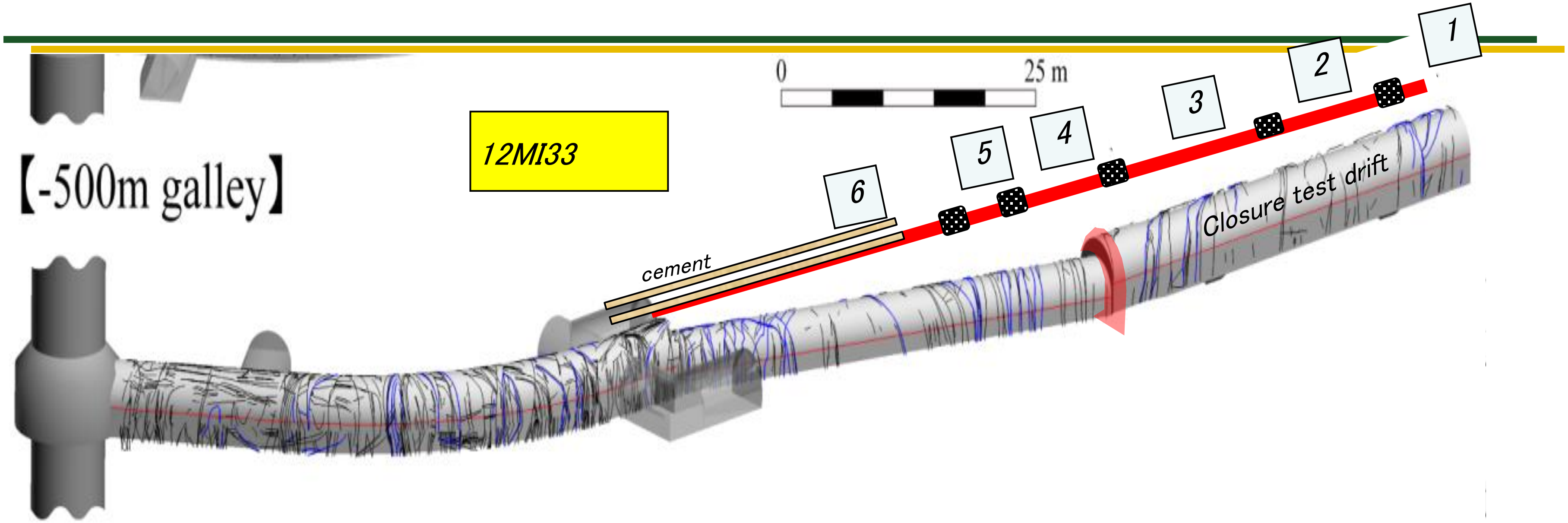
Available Fracture Data



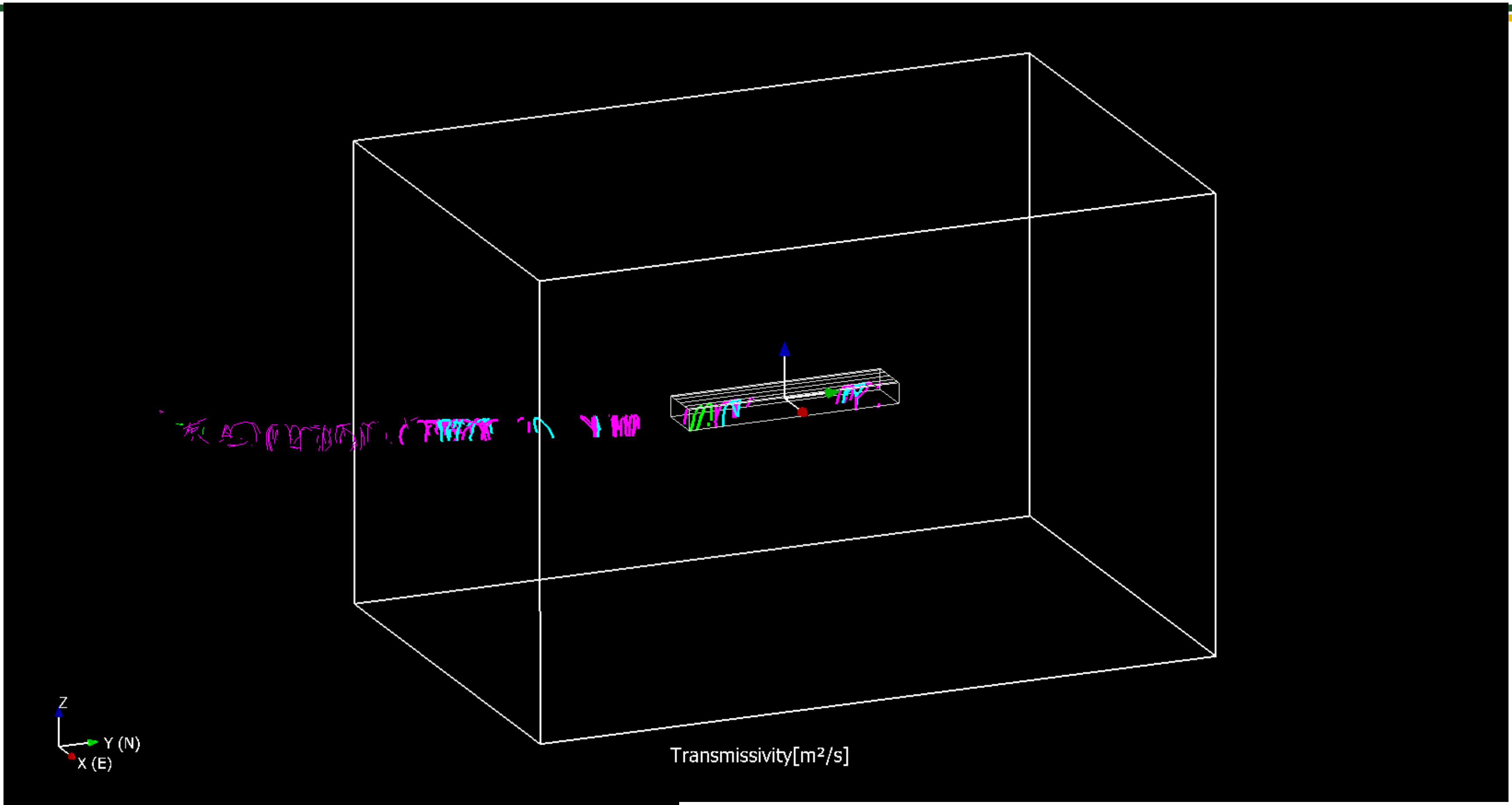
- Trace data for Access Drift, Inclined Drift, and Closure Test Drift (CTD)
- **2,023** fractures
- Fracture data: trace length, dip, strike, and alteration
- Observed flow range:
  - N: no inflow
  - W: wet (< 0.1 L/min)
  - D: drop (>0.1 L/min)\
  - F: flow (>1 L/min)

Analyzed Fractures

	F (>1.0 L/min)	D (>0.1 L/min)	W (<0.1 L/min)	Total Number of Fractures
CTD	4	15	3	233
Inclined Drift	14	42	-	477
Access Drift	-	65	3	1.313
Total	18	122	6	2,023

- *The model includes Inclined Drift and CTD.*
- *Access Drift fractures were analyzed, but the drift is outside of the modeling domain.*
- *Fractures included in the model are fractures with observed flow (F, D, and W).*

Trace Data for Three Drifts



- *Blue – F fractures*
- *Purple - D fractures*
- *Green - W fractures*

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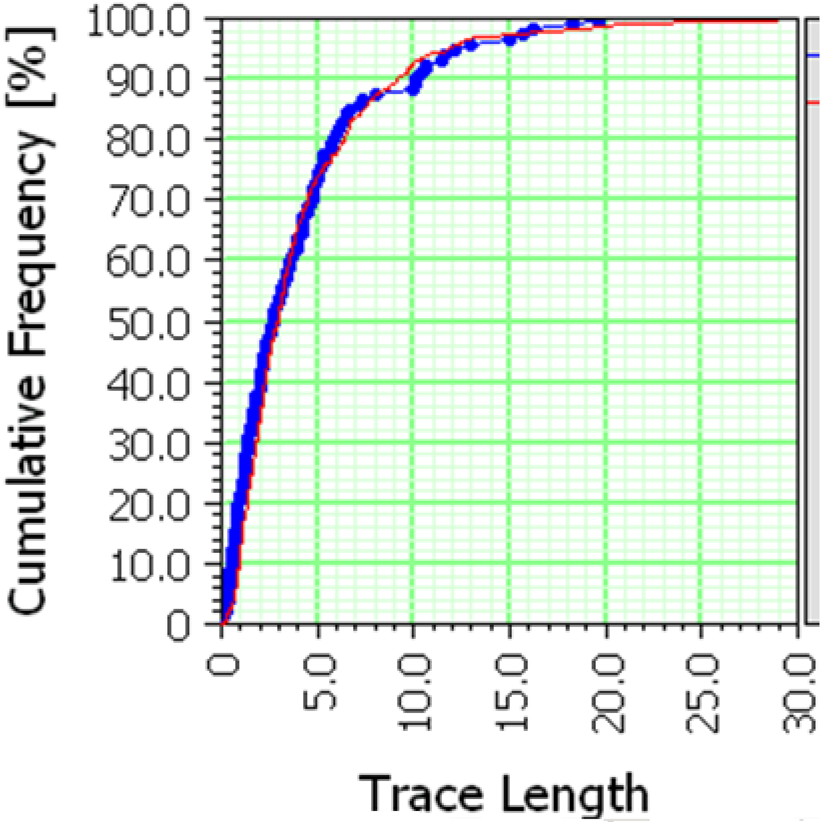
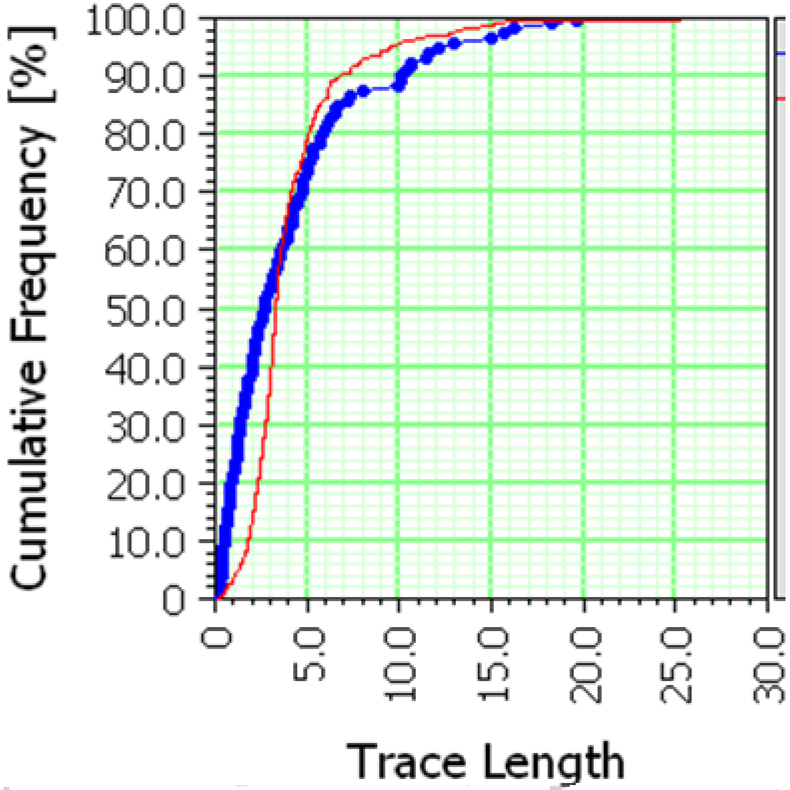
Fracture Size Analysis: D Fractures

Lognormal



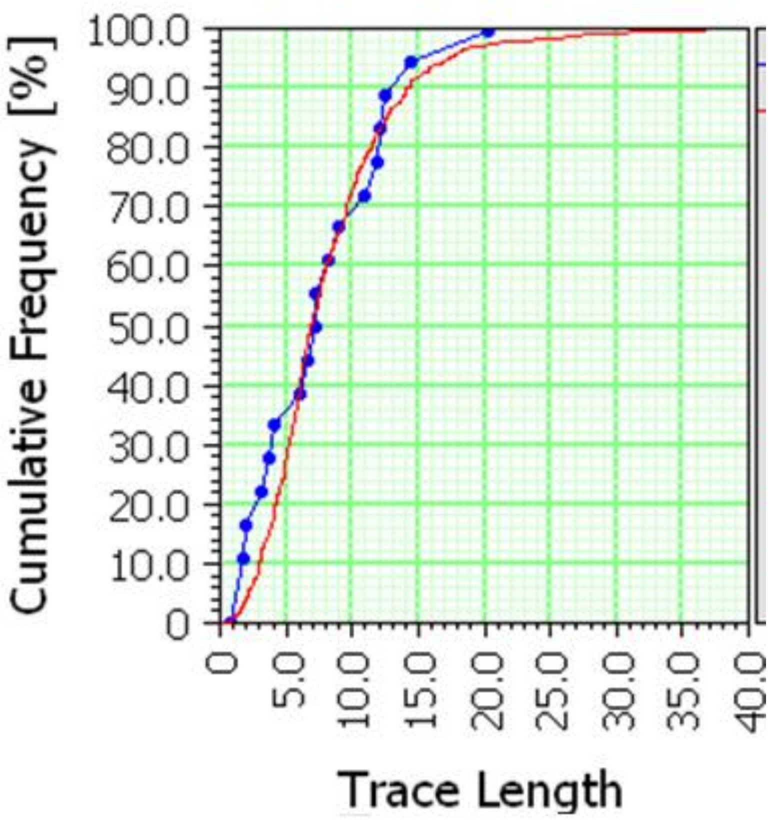
Power Law



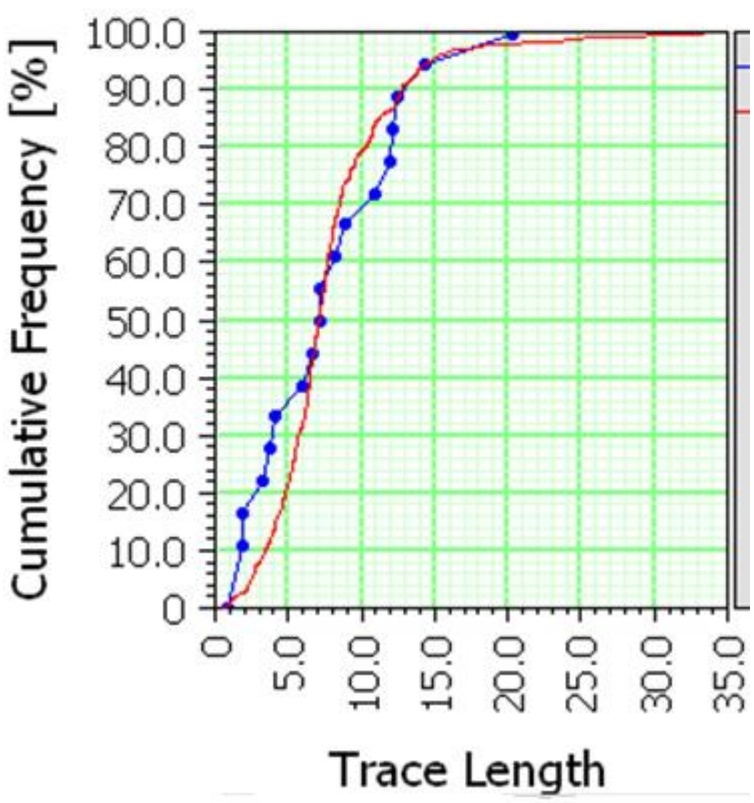
Mean radius 1.42 m, St. dev. 1.29

Fracture Size Analysis: F Fractures

Lognormal



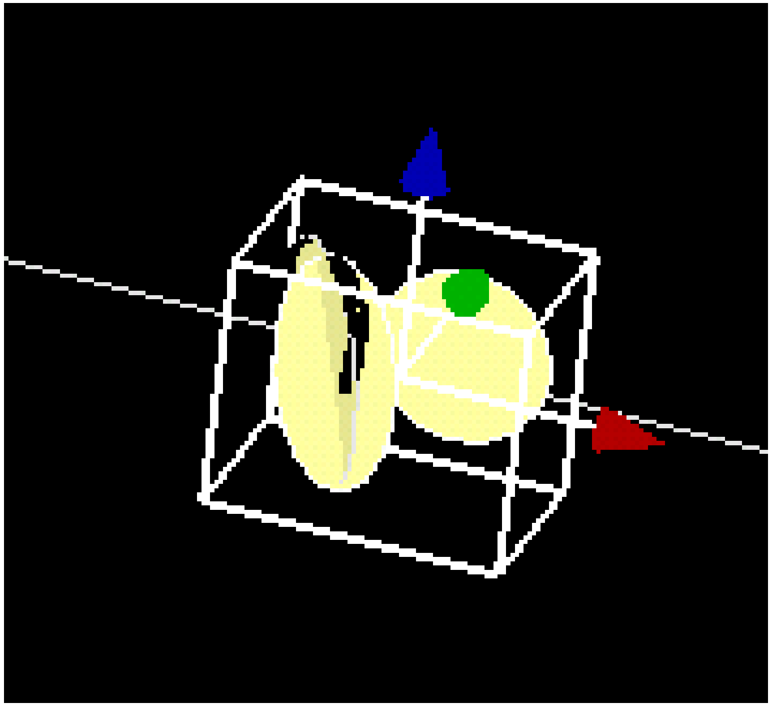
Power Law



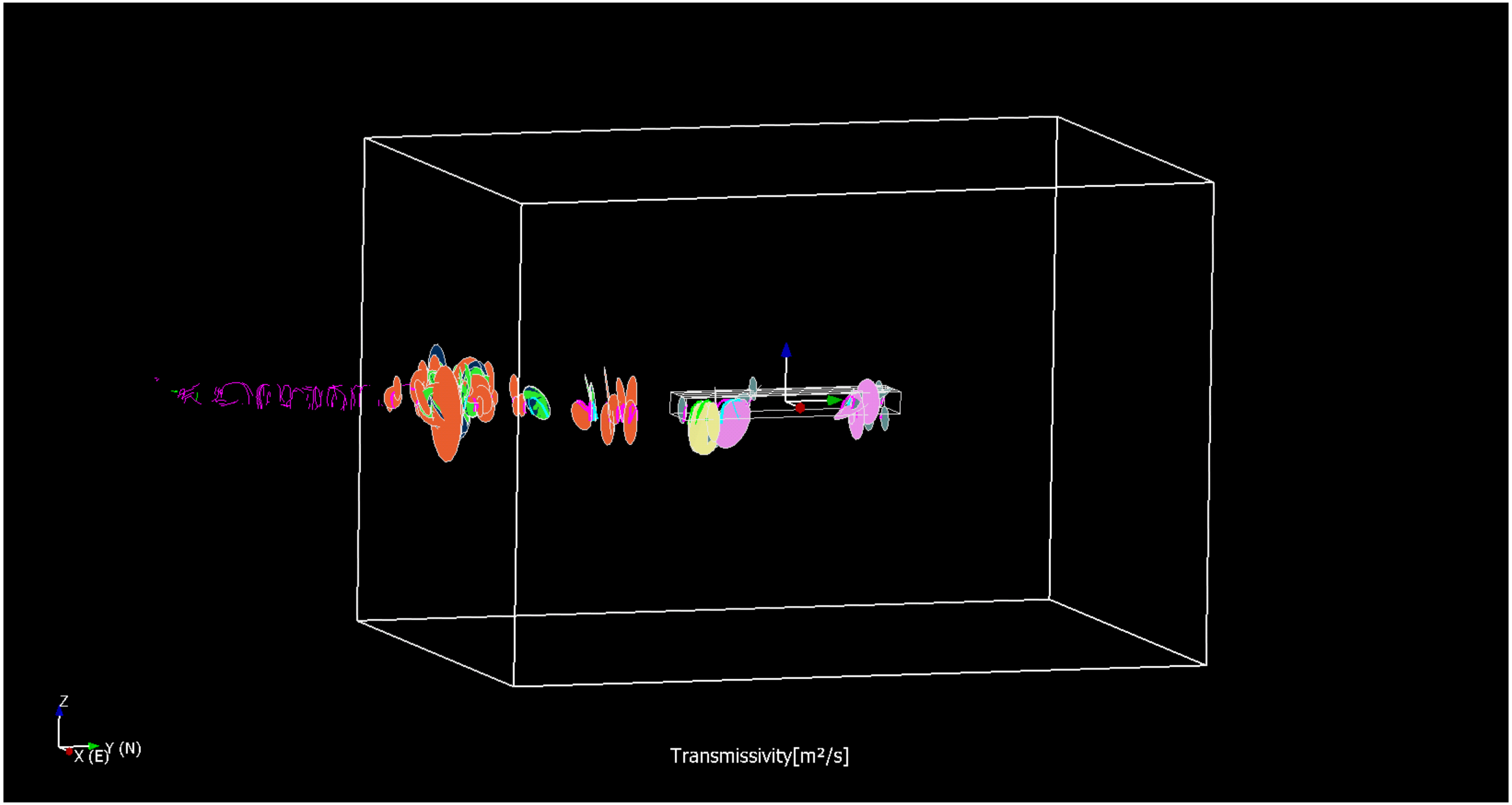
Mean radius 3.88 m, St. dev. 2.15

Generating Fractures from the Trace Data and Fracture Size Analysis

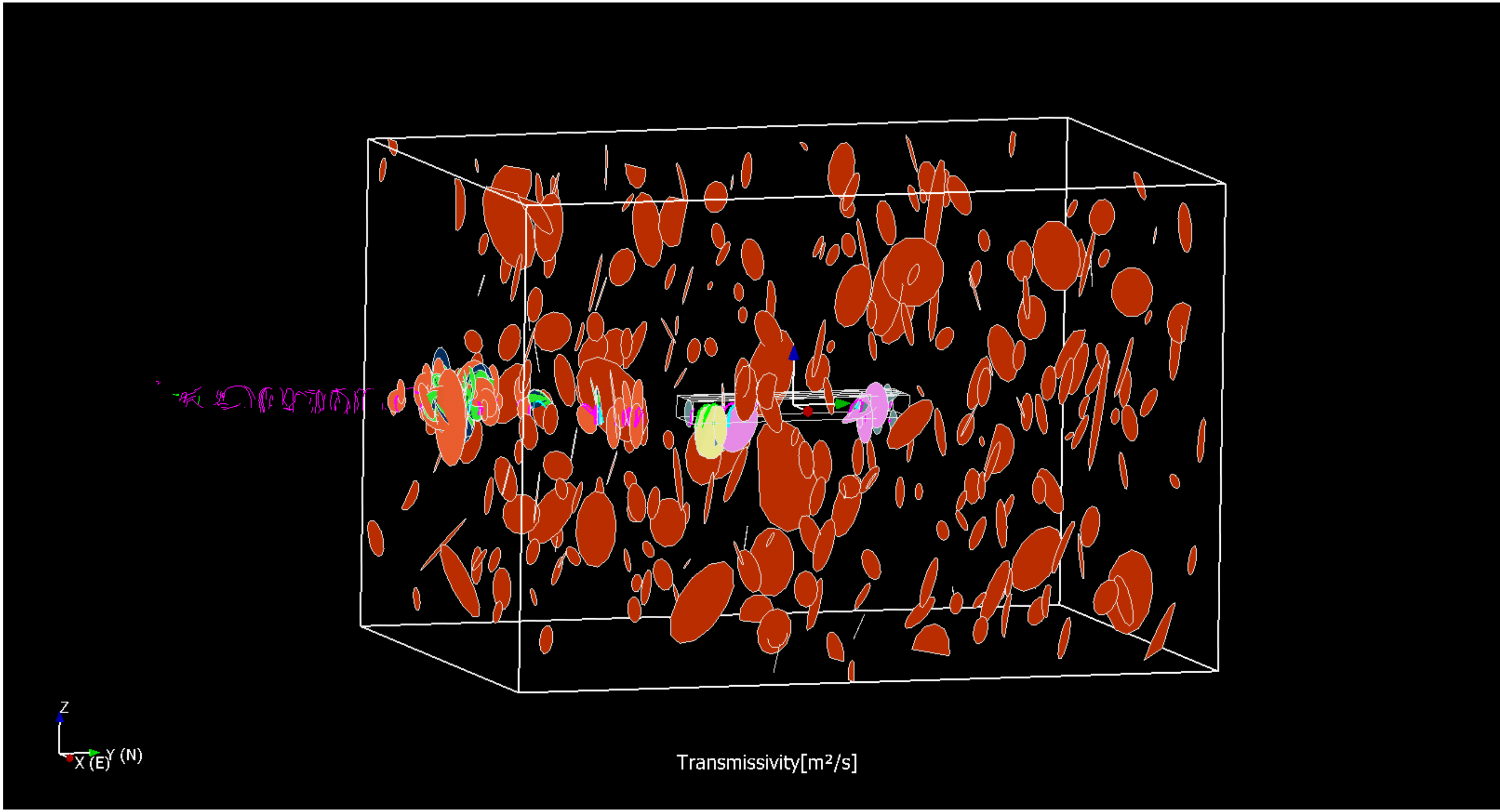
- The dip direction and dip angle of the fracture are derived from the plane containing the fracture traces.
- The parameters of the lognormal distribution are used to define the fracture size.



Inclined Drift and CTD Fractures

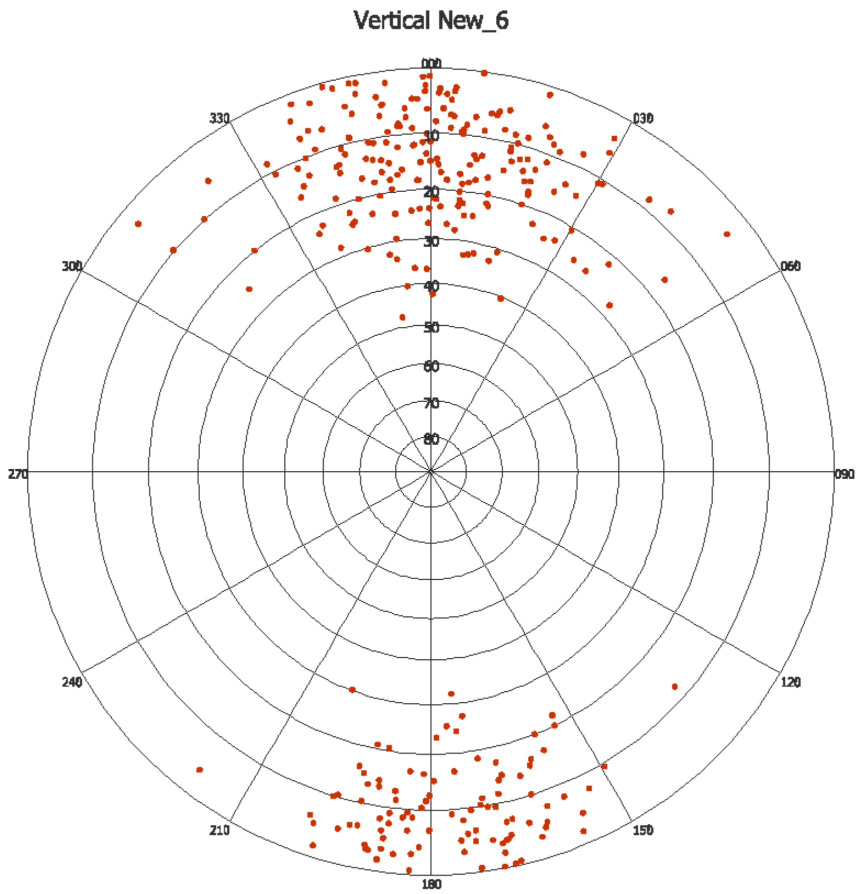


Stochastic Vertical Fractures



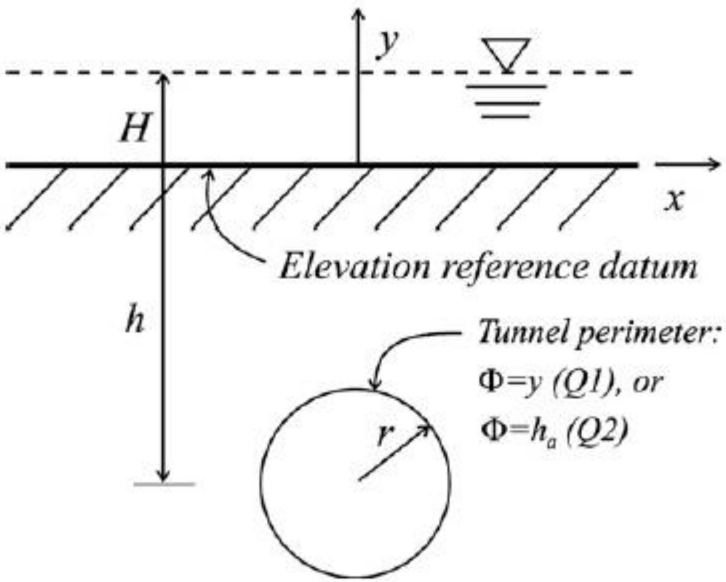
- *Fracture size defined using lognormal distribution.*

Stochastic Vertical Fracture Stereogram



Initial “Guess” of Fracture Transmissivity

Inflow into Circular Tunnel



Analytical Solution

$$Q_1 = \frac{2\pi k_{aq}(A+H)}{\ln\left(\frac{h}{r}+\sqrt{\frac{h^2}{r^2}-1}\right)}$$

where

$$A = h(1-\alpha^2)/(1+\alpha^2)$$

and

$$\alpha = \frac{1}{r}\left(h-\sqrt{h^2-r^2}\right)$$

Inflow >1 L/min -> Fracture transmissivity >3.2x10^{-15} m^3
Inflow >0.1 L/min -> Fracture transmissivity >3.2x10^{-16} m^3

Converting DFN to Continuum Model with Oda Method

- *Oda calculates permeability tensors in three dimensions for each cell.*
- *Oda tensor is a simplification of Darcy's Law for flow through an isotropic porous medium.*
- *The fracture permeability (k) is projected onto the plane of the fracture and scaled by the ratio between the fracture volume (porosity) and the volume of the grid cell.*

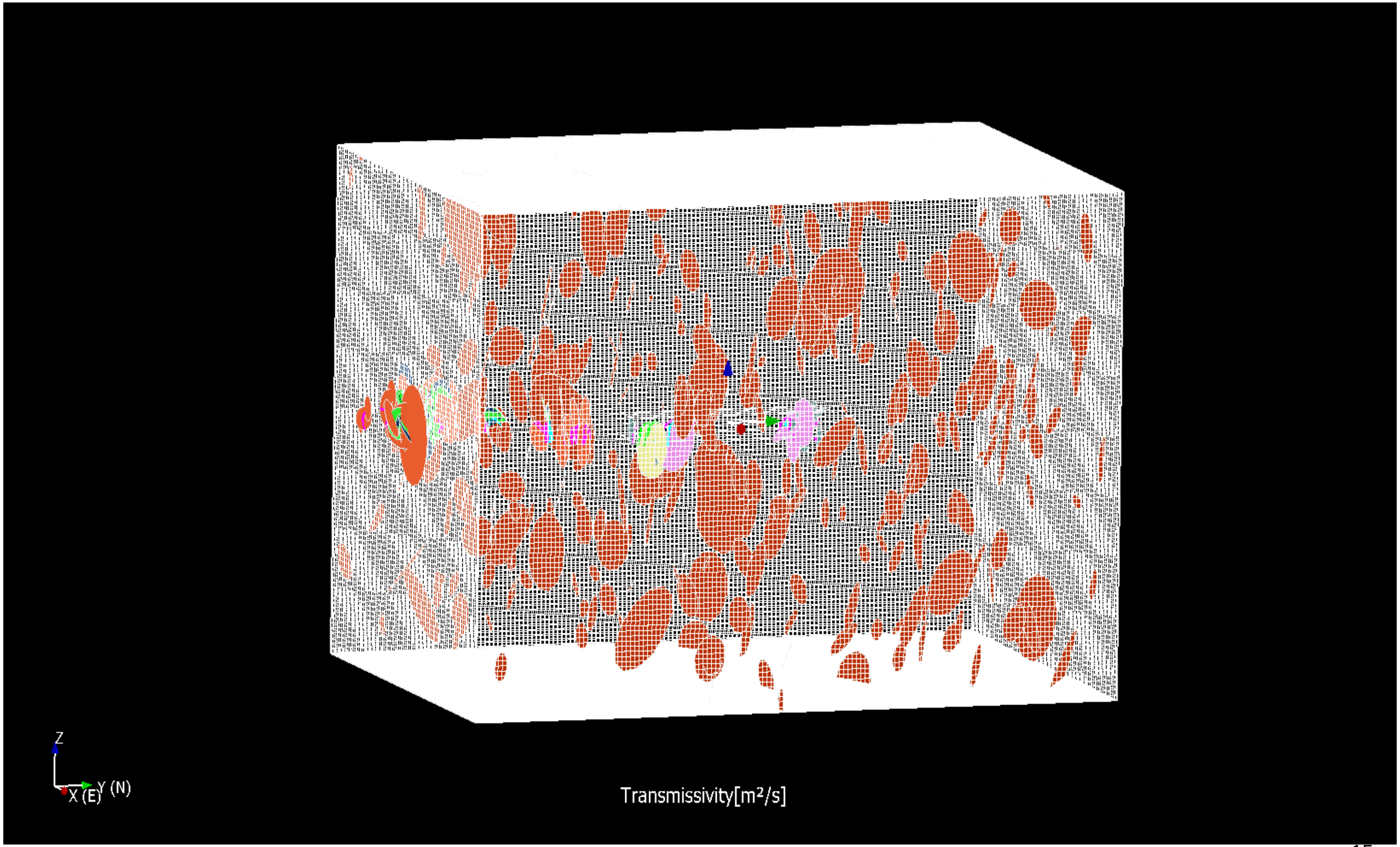
$$F_{ij} = \frac{1}{V} \sum_{k=1}^{N} A_k T_k n_{ik} n_{jk}$$

Fij = fracture tensor
V = grid cell volume
N = total number of fractures in grid cell
Ak = area of fracture k
Tk = transmissivity of fracture k
nik, njk = the components of a unit normal to the fracture k

$$k_{ij} = \frac{1}{12}\left(F_{kk}\delta_{ij} - F_{ij}\right)$$

kij = permeability tensor
Fij = fracture tensor
δij = Kroenecker's delta

Converting to Orthogonal Grid: 1mx1mx1m



Future Work

- *Define fracture permeability pdf for each group of fractures (F, D, and W) generated from trace data for CTD and Inclined Drift.*
- *Analyze other data available for this area to understand how many fracture sets are present and what are their properties.*
- *Generate stochastic fractures based on the properties of the trace data and other available data.*
- *Define fracture permeability pdf for each set of stochastic fractures.*
- *Generate representative number of realizations (50 or more) of the stochastic fractures in the modeling domain.*
- *Convert DFN realizations into continuum model for flow and transport simulations.*
- *Analyze the connectivity of the stochastic and trace data based fracture networks.*
- *Sensitivity analysis related to fracture size and properties of both, trace based and stochastic fractures.*

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