

## FracMan 7.0 Nuclear Edition (FRAN)

Discrete Fracture and Hybrid DFN/EPM Groundwater Flow and Transport

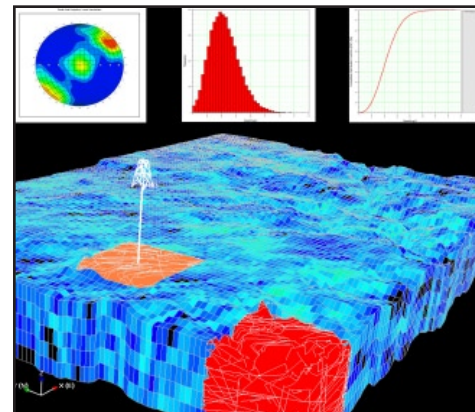
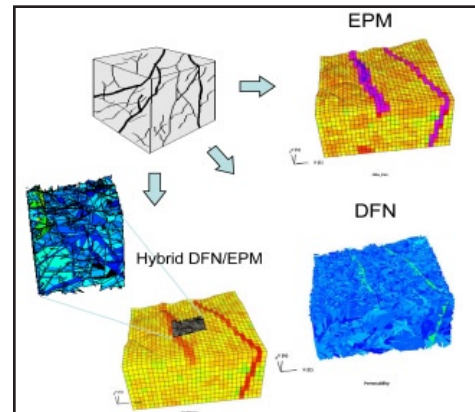
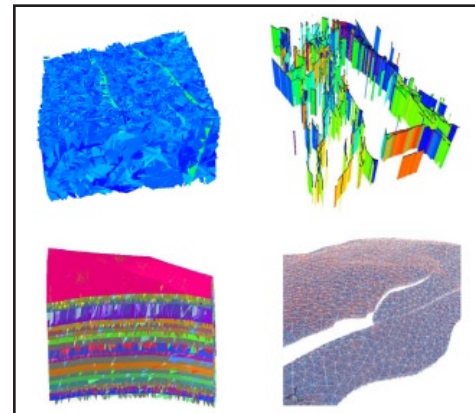
FracMan7 Nuclear Edition (FRAN) provides unmatched power for hydrogeologic analysis of fractured rock. FRAN combines the power of realistic, detailed 3D discrete fracture networks with flow and transport in discrete fracture networks with integrated rock matrix interaction.

### Fracture Geometry Features

- Custom discrete fracture network (DFN) models for Crystalline, Sedimentary, and Volcanic Rocks
- Spatial Control of Intensity, orientation, and properties, including correlations to curvature and structural position
- Sealing and Partially Sealing Faults, including simulation of fault core and offsets
- Conductive Fault Damage Zones
- Variation of flow and transport properties at fracture intersection zones to support alternative channeling approaches
- Variability of properties within fractures and fracture zones using statistical, geostatistical, and fractal approaches
- Analysis of grout injection for tunnel inflow control
- Linkage of fracture hydraulic properties to in situ stress according to critical stress and  $\sigma_{hmax}$  approaches

### Groundwater Flow Features

- Support for fracture only (type-1), fracture plus matrix storage (type-2), fracture and matrix permeability and storage (type-3), and equivalent matrix (type-4) fractured rock aquifers
- Direct implementation of flow barrier (sealing and partially sealing) faults in the flow solution
- Available upscaling to MODFLOW, FEFLOW<sup>®</sup>, and other EPM (Continuum) Hydrogeologic Models
- Neumann, Dirichlet Boundary, and Mixed Boundary Conditions
- Steady state and transient solutions
- True multiple porosity steady-state and transient flow with networks of discrete fractures and integrated rock matrix volume elements
- Hybrid discrete fracture network modeling, upscaling fracture networks to EPM (Continuum) elements where possible, while maintaining fully detailed DFN networks where detail is needed
- Support for spatially variable infiltration and moving phreatic surfaces
- Wellbore storage and skin effects



**“FracMan revolutionizes fractured rock hydrogeology!”**

**Solute Transport Features**

- Particle tracking (PT) solution and graph theory solutions to identify streamlines and transport pathways through fractures and rock matrix
- Laplace Transform Galerkin (LTG) transport transport with multiple immobile zone porosities
- Transport solution according to advection-dispersion equation
- Optional links for CTRW (continuous time random walk) transport equations
- Surface (K<sub>a</sub>) and Volumetric Sorption (K<sub>d</sub>), Diffusion, and Biodegradation
- Constant and time-varying mass rate and concentration boundary conditions
- Radionuclide decay and speciation for both particle tracking and Laplace Transform Galerkin solutions
- 1-D, 2-D, and 3-D transport solutions, including 3-D networks of 1-D pipes for rapid solution of complex multi-porosity transport problems
- Graph theory analysis of transport and connectivity pathways
- Tributary drainage and compartmentalization analysis
- Solution of heat flow and thermal boundary conditions

**Case Study Applications Available**

- Carbon Sequestration
- Environmental Restoration
- Radioactive Waste Repository Licensing
- Upscaling from fracture networks to FEFLOW and MODFLOW
- Hybrid Continuum/Discrete Fracture (EPM/DFN) Modeling
- Paleo-hydrogeologic modeling of glacial and brine end-members
- Water supply from fractured aquifers

**Modules Included**

- FracMan7 Basic – Discrete Fracture Network Modeling and Visualization
- SamEdit – Interactive Control of Simulations and Boundary Conditions
- MAFIC Pro – Multiple Porosity Flow and Transport
- PAWorks Pro– Laplace Transform Galerkin (LTG) Multiple Porosity Transport and Graph Theory Pathways Analysis

