# Fracture Characterization, Modeling of Hydrology and Non-Reactive Transport at the Mizunami Underground Research Laboratory

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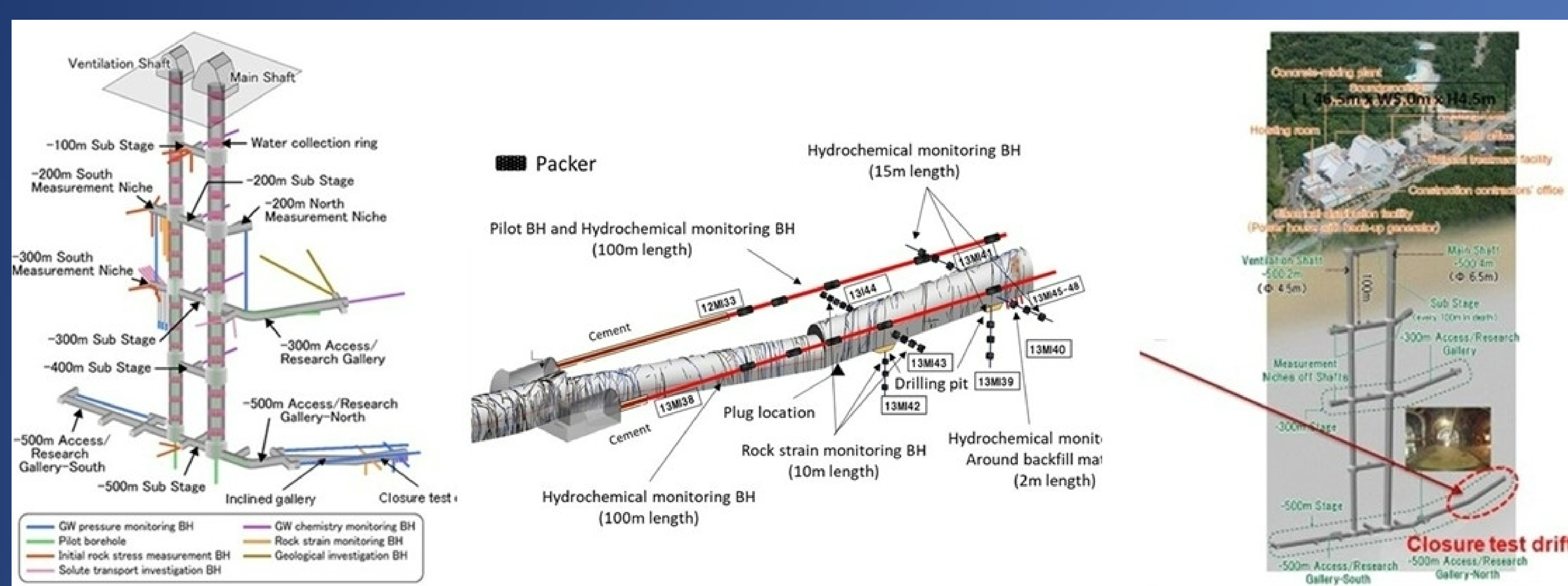
***ABSTRACT:***

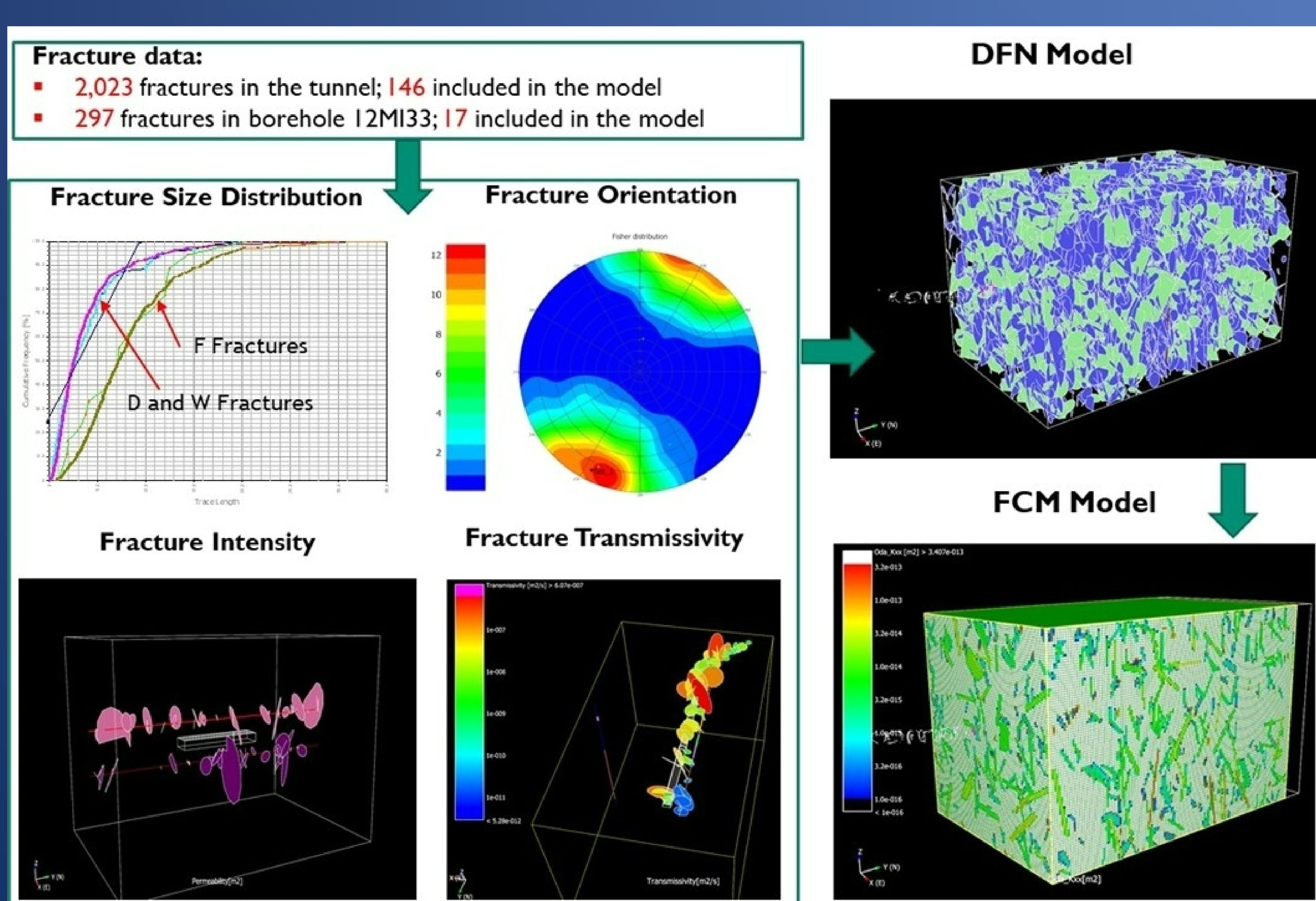
**Experimental data from the Mizunami Underground Research Laboratory in Central Japan provided by Japan Atomic Energy Agency (JAEA) have been used to develop a discrete fracture network model, a hydrology model and a non-reactive transport model for the study area. Model development and simulation results, including history matching are presented. The study is part of DECOVALEX2019, Task C (GREET).**




**The Mizunami Underground Research Laboratory**

## Development of a Fracture Model

**A discrete fracture network model was developed using project experimental data. The major input data were fracture traces measured on the tunnel walls and fractures observed in boreholes. These data were used to derive fracture orientation and fracture intensity distributions and to generate stochastic fractures within the modeling domain. The FracMan based fracture model was upscaled to an orthogonal continuum mesh with 2x2x2 m$^3$ cell size.**




**Steps in Fracture Model Development**

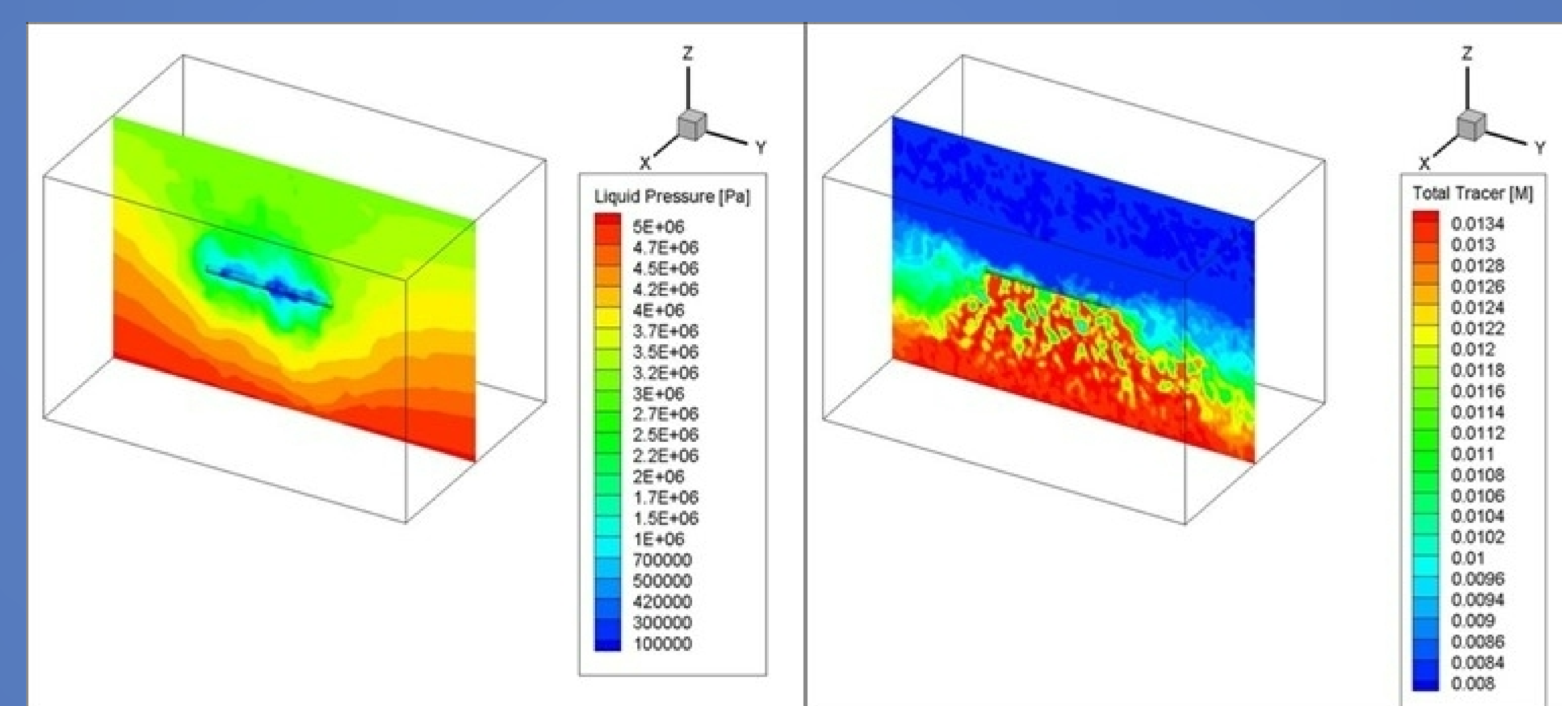
**Developed Fracture Data using FracMan Software**

| Fracture Set | Trend (⁰) | Plunge (⁰) | Fisher Dispersion κ | Volumetric Intensity $P_{32}$ (1/m) |
|---|---|---|---|---|
| Set 1 | 208 | 8 | 7 | 0.22 |
| Set 2 | 303 | 1.3 | 3.6 | 0.086 |

## Modeling Hydrology and Non-Reactive Transport During Tunnel Excavation

**Numerical modeling of flow and transport through fractured crystalline rock was conducted in support of the study of migration of radionuclides from a high-level nuclear waste repository. The modeling involved prediction of inflow, pressure and chloride history at observation points based on experimental data of tunnel excavation progress. Upscaled permeability and porosity fields for 10 realizations, for two domains were used. The PFLOTRAN numerical code was used for the simulations. Simulation results were compared with experimental data.**

- **Base case domain size: 200 m x 300 m x 200m (1,500,000 grid blocks)**
- **Enlarged domain size: 1386 m x 1486 m x 806 m (2,352,987 grid blocks)**
- **Initial Condition: Hydrostatic pressure and Cl concentration gradient**
- **Boundary Conditions: specified pressure and chloride concentration at domain boundary provided by project**




**Simulation results of distributions of pressure and chloride concentration at end of excavation (173 days of simulation time) for base case domain**


**Predictions of Inflow as a result of tunnel excavation for 10 realizations. Results shown for the two domain sizes together with experimental data.**

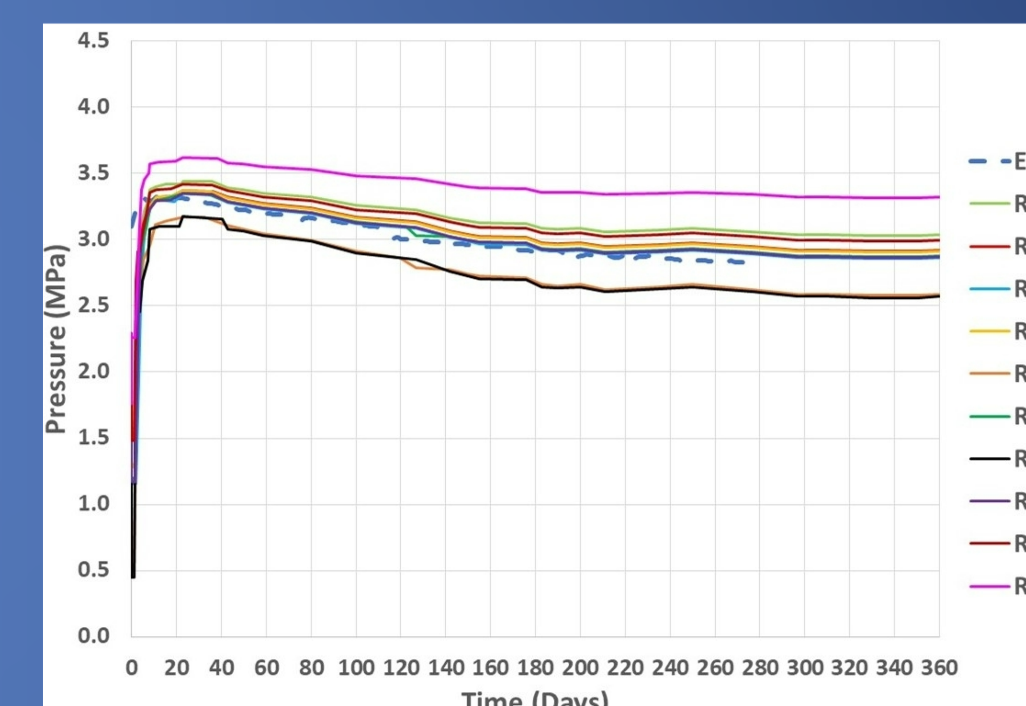
## REFERENCES:

*Evaluation of Spent Fuel Disposition in Crystalline Rocks: FY18 Progress report.*. M2SF-18SN010302051 by Y. Wang, T. Hadgu, E. Kalinina, J. Jerden, V. K. Gattu, W. Ebert, H. Viswanathan, H. Boukhalfa, S. Chu, J. Hyman, S. Karra, N. Makendonska, P. Reimus, K. Telfeyan, L. Zheng, H. Deng, S. Nakagawa, K. Kim, T. Kneafsey,, P. Dobson, S. Borglin, C. Doughty, M. Voltolini, M. Zavarin, E. Balboni, C. Atkins-Duffin.

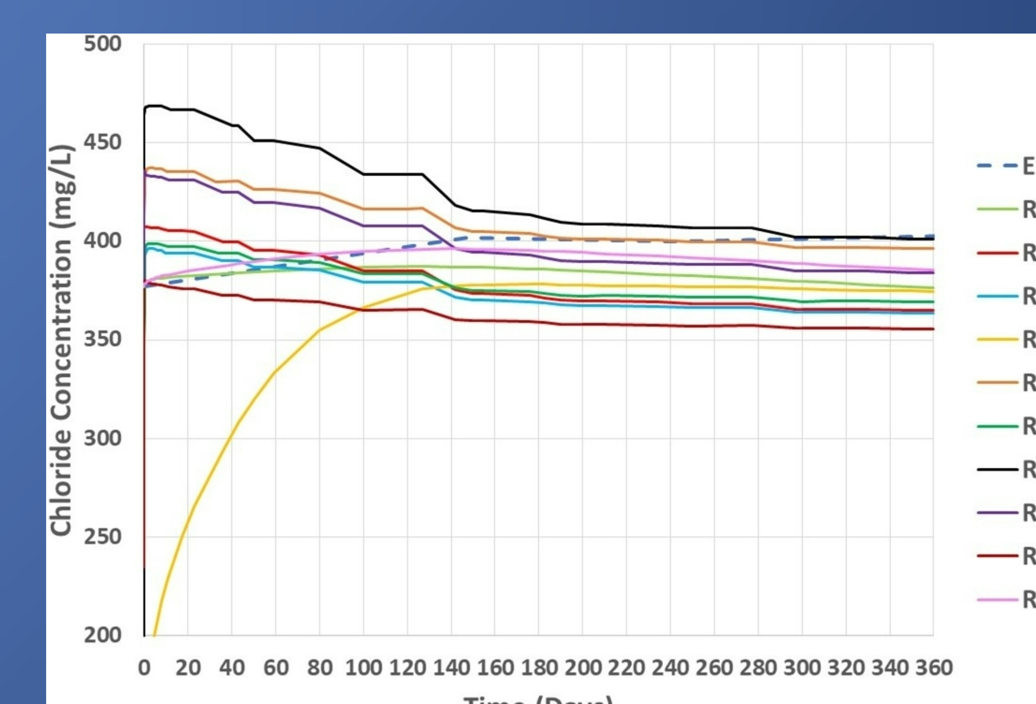
## Modeling of Flow and Transport During Recovery Experiment

**The Closure Test Drift (CTD) was isolated using a concrete plug and filled with water. Hydraulic and chemical recovery were monitored. Flow and transport modeling were conducted to simulate the recovery experiment.**

- **Initial pressure at CTD: 1 atm.**
- **Initial pressure and chloride data at observation points in Borehole 12MI33 used.**
- **Base case domain and original boundary conditions used.**




**Predicted pressure recovery at an observation point in Well 12MI33 together experimental data**




**Predicted chloride concentration during recovery at an observation point in Well 12MI33 together experimental data**

## Summary

Field experimental data on fractures, hydrology and chemistry were utilized in the study of nuclear waste disposal in crystalline rock. The modeling analysis supported by field data resulted in better fracture characterization and prediction of flow and transport. Comparison of modeling results with models also helped refine prediction methods.

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