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# Site Characterization & Preliminary Performance Assessment Calculation Applied To JAEA-Horonobe URL Site of Japan

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## 1. Introduction

JAEA-Horonobe Underground Research Laboratory (URL) is designed for research & development on high-level radioactive waste (HLW) repository in sedimentary rock. For a potential HLW repository, understanding and implementing fracturing & faulting system, with data from the site characterization, into the performance assessment is essential because fracture & fault will be the major conductors or barriers for the groundwater flow and radionuclide release. The objectives are i) quantitative derivation of characteristics and correlation of fracturing/faulting system with geologic and geophysics data obtained from the site characterization, and ii) preliminary performance assessment calculation with characterized site information.

## 2. Site Characterization

Fracturing and faulting system of the URL site (Fig 1) is characterized from 12 borehole geophysical logging data, regional geologic/structural data, and fracture/fault data (orientation, intensity, size) obtained from the surface-based investigations.

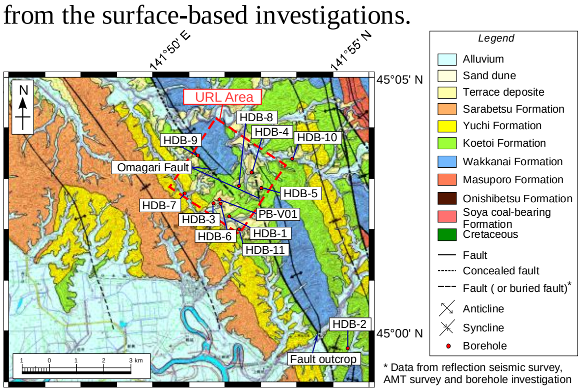


Fig 1. Geological map in/around the URL area and locations of deep borehole investigations

Volumetric fracture intensity ($P_{32}$ [$m^2/m^3$]) [1] is obtained as 0.0187 and 0.025 for Koetoi and Wakkanai formations, respectively. To take into account the heterogeneity of the fracture intensity, volumetric fracture intensity potential (or probability) is estimated statistically over the entire modeling volume (see Fig 2) by the correlation and the multi-linear regression analysis using the observed geophysical (14 parameters), structural (1 parameter), curvature of formation surfaces (6 parameters). Thorium content, self-potential, and curvature are found to be significant to fracture intensity in the current study [2].

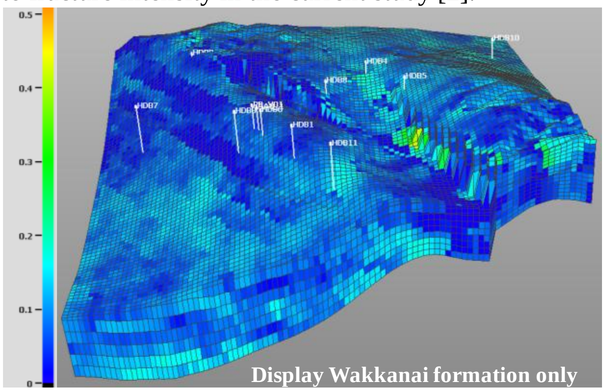


Fig. 2. Volumetric Fracture Intensity Potential Map

Fracture orientation data was analyzed from the borehore televiewer (BHTV) and core data for selected six boreholes. Fig. 3 shows the sampling bias corrected conductive fracture orientation (rose diagram and contour plot) relative to bedding surfaces obtained by 3D rotation of fracture orientation data with respect to the bedding surfaces.

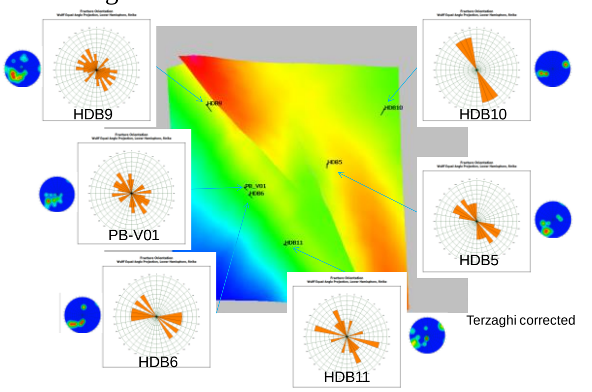


Fig. 3. Relative Orientation of Conductive Fractures to Bedding

Fracture size has been determined as power law distribution [1] with exponents ranging between 3.5 and 4.0, which is obtained based on correlation among fracture thickness from boreholes, fracture displacements from outcrop, and fracture trace lengths [3]. The trace length $L$ (m) of the fault is calculated from the fault rock thickness $W$ (cm) in drill core using the following equation [3],

$$L = \left(\frac{W}{2.25}\right)^{3.38} \qquad (1)$$

Transmissivity of conductive fractures is obtained as mean and standard deviation of $1.43\times10^{-5}$ $m^2/s$ and $2.43\times10^{-5}$ $m^2/s$, respectively, for Wakkanai formation. In Koetoi formation, mean transmissivity is obtained as $3.73\times10^{-8}$ $m^2/s$ and standard deviation is $7.19\times10^{-8}$ $m^2/s$.

## 3. Three-Dimensional DFN Modeling

A 3-D discrete fracture network (DFN) is constructed from the characterized fracture & faulting information in JAEA-Horonobe URL area (5km-scale) using FracMan® [1]. Deterministic and stochastic fractures in Koetoi and Wakkanai formations are considered in constructing 3-D DFN model. Fig 4 shows the resulting hydraulic heads through the major conductive fractures (equivalent fracture radius >64m [3]).

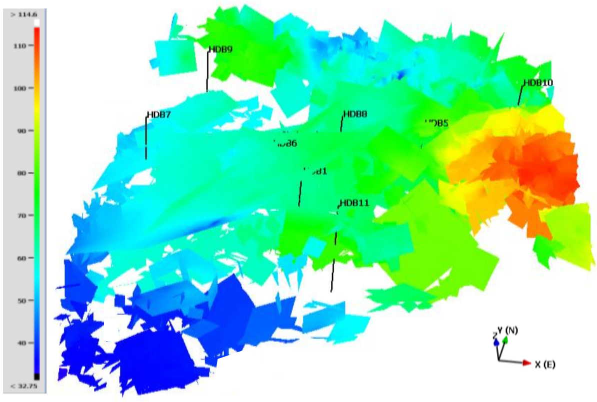


Fig. 4. Hydraulic Head Distribution for DFN Model

Flow path analysis is performed for three boreholes located in the vicinity of the shaft. The minimum, average, and maximum flow paths are obtained as 283m, 760m, and 3393m, respectively.

## 4. Preliminary Performance Assessment Calculation

Performance assessment (PA) related parameters are required to derive explictly from the characterized site specific data. Estimation of radionuclide release for given scenarios/conceptual models [4] is one of key factors to assess the performance of potential repository of radioactive wastes. One dimensional analytical transport model through a single fracture with matrix diffusion [5] is considered here among various conceptual transport models [1, 4, 6].

Normalized concentration ($N(x,t)/N_0$) of Np-237 is estimated with derived flow parameters (water velocity) and travel lengths (flow paths) from the constructed 3D DFN model (see Fig 4). For Wakkanai formation, bulk porosity of 0.38 [7], pore diffusion coefficient of $6.31\times10^{-4}$ $m^2/yr$, and retardation factor of 2334 [6] are considered.

Fig 5 shows a preliminary result for Np-237 (decay constant of $3.24\times10^{-7}$ $yr^{-1}$) nomalized concentration at estimated average flow paths (i.e., $x$=760m) with maximum water velocity (Case A, $v=1.38\times10^{-4}$ m/s) and average water velocity (Case B, $v=4.05\times10^{-5}$ m/s) through a representative single fracture obtained from the constructed 3-D DFN by assuming leach time of 5000 yr [5].

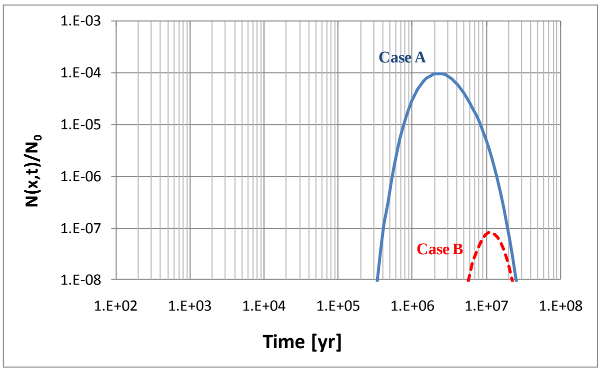


Fig. 5. Normalized Concentration of Np-237

## 5. Conclusions

Characteristics and correlation of fracturing/faulting system with geologic, structural, geophysical data obtained from the JAEA-Horonobe URL have been derived quantitatively. Characterized information has been fully integrated in developing regional scale 3D-DFN model, and in assessing the performance of (hypothetical) potential HLW repository.

## REFERENCES

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