Case studies based on JAEA's URLs site description

Horonobe URL Project

Applicability of Safety Assessment Methodology

Workshop on "Assessing the suitability of host rock"

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JAEA's recent activities (again)

with following JAEA's URLs programs and schedules

- Development of heterogeneous pathway assessment methodology from deep underground to surface environment,
  - for evaluating the nuclide retardation effect,
  - using URLs surface-based investigation data.
- Development of host rock classification methodology from nuclide transport retardation effect in relatively larger scale (regional-site) site descriptive models.
  - with defining key parameters indicating nuclide retardation effect, such as nuclide transport path length, velocity and etc.
- Developing of quantitative host rock performance evaluation methodology at abstracted host rock,
  - for prospecting variability of host rock performance caused by not evenly identified minor structures.
  - Quantify host rock performance, according to available data at surface based investigation phase.
  - This examination might contribute not only for DIA selection, but also next phase investigation at / around tunnel.

Objectives of the 1st topic

- Development of heterogeneous pathway assessment methodology from deep underground to surface environment

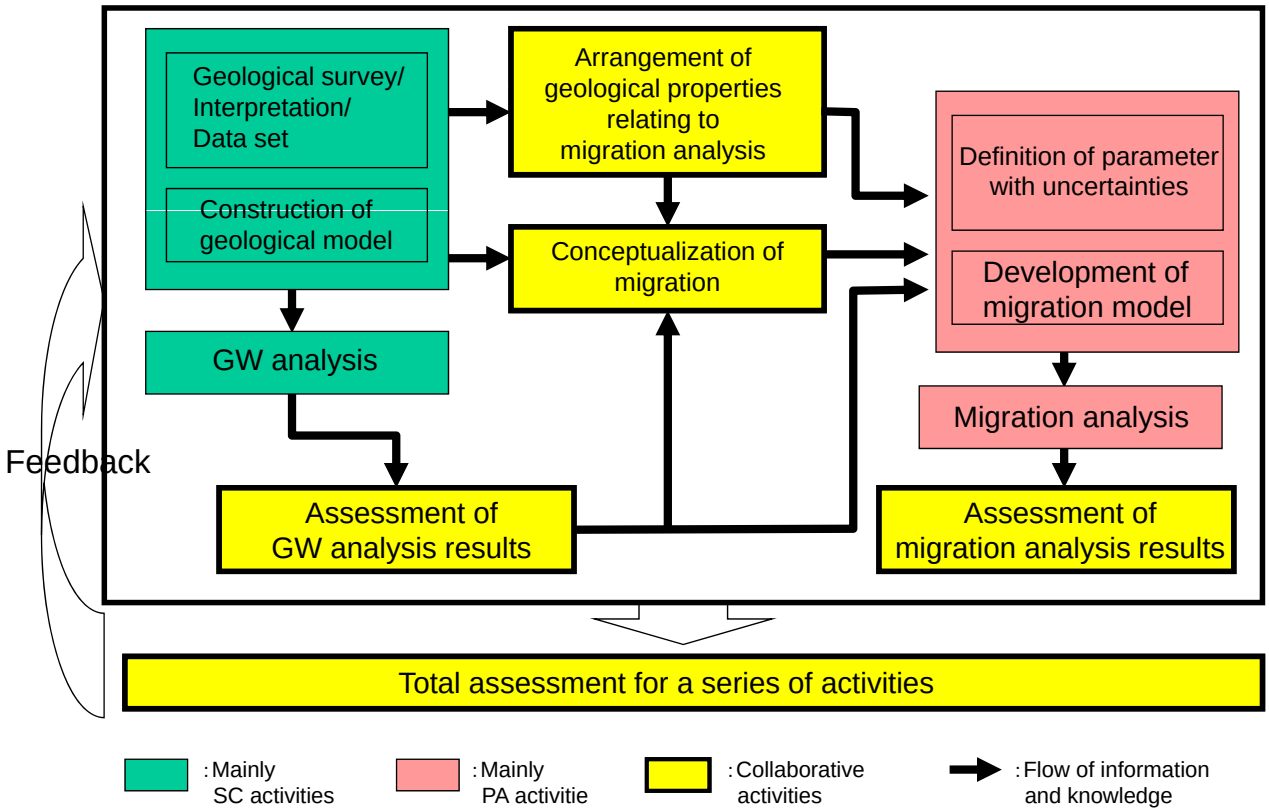
❑ *To reveal the methodology used actual data of geological environment – aim to compile knowledge database*

❑ *To evaluate applicability of the H12 methodology*

- Represent a series of the safety assessment procedure
- Extract sensitive factors
- Clarify important points such as impact of uncertainty
- Investigate modeling method

- Evaluate the result from surface-based investigations
- Extract issues for the next investigation phases

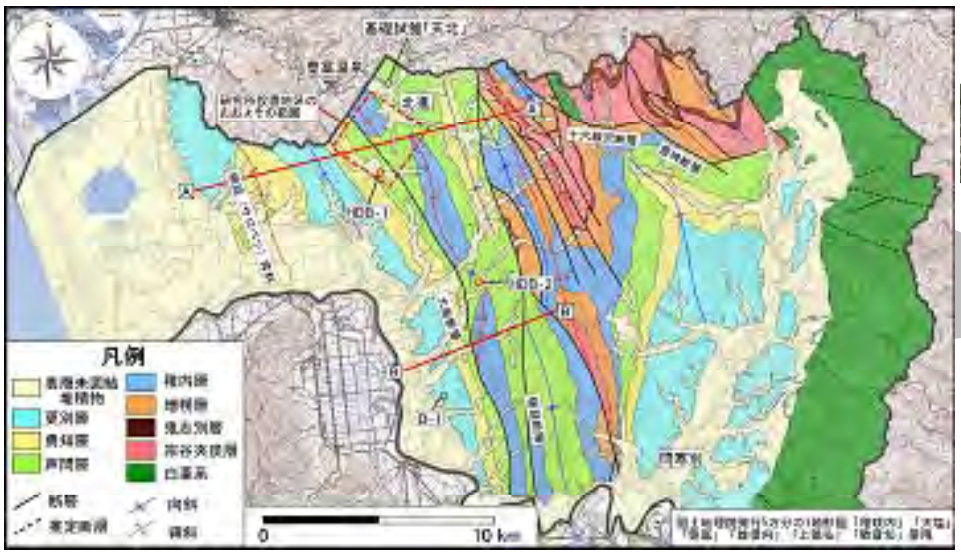
A frame of activities between SC & PA

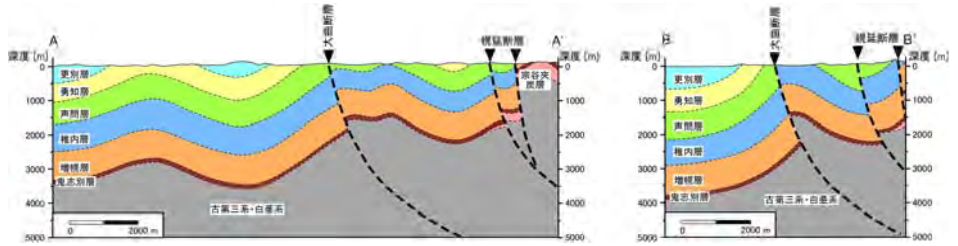


Strategy and assumptions

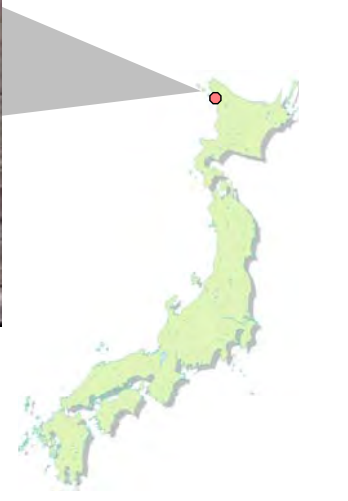
- Based on same methods as specified in H12 Report
- Conceptualization of solute transport: Porous media
  →True velocity from groundwater flow simulation
  →Connect 1D models along a transport pathway
- Assumed to select a relevant geological environment
- Except for the biosphere
- Laboratory experimental data by core specimen :
  → Actual data from surface-based investigation
- Steady state condition based on the present status of characteristics of geological environment

Geological Map of Horonobe area



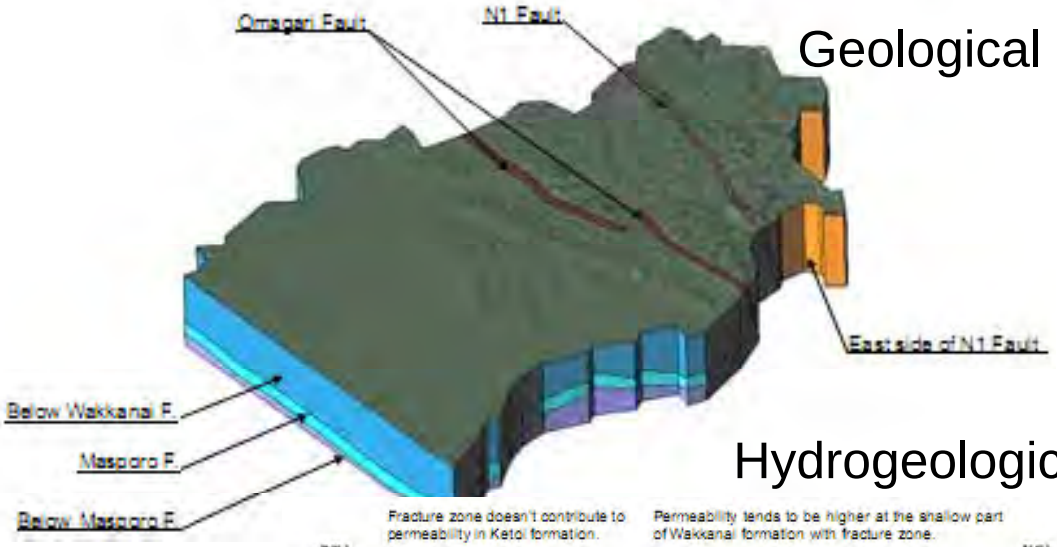


Horonobe URL

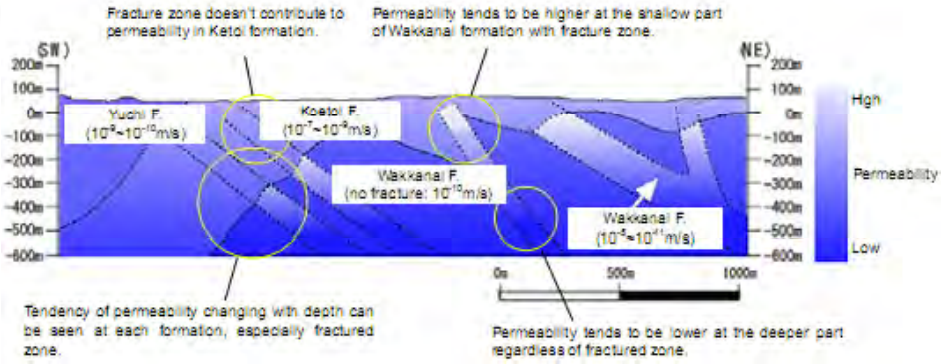


Modeling of Geological Environment

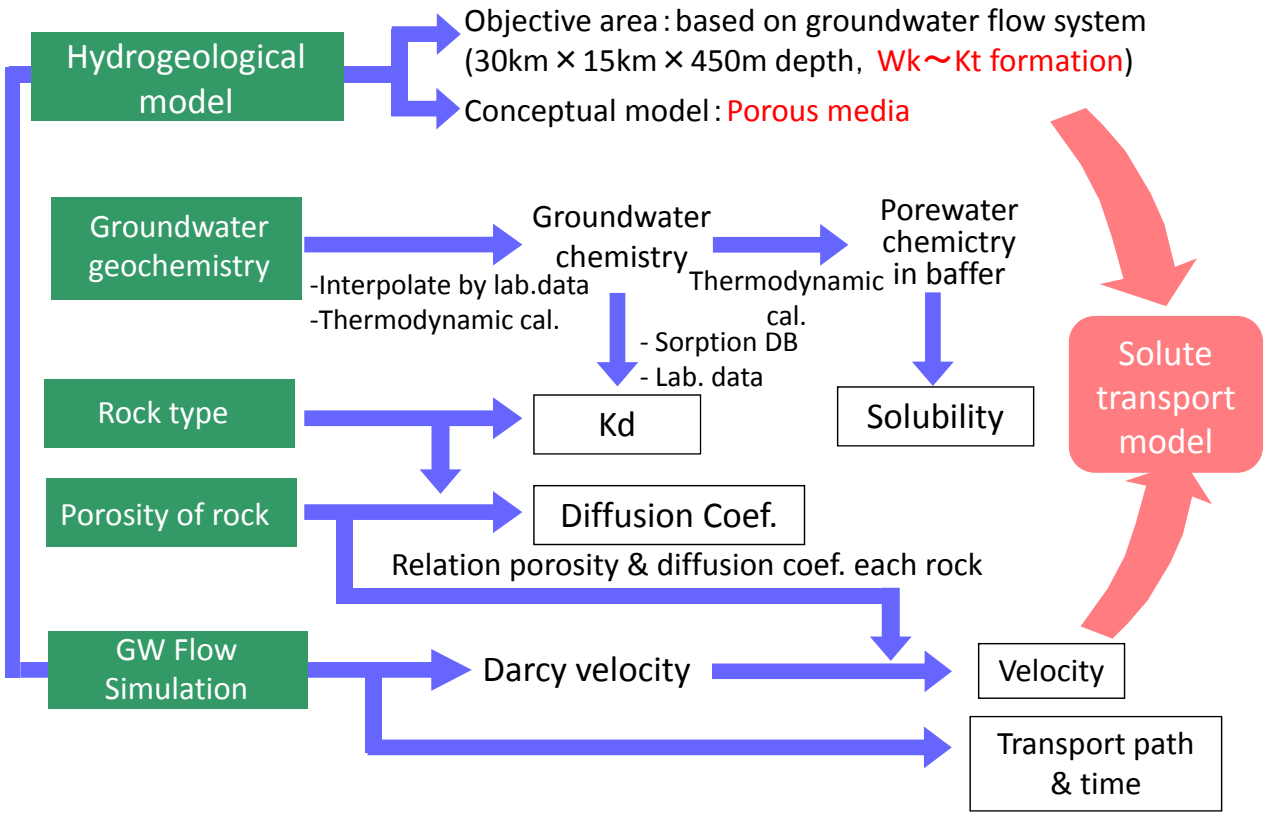
Geological Model



Hydrogeological Model

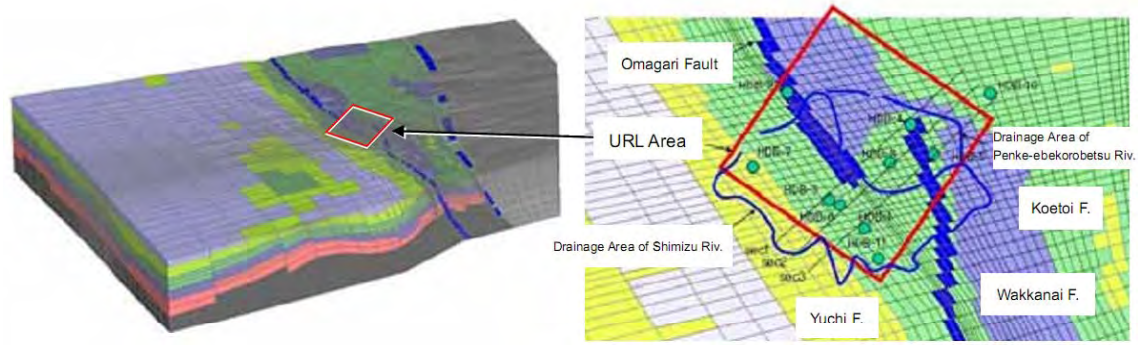


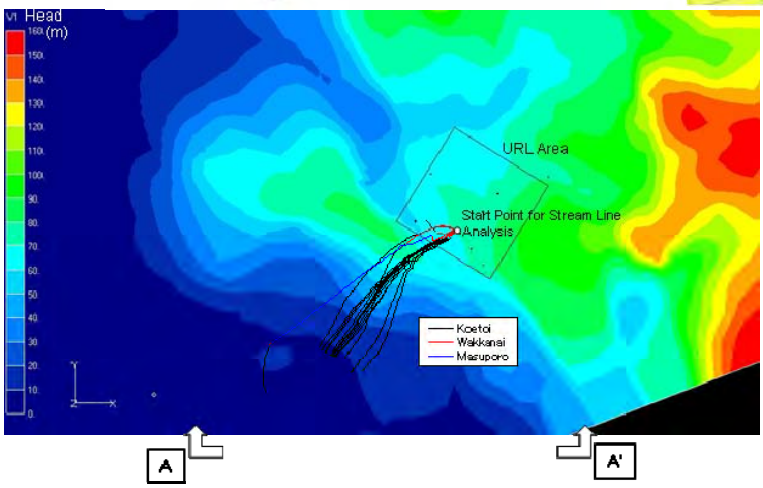
Conceptualization of Solute Transport

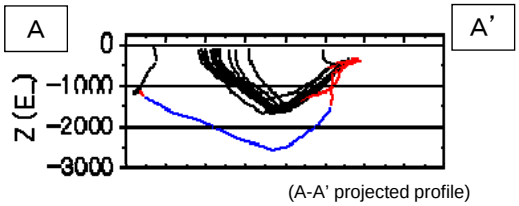


Extract transport pathway

Objective Area for Groundwater Flow Analysis



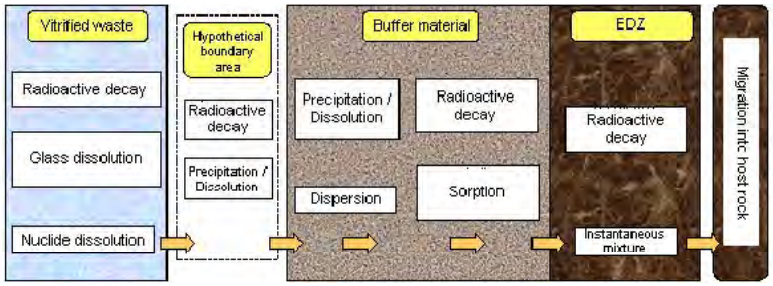




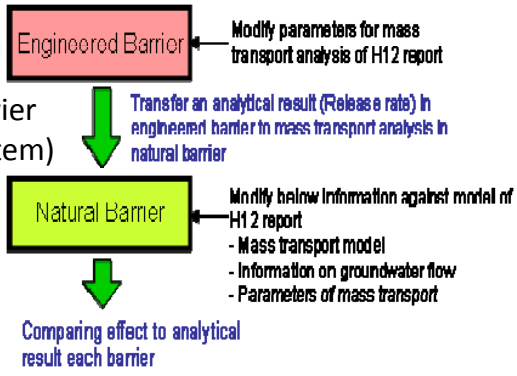
(A-A' projected profile)

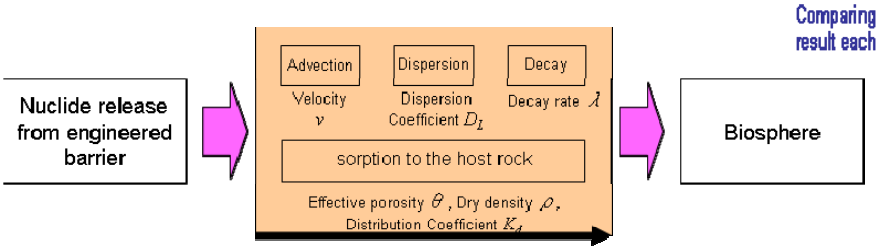
Result of Groundwater Flow Analysis
(Left: Horizontal plain at EL.-400m
Upper: A-A' cross section)

Solute Transport Model



Schematic View of Solute Transport in Engineered Barrier
(One dimensional model with cylindrical coordinate system)





Schematic View of Solute Transport in Natural Barrier
(One dimensional porous media)

These settings are assumed as same as method of H12 Report

Setting parameters

[Groundwater Flow]
- Velocity
- Transport distance

[Solute Transport in Natural Barrier]
- Porosity of rock
- Diffusion coefficient of rock
- Kd of rock
- Dispersion length
- Amount of input source

[Solute Transport in Engineered Barrier]
- Solubility of buffer material
- Diffusion coefficient of buffer material
- Kd of buffer material
- Flow rate into EDZ

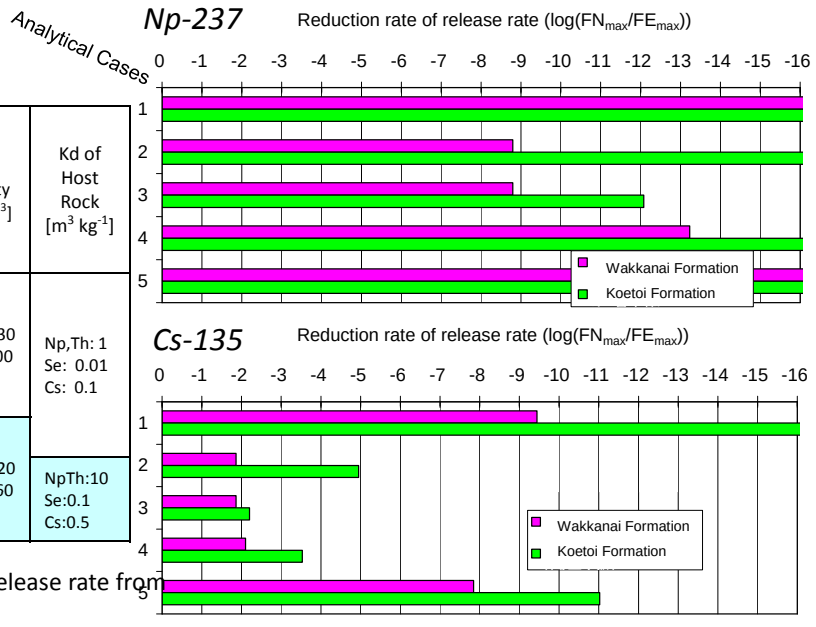
		Setting value	Uncertainty	Remarks
Pathway length [m]		1) Apply pathway information from GW flow analysis 2) Wk:250, Kt: 6,000	2) Wk: 250~2,000 Kt: 700~6,000	
Darcy velocity [m y^{-1}]		1) Apply pathway information from GW flow analysis 2) Wk: 6×10^{-4} Kt : 3×10^{-3}	2) 1/10~10 times of Setting value	
Flow porosity	Wk	0.38	1/10	
	Kt	0.54		
Dispersion length		0		
Porosity of host rock	Wk	0.38	1/10	=Hydraulic effective porosity
	Kt	0.54		
Dry bulk density of host rock [g cm^{-3}]	Wk	1.43	2.22	Uncertainty are set by 1/10 of porosity
	Kt	1.00	2.06	
Effective diffusion coef. of host rock [m^2 s^{-1}]	Wk	$2x10^{-11}$	$1x10^{-12}$~$7x10^{-10}$	28.3 deg. C
	Kt	$4x10^{-10}$	$3x10^{-12}$~$1x10^{-9}$	
Distribution coefficient of host rock [m^3 kg^{-1}]	Se	0.01~0.1	0.001~0.1	
	Cs	0.1~0.5	0.05~1	
	Np	1~10	0.1~50	
	Th			
Effective diffusion coefficient in buffer material [m^2 s^{-1}]	Se	$2x10^{-10}$		40 deg. C
	Cs	$4x10^{-10}$		
	Np	$2x10^{-10}$		
	Th			
Distribution coefficient in buffer material [m^3 kg^{-1}]	Se	0		
	Cs	0.001		
	Np	1		
	Th			
Solubility in buffer material [mol l^{-1}]	Se	$5x10^{-11}$		
	Cs	Soluble		
	Np	$5x10^{-8}$		
	Th	$8x10^{-6}$		
Flow rate into EDZ [m^3 y^{-1}]		0.005	0.001~0.05	

Example result of solute transport analysis

Analytical Cases

Case	Darcy Velocity [m/y]	Flow Rate into EDZ [m^3/y]	Path way Length [m]	Hydraulic Advective Flow Porosity [-]	Dry Density [kg/m^3]	Kd of Host Rock [m^3 kg^{-1}]
1	Wk: 6e-4 Kt : 3e-3	0.005	Wk: 250 Kt :6,000	Wk: 0.38 Kt : 0.54	Wk:1430 Kt: 1000	Np,Th: 1 Se: 0.01 Cs: 0.1
2	Wk: 6e-3 Kt : 3e-2	0.05				
3			Wk: 250 Kt : 700			
4				Wk: 0.038 Kt : 0.054	Wk:2220 Kt:2,060	
5						NpTh:10 Se:0.1 Cs:0.5

Max. release rate normalized by max. release rate from assumed EB.



-The decrease in release rates caused by the natural barrier would be large
-the decrease rate is sensitive to changes in parameters such as true velocity, porosity and Kd.

Results of 1st Topic

-We showed a series of safety assessment methodology established in the H12 Report based on actual data.

-The required procedure from SC to PA has been summarized as a work flow.

-Through the sensitivity analysis of solute transport, it was confirmed that the analytical results (decrease in release rates) caused by the natural barrier would be large and was sensitive to changes in parameters such as true velocity, porosity and Kd.

Approach, as one of key methods to be developed

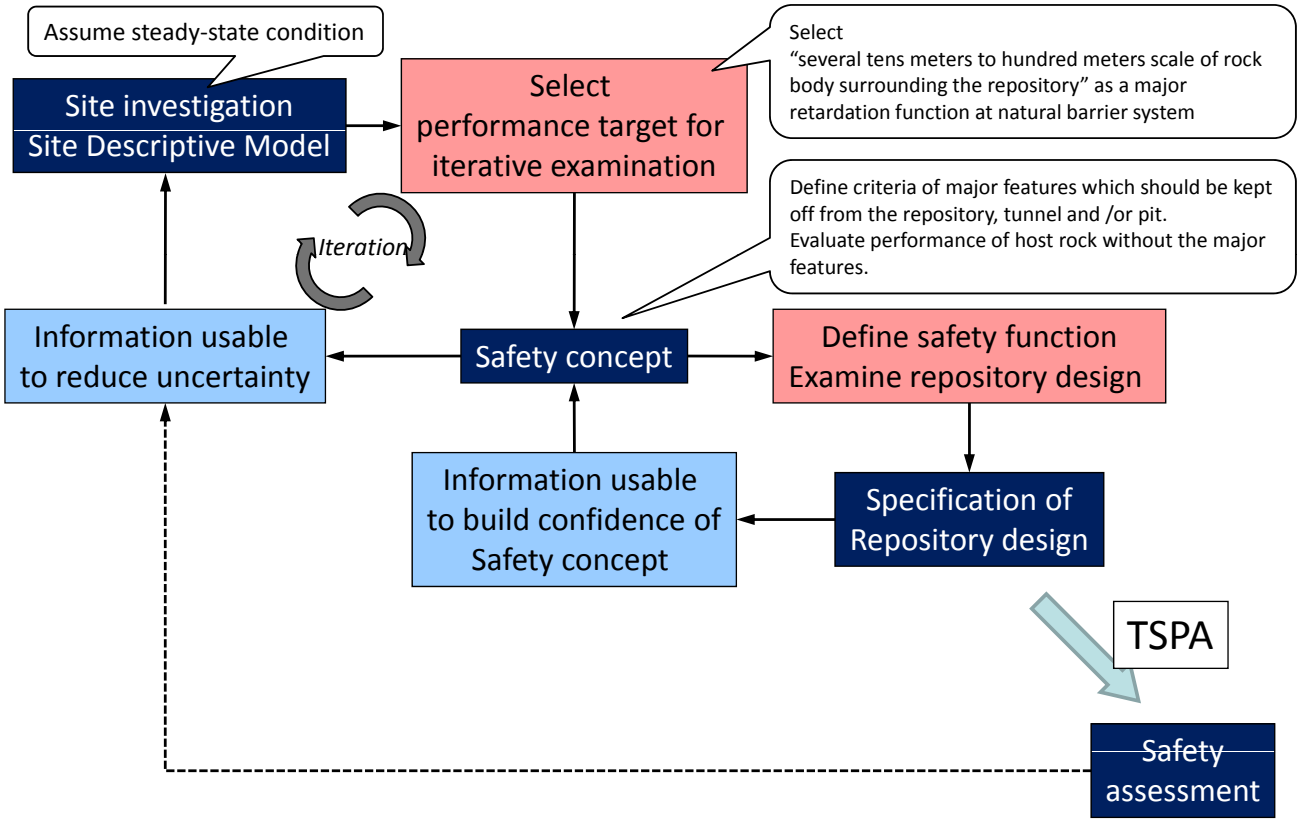
with following URLs programs and schedules

The 2nd topic

- Development of the host rock classification method by evaluating nuclide retardation effect in regional-site scale
  - Define key parameters indicating nuclide retardation effect, such as nuclide transport path length, velocity and etc.
  - Demonstrate the methodology how to abstract the relatively high performance area based on the key parameters.

- Development of quantitative evaluation method of abstracted host rock performance
  - Quantify host rock performance, according to available data at each infestation step.

Linkage between site-investigation and safety concept



Indices for evaluating nuclide retardation effect

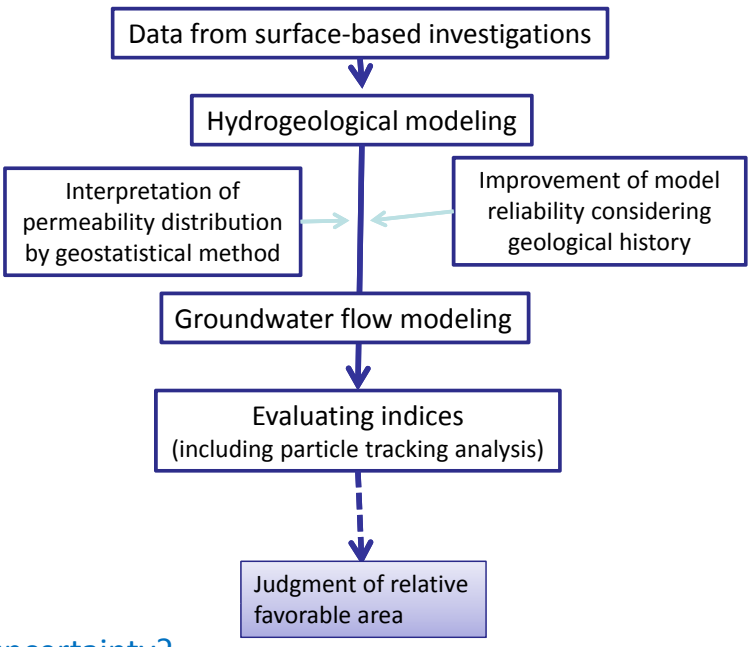
In order to evaluate nuclide retardation effect in regional area, transport properties such as transport pathway and flow velocity are indispensable

Uncertainty due to limitation of data

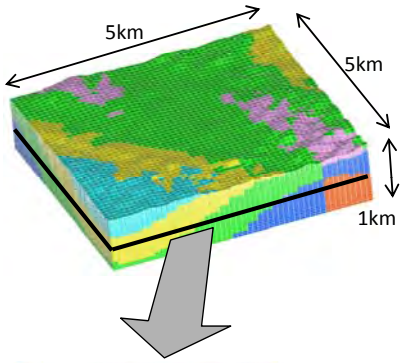
Quantitative Indices

- (1) Flow Rate
- (2) Travel time of groundwater flow
- (3) Environment at discharge area
- (4) Hydrochemical condition
- (5) Travel time of solute transport

What indices are insusceptible to uncertainty?



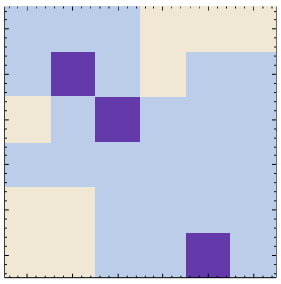
An example indices for evaluation



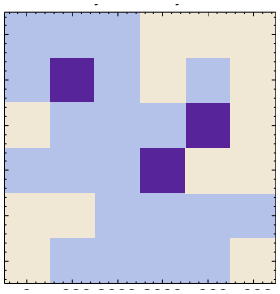
Darcy velocity (m/y)

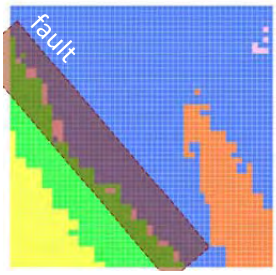
1e-5
1e-3
1e-1
1e+1

Reference case



Alternative case

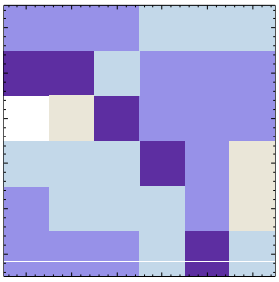


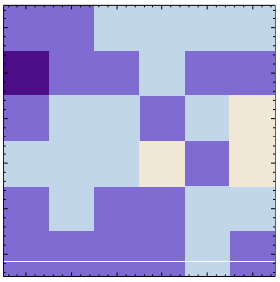


Geological Formation
A
B
C
DU
DL
E

Travel time to ground surface by Darcy velocity (y)

1e+8
1e+4
1e+0



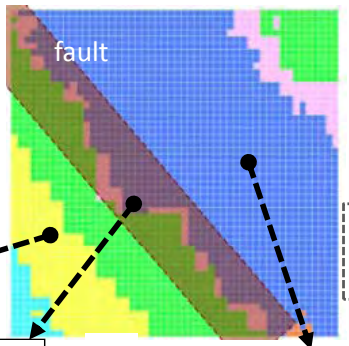


Cross section at EL. -500m
(5 km x 5 km)

An example of evaluating methodology

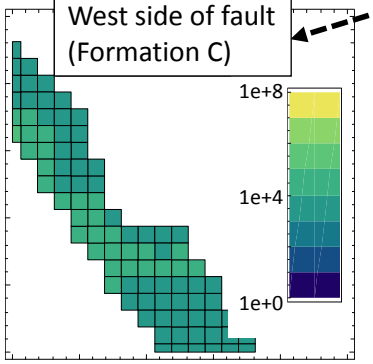
Principle

- Unit of objective area: 100m (Working hypothesis)
- To calculate a travel time of groundwater flow required to reach a hundred meter distance from start point by particle tracking analysis
- To evaluate in each formation and depth

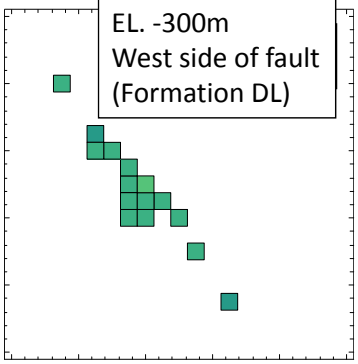


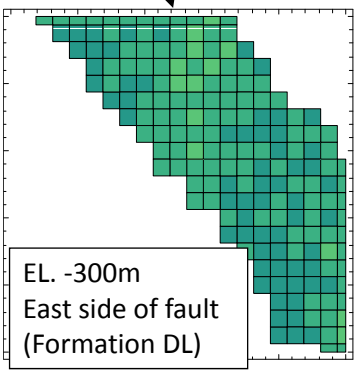
(5 km x 5 km)
Geological Formation
A
B
C
DU
DL
E

EL. -300m
West side of fault
(Formation C)



EL. -300m
West side of fault
(Formation DL)





EL. -300m
East side of fault
(Formation DL)

Travel time required to reach 100m distance calculated by Darcy velocity (y)

-We showed examples for evaluating methodology nuclide retardation effect
-Which indices will be relevant? How large should be defined as objective area? …