Case studies based on JAEA's URLs site description Mizunami Underground Research Laboratory, an example of fracture rock

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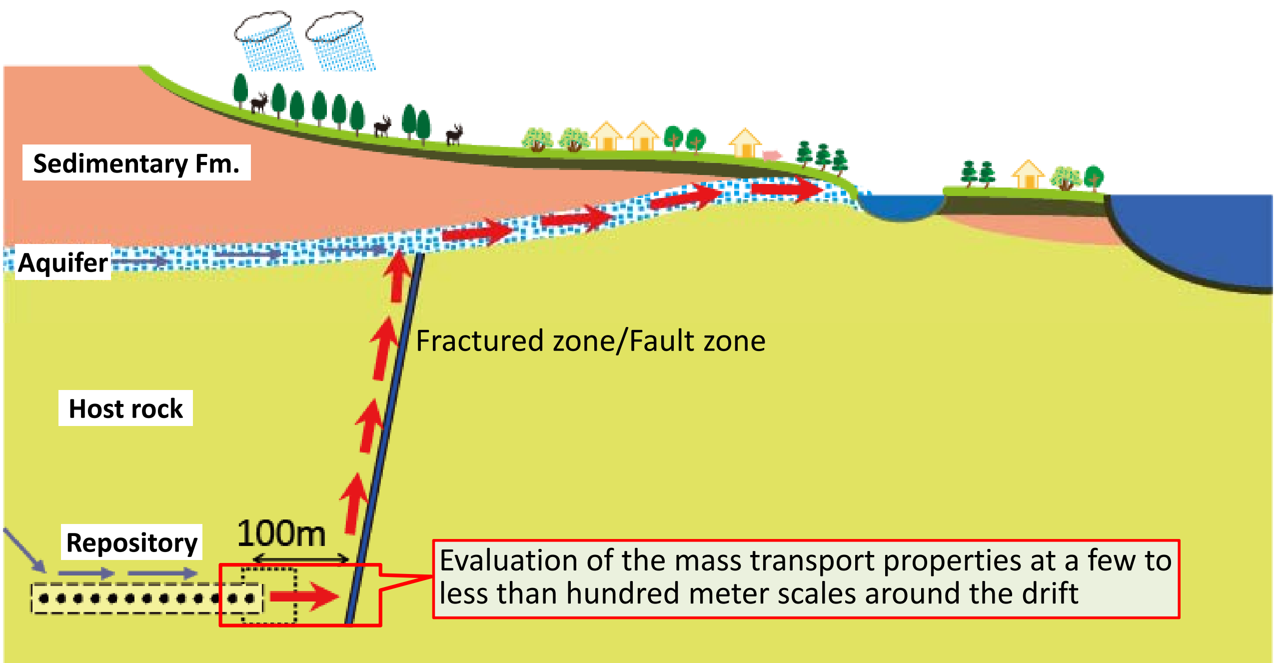
Today contents

- The current results of geological environmental investigations in/around Mizunami URL (previous presentation)
- Aim of mass transport/nuclide retardation investigation
- Concept of mass transport/nuclide retardation processing
- Goals of the mass transport/nuclide retardation investigations on MIU project based on the existing information
- Examples of in-situ and laboratory tests
- Status of international collaboration works
- An instance of effort for nuclide retardation investigations

Aim of mass transport / nuclide retardation investigation

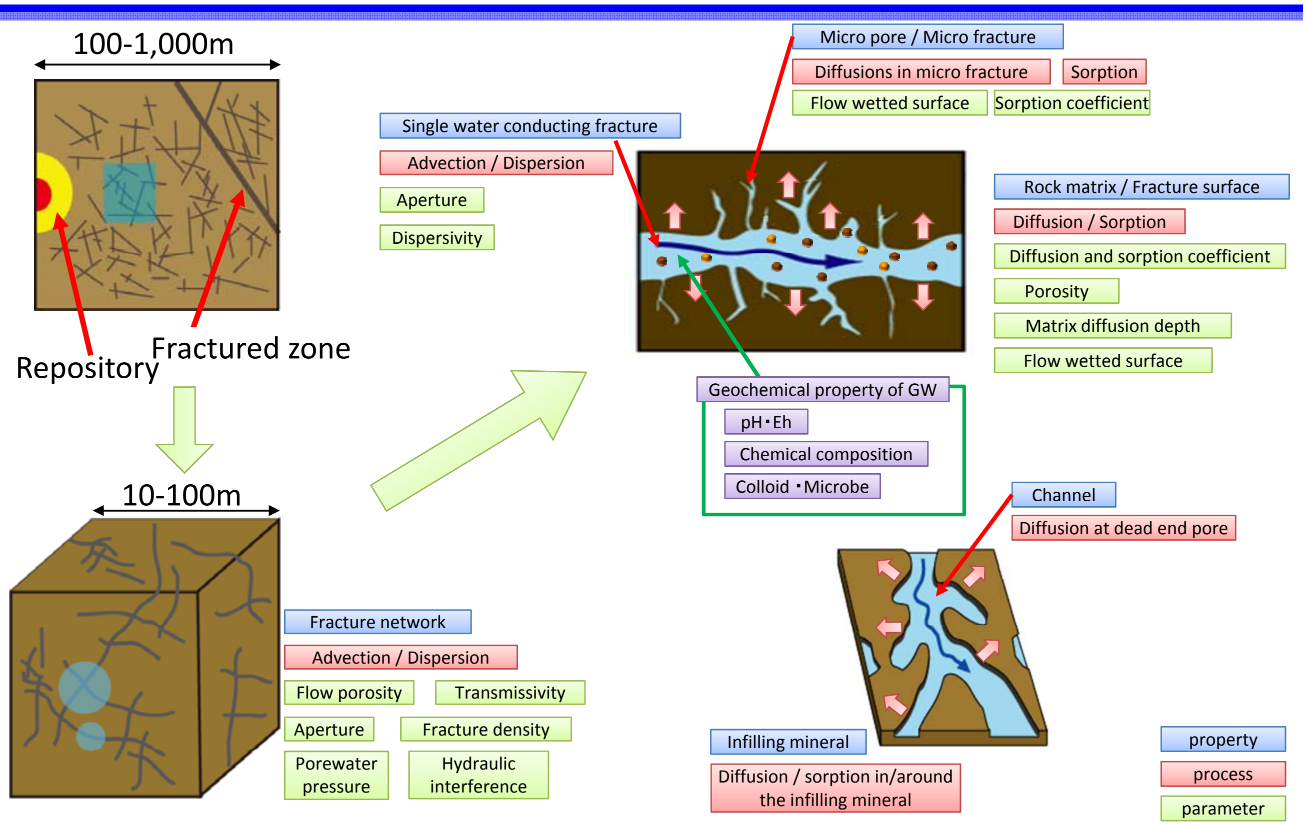
- To develop systematic methodology for relevant investigation and evaluation of structure, which contribute to groundwater flow between tunnel wall's back and 100m ahead, groundwater flow system and mass transport properties
  - ✓ to assess for relevance of hydrogeological model and mass transport conceptual model, and to update their models
  - ✓ to obtain parameter using on mass transport analysis
  - ✓ to understand mass transport and retardation processes

Concept of mass transport processing (1)



Modified from JNC(1999)

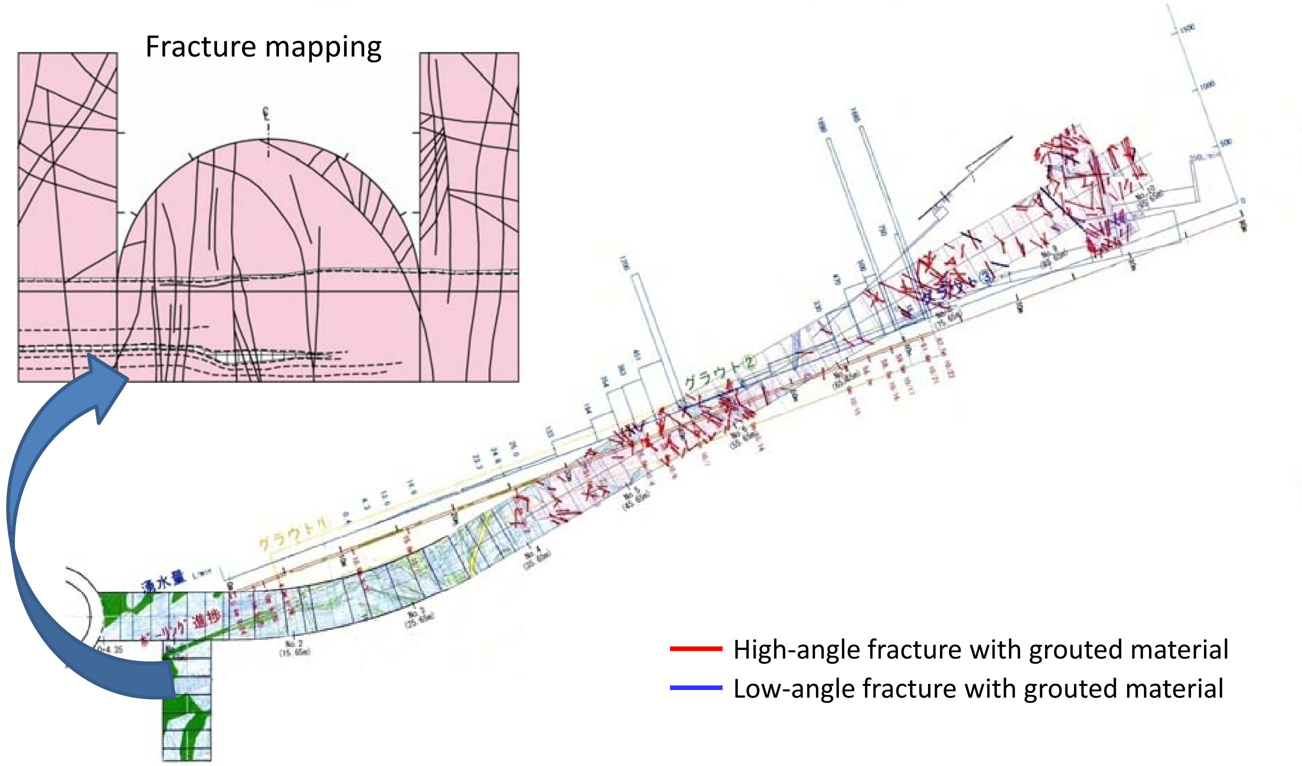
Concept of mass transport processing (2)



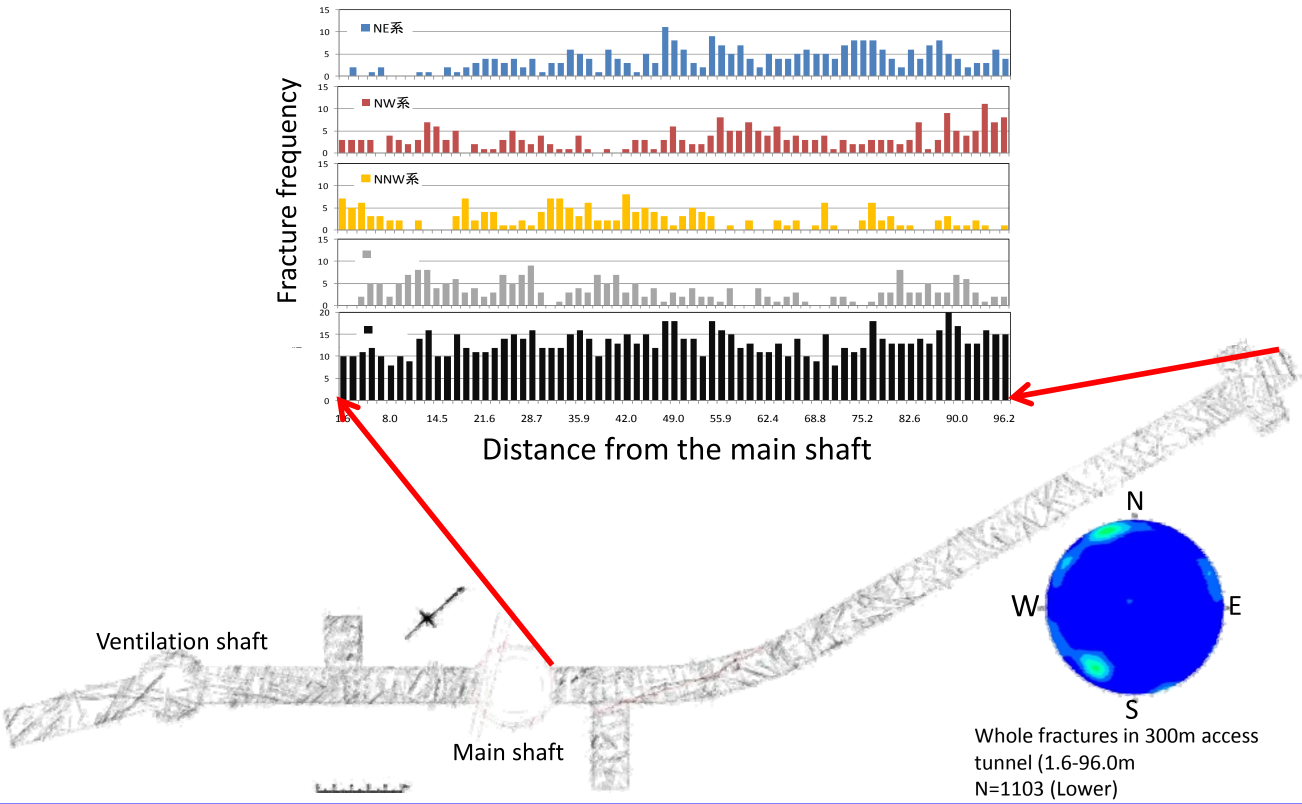
Goals of the mass transport and nuclide retardation investigations at MIU project based on the existing information

- Understanding the relation between the heterogeneous geological environments and nuclide retardation
  - the heterogeneous geological environments are observed in/around the shafts and research galleries at MIU site
- Development of techniques for characterising the mass transport and nuclide retardation
  - in-situ and laboratory test
  - mass transport analysis
- To clarify remaining issues in the mass transport and nuclide retardation
  - a parameter for mass transport and nuclide retardation is difference between in-situ and laboratory test

Current result of fracture distribution at GL-300m stage (1)



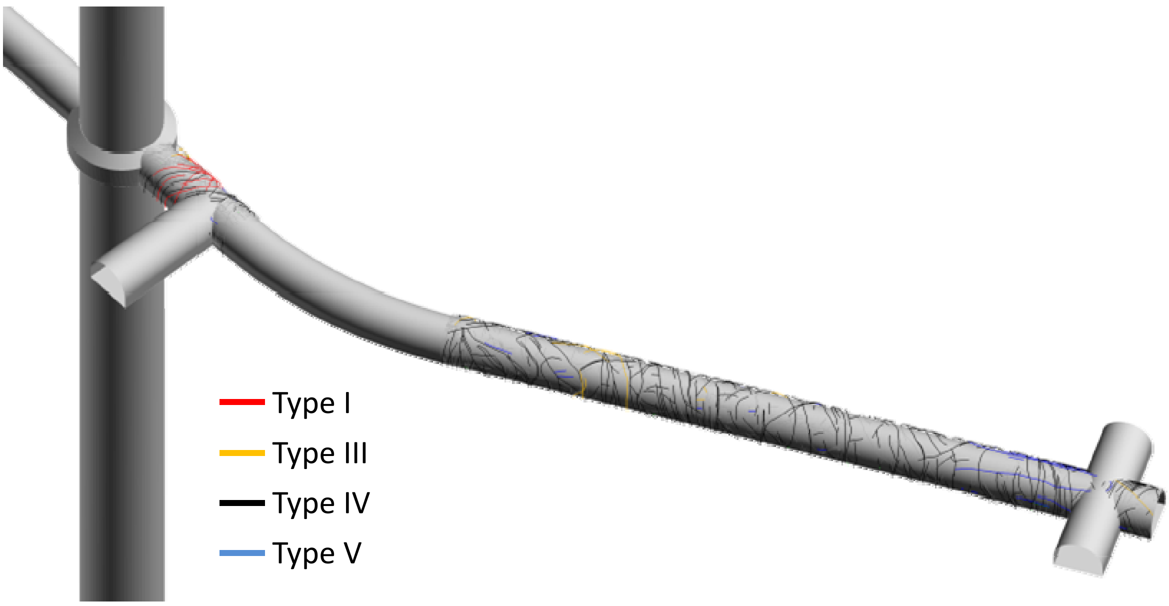
Current result of fracture distribution at GL-300m stage (2)



Classification of fractures in/around shafts and research galleries

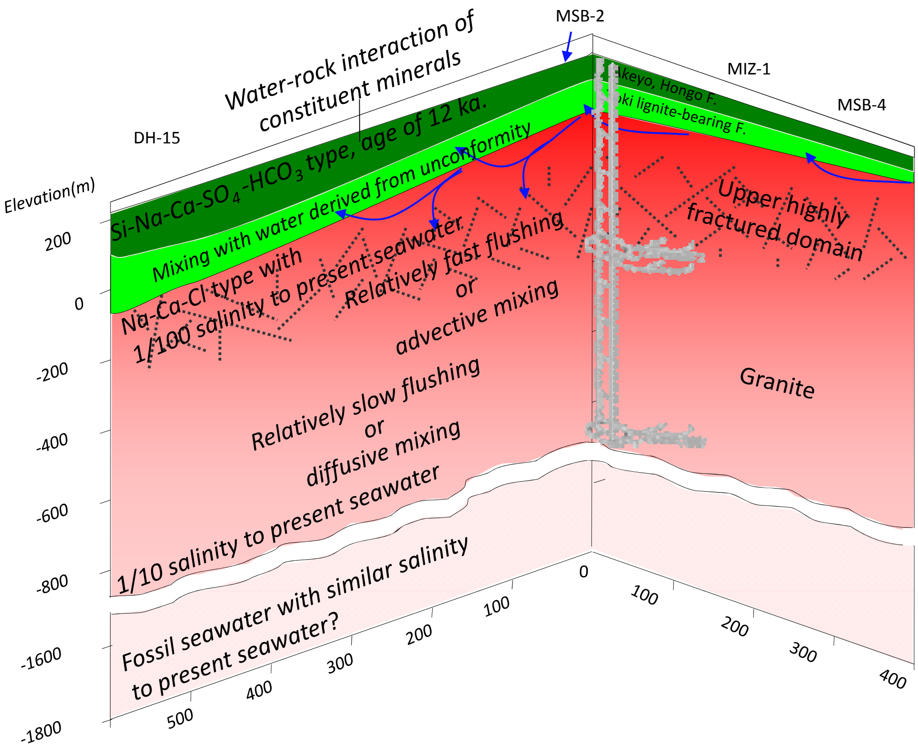
Type	In-filling mineral	Alteration of host rock	Conductivity	Geological period (Ma)
I Fracture (high-temperature type)	Chlorite	-	Low	69-43
II Fault	-	Strongly alteration	Low	64-43
III Fracture (high-temperature and altered type)	Chlorite	Greenish or whitish alteration	Low	64-43
IV Fracture (Low-temperature type)	Calcite, Chlorite	Orangish or grayish alteration	High	69-24
V Fracture (Low-angle fracture)	Calcite	-	High	43-22

Distribution of fractures in/around the shafts and research galleries at GL-300m stage



<u>There is not information of mass transport properties regarding fractures.</u>

Distribution of the groundwater chemistry around Mizunami URL



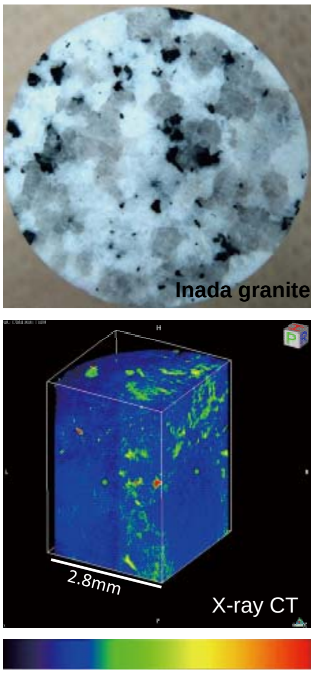
Investigation scale and items

Invastigaton scale	Fracture network (~a few tens of m)		Single water conducting fracture (~about 5m)			Rock matrix (~a few 10cm)		
Investigation items	hydrological characterisation	Tracer test	Tracer test	Large-scale lab. test	Fracture internal structure	Long term diffusion test	Sorption and diffusion test	Pore structure in rock matrix
In-situ/Lab. test	In-situ	In-situ	In-situ	Lab. test	Lab. test	In-situ	Lab. test	Lab. test
Data/dataset								
Geological property of fracture								
Fracture filling materials	O					O		
Fracture density / aperture	O				O	O		
Hydrological property								
Hydraulic pressure	O					O		
T/K/S/Ss	O			O				
WCF location / frequency	O							
Hydraulic connectivity	O							
Mass transport parameter								
Hydro-transport aperture								
Dispersivity								
Flow porosity								
Flow wetted surface								
Fracture 3D distribution					O			
Parameter on diffusion / sorption in rock matrix								
Diffusion coefficient							O	
Sorption coefficient							O	
Effective porosity							C	O
Matrix diffusion depth							O	
Pore structure								O
Geochemical property of groundwater								
Water chemistry (pH, Eh, chemical composition, etc.)	O		O			O		
Colloid	O		O			O		
Microbe	O		O			O		

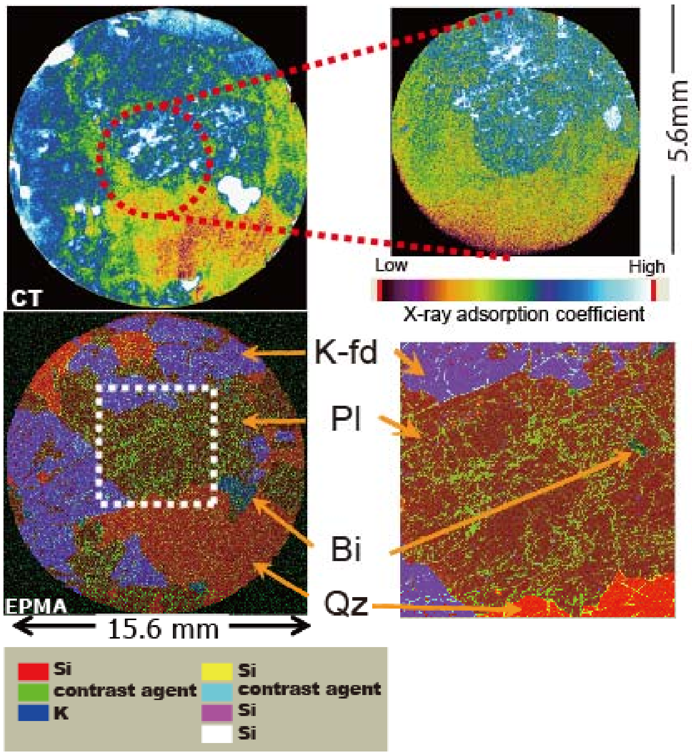
In-situ test | Lab. test | In-situ test | Lab. test

: Date is observed
: Data is calculated

Examples of in-situ and laboratory tests
1) pore structure and elements mapping

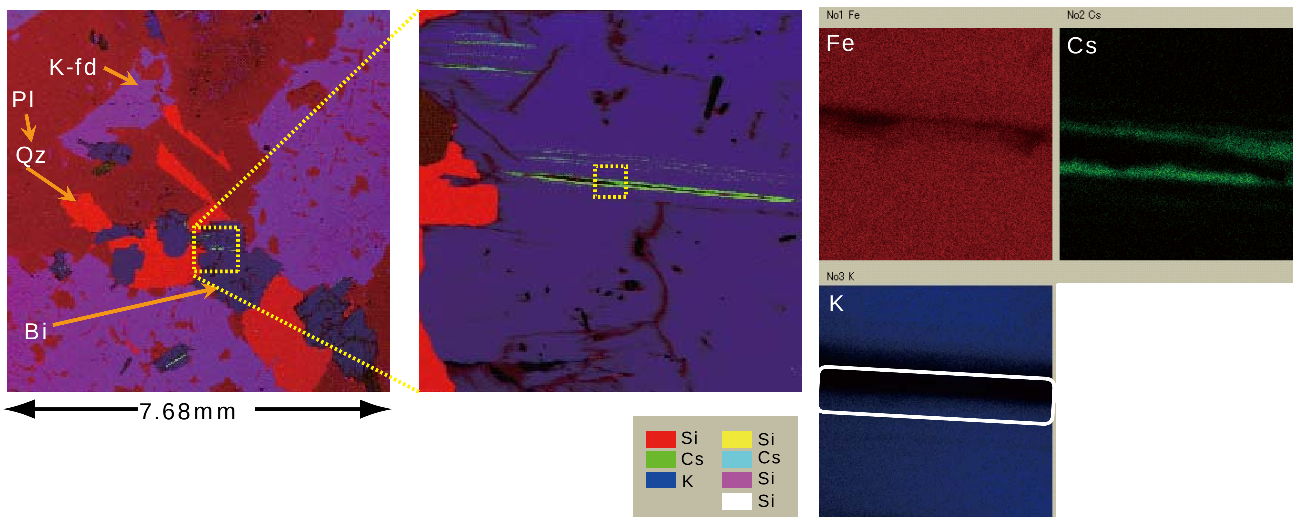


3D visualization of pore structures by X-ray CT



X-ray CT and EPMA analysis of granite (IRI, 2007)

Examples of in-situ and laboratory tests
2) pore structure and elements mapping

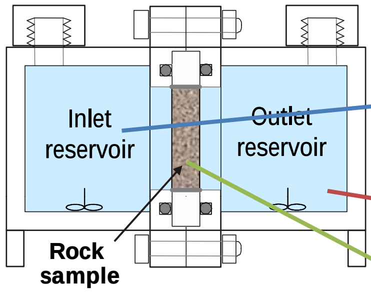


Cs selectively absorb on biotite rim

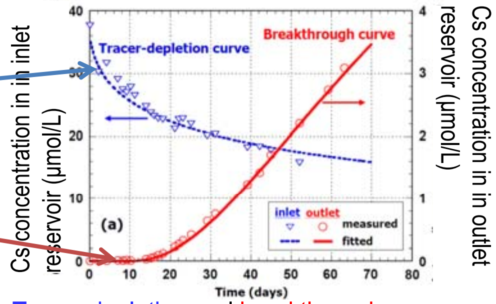
Sorption of Cs^+ on edge part showing low concentration of K^+

EPMA analysis (IRI, 2007)

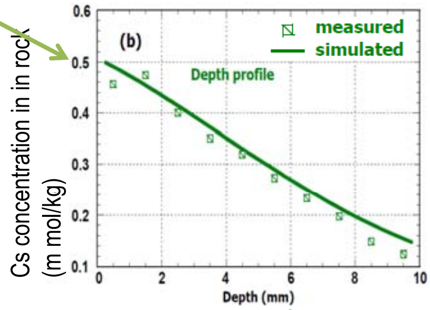
Examples of in-situ and laboratory tests
3) Diffusion experiment



Through-diffusion experiment



Tracer-depletion and breakthrough curve

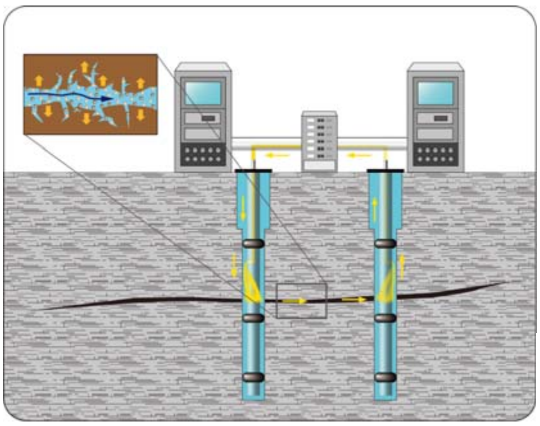


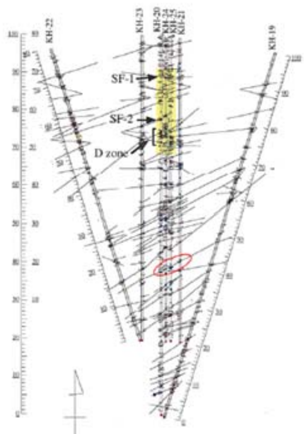
Depth profile

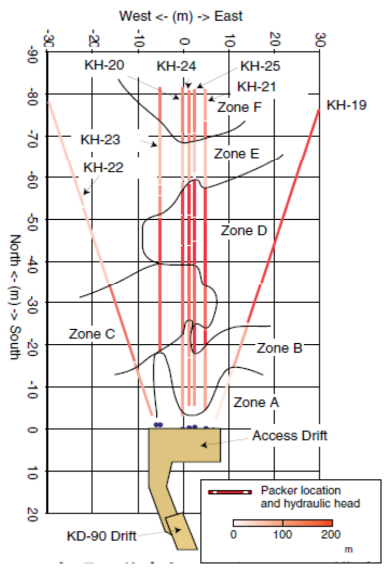
Advantage
- ✓ It is easy to estimate for test interval
- ✓ Cheaper than in-situ test
- ✓ Many samples are tested simultaneously

Demerit
- ✓ Boundary conditions are different between in-situ and laboratory

Examples of in-situ and laboratory tests
4) Example of tracer experiment (cross hole test)



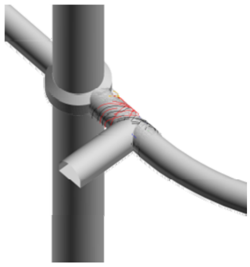




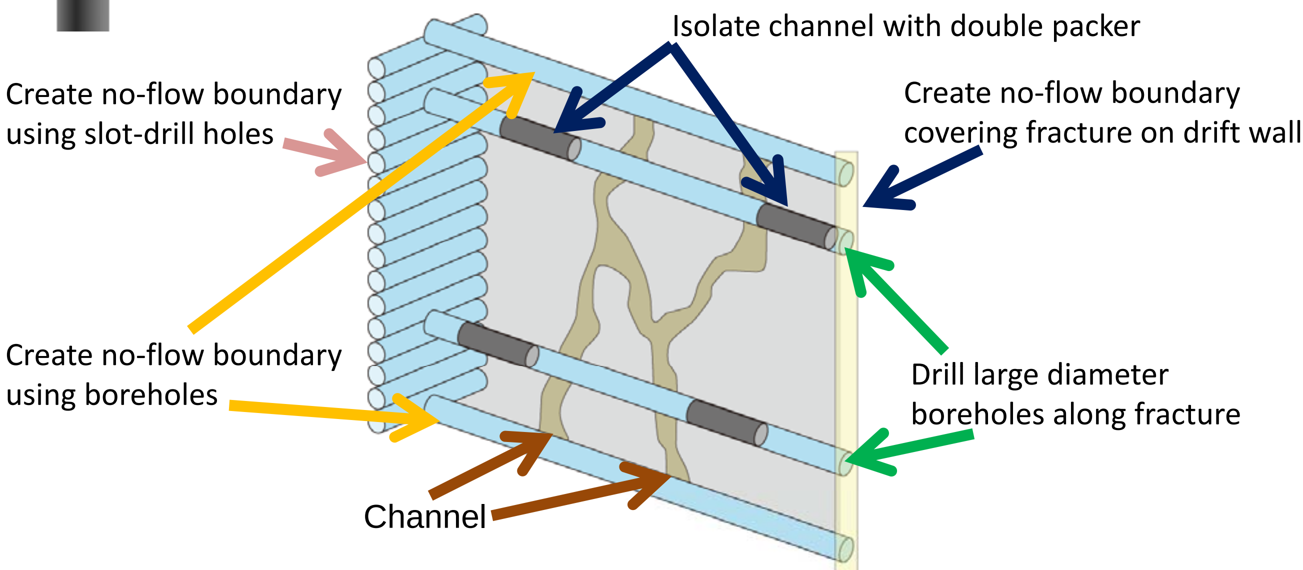
- Goal
  - ✓ Developing the concept of selecting test location and test procedure, etc.
    - ➢ Fracture network
    - ➢ Single fracture
  - ✓ Confirmation of applicability to the test equipment.

◆JAEA had experienced at Kamaishi.

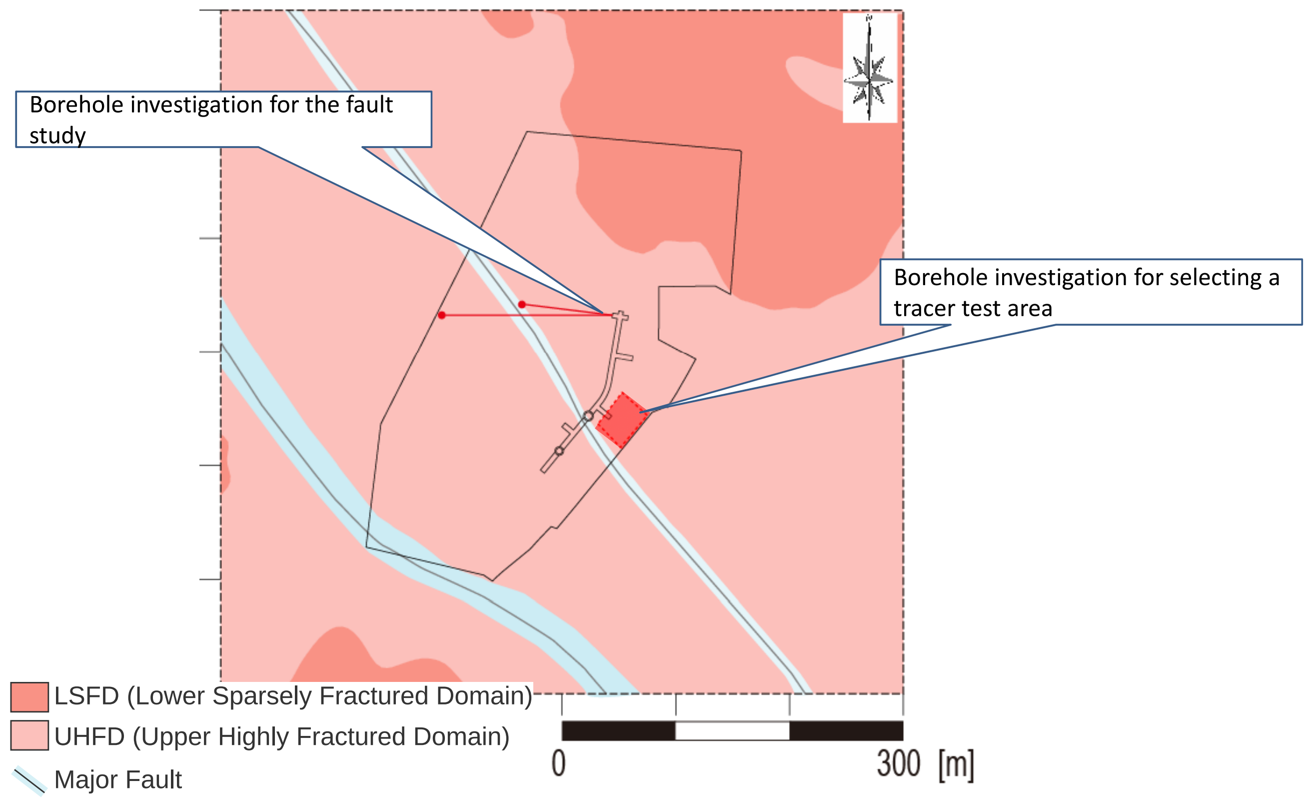
Examples of in-situ and laboratory tests
5) Example of tracer experiment under the flow controlled



- ✓ Low permeability single fracture
- ✓ Background of hydraulic gradient
- ✓ Short and Long term experiment



Current status of in-situ investigations at GL-300m stage



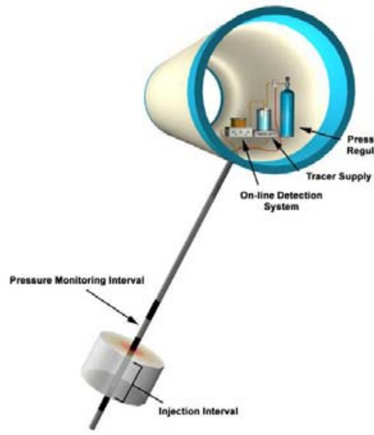
Strategy and methodology for selecting tracer test location

- To clarify the relation between geological structures and mass transport properties.
  - Laboratory test
  - Predictive borehole investigation
- To select a target of the geological structure for the tracer test (mass transport investigation).
  - Part of the matrix in/around host rocks
  - Fault and fracture
    - Fault
    - Single fracture or fracture network
  - Predictive modeling and analysis

Remained issue for in-situ tracer test

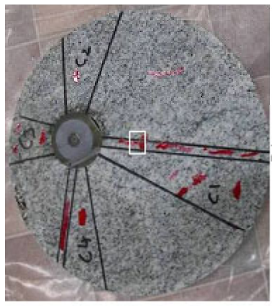
- It is possible to evaluate the flow porosity contributed to advection.
- It is limited to apply a result of tracer test to performance assessment
  - The conductivity of target fracture observed in tracer test is higher than the conductivity of an important fracture regarding performance assessment.
    - ✓ It is very difficult to investigate the low conductivity fracture under the natural conditions.
  - A conductivity of target fractures investigated is higher than important fracture for mass transport analysis. The internal structure may be different.
  - The result of diffusion coefficient evaluated by in-situ test tends to be higher than that evaluated by the laboratory test (<u>one of the international remaining issues</u>).
  - Hydrological condition during tracer test is different from natural groundwater flow.
    - ✓ It is unsuitable to evaluate the flow wetted surface.
  - It is not enough to understand the mass transport processing.
  - The parameters observed in tracer test might be unique characteristics.

Status of international collaboration works (1)
1) Long term diffusion test at GTS



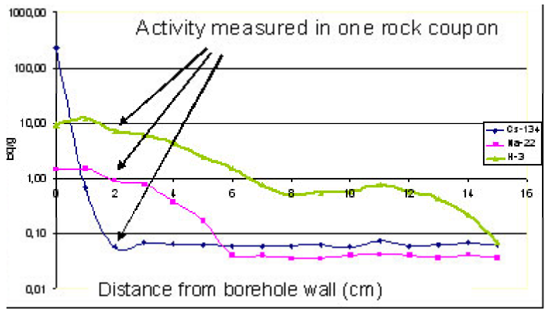
Layout of the long term diffusion test at GTS

A. Möri, P. Soler, K. Ota, V. Havlova 2007 'Grimsel Test Site Phase VI, LTD WP 1: Predictive Modelling for LTD Monopole Experiment', Nagra NAB 07-42



Over coring and core material

http://www.grimsel.com/gts-phase-vi/ltd/ltd-phase-i-update



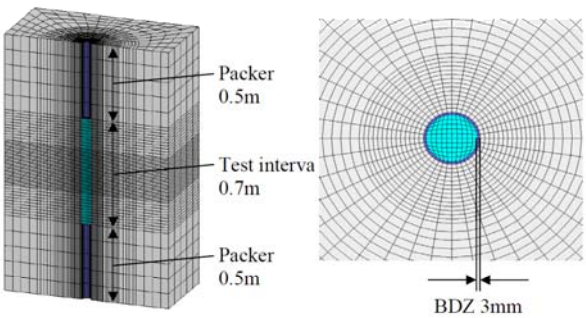
Results of diffusion profiles

http://www.grimsel.com/gts-phase-vi/ltd/ltd-phase-i-update

Status of international collaboration works (2)
2) Modeling works with LTD project at GTS

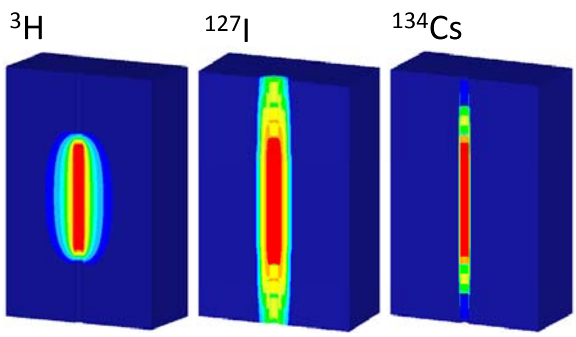
Distribution of tracer concentration in the rock matrix predicted by 3D Nflow

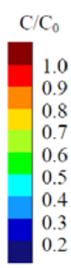
Conceptual model for D analysis



A. Möri, P. Soler, K. Ota, V. Havlova 2007 'Grimsel Test Site Phase VI, LTD WP 1: Predictive Modelling for LTD Monopole Experiment', Nagra NAB 07-42

Distribution of tracer concentration



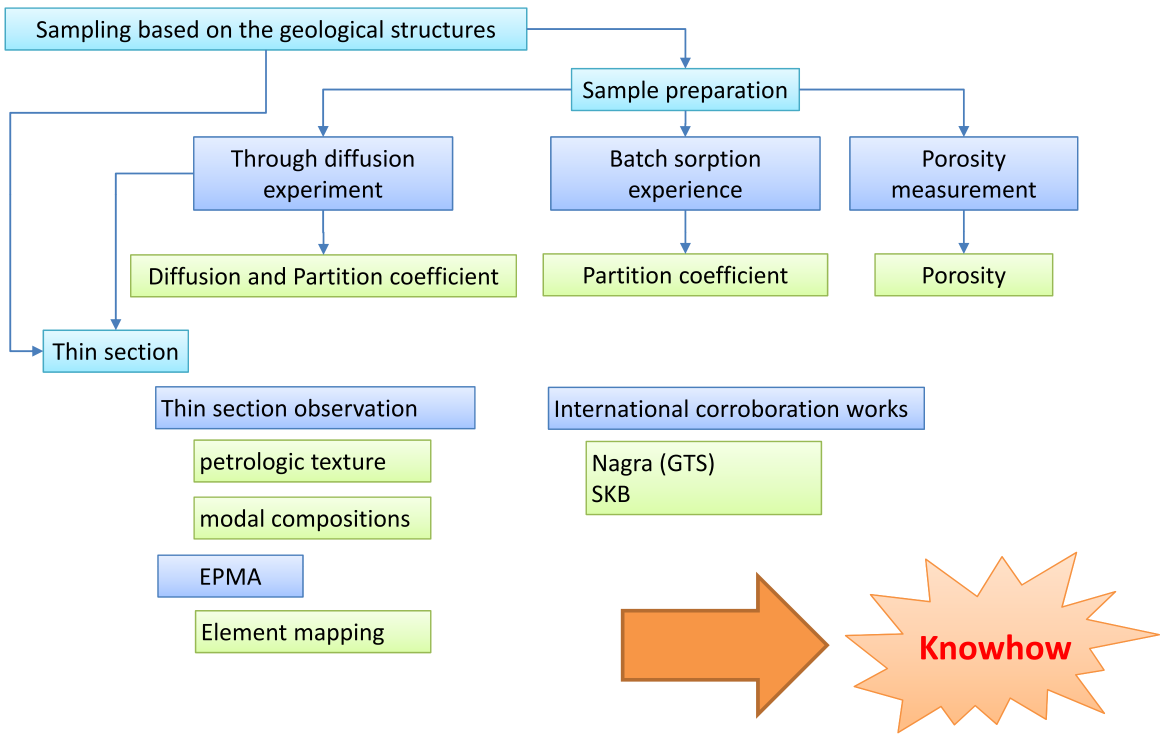


After 5 years

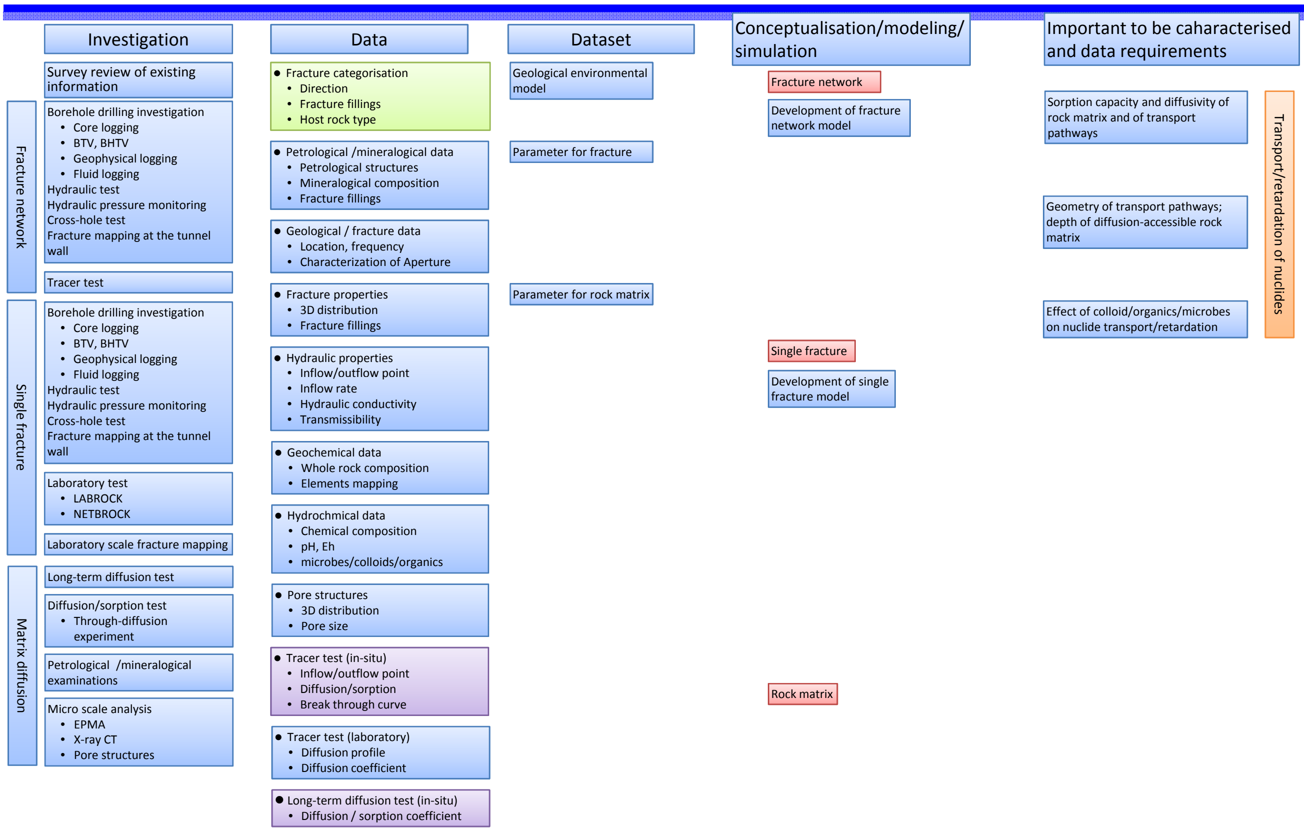
A. Möri, P. Soler, K. Ota, V. Havlova 2007 'Grimsel Test Site Phase VI, LTD WP 1: Predictive Modelling for LTD Monopole Experiment', Nagra NAB 07-42

- Only reference parameter values were used for the comparison.
- Tracer diffuses in 3D direction.
- ^{127}I and ^{134}Cs diffuse not only into the rock matrix perpendicular to the injection borehole but also upwards and downwards within the BDZ along the borehole.

A instance of effort
task flow for the diffusion and sorption test in laboratory



A instance of effort
Data flow diagram of nuclide retardation



Conclusion (1)

Important aims and investigation items in MIU project are

- Understanding the relation between the heterogeneous geological environments and nuclide retardation
  - Relation between the fracture types and mass transport properties
    - ✓ porosity
    - ✓ diffusion and sorption properties, etc.
  - Understanding the depth dependency of nuclide retardation
    - ✓ GL -300m and -500m access/research gallery
  - An important characteristic in performance assessment should be clarified.
    - ✓ Geological environments
    - ✓ Mass transport properties

Conclusion (2)

- Establish the transferability of laboratory-derived solute transport/retardation data to in-situ conditions
  - To obtain the in-situ data by using shafts and research galleries
  - To obtain the laboratory scale data by using the facilities of ENTRY and QUALITY in Tokai works
  - International collaboration works

- Establish the strategies of nuclide retardation investigations
  - Development of the task flow for nuclide retardation investigations
  - Development/update of the data flow diagram for nuclide retardation

Discussion points

- **How do you think the goals of mass transport and nuclide retardation investigations on MIU project?**
  - Whether a similar research has already been performed or not?
- How should be decided the (in-situ) test location?
  - What is a degree of conductivity for applicable tracer test?
  - It is important that the hydraulic pressure is stable for the long term diffusion experience. How can the test condition be allowed?
- Necessity of considering the near field effects (e.g. EDZ).