An approach for the host rock assessment methodology development in JAEA, based on URLs site investigation data

Workshop on "Assessing the suitability of host rock"
Yokohama Minato-Mirai , Landmark Tower
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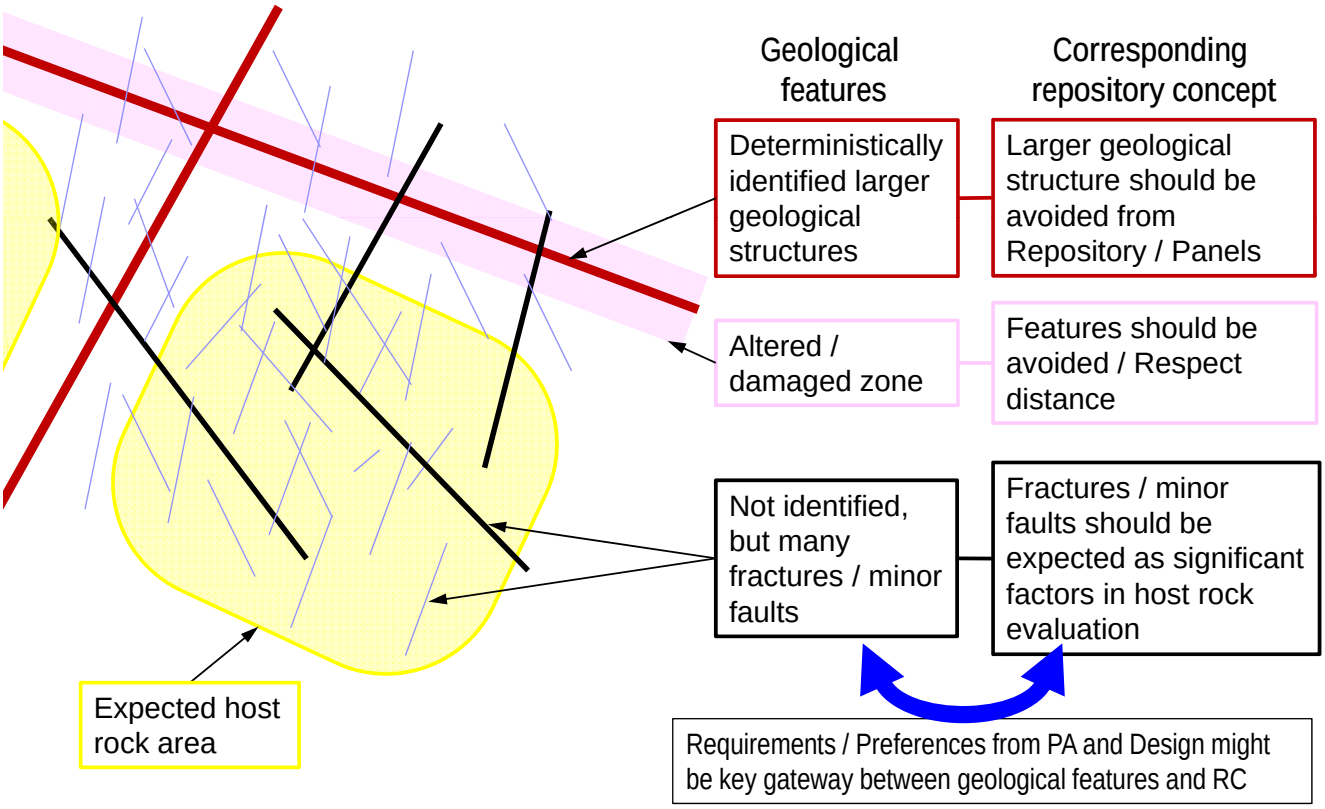
Atsushi Sawada
Japan Atomic Energy Agency

Stepwise Approach for the site selection

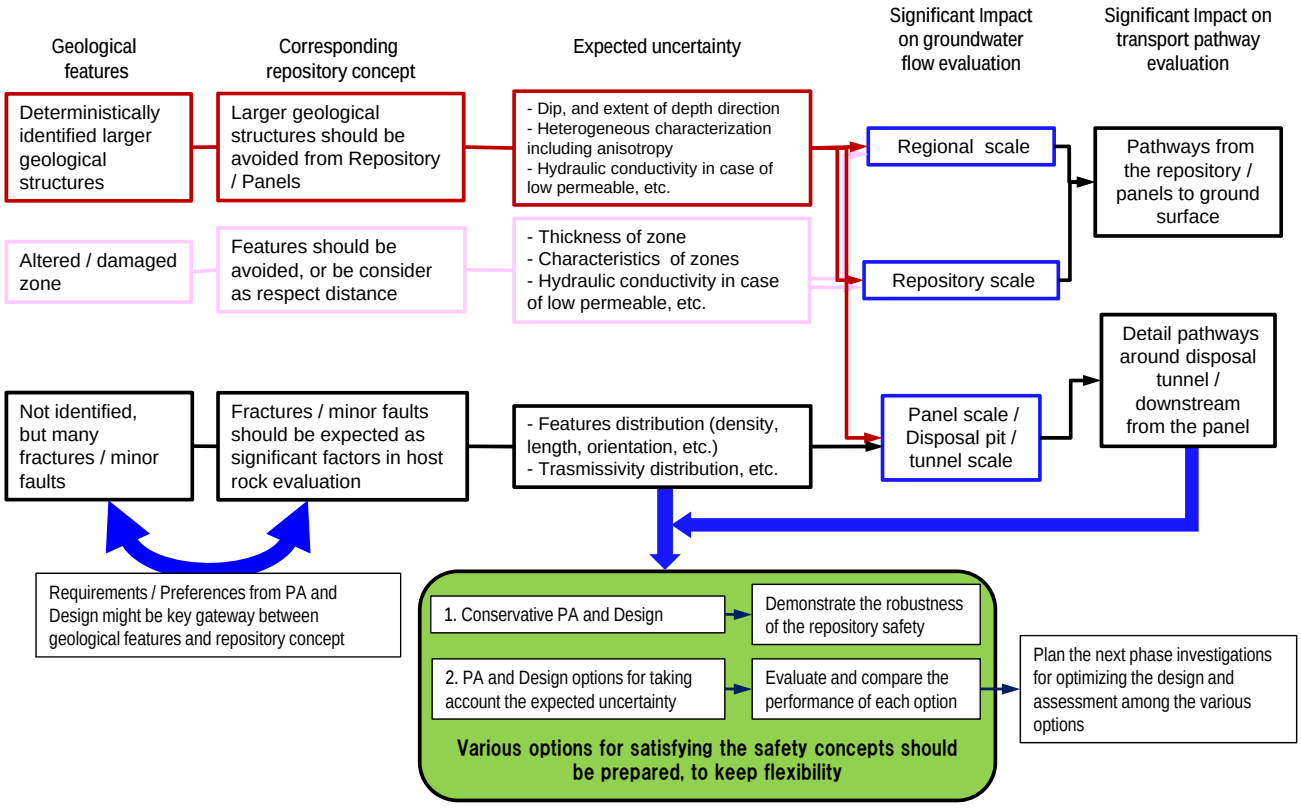
NUMO's strategy for the safety of geological disposal, NUMO-TR-09-05

- **Selection of Detailed Investigation Area** (based on Preliminary Investigation: First half of the surface based investigation)
  - Establish the basic layout of the repository
  - Preliminary evaluation of the long-term safety
- **Selection of Repository site I** (Based on Detailed Investigation: Later half of the surface based investigation)
  - Define the basic layout of the repository
  - Evaluation of the long-term safety
- **Selection of Repository site II** (Based on Detailed Investigation: Investigations in an Underground Investigation Facility)
  - Define the basic design of the repository
  - Assessment of the post-closure long-term safety

Key geological features and corresponding repository concept for defining repository layout at selecting DIA



Expectation of uncertainty of the key geological features and flexible PA and design methodologies



Methodologies development

for defining layout and evaluating repository safety

- It is required to develop the methodology for evaluating,
  - suitable host rock volume,
  - based on the performance assessment of nuclide retardation effect on engineered barrier system and natural barrier system, and
  - to prospect the long-term safety based on the safety assessment.

- Applicability should be studied by URLs data
  - for abstracting the criteria required of both engineered barrier and natural barrier system, and
  - for illustrating of the examples how to satisfy the criteria based on the limited amount of data at each step of the site investigation.
  - The study might be constrained by JAEA's URL programs and schedule.

JAEA's recent activities of methodology development

with following JAEA's URLs program and schedule

- 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 rock classification methodology,
  - based on 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 more quantitative host rock performance evaluation methodology at selected host rock area,
  - for evaluating variability of host rock performance based on the expected uncertainty of minor structures distributed in the host rock area,
  - the minor structures which could not fully identified, at surface based investigation.
  - This examination might also contribute to planning the next phase investigation at / around tunnel, such as DI in an underground investigation facility, or underground investigation phase of URLs.

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    ➡ Kunimaru-san will present an example of the experimental plan at MIU site

An approach of quantitative evaluation of host rock performance

Step1: Select target area

↓

Step2: Define geological structures and the conceptualization

↓

Step3: Compile data set from site investigation

↓

Step4: Evaluate nuclide retardation performance at the selected target

An approach of quantitative evaluation of host rock performance

with an example of applying Mizunami URL data set

Step1: Select target area

Select "several tens meters to hundred meters scale of rock body surrounding the tunnel"

Step2: Define geological structures and the conceptualization

1) Deterministically defined faults and fractures
2) Stochastically defined background fractures

Step3: Compile parameter values based on site investigation data set

1) Deterministically defined faults and fractures
2) Stochastically defined background fractures

} Characteristics (transmissivity, orientation, size and etc.), investigation method, phase, etc.

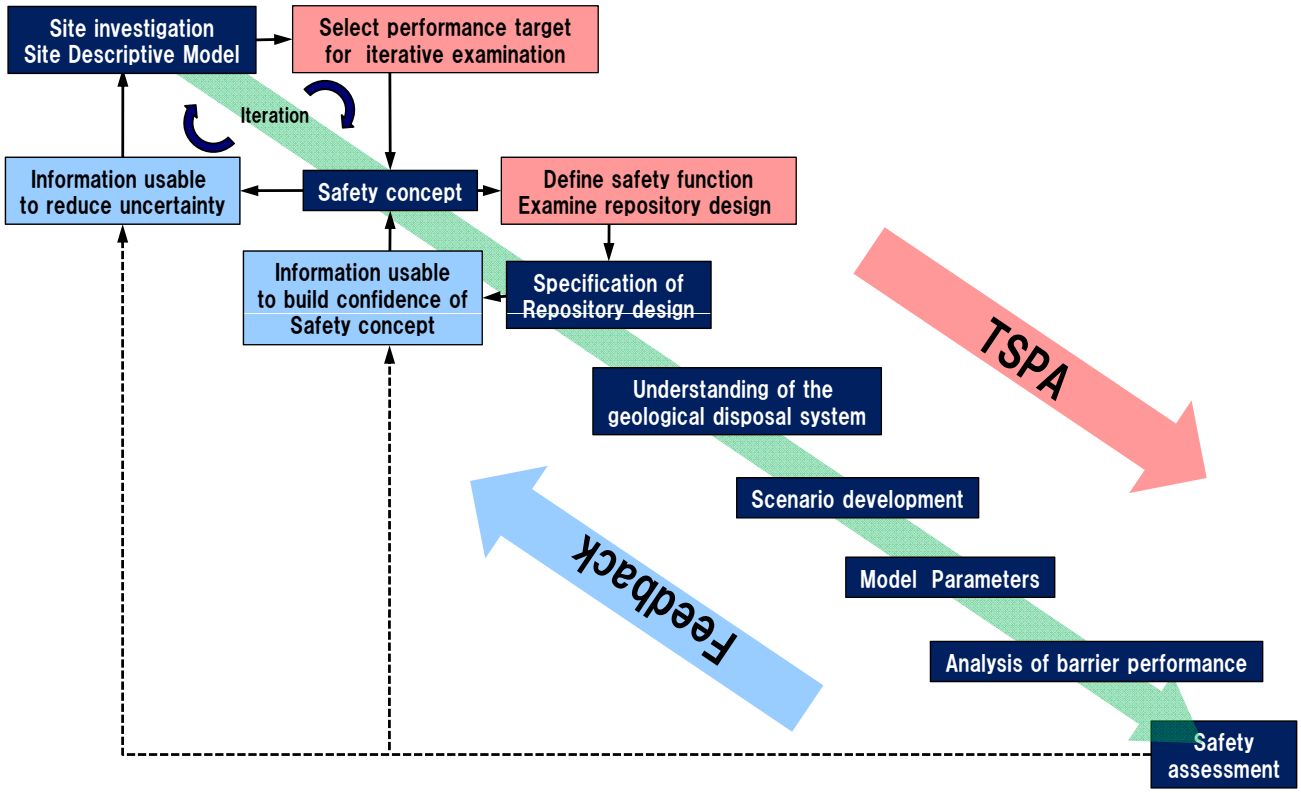
Step4: Evaluate nuclide retardation performance at the selected area

- Calculate nuclide transport, with assuming each structure continues, independently.
- Classify all structures in order of the nuclide retardation effect.

Quantitative evaluation of the host rock performance

The classification of1) characteristics each structures, 2) investigation method & phase, 3) retardation performance, might be useful,
- to abstract the criteria of major structures which should be kept off from the repository, tunnel and /or pit, and
- to evaluate quantitative retardation effect of remaining rock volume without the major structure

TSPA and Feedback to the site investigation



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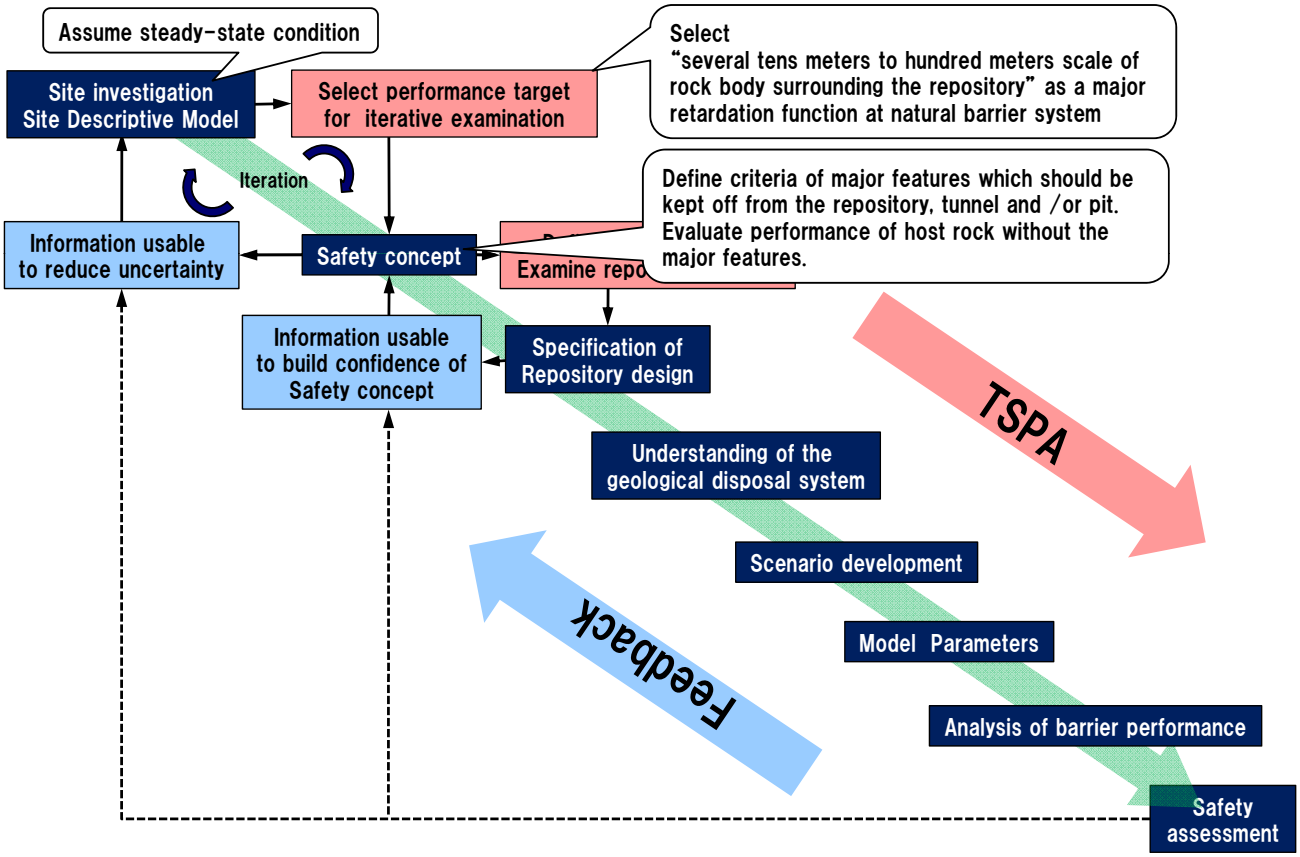


Several tens meters scale host rock characterization

- **Several tens meters to hundred meters scale of rock body surrounding the repository,**
  - · was one major retardation function at natural barrier system in H12 Report.
  - · could be modeled as certain (but, minimum) transport distance in natural barrier, compared with relatively uncertain total transport length from the repository to the ground surface.

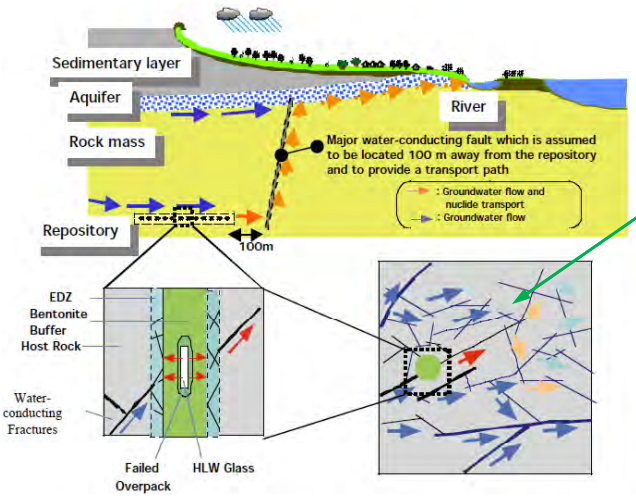
  <--- conservative manner : Near-field approach, relies on EBS and surrounding host rock.

- **Limited data available at the surface based investigation**
  - · More detailed data might be available from the tunnel (at DI stage and construction stage).

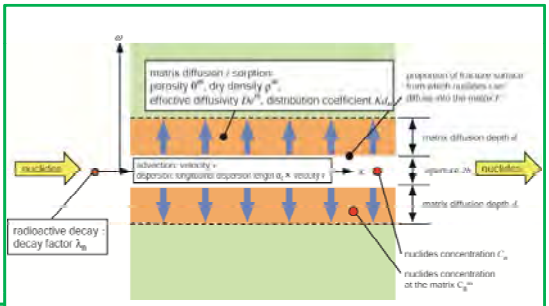
  -> Quantification and/or improvement a confidence will be possible, with the repository development

H12 report: Natural barrier assessment scheme

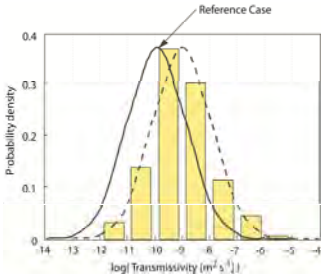
- **Host rock**
  - Select 100 meters host rock located downstream of the repository
  - Apply conventional method (one-dimensional multiple pathway model)
  - Focus transmissivity, T, distribution as major factor or rock heterogeneity
- **Major Water Conducting Fault, keeping 100 meters off from the repository**
  - Define simply minimum pathway upward to aquifer
  - Assume maximum T of host rock



Conceptual illustration of nuclide transport pathway considered in H12 report



One-dimensional nuclide transport model



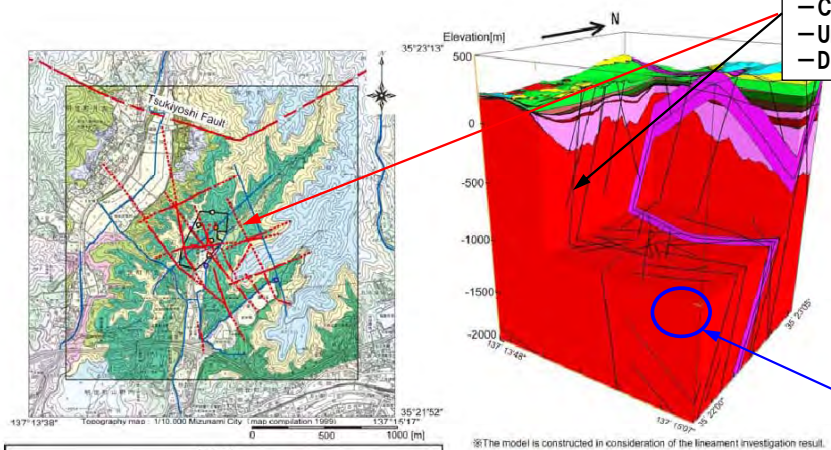
Transmissivity distribution

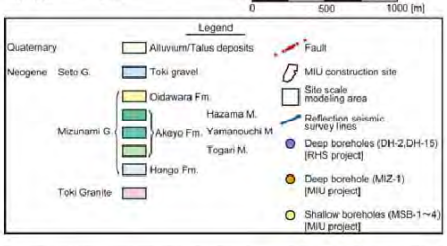
An example of site descriptive model based on the surface-based investigation, MIU site

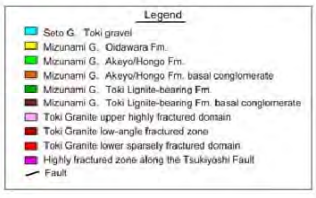
Surface based investigation (phase 1) report, JAEA Research 2007-043

Mizunami URL case, 2km x 2km scale model

Deterministically defined faults
- Characteristics, parameter values
- Uncertainty
- Detection, characterization method, phase







Geological features and structural elements			Hydraulic conductivity Log k(m s⁻¹)]
Sedimentary rock	Mizunami Group	Seto Group	-5.0
		Oidawara Formation	-8.5
		Akeyo/Hongo Formation	-7.6
		Akeyo/Hongo Formation basal conglomerate	-6.3
		Toki-lignite bearing Formation	-6.3
		Toki-lignite bearing Formation basal conglomerate	-5.9
Toki granite		Upper highly fractured domain	-6.7
		Low angle fractured zone	-5.4
		Lower sparsely fractured domain	-7.7
Highly fractured zone along the Tsukiyoshi fault			-5.4
fault		Main part of Tsukiyoshi fault	-11.0
	Other faults	Parallel to fault	-4.0~-9.0
		Normal to fault*	-11.0

*Sensitivity analysis about hydraulic anisotropy : 1 of 14 faults

Fig. 3.2.5(2)-1 Geological map and geological model revised using the crosshole investigation phase data

Water conducting features in Toki-granite, an example of DH-2 borehole investigation

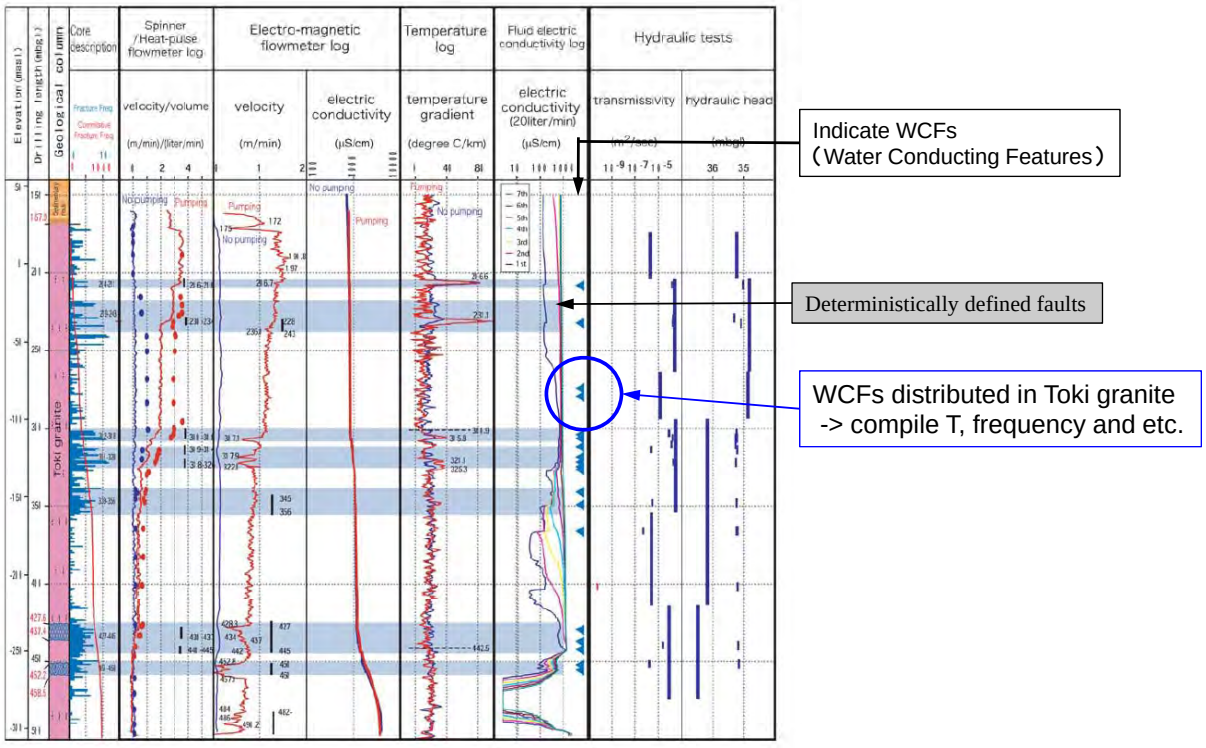


Fig. 3.3.6-1 Results of fluid logging and hydraulic test in 500m borehole

Summary

•Introduction

- NUMO's stepwise approach for the site selection, defining layout and preliminary safety assessment methodology at selecting DIA will be required.
- It is important to expect uncertainty of key geological features and to prepare the flexible PA and design methodologies

•Approach for developing host rock assessment methodology

- 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 rock classification methodology from nuclide transport retardation effect in relatively larger scale (regional-site) site descriptive models.

•An approach of quantitative evaluation of host rock performance

- 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.
- This approach has a part of function to play total performance assessment methodology, but one of key methodology for quantifying the host rock suitability assessment
- The lessons learned from the examination will also be feedback to the next phase investigation planning from the tunnel.