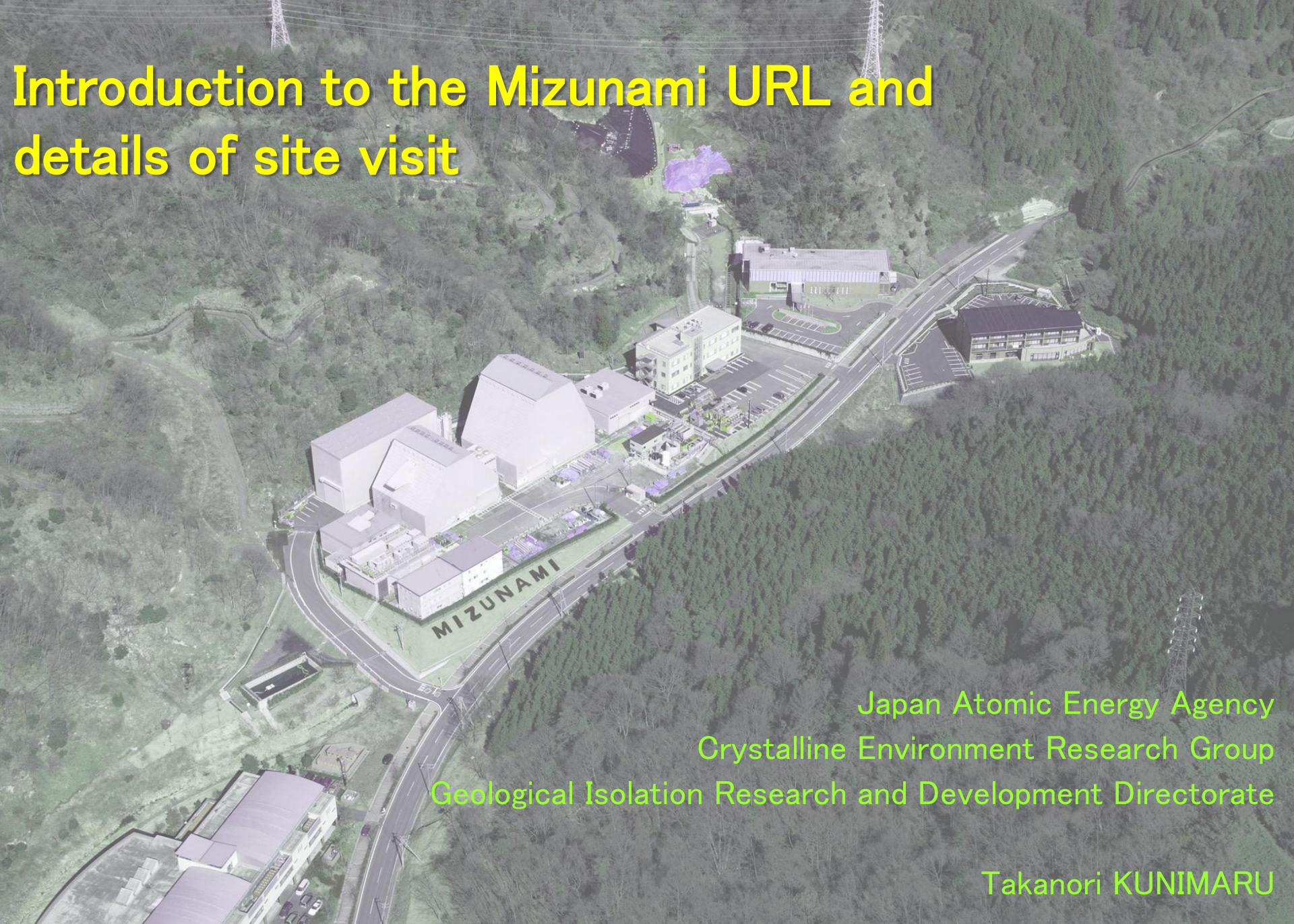


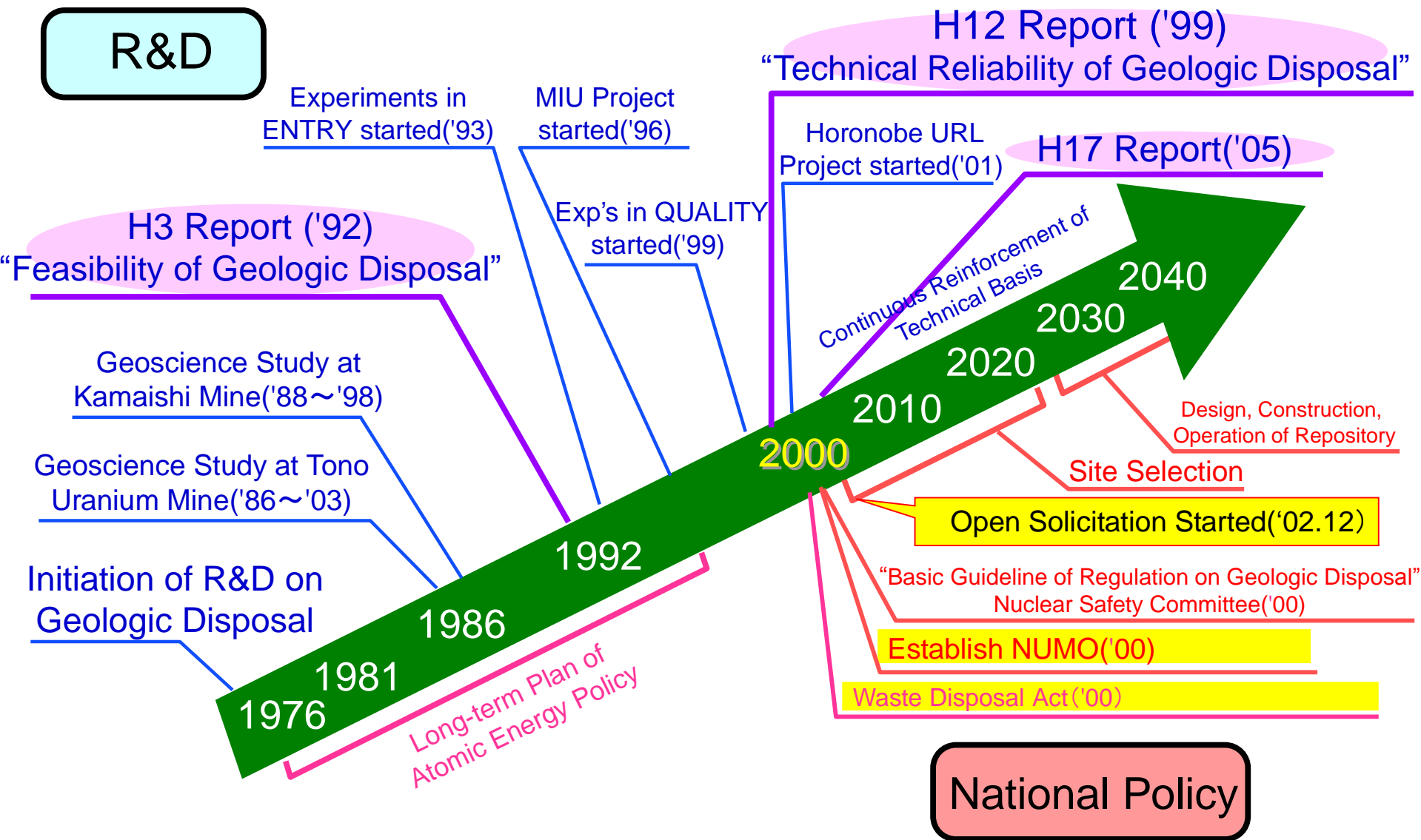
Introduction to the Mizunami URL and details of site visit



Japan Atomic Energy Agency
Crystalline Environment Research Group
Geological Isolation Research and Development Directorate

Takanori KUNIMARU

Schedule of Geological Disposal in Japan...

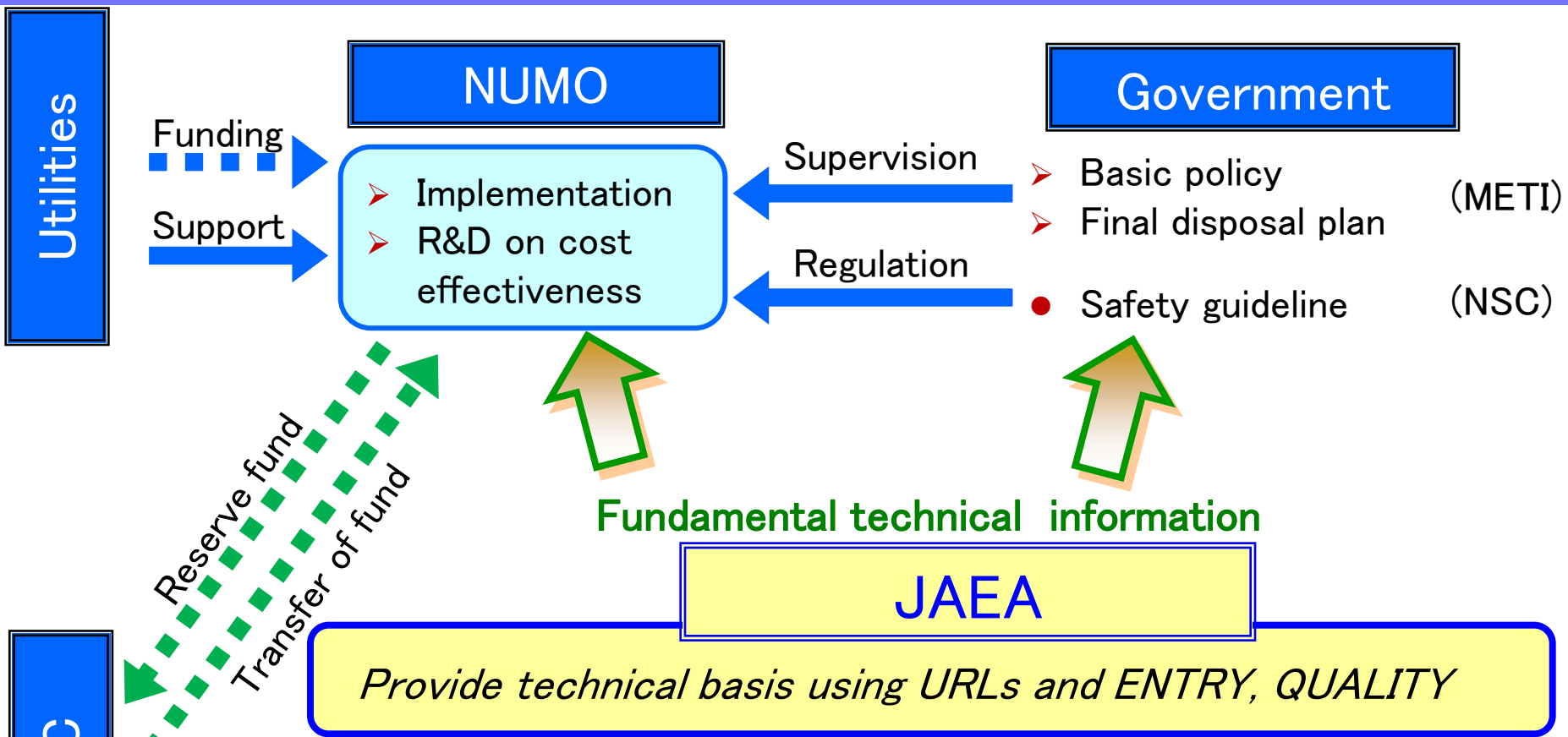


Conclusion of H12 Report and JAEA's R&D programs

- H12 report were concluded:
 - Although Japan lies in a tectonically active setting with fairly complex geology, a well-founded understanding of key geological events and processes allows selection of stable areas as potentially suitable sites
 - The fundamental practicality of repository and engineering technology has been demonstrated for several design concepts
 - Integrated performance assessment for defined systems shows that the safety concept is robust, offering large safety margins and having low sensitivity to model and database uncertainties.

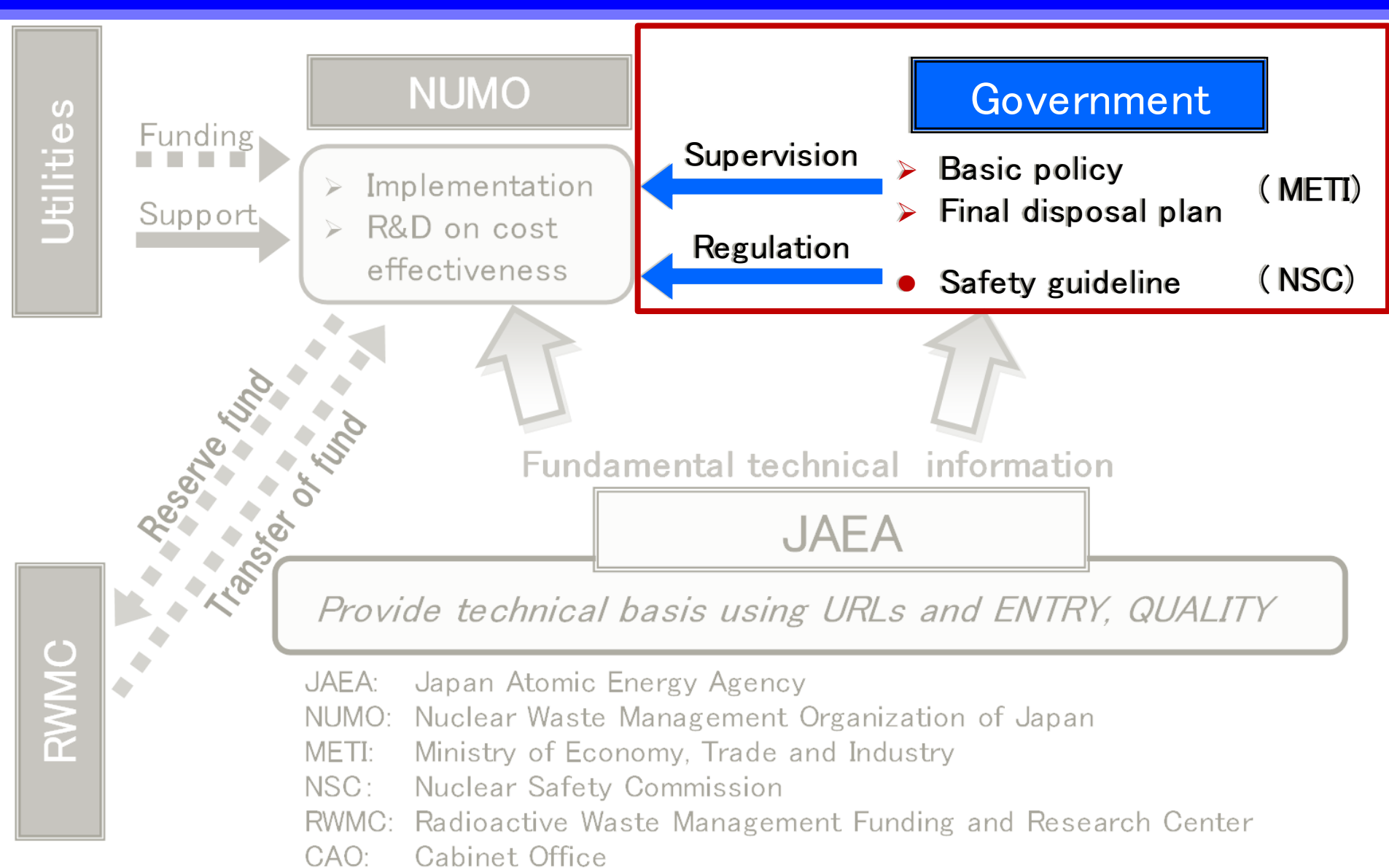
- Current JAEA's R&D program aims to enhance reliability and confidence and its emphasis is placed on:
 - Confirmation on applicability of disposal technologies to specific geological environment at study sites
 - Better understanding of long-term behavior of engineered and natural barriers.

Relevant organisations of HLW geological disposal in Japan (before the Tohoku Region Pacific Coast Earthquake)

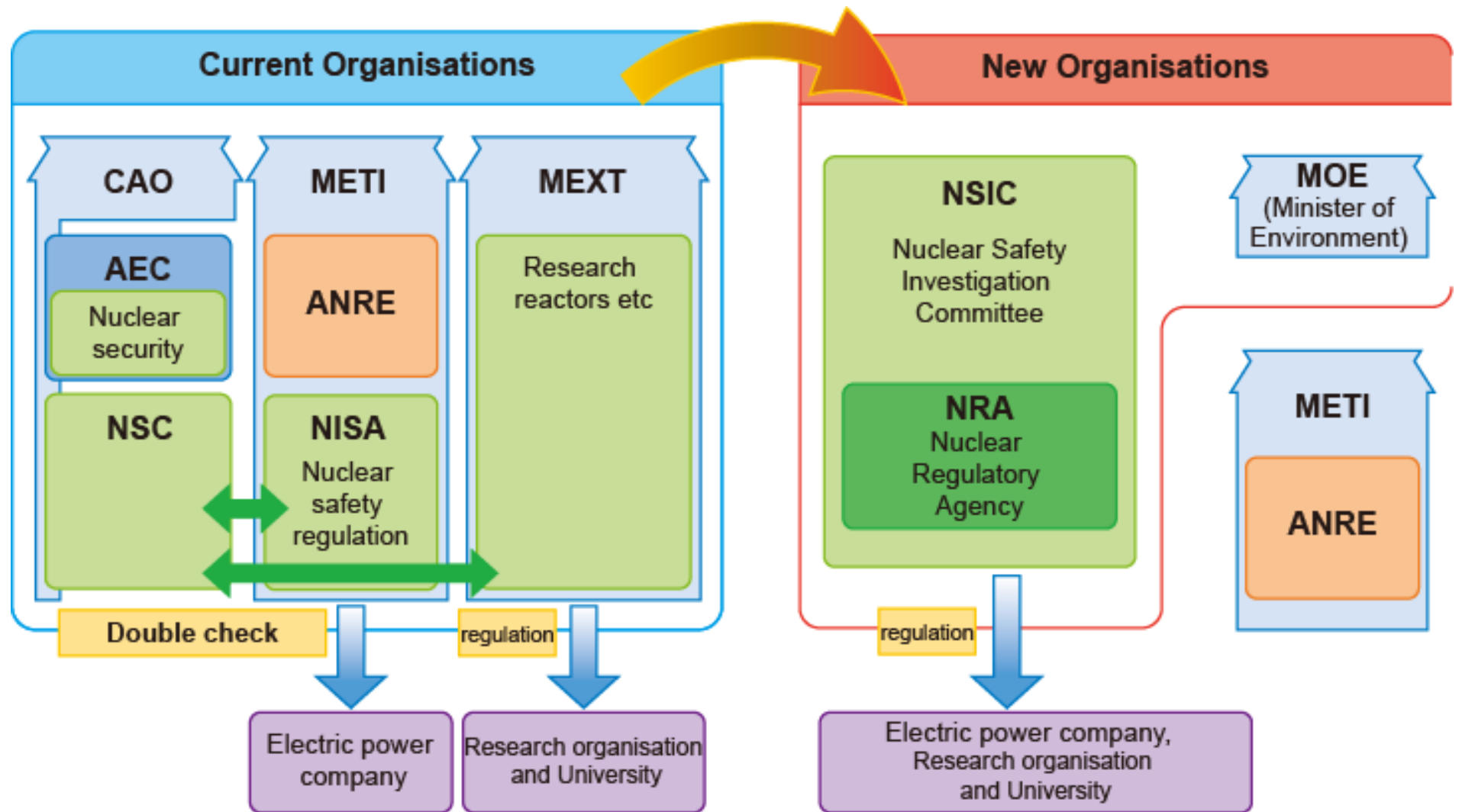


- JAEA: Japan Atomic Energy Agency
- NUMO: Nuclear Waste Management Organization of Japan
- METI: Ministry of Economy, Trade and Industry
- NSC: Nuclear Safety Commission
- RWMC: Radioactive Waste Management Funding and Research Center
- CAO: Cabinet Office

Relevant organisations of HLW geological disposal in Japan (before the Tohoku Region Pacific Coast Earthquake)



Reorganisation for nuclear regulation in Japan after the Tohoku Region Pacific Coast Earthquake



Geological information of Japan

Geologic age of the world URL

Era	Period	Ma.	
Cenozoic	Quaternary	0	
	Tertiary	Neogene	1.7
		Paleogene	24
Mesozoic	Cretaceous	64	
	Jurassic	140	
	Triassic	208	
Paleozoic		242	
Precambrian		564	

Japan (Horonobe)
USA (Yucca Mt.)
Belgium (Mol)

Japan (Mizunami)
Germany (Goreleben)

Switzerland (Mt. Terri)
France (Bure)

Switzerland (Grimsel)

Canada (Whiteshell)
Sweden (Aspö)
Finland (Olkiluoto)

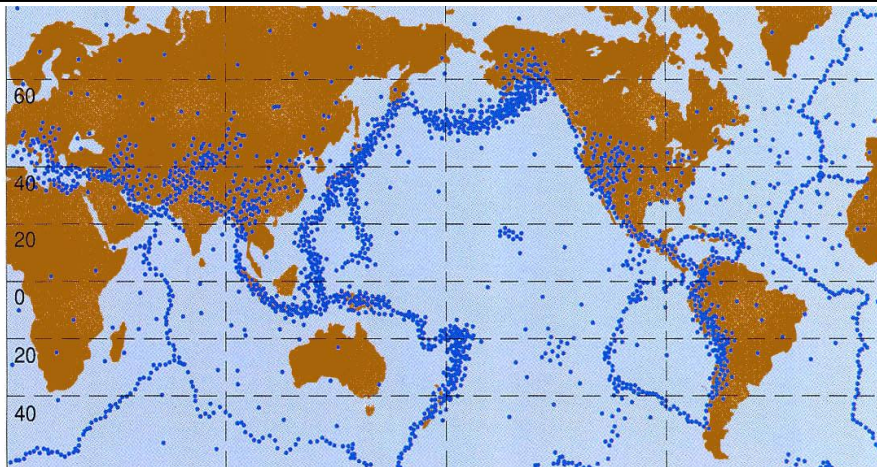
Geology at EL-500m

- Granitic rocks
- Crystalline schist
- Basaltic rocks
- Rhyolitic rocks
- Gabbroic rocks
- Limestone
- Pre-Tertiary sedimentary rocks
- Neogene volcanic rocks
- Neogene sedimentary rocks
- Quaternary volcanic and sedimentary rocks

Horonobe

Mizunami

Epicenters in the world (Japan in the mobile belt)



Crystalline rocks
Sedimentary rocks

JAEA's R&D Facilities for HLW Disposal

Tokai R&D center and Two off-site URLs

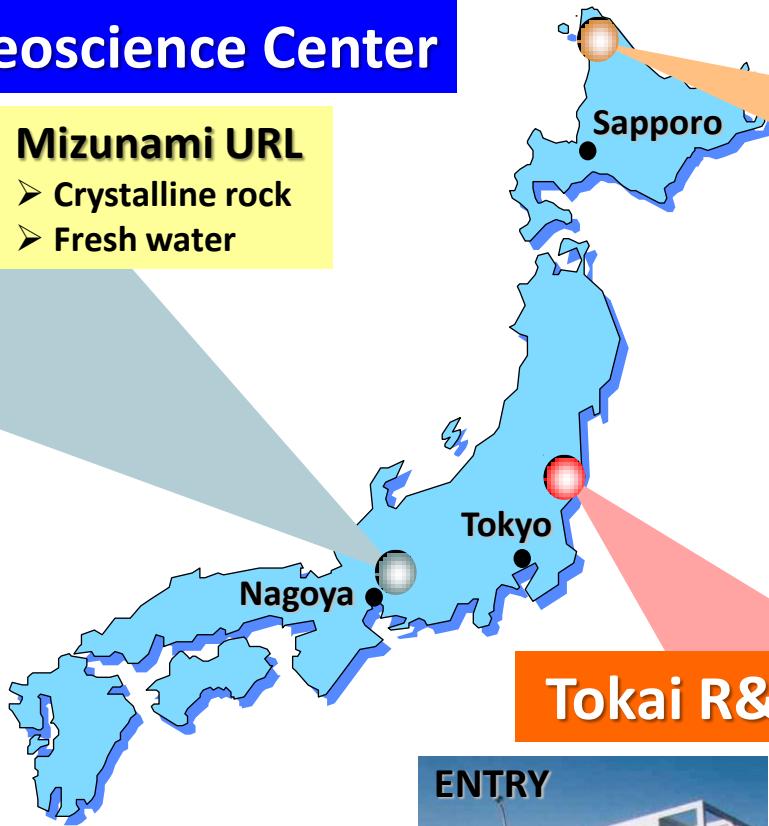
Tono Geoscience Center



Mizunami URL

- Crystalline rock
- Fresh water

Image view



Horonobe Underground Research Center

Horonobe URL

- Sedimentary rock
- Saline water

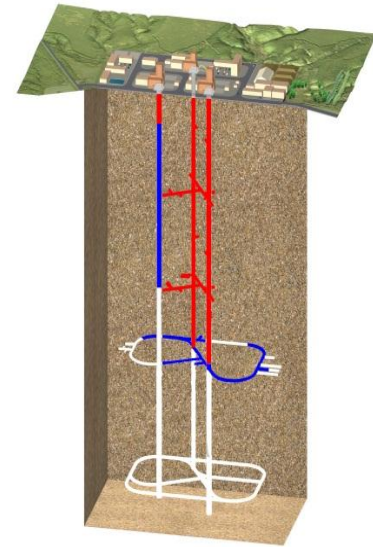


Image view

Tokai R&D Center



ENTRY

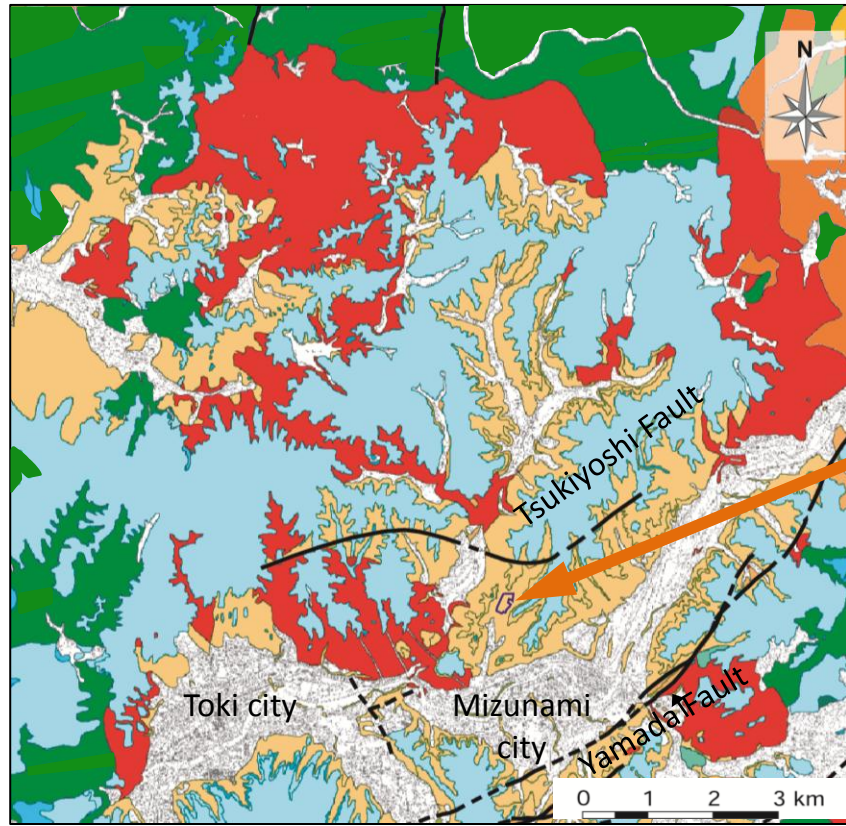
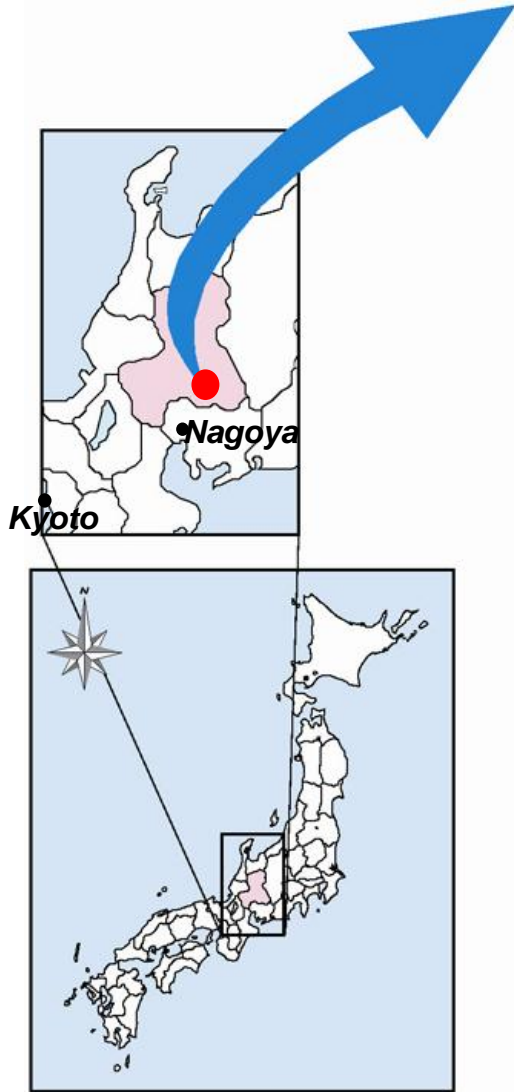


QUALITY

ENTRY ; Engineering scale Test and Research facility

QUALITY ; Quantitative Assessment radionuclide migration experimental faciLITY

Location of MIU Site



Geological map of the Tono district (after Itoigawa, 1980)

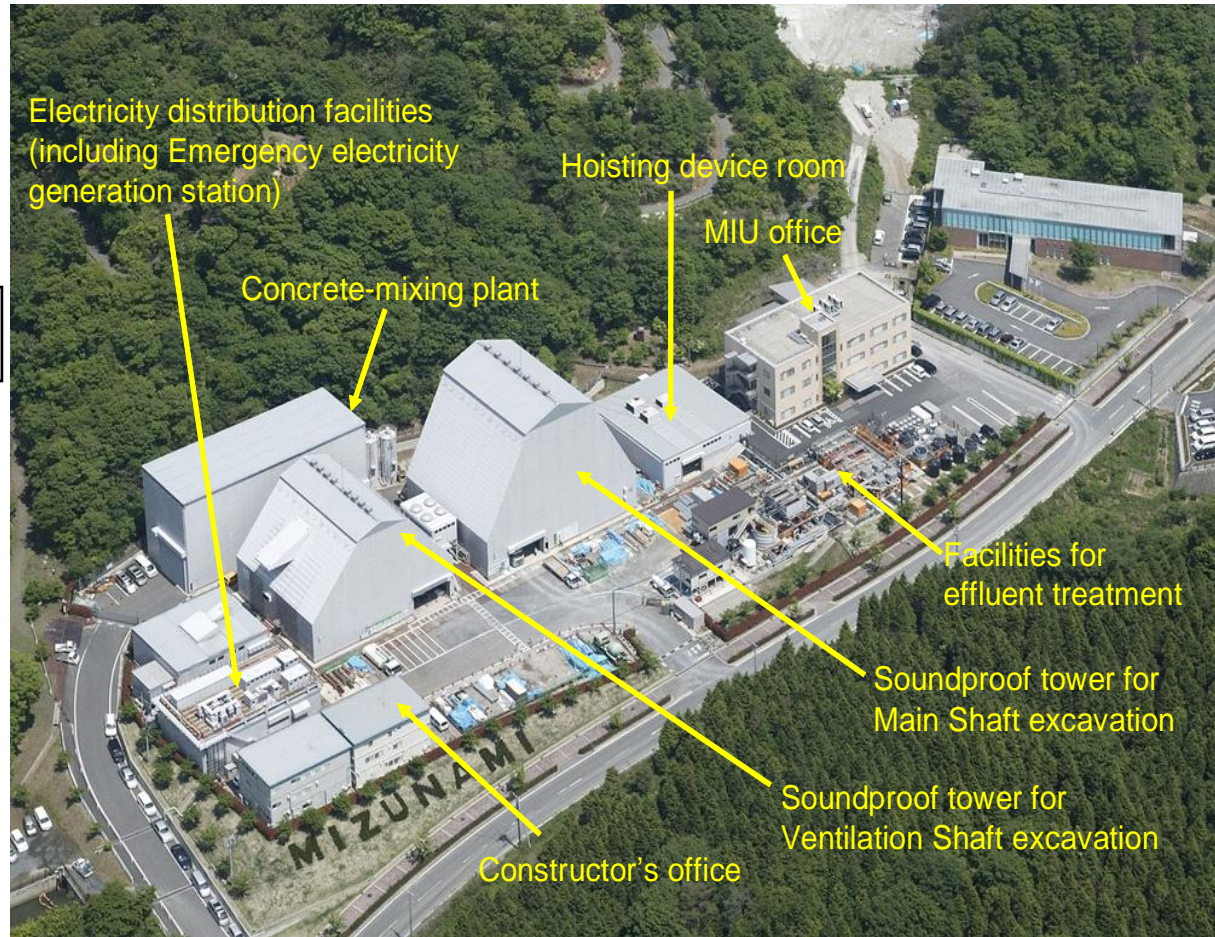
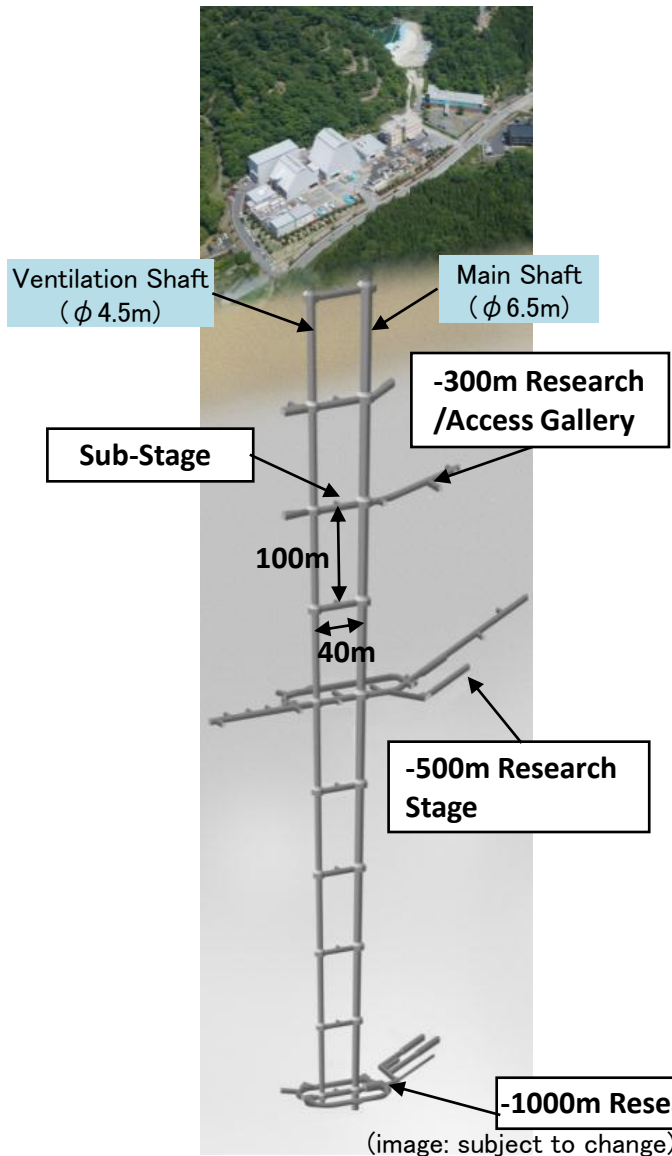
Legend

- Tokai Gr.
- Mizunami Gr.
- Toki Granitic body
- Nohi Rhyolite
- Sedimentary-metamorphic rocks of the Mino Terrane
- Fault



MIU construction site

MIU Facilities



History of Tono Geoscience Center

Year	Event
1962	Discovery of outcrop of uranium mineralization by the Geological Survey of Japan
1965	Establishment of Tono Exploration Office in Toki City
1986	Commencement of Geoscientific Research
1991	Excavation of a shaft (No.2 Shaft) for Geoscientific Research in Tono Mine
1992	Commencement of Regional Hydrogeological Study
1996	Commencement of Mizunami Underground Research Laboratory Project
2003	Commencement of excavation of Main and Ventilation Shafts (July)

Why was Tono area selected for MIU site?

- Geological environment:
 - granitic rock body exists in this area
- Location:
 - Central Japan
 - easy access by train and car

And

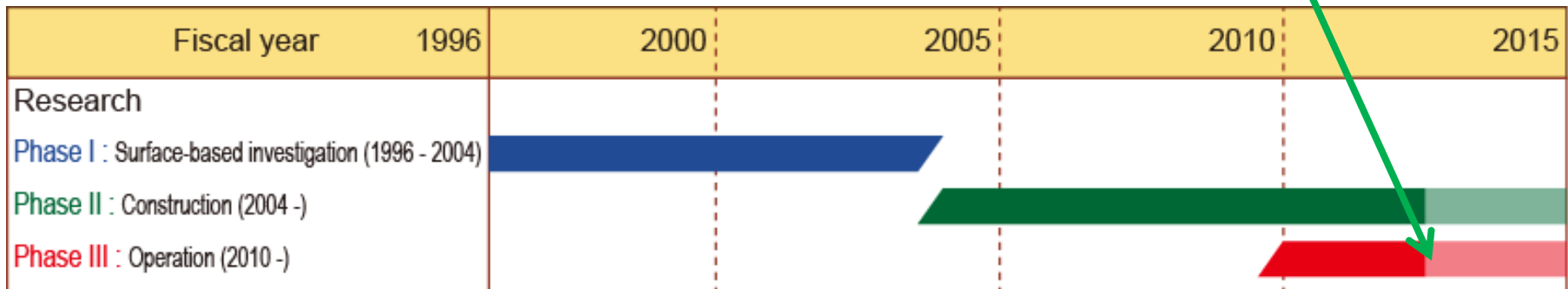
⇒ Existence of field exploration office in the vicinity since 1965 and accumulated geological information

Therefore

⇒ Existence of knowledge and experience together with experts and technology in the field of earth sciences

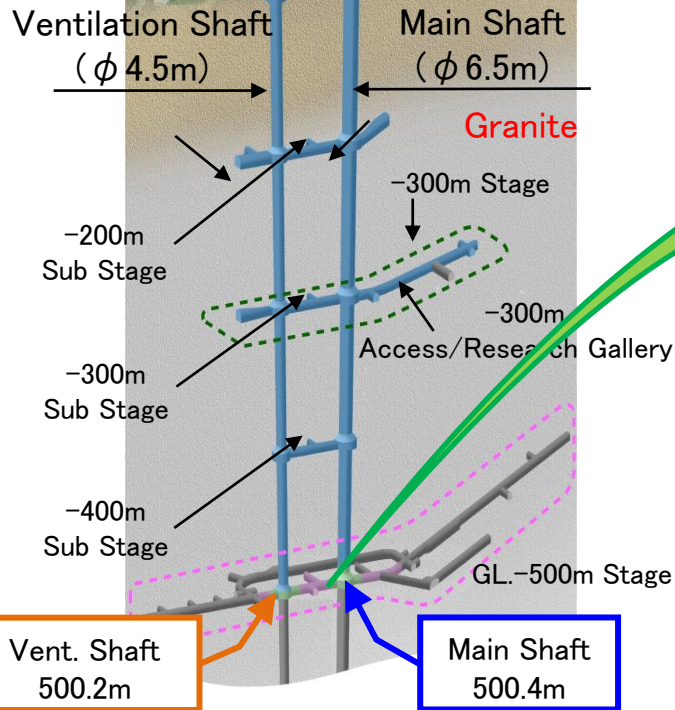
Timetable of MIU project

Current depth
 Main shaft : GL-500.4m
 Ventilation Shaft : GL-500.2m

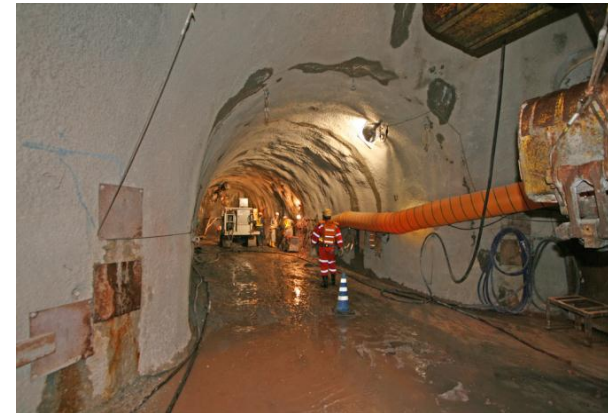


Status for excavating shaft and gallery

- Already excavated area
- Excavated area in FY 2011
- Excavating and excavated area in 2012



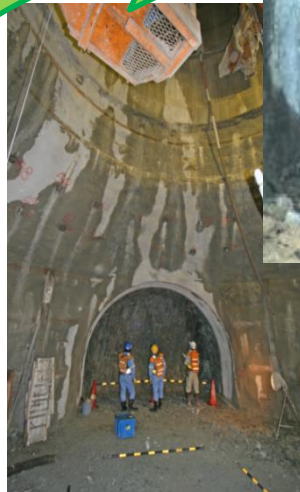
-500m Access/Research Gallery-North



-500m Access/Research Gallery-South



GL-500m stage had been completed on 30th July 2012



Aims of each phases

■ Phase I: Surface-based investigation

- Construct models of the geological environmental from all surface-based investigation results that describe the geological environmental prior to excavation and predict excavation response
- Formulate detailed design concepts and a construction plan for the underground facilities
- Establish detailed investigation plans for Phase II

■ Phase II: Construction

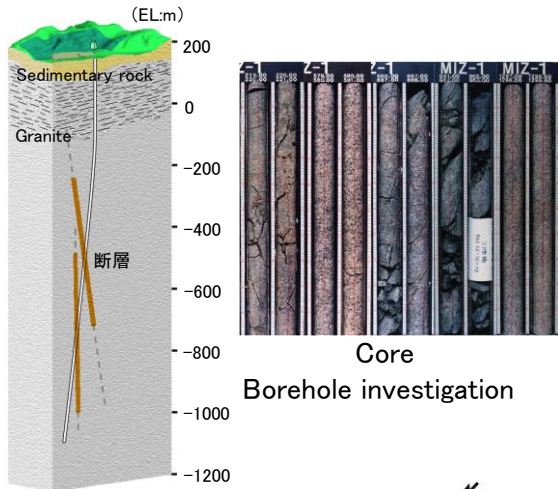
- To acquire data on the geological environment by investigations from shafts and drifts and predict the characteristics of the geological environment around the drift
- To verify predictions made in phase I
- To evaluate the effectiveness of engineering techniques used for design and construction of underground facilities
- Establish detailed investigation plans for Phase III

■ Phase III: Operation

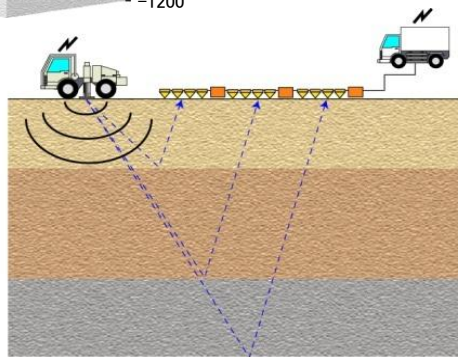
- To acquire data on the geological environment via investigations in drifts
- To verify predictions made in phase II
- Demonstration of engineering techniques for deep underground utilisation

Step-wise investigations

Phase I [Surface-based investigation]



Core
Borehole investigation

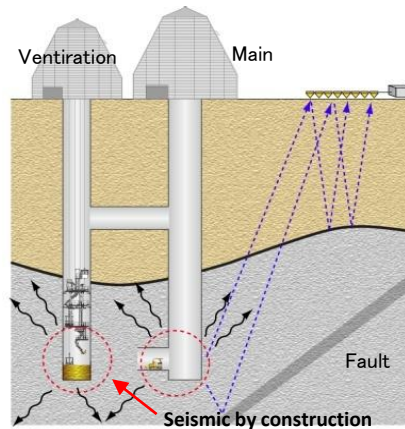


Reflection seismic investigation

Phase II [Construction]



Geological mapping/sampling

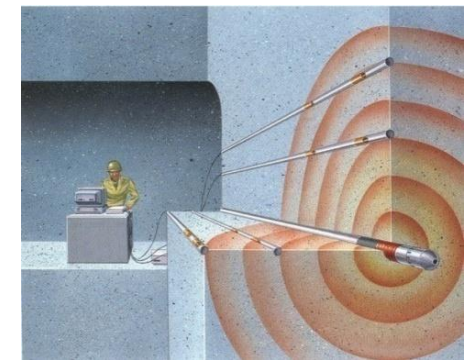


Reflection seismic investigation using the construction effect

Phase III [Operation]



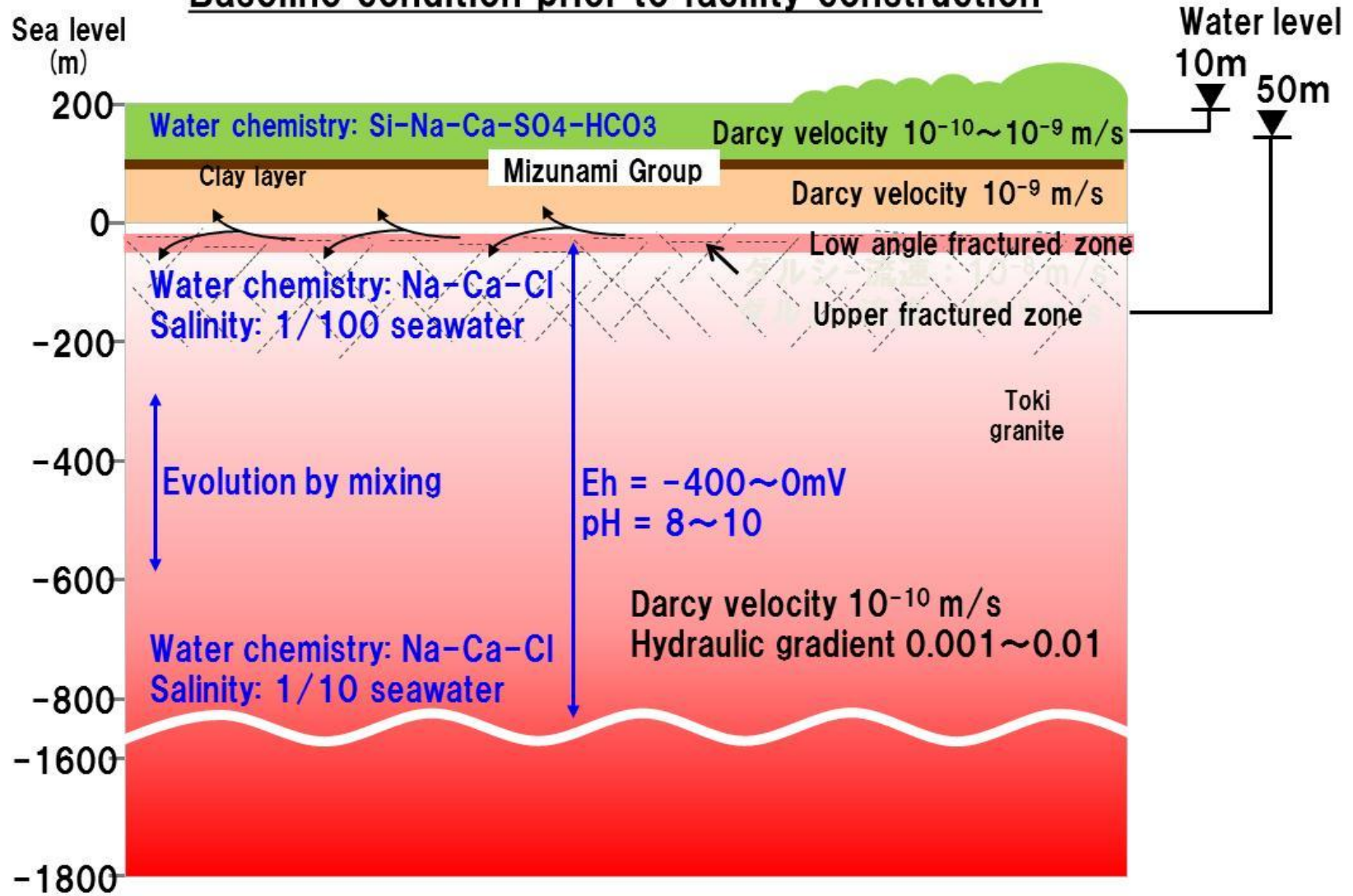
Borehole investigation



Geophysical investigation

Geological environment model based on the result of Phase I investigation

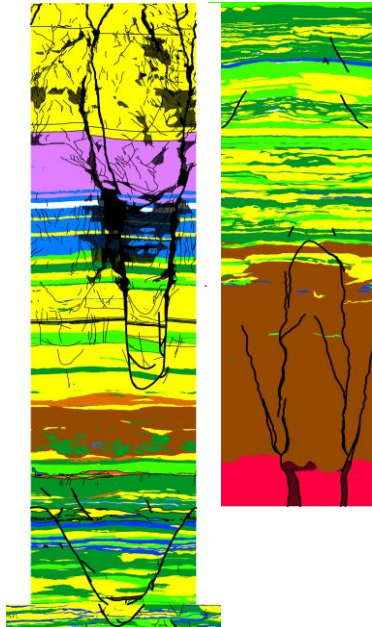
Baseline condition prior to facility construction



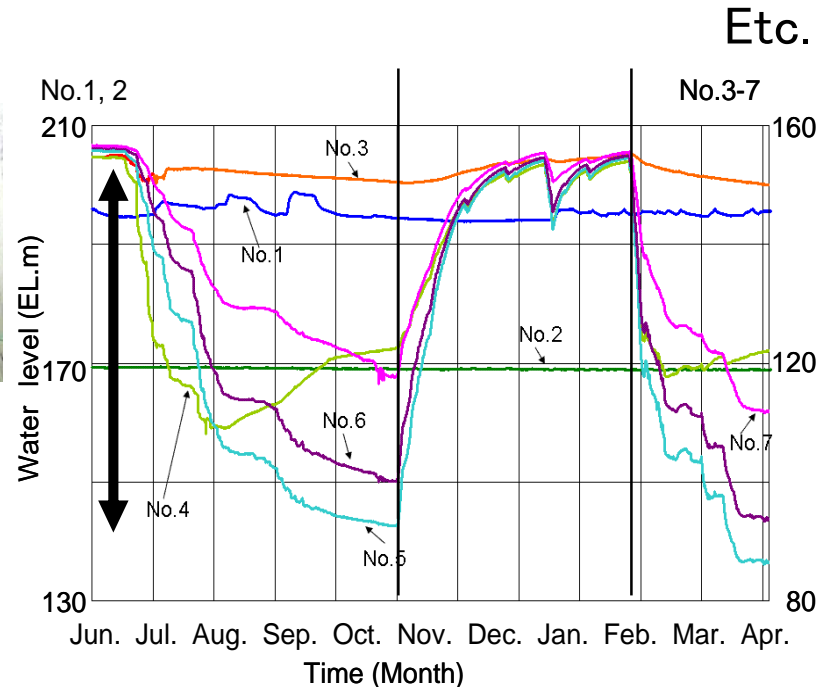
Phase II Investigation

Main investigation items, aim and goals are:

- Estimate geological environment around shafts and galleries
- Assess applicability of investigation techniques through verification of geological models established in Phase I
- Measure impact on geological environment during MIU construction
- Confirmation on applicability of construction techniques



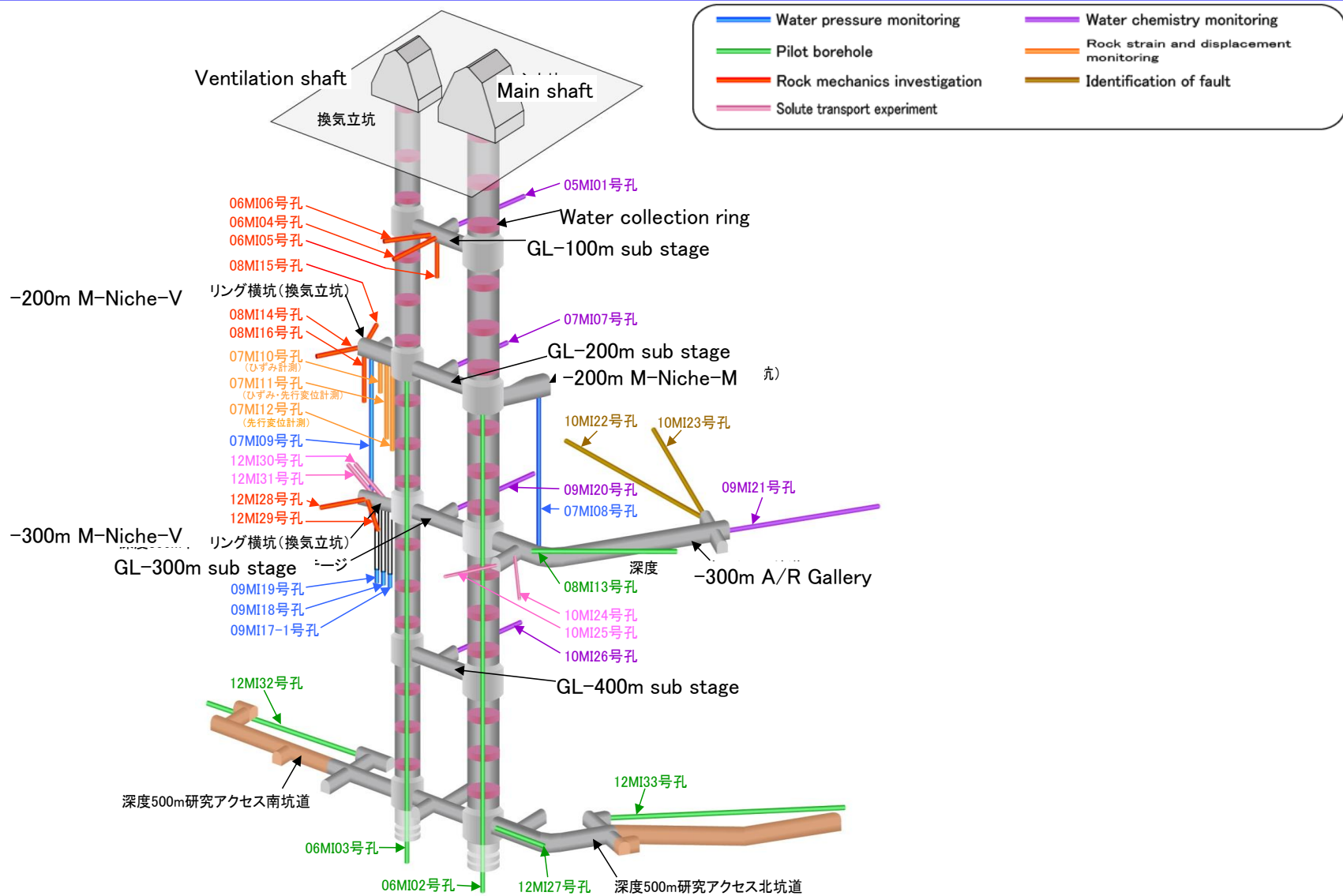
Geological mapping



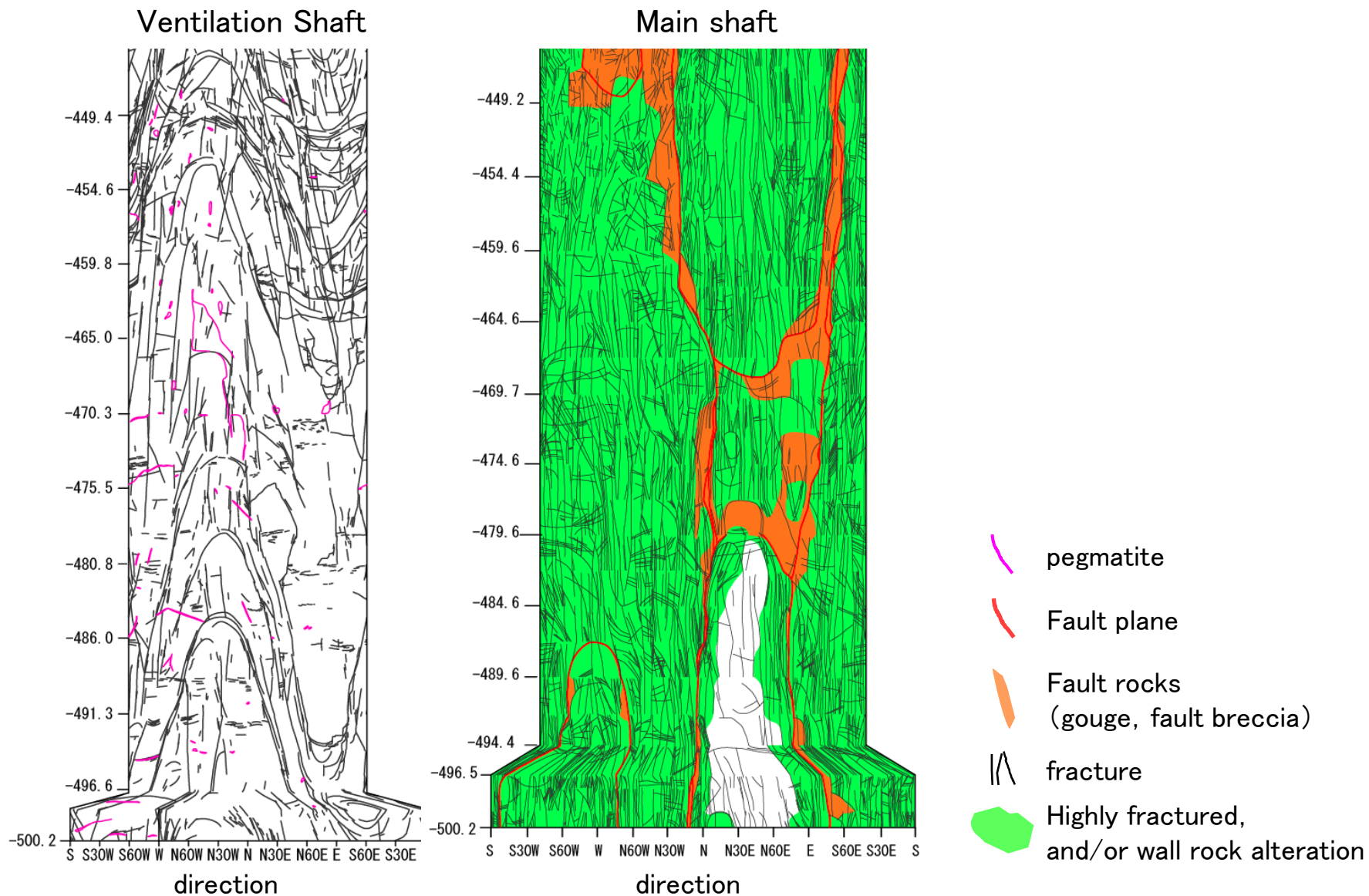
Long-term monitoring

Etc.

Existing borehole in the URL

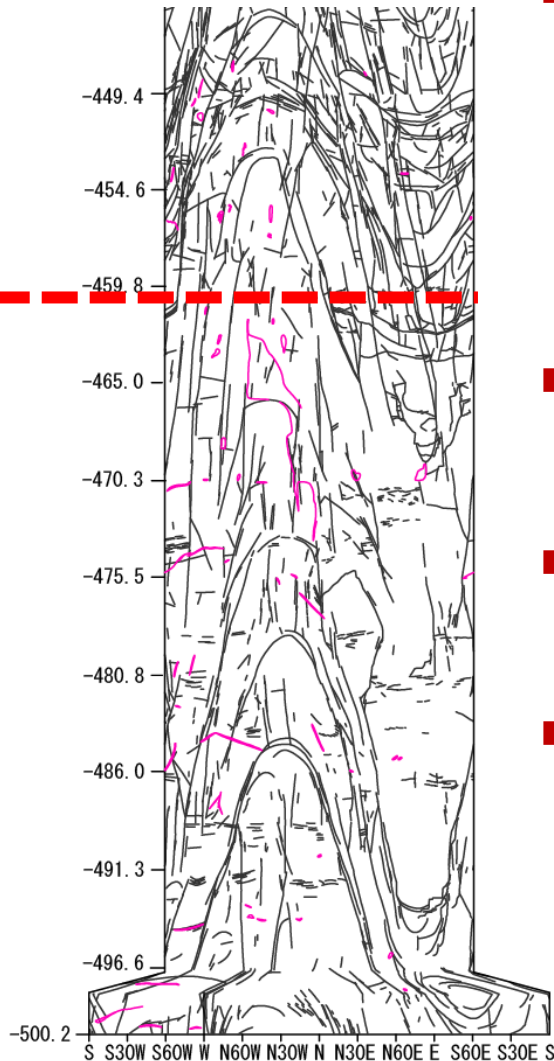


Results of wall mapping investigation



Conclusion of wall mapping investigation at ventilation shaft

Ventilation Shaft



■ Fracture density

- A lot of the low angle fracture is observed above GL-300m
- The density of high angle fracture increase with depth from around GL-250m
- Total amount of fracture number decrease from GL-460m conspicuously

■ Fracture direction

- High angle fractures above GL-300 is roughly NNW
- High angle fractures below GL-300 is roughly NE

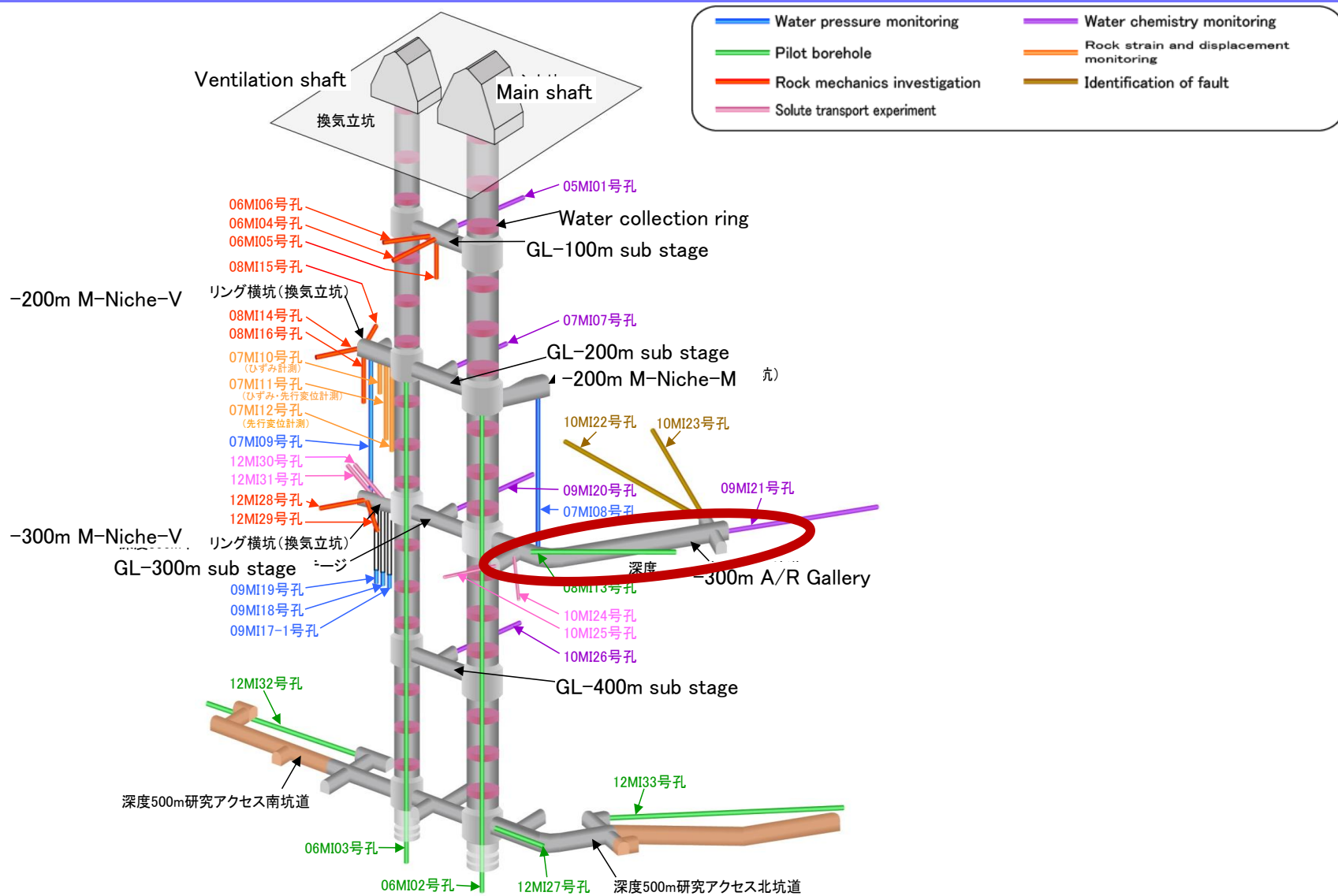
■ Geological history of fractures

- In many cases low angle fractures seem not to cut the high angle fractures

■ Fracture fillings

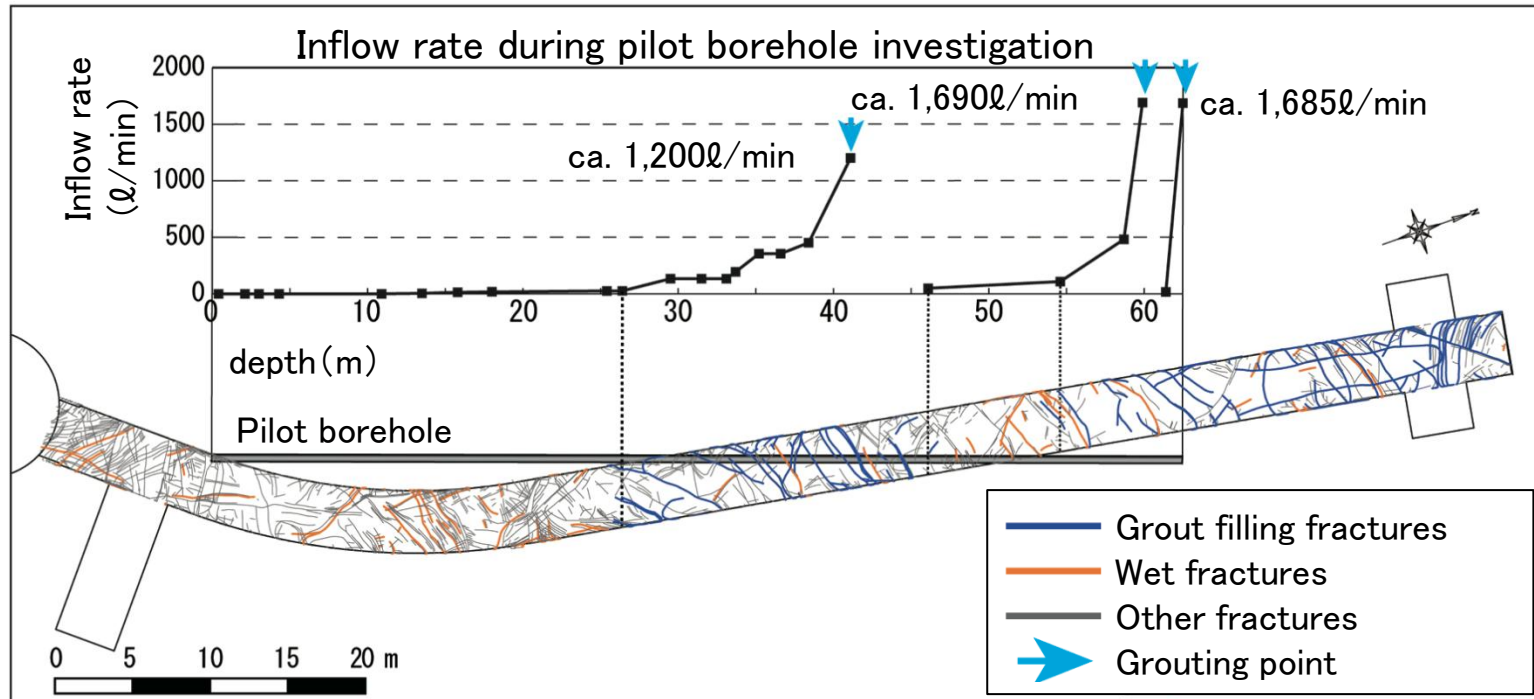
- A fracture fillings are not observed in the almost all of low fractures. But the carbonate minerals are observed in some fractures.
- The carbonate and clay minerals are observed in the high angle fractures.

Existing borehole in the URL



Definition of flow-path fractures in/around drift at GL-300m

- Large inflow was occurred during the pilot borehole investigation before excavating the drift at GL-300m. Therefore the grout was used during the drift excavation.
- The fractures filled by grout material is observed in/around grouting area.



Fracture distribution and inflow rate of the pilot borehole

Definition of flow-path fractures in/around drift at GL-300m

- Large inflow was occurred during the pilot borehole investigation before excavating the drift at GL-300m. Therefore the grout was used during the drift excavation.

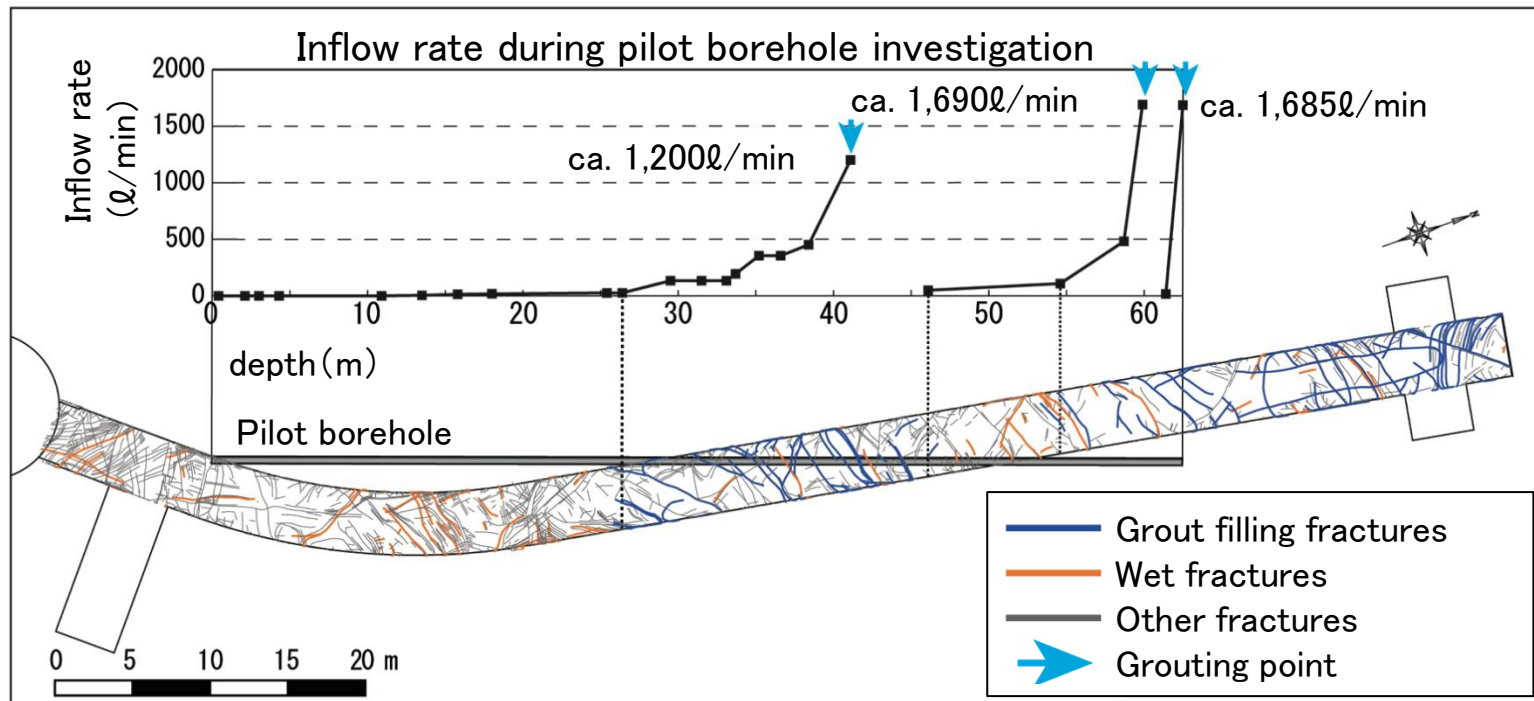
➤ The fracture distribution and inflow rate of the pilot borehole are shown in the following figure.



Fracture distribution and inflow rate of the pilot borehole

Definition of flow-path fractures in/around drift at GL-300m

- Large inflow was occurred during the pilot borehole investigation before excavating the drift at GL-300m. Therefore the grout was used during the drift excavation.
- The fractures filled by grout material is observed in/around grouting area.



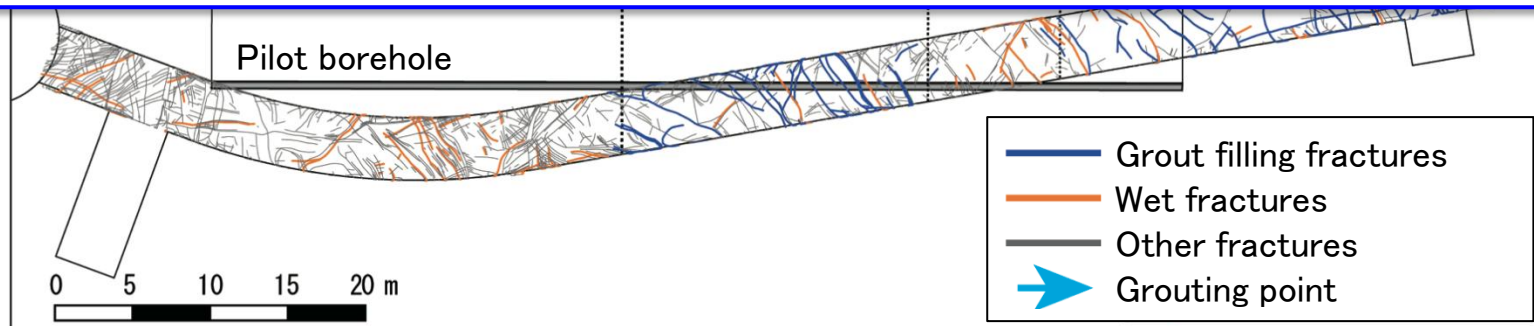
Fracture distribution and inflow rate of the pilot borehole

Definition of flow-path fractures in/around drift at GL-300m

- Large inflow was occurred during the pilot borehole investigation before excavating the drift at GL-300m. Therefore the grout was used during the drift

Flow-path fractures are defined based on the presence or absence of grout material in the fractures:

- **The Major Flow-path Fracture (Major FF)** is filled by grout material
- **The Minor Flow-path Fracture (Minor FF)** is not filled by grout material but it is observed a small inflow or wet state.

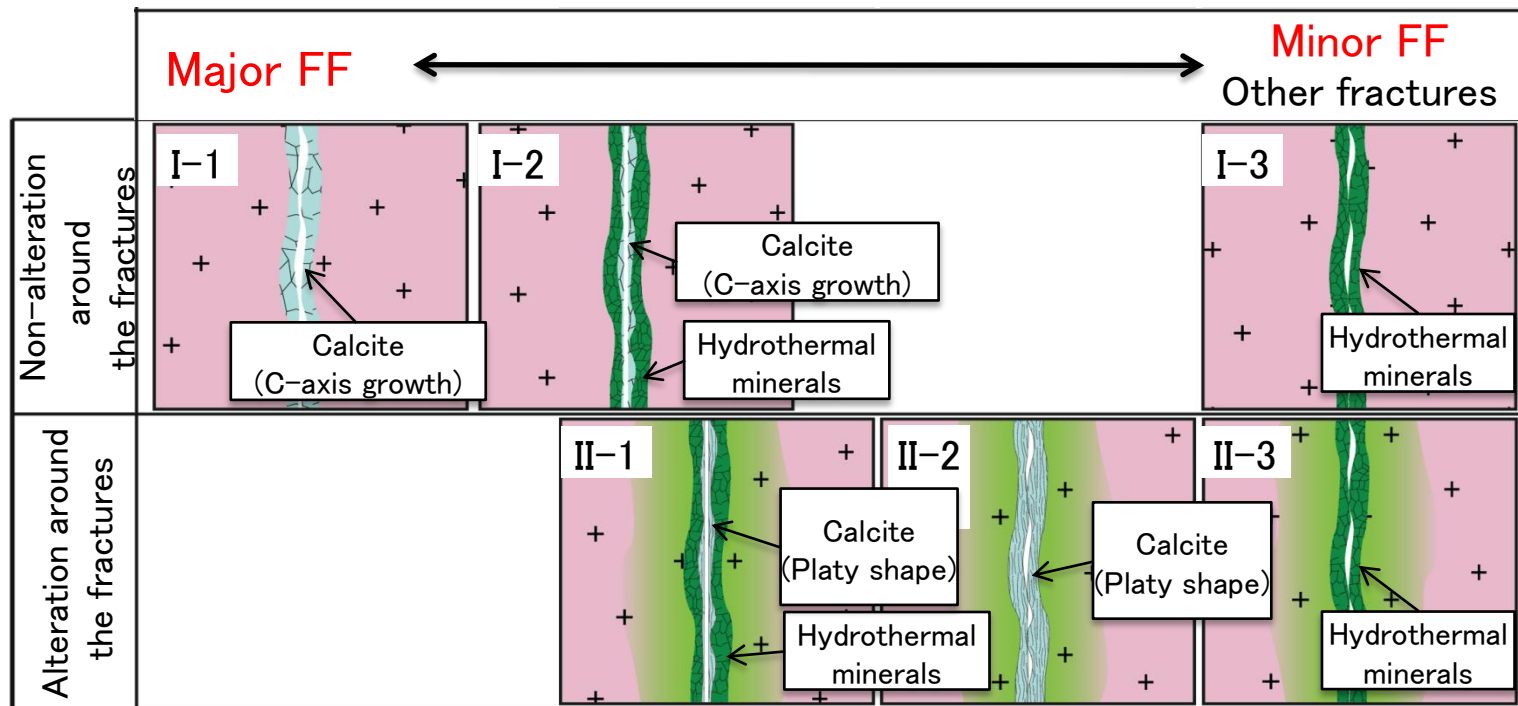


Fracture distribution and inflow rate of the pilot borehole

Summary

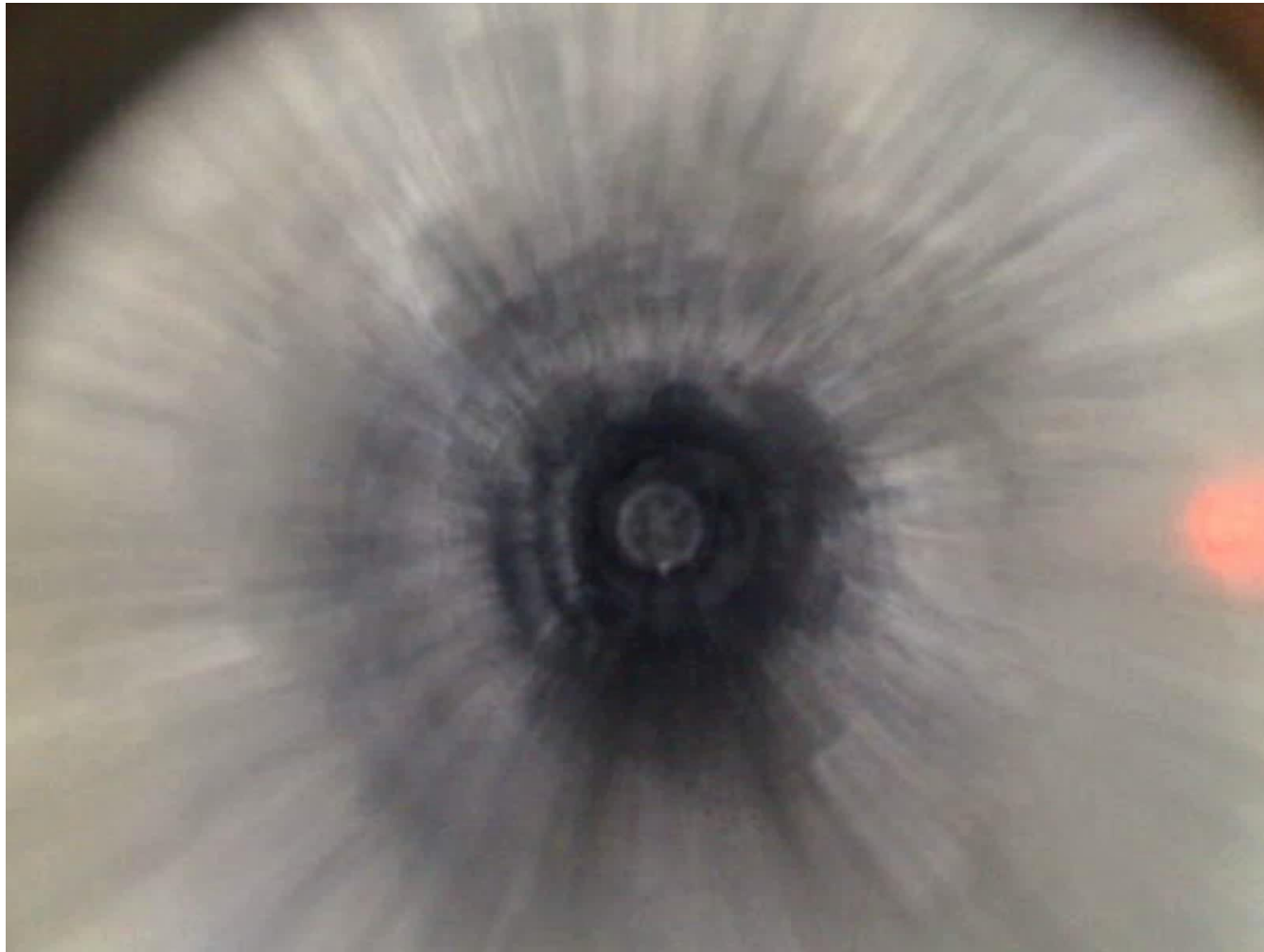
–Geological characterisation of flow–path fractures–

- Fractures covered with carbonate minerals behave as flow–path fracture.
 - Fractures without alteration behave as flow–path fracture.
- ⇒ Both fracture fillings and alteration around fracture is important to distinguish flow–path fracture.



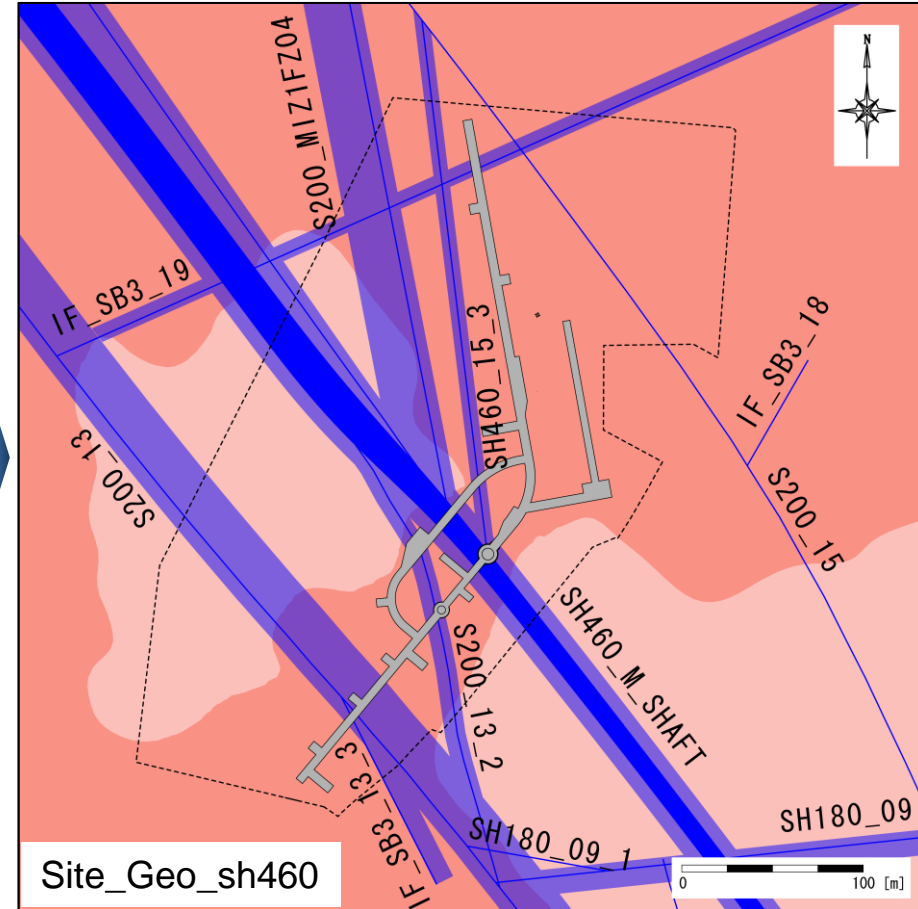
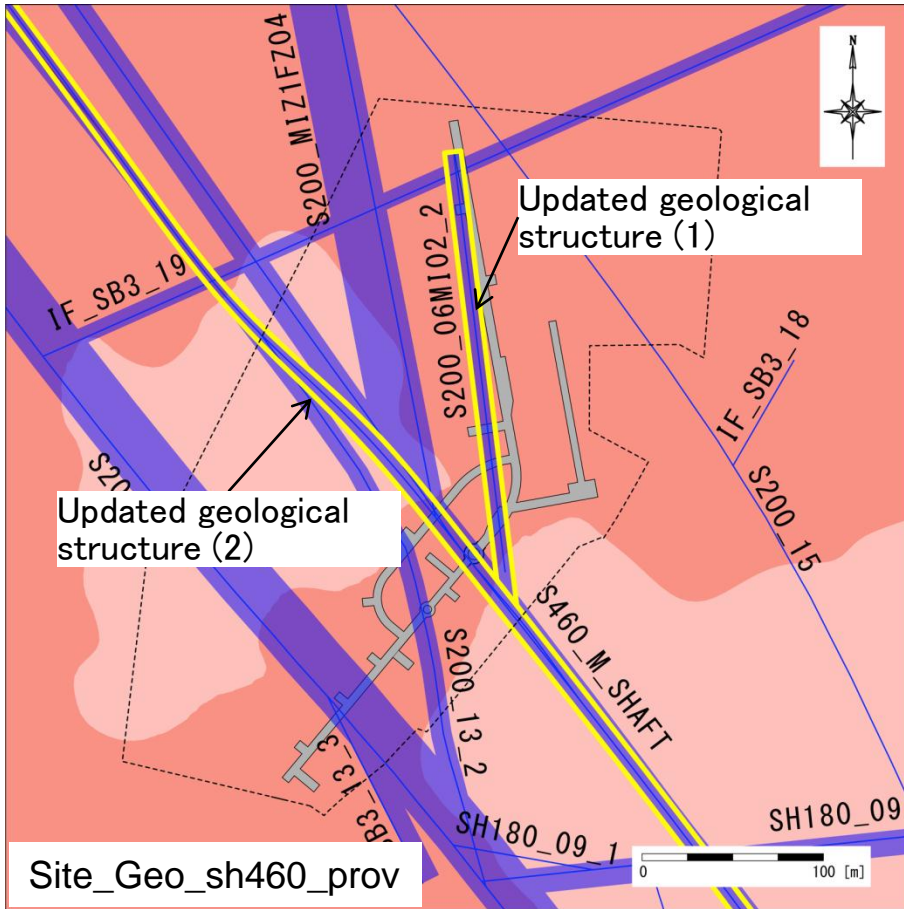
Conceptual model of relationship between petrography and flow–path fractures

Groundwater flow in the fracture



Updated geological model at GL-500m stage based on the result in F.Y. 2011 (1)

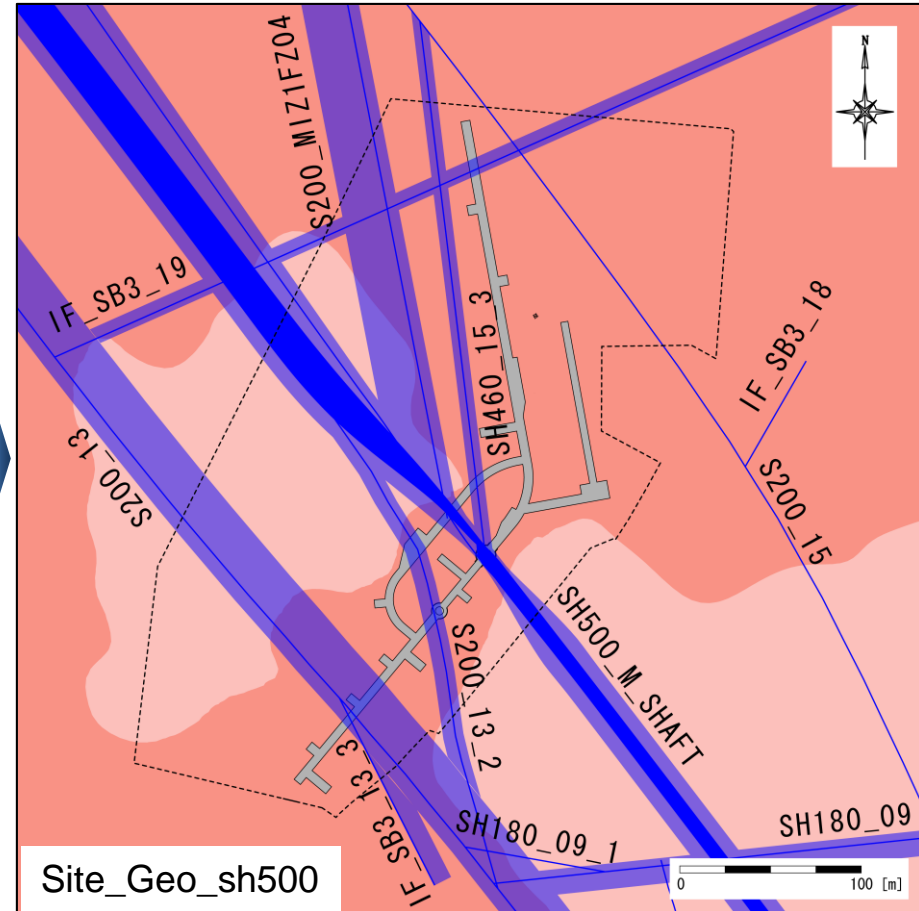
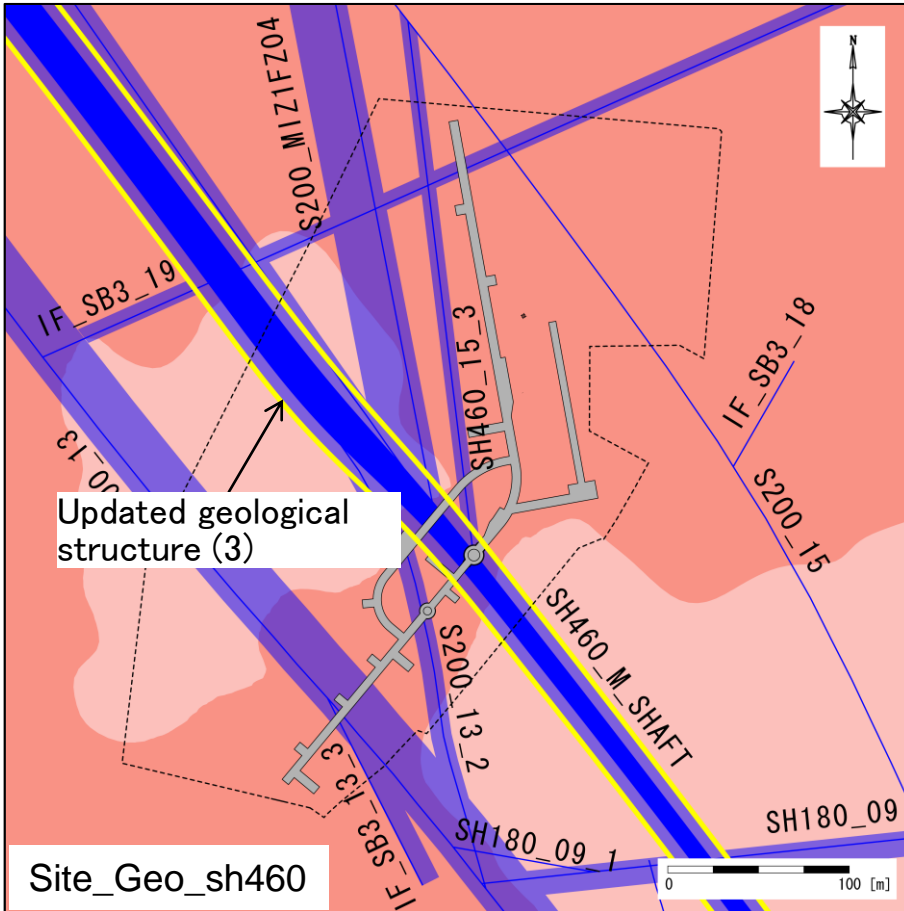
Model updated



This model was developed based on the result of wall mapping until GL-460m

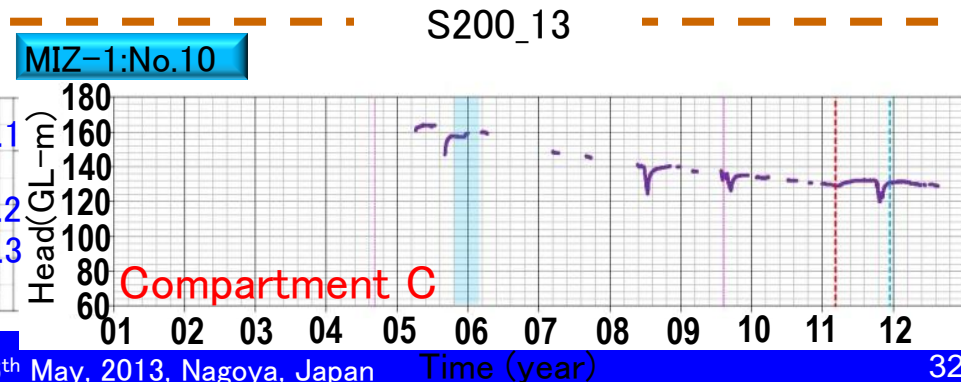
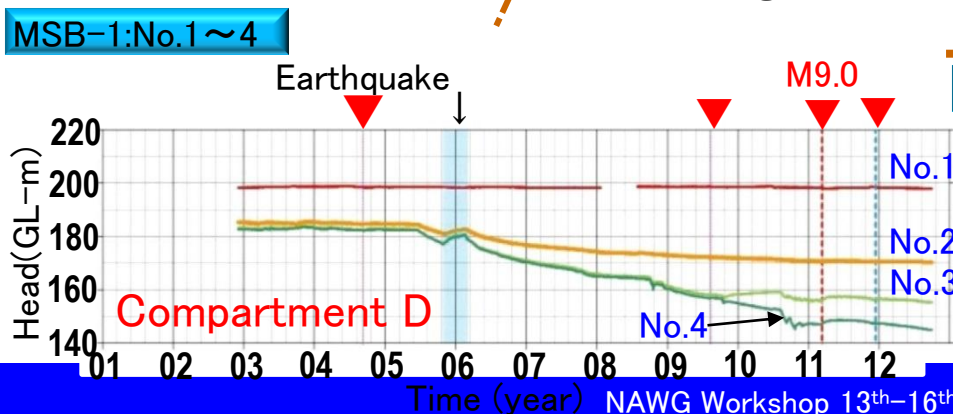
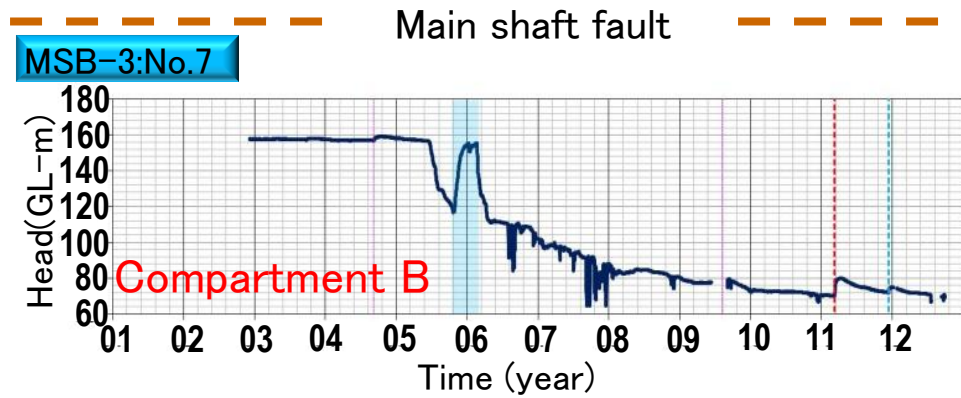
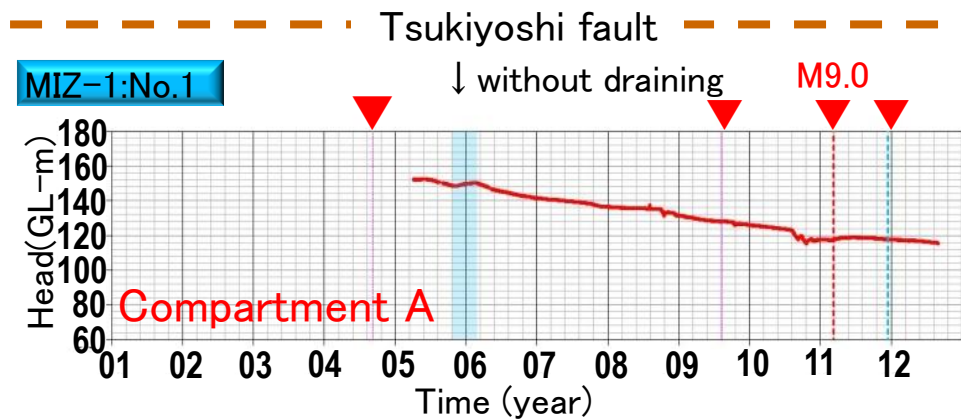
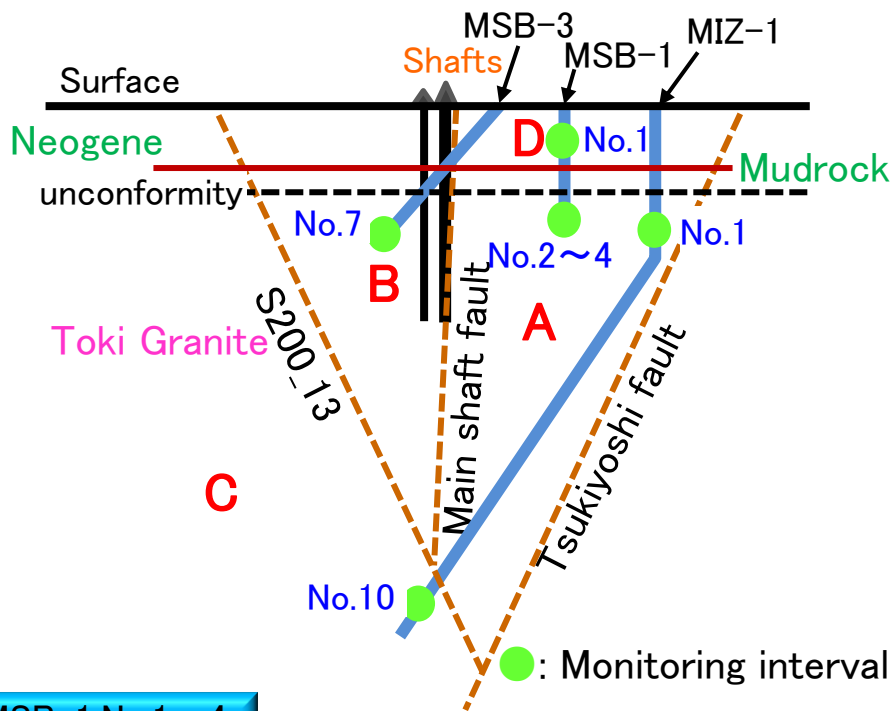
Updated geological model at GL-500m stage based on the result in F.Y. 2011 (2)

Model updated



This model was developed based on the result of wall mapping until GL-500m

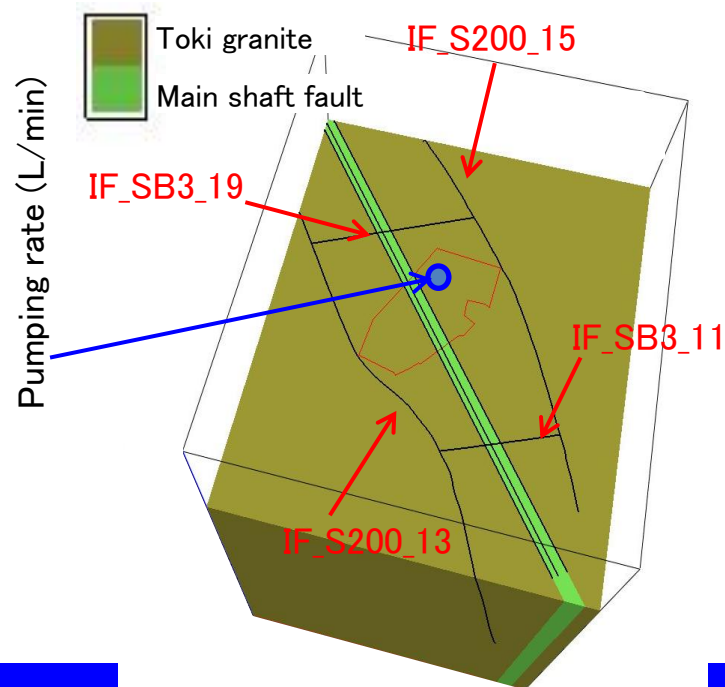
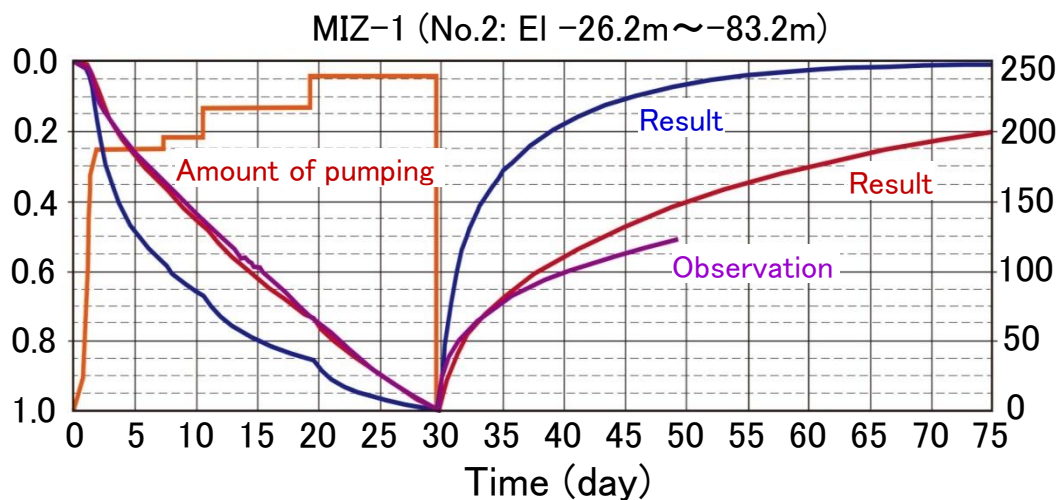
Hydraulic pressure monitoring results



Groundwater simulation results

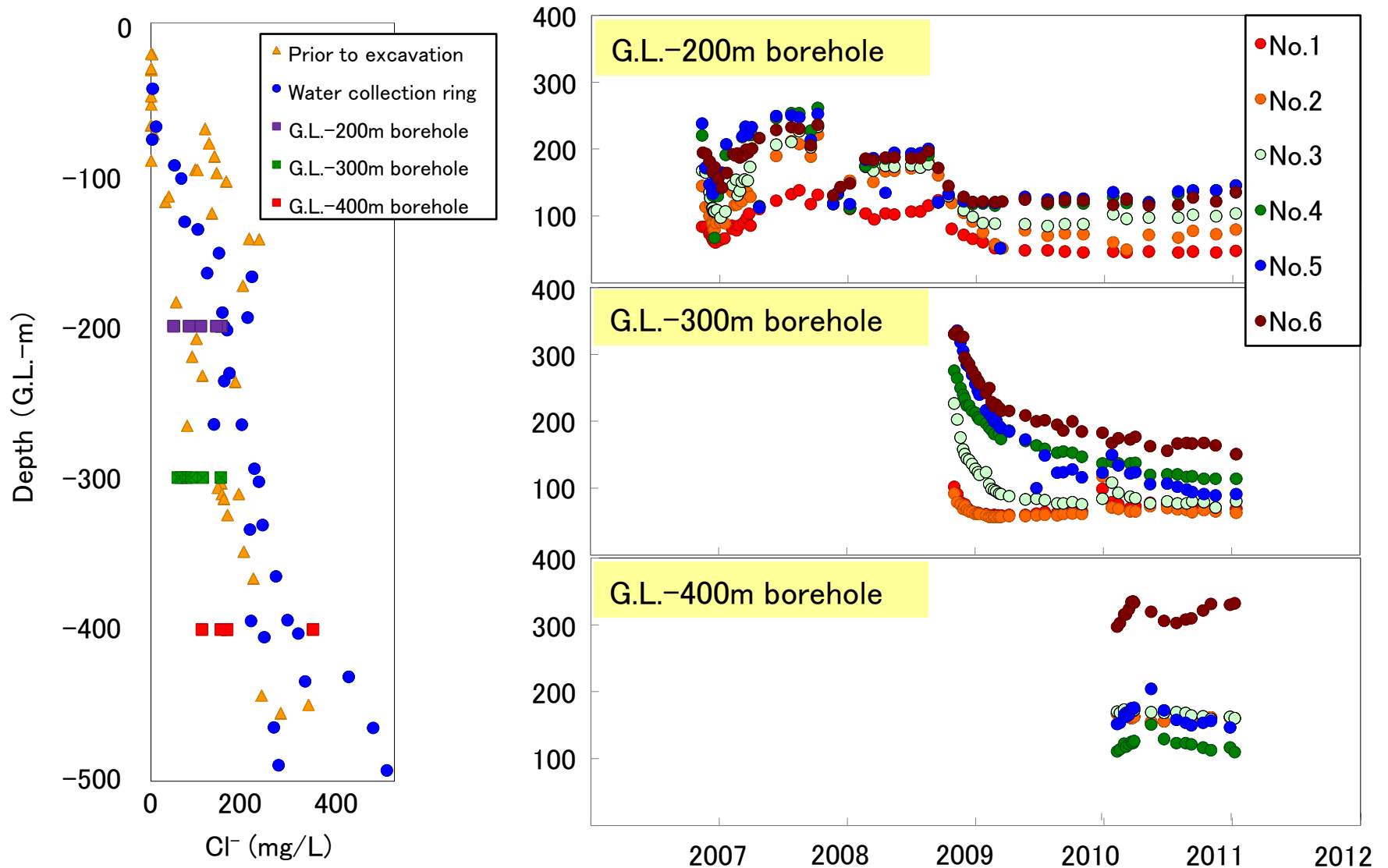
◆ The suitability of compartment structures are validated by groundwater simulation

Case	Hydraulic conductivity (m/s)					
	Toki granite	Main shaft f.	IF_S200_13	IF_S200_15	IF_SB3_11	IF_SB3_19
Absence of Compartment	3.2E-08	5.0E-11	3.2E-08	3.2E-08	3.2E-08	3.2E-08
Presence of Compartment	3.2E-08	5.0E-11	1.0E-11	1.0E-11	1.0E-11	1.0E-11



Result: Absence of Compartment
 Result: Presence of Compartment

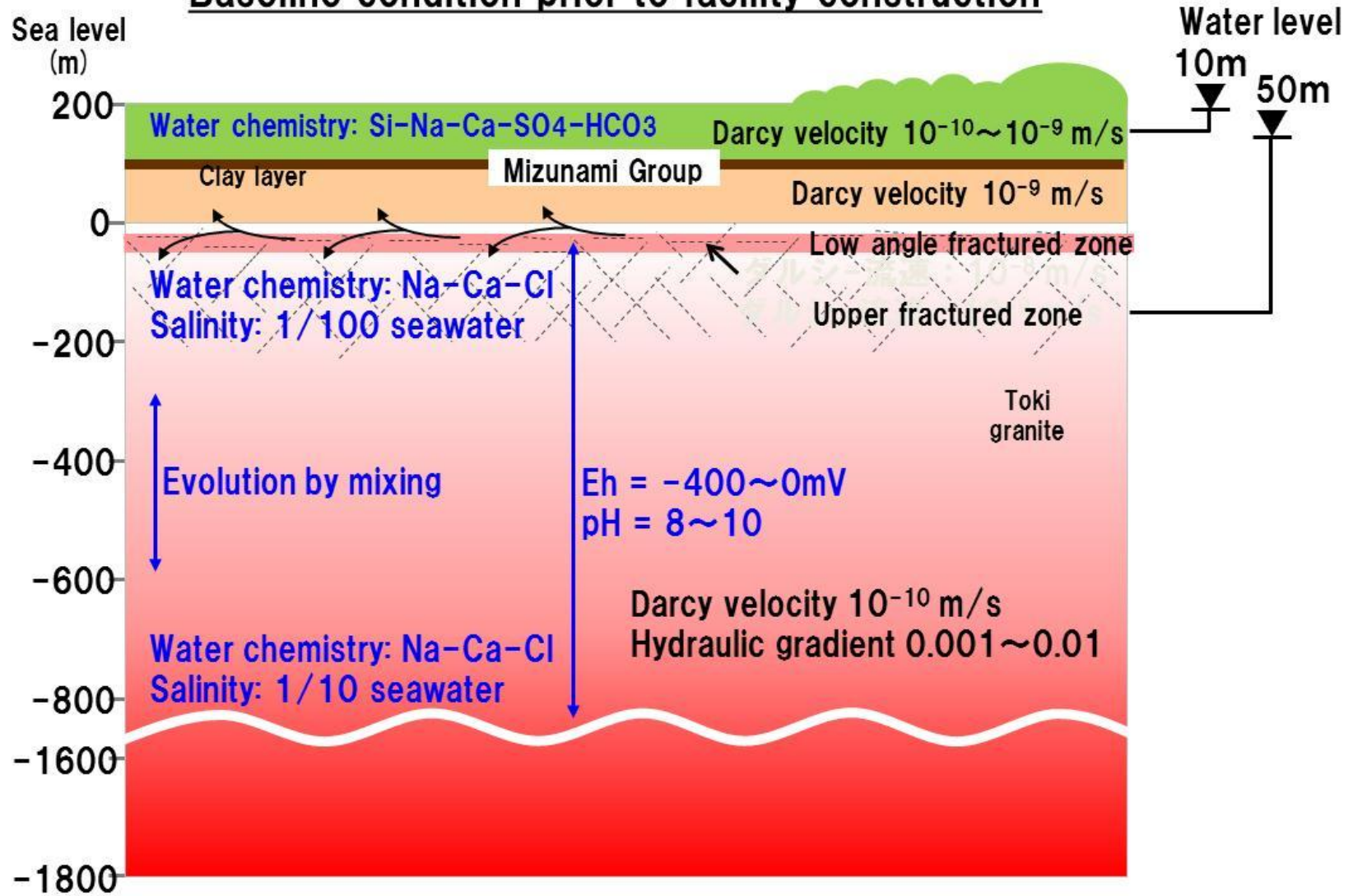
Change of chemical condition by long-term monitoring



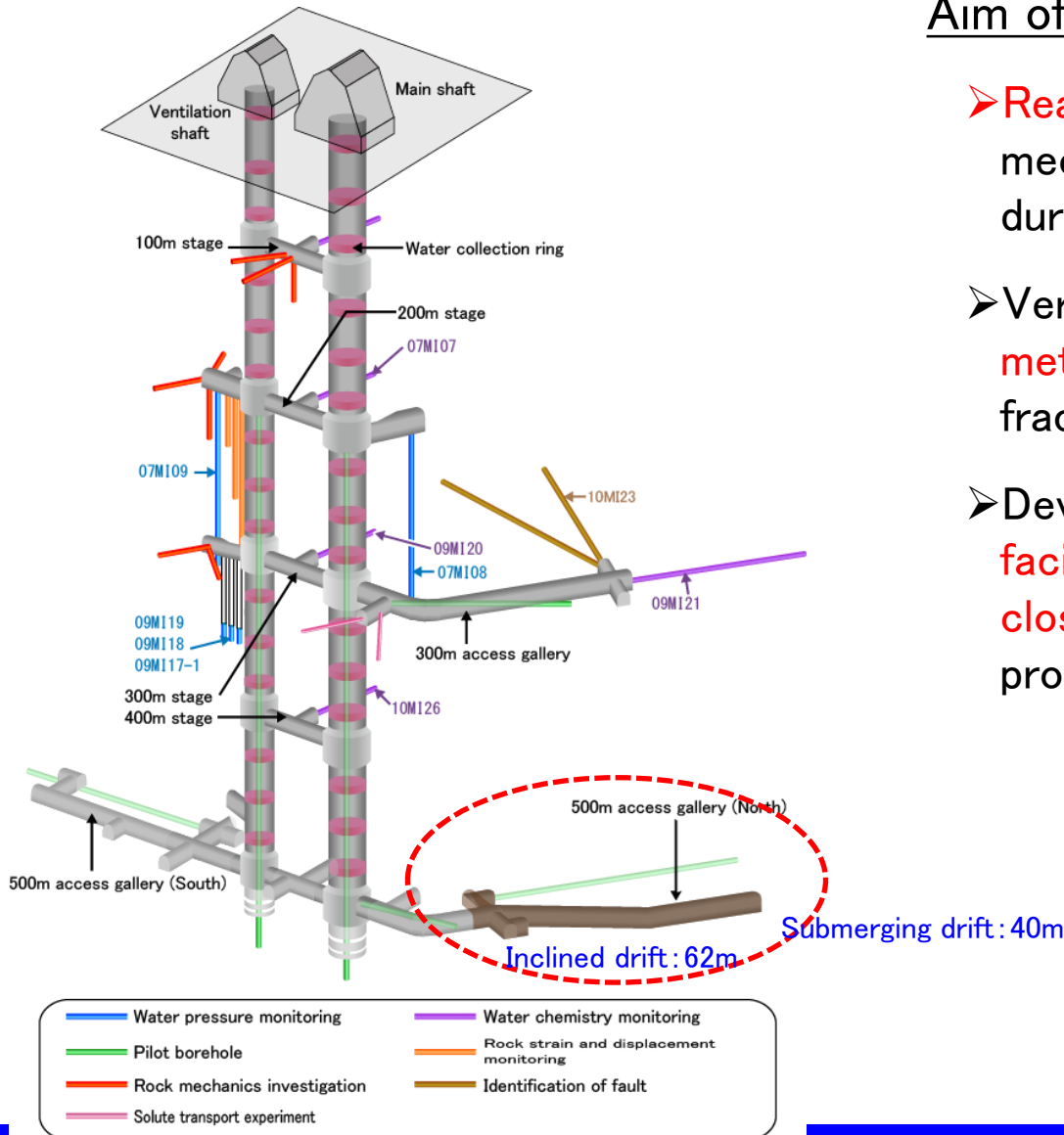
At first salinity increases due to upwelling of deep saline water, and then it decreases by infiltration of low-salinity shallow water with time.

Geological environment model based on the result of Phase I investigation

Baseline condition prior to facility construction



Rock mechanical and hydrochemical investigations in and around closed drift (in Phase III)

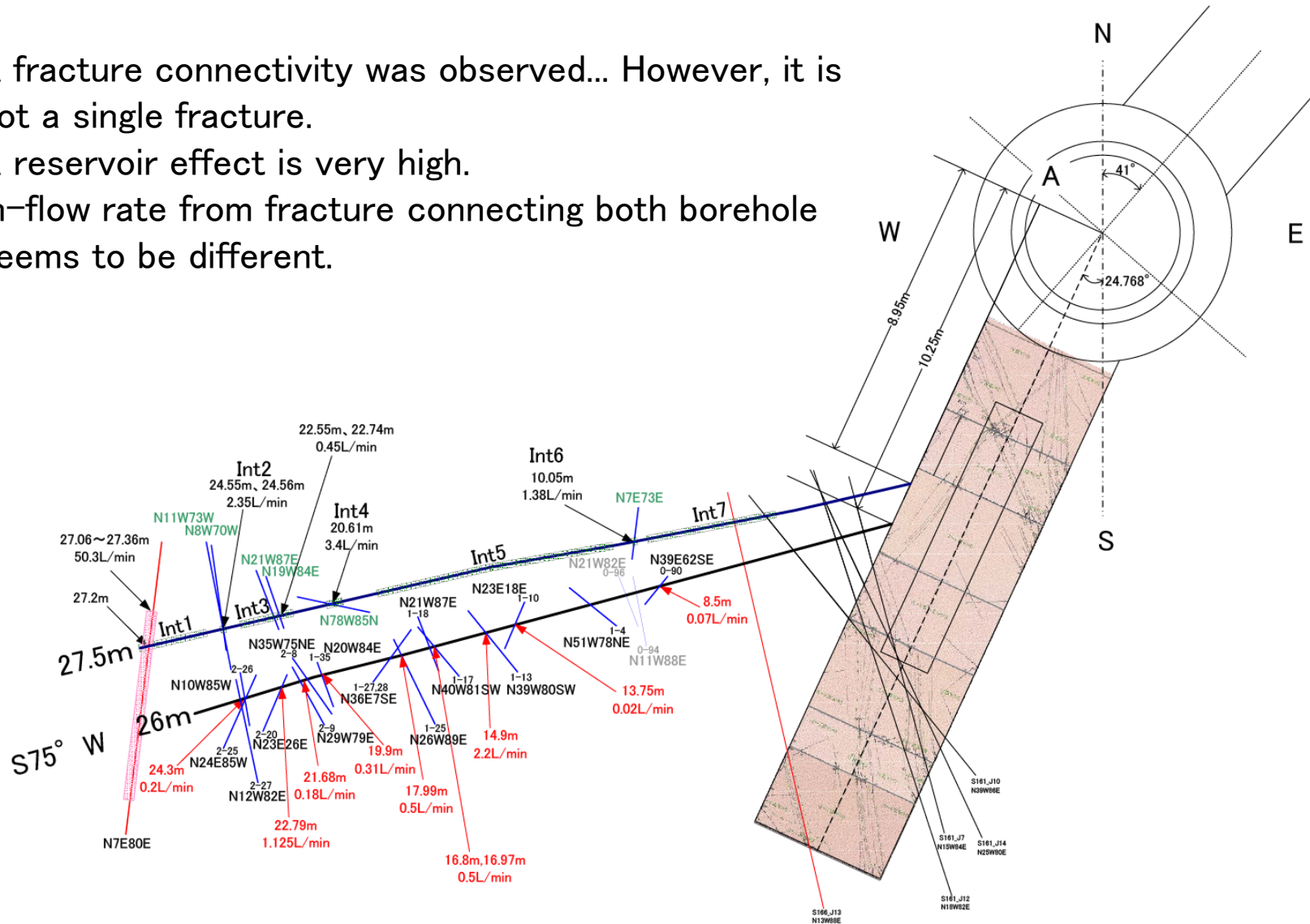


Aim of drift submerging experiment

- Realize the recovery process and mechanism of geological environment during facility closure
- Verify the H-M-C-B simulation methods for recovery process in fractured granite
- Develop the monitoring technique for facility closure phase and appropriate closure method taking recovery process into account

Preliminary result of borehole investigation for the solute transport study collaboration with CRIEPI (in Phase III)

- A fracture connectivity was observed... However, it is not a single fracture.
- A reservoir effect is very high.
- In-flow rate from fracture connecting both borehole seems to be different.

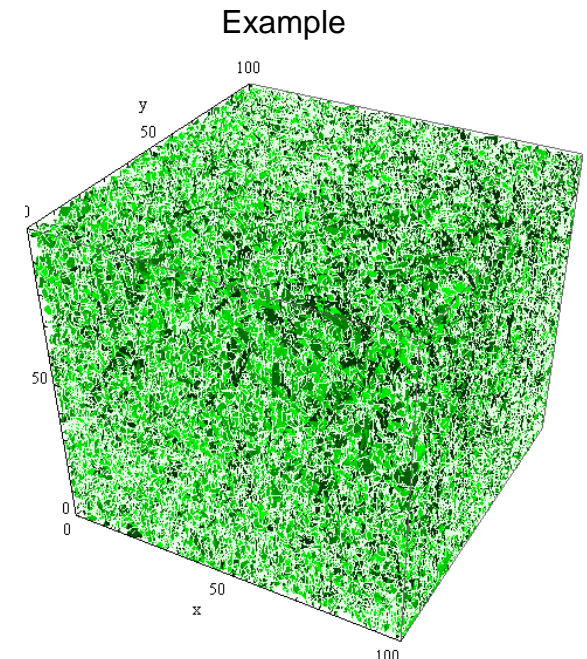
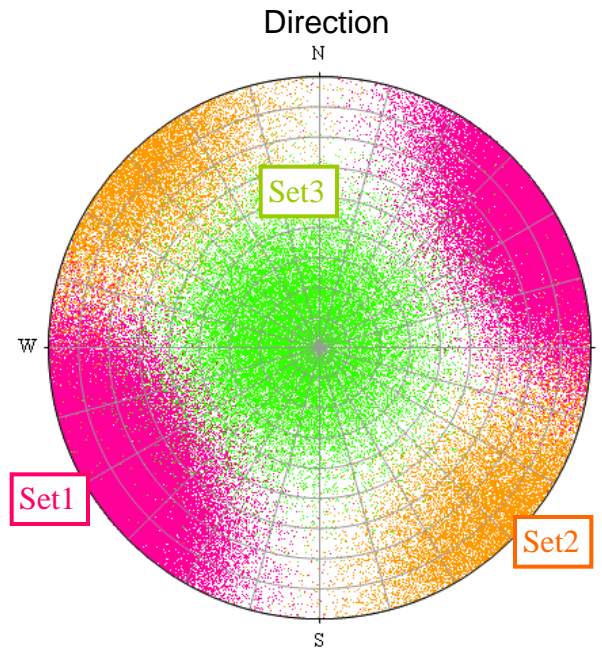
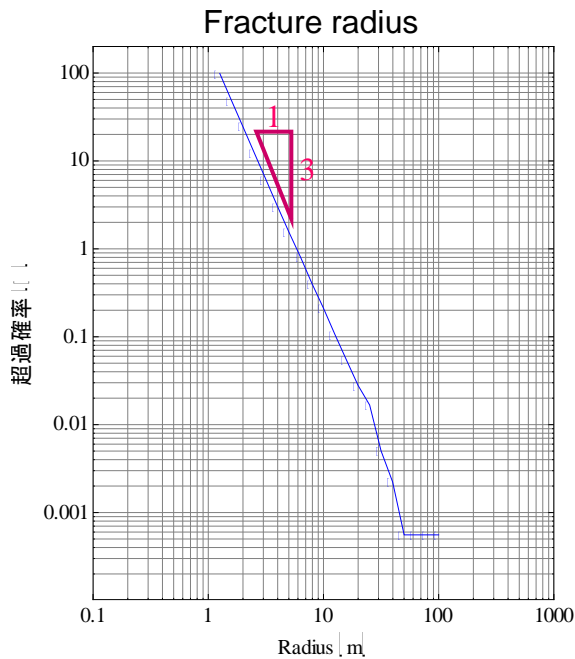
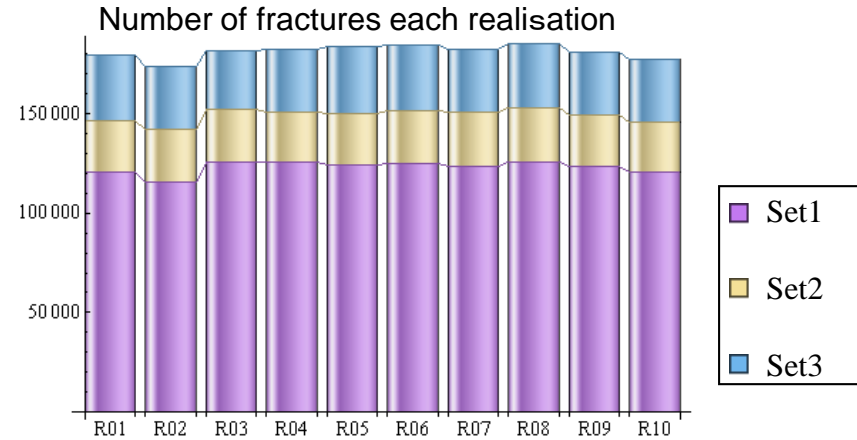


Development of block scale model

-Discrete Fracture Network (DFN) Model-

Paramers

Rlzn. No.	Set 1	Set 2	Set 3	Set4	Set 5	Total
R01	120,744	25,460	32,998	-	-	179,202
R02	115,448	26,550	31,467	-	-	173,465
R03	125,504	26,526	29,953	-	-	181,983
R04	125,701	24,912	32,006	-	-	182,619
R05	123,991	26,392	33,421	-	-	183,804
R06	125,057	26,817	32,937	-	-	184,811
R07	123,425	27,368	31,707	-	-	182,500
R08	125,500	27,177	32,710	-	-	185,387
R09	123,510	26,033	31,782	-	-	181,325
R10	120,501	25,567	31,680	-	-	177,748
Average	122,938	26,280	32,066	-	-	181,284

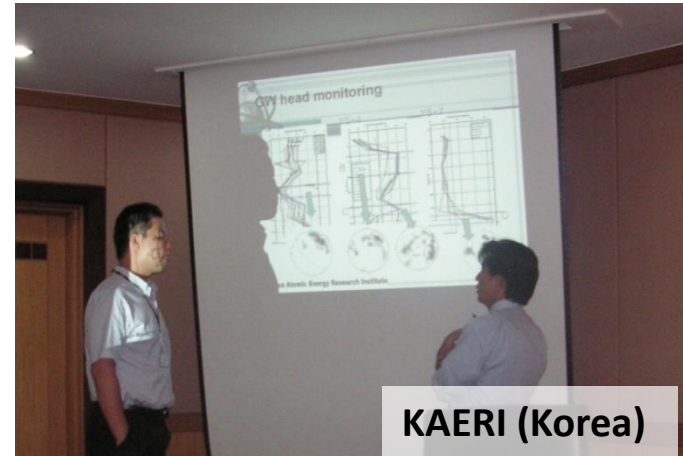


International Collaboration

Information exchange



Nagra (Switzerland)

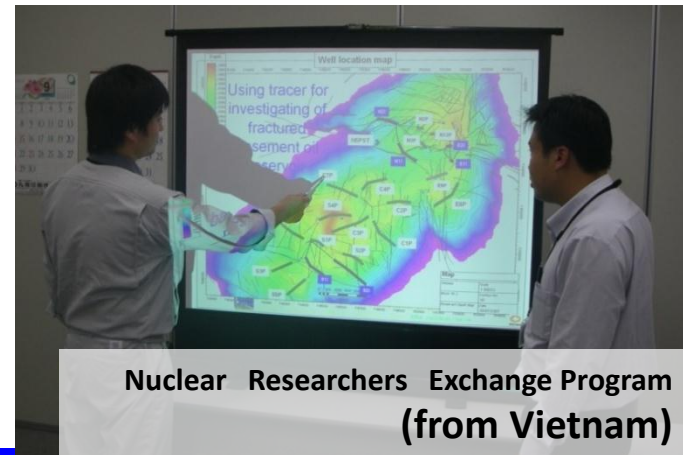


KAERI (Korea)

Technical training



@ KAERI facilities (Korea)



Nuclear Researchers Exchange Program
(from Vietnam)



“Thank you very much for your attention”



MIU Construction Site Tour

-Putting on the Protective Equipment-

In your locker



-Jumpsuit
Size :
SS – 5XL



-Reflective vest
- Socks



-Helmet
Fasten the buckle.



-Cotton work gloves



- Rubber work boots
Size:
23.0 - 30.0 cm
-Sneakers
Size : 22.0 cm



-Locker Key
Please leave your valuable stuff in the locker.



Cell phone and camera can be attached to the key strap to prevent them from falling.

- ★ Not allowed to bring something, that might have a risk of falling.
- ★ You may be asked to wear the dust mask, according to the construction condition.
- ★ Please feel free to ask JAEA staff, if you have any further questions.

Appropriate Protective Equipment



* **Helmet**

Reflex vest

Jumpsuit

* **Work gloves**

* **Rubber work boots (Steel toe)**

PHS



**-for location tracking
-for emergency**

※PHS will be handed after wearing the jumpsuit

* :For surface facility touring

MIU Construction Site Tour

Please stay with your designated guides and follow their instructions at all times throughout the tour!

Tour : Surface Facilities

【Effluent treatment facility】



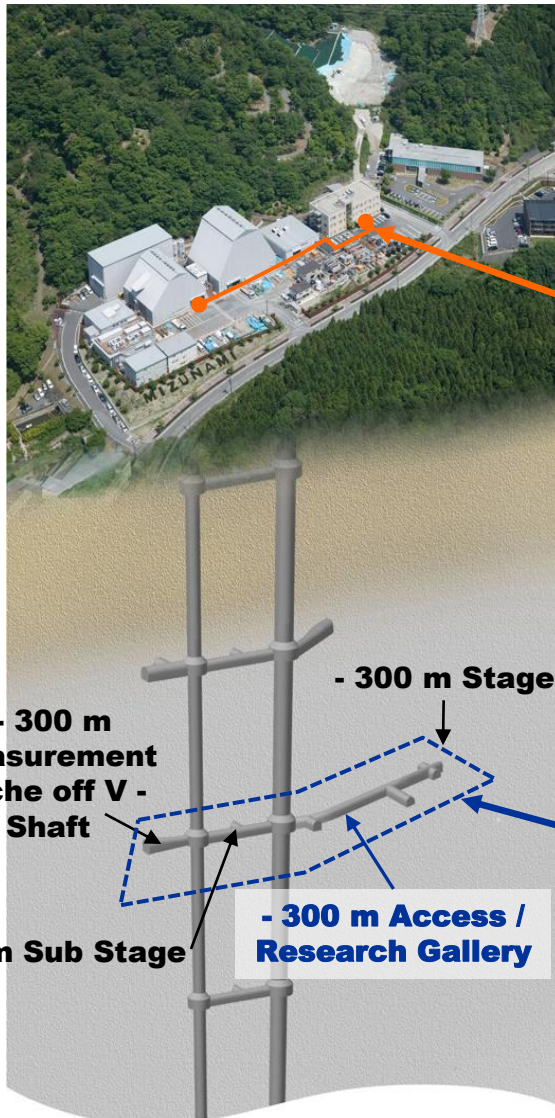
【Scaffold, M- Shaft】



【Hoisting room】



【Scaffold, V-Shaft】



Tour : - 300 m Stage



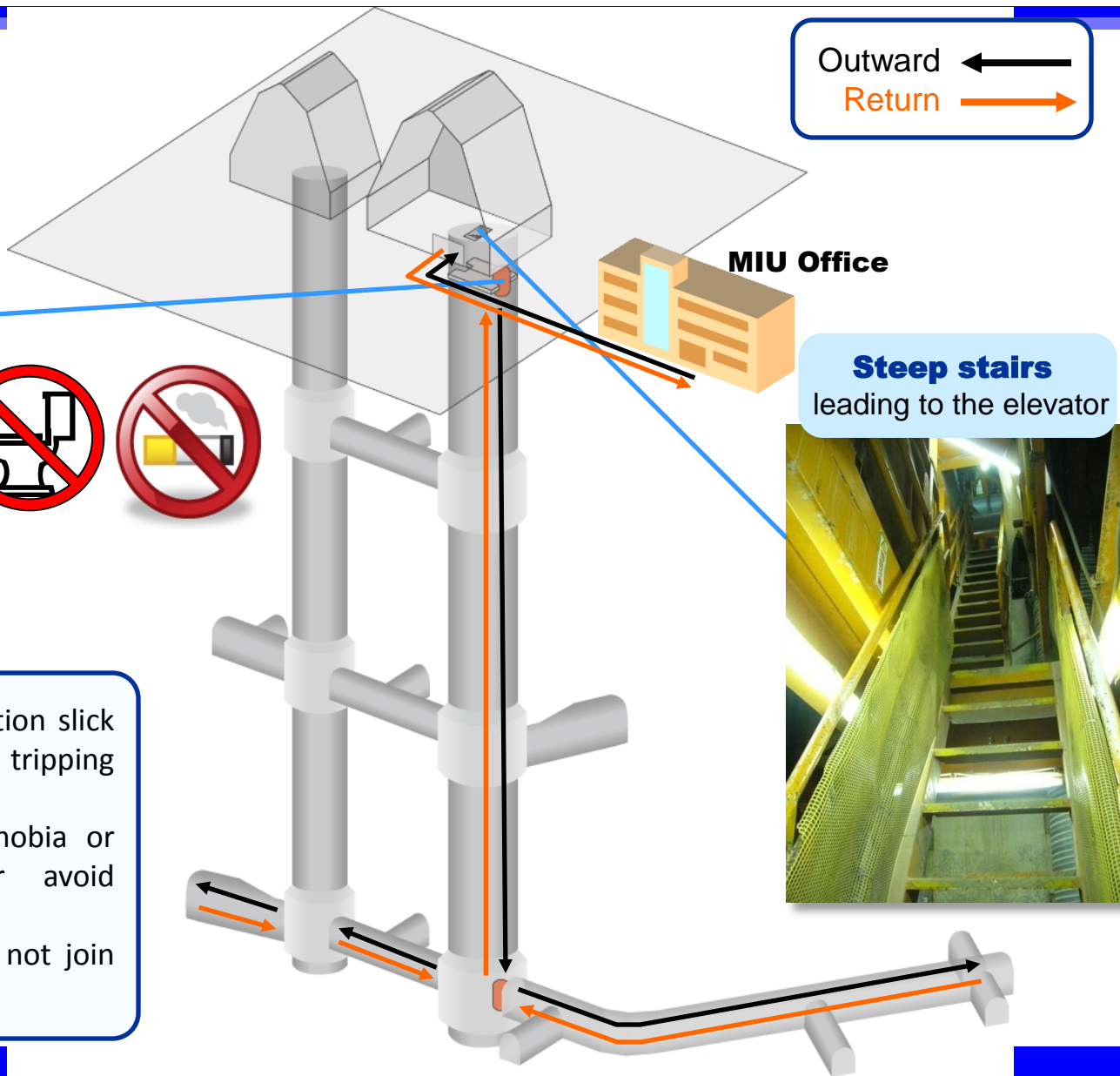
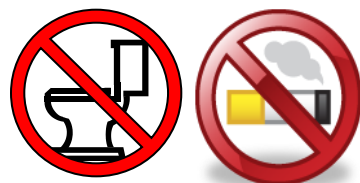
【- 300 m Access/ Research Gallery】



【- 300 m Measurement Niche off V-Shaft】

Tour route: – 300 m Stage

Workers Elevator
(Capacity: 10 people)



Outward ←
Return →

MIU Office

Steep stairs
leading to the elevator



- Watch where you walk, be caution slick or wet surfaces, steep stairs and tripping hazards.
- Someone suffers from acrophobia or claustrophobia would better avoid making the tour.
- If you are pregnant, please do not join this tour.