*International Review Workshop on JAEA's URL projects*

# Current Status of Next Phase Plan

## - Horonobe Underground Research Laboratory -

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# External needs considered to confirm importance of response to national program requirements (1/2)

① **Basic R&D expected for the latter half of detailed investigation, described in " R&D plan on geological disposal project – R&D for Preliminary and detailed Investigation stages-(2013) NUMO"**

a) Geological environment*:
- Development of comprehensive technologies for the investigation and evaluation of the deep geological environment by carrying out geoscientific basic research
- Advancement of technology for the investigation and evaluation of the deep geological environment (geophysical survey, GW flow and flow path property)

b) Design and construction of engineered barrier:
- Advancement of methodology on evaluation of long-term changes in the system performance, considering coupled behavior of engineering barrier
- Confirmation of design/construction technologies and performance of buffering material, backfilling material and plug, using research galleries of URL
- Establishment of conditions necessitating retrieval is required and development of retrieval technology according to the disposal options

c) Design of underground facility:
- Specification of updating method of the facility design, depending on the progress of site investigation
- Establishment of basic criteria for emplacement of HLW and development methodology for evaluation of fractures
- Demonstration of grouting technology and performance, using the research gallery of URL

d) Safety assessment:
- Modelling of phenomena and update of system performance assessment model
- Development of analysis tools
- Update of databases such as thermodynamic database and sorption database
- Clarification of demonstration methodology and procedures in the underground facility
- Development of a modelling methodology and database for long-term evolution of biosphere
- Acquisition of natural analogue examples and updates of its application methodology for safety assessment

Response to national program requirements

- Verification of the crustal-movement buffering capacity of sedimentary rocks
- Near-field performance study
- Demonstration of repository design options

*: Technologies for understanding geological environment should support investigation and evaluation for design and construction of engineering barrier, design of underground facility and safety assessment.

# External needs considered to confirm importance of response to national program requirements (2/2)

② **Research issues encouraged by regulatory relatives organization**, described in the report of "In preparation for making basement of safety regulation of HLW disposal (2003)" by **Radioactive Waste Safety Subcommittee**, Nuclear and Industrial Safety Subcommittee, Advisory Committee for Natural Resources and Energy
- a) Natural phenomena
- b) Future human activities (Human intrusion)
- c) Radionuclide migration through groundwater flow system

③ Urgent issues, such as long-term stability of geological environment, **suggested by Science Council of Japan (2012)** from the experience of the Great East Japan Earthquake (e.g. the appropriate consideration against uncertainty in natural phenomena)

④ **Basic Energy Plan (2014.4)** described as following,
- ✓ With effort on the premise of waste disposal, it should be possible for future generation to choose the best disposal method if other better option will be put to practical use, by allowing reversibility and retrievability of radioactive waste.
- ✓ The investigation and research regarding influence of such a case of maintaining retrievability by keeping repository open should progress in order to bring how to manage HLW into shape until closure of repository

**Response to national program requirements**

→ Near-field performance study

→ Verification of the crustal-movement buffering capacity of sedimentary rocks

→ Demonstration of repository design options

# Summarized response to national program requirements

| | Conclusions from Horonobe URL studies | Next Plans of Horonobe URL |
|---|---|---|
| **A1**: Understanding of Initial Geo-environmental conditions (GeC) | - Methods to identify appropriate area for URL/repository construction for surface-based investigation phase have been developed & applied.<br>- Initial GeC has been well characterized. | - Basically completed; data would be compared after obtaining data post closure of URL |
| **A2**: Understanding of short-term Changing/Recovering Behavior of GeC | - Methods to design & construct URL/repository using conventional technology have been confirmed.<br>- Methods to identify EdZ & EDZ have been developed & tested.<br>- Material to reduce environmental impact has been developed & applied. | - THMC experiment with model development (on-going)<br>- Testing of solute migration models under *in-situ* conditions<br>- Demonstration experiments of EBS considering disposal options |
| **A3**: Understanding of long-term Changing/Recovering Behavior of GeC | - Methods to close URL/repository have not yet tested.<br>- Methods to evaluate long-term evolution of GeC have been constructed and tested.<br>- Long-term scenario of changing/recovering behavior useful for PA has been constructed. | - Development/testing of drift closure & retrieval technology<br>- Development of Long-term monitoring technology for understanding of initial GeC post closure of URL<br>- Testing of buffering/resilient potential in sedimentary rock |

**Response to national program requirements**

- Near-field performance study
- Demonstration of repository design options
- Verification of the crustal-movement buffering capacity of sedimentary rocks

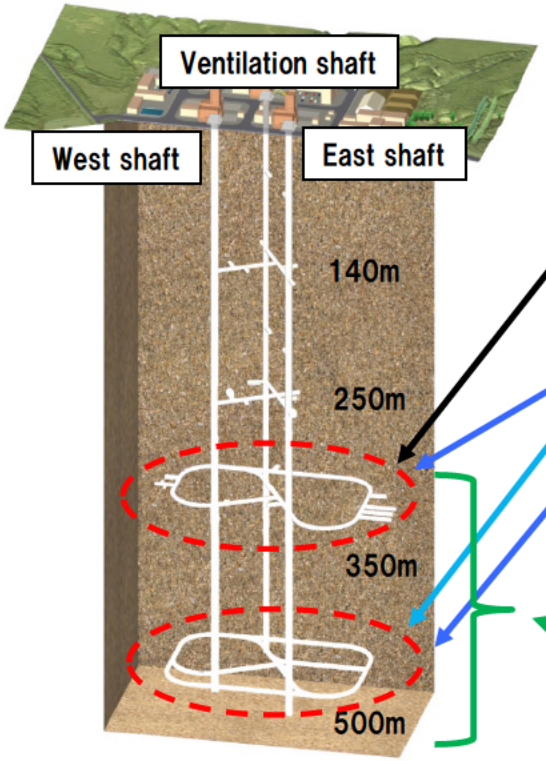
# Goal, phenomena and testing for each response to national program requirements (1/2)

| Response to national program requirements | Goals | Phenomena | Testing | Related Research |
|---|---|---|---|---|
| Near-field performance study | ✓ To observe near-field coupled THMC phenomena in-situ and to make a confidence of coupled THMC models<br>✓ To observe near-field coupled THMC phenomena under high temperature condition<br>✓ To validate the estimated corrosion rate by laboratory experiments<br>✓ To obtain "in-situ" mass transport properties related to advection, dispersion, diffusion, sorption, etc. in fractured sedimentary rock<br>✓ To confirm applicability of safety assessment methodology using these data<br>✓ To develop of long-term monitoring technology | ✓ Near-field coupled THMC phenomena during unsaturated conditions<br>✓ Corrosion under aerobic and anaerobic conditions<br>✓ Essential retardation characteristics due to fractured sedimentary rock, Heterogeneity and anisotropy of mass transport characteristics and pathways in fractures and/or pores in sedimentary rock<br>✓ Damage and disturb processes during facility operation, and recovery process after closure | ✓ H12-V test (full-scale EBS test for vertical emplacement EBS design indicated H12 report)<br>✓ High temperature (>100°C) test<br>✓ Overpack corrosion test<br>✓ In-situ mass transport test | DECOVALEX-THMC, TIMODAZ, LOT project, Mont terri project, Grimsel Test Site, etc. |

# Goal, phenomena and testing for response to national program requirements (2/2)

| Response to national program requirements | Goals | Phenomena | Testing | Useful Reference |
|---|---|---|---|---|
| Demonstration of repository design options | ✓ To demonstrate the feasibility of remote emplacement and retrievable technologies of PEM type<br>✓ To confirm of engineered barrier behaviour until retrievability<br>✓ To develop the investigation techniques, design criteria and design methods for repository panels, deposition tunnel and deposition hole layout<br>✓ To develop the grouting technology considering high GW pressure and dissolved gas in sedimentary host rock<br>✓ To develop the lining technology of disposal pit | - | ✓ DER Test (demonstration of remote emplacement & retrievable technologies)<br>✓ LDM study (Layout Determining Methodology | ESDRED, RSC programme (POSIVA), etc. |
| Verification of the crustal-movement buffering capacity of sedimentary rocks | ✓ To validate of hydro-mechanical buffering capacity of sedimentary rock against fault reactivation<br>✓ To develop the general evaluation method for the buffering capacity<br>✓ To clarify erosion phenomena of buffer material by fault reactivation<br>✓ To understand colloid formation, migration behavior and interaction with nuclide (natural elements or added cold tracer) in various conditions | ✓ Temporal increasing of permeability and weakening of fault zone during reactivation<br>✓ Self-sealing/healing of fault zone after the reactivation<br>✓ Bentonite eroded due to GW pressure increase by fault reactivation<br>✓ Colloid formation from buffer material<br>✓ Advection/dispersion of the colloid | ✓ BC test (Buffering capacity of sedimentary rock)<br>✓ SC test (Severe condition) | Mont terri, project, Clay Club, Colloid project at the GTS (CFM, FEBEX), etc. |

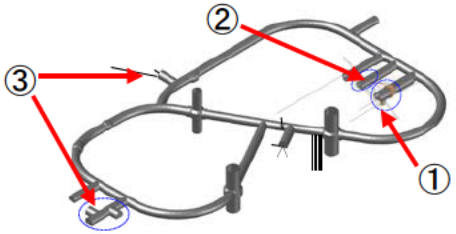
# An illustration of summarized overall design for R&D in Horonobe URL




＊ This layout may be changed depending on the results of future investigations

◆Near-field performance study

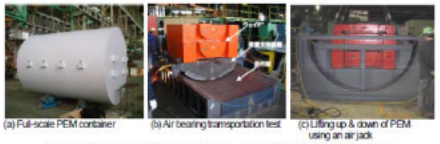
- ✓H12-V test【①】
- ✓Overpack corrosion test【②】
- ✓In-situ mass transport test【③】
- ✓High temperature test (>100°C)

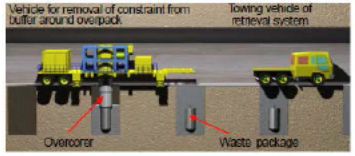



350m gallery

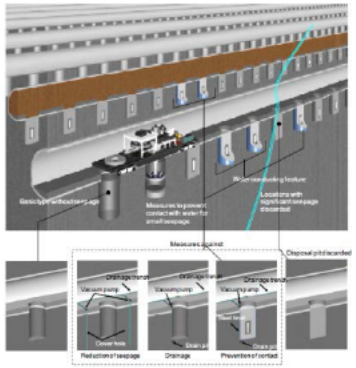
◆Demonstration of repository design options

- ✓DER test
- ✓LDM study



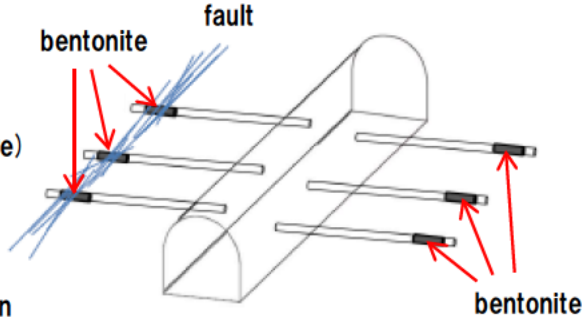

Example of the RER test



Example of the LDM study (grouting/lining)

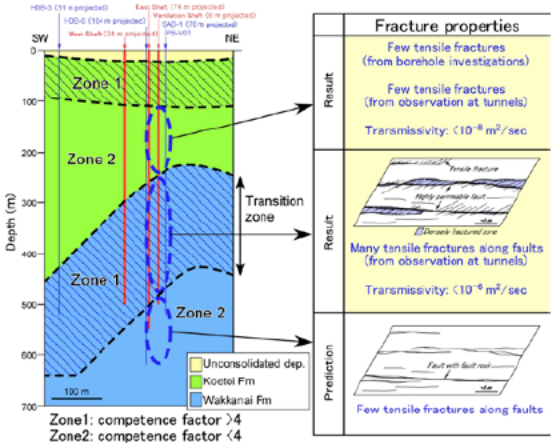
◆ Verification of the crustal-movement buffering capacity of sedimentary rocks

- ✓BC test
- ✓SC test




- Injection (hydrofracture) tests for fault zones using boreholes
- Monitoring of erosion phenomena, colloid formation and migration behavior

SC test




BC test

- Injection (hydrofracture) tests for fault zones using boreholes at high DI domain (e.g. Zone 2)
- Permeability (and pore pressure) monitoring before and after the disturbing tests
- Verifying the empirical relation and implication