Project Research — **Establishment of Optimal Risk Management**

High-level Radioactive Waste Management

Background and Objective

The long-term stability of underground facilities and the suppressive function of ultra-long-term radioactive nuclide migration using engineered and natural barriers are required and can be considered by looking at the geological/rock mechanical/hydraulic properties of deep-seated rock mass in the geological disposal of HLW.

In this project research, CRIEPI verifies the survey flow diagram for the PI (preliminary investigation), which was proposed by CRIEPI, and clarifies the applicability of survey technologies for the PI and the DI (detailed investigation) and the long-term behavior of near-field engineered and natural barriers.

Main results

1 Systematization and Verification of Survey Technology and Estimation Method for Site Selection

As a collaboration project with NUMO (Nuclear Waste Management Organization of Japan), geophysical exploration (N11038) and drilling in accordance with the survey flow diagram of the PI that was advanced by CRIEPI (N11) were conducted at CRIEPI's Yokosuka site during 2006 to 2009, and the applicability for site selection was verified (N15). In addition to this, the build process for the monitoring system in the borehole was proposed based on in-situ survey results. These results are very helpful for NUMO in planning the PI.

2 Development of Advanced Element Technology for Site Selection

The following element technologies, which were supposed to be very important for site selection, were developed and upgraded.

(1) Survey technology at the underground tunnel: Survey technology developed at the Mont Terri tunnel in Switzerland (N14) was applied to JAEA's Horonobe URL, and applicability to the Japanese site was confirmed.

(2) Groundwater dating: A new groundwater dating method using helium and carbon isotopes was developed (N10001) in order to estimate groundwater flow, and this method was applied to the Tono area. Considering the mixing process of water chemistry, groundwater flow was estimated and the validity of this method was confirmed (Fig. 1).

(3) Directional drilling technology: A horizontal borehole with a length of 950 to 1,000 m was drilled, and a hydraulic test in this borehole was carried out (Fig. 2). We then could envision the optimal realization of directional drilling from these results.

These results were reflected in the planning for the PI and NUMO technical report (2010 report). The directional drilling and groundwater dating were conducted as funded research from METI (Ministry of Economy, Trade and Industry), and these applications at the Hornobe and Tono sites were conducted as a collaboration project with the JAEA (Japan Atomic Energy Agency).

3 Development of Survey Technology and an Estimation Method for the Design of Disposal Facilities

Using a centrifuge, installing a 1/30th model of a near-field of vitrified waste, the acceleration tests were conducted for a maximum of two months. These tests enabled the ability to estimate the long-term behavior of the soil pressure of a bentonite buffer and the displacement of overpack for about 165 years (Fig. 3) (N11037) (N11040).

Other reports: (N11021), (N11033) and (N11036)

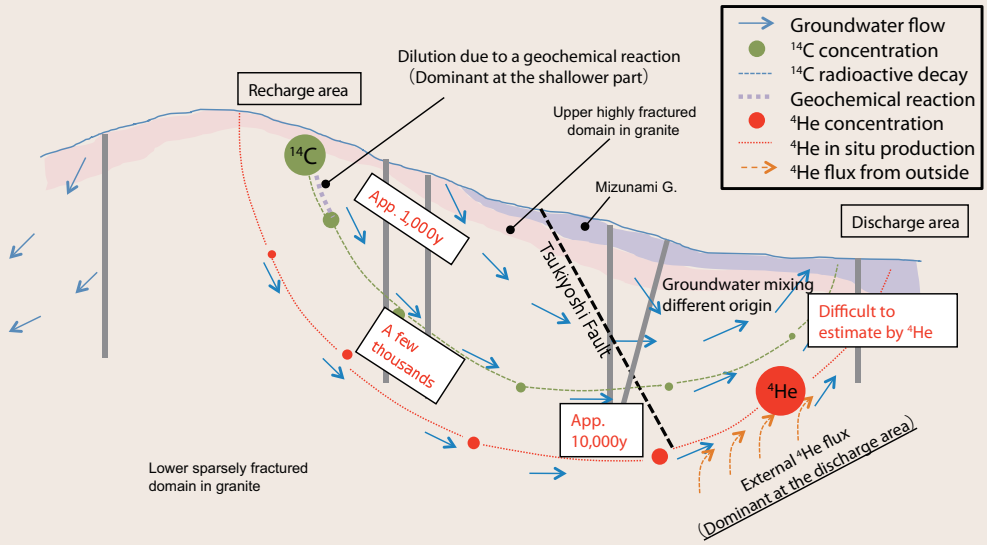

Fig. 1: Conceptual transport model of ^{14}C and ^{4}He for groundwater dating in the Tono area

A groundwater dating method for very old groundwater has been applied to a granitic area, and these results are consistent with the groundwater flow deduced from the previous investigation.

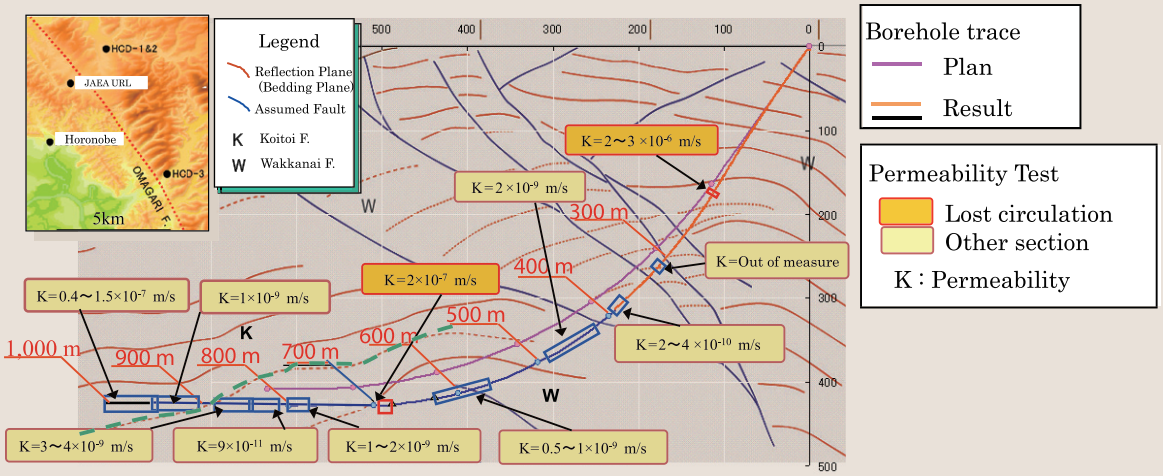

Fig. 2: Results of controlled drilling and the permeability test in the borehole

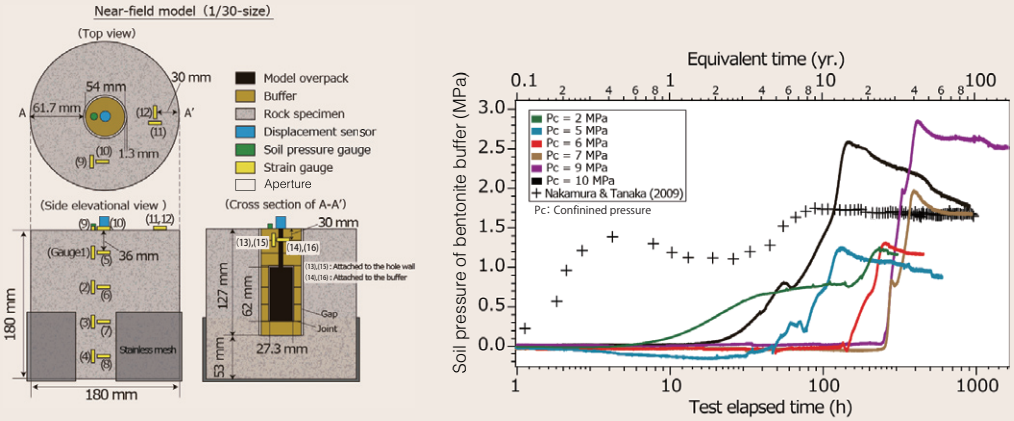

Fig. 3: Prediction experiment of long-term behavior in the near-field using the "CENTURY5000-THM" centrifuge (left: near-field model of this study, right: time-dependent change of the soil pressure of the bentonite buffer through the difference of the boundary condition)

The present results under the stress-state conditions demonstrate that the maximum soil pressures of the buffer depend on the earth pressures (Pc) and that they decrease after the maximal, which is different from the results of the previous study under the strain-state conditions (Nakamura and Tanaka, 2009).