High-Level Radioactive Waste Management

Background and Objective

Long term durability of underground facility and suppressive function of ultralong term radioactive nuclide migration are required by considering geological/rock mechanical/hydraullic properties of deep seated rock mass in the geological disposal of HLW. In this project research, CRIEPI proceeds with the development of elementary technology and systematization of these technologies for the PI (preliminary investigation) and the DI (detailed investigation).

Main results

1. Systematization and verification of survey technology and estimation method for site selection

In order to conduct ecomic and rational PI, systematic survey and estimation flow diagram of the PI is proposed based on the results of desk simulation to the virtual site and the knowledge accumulated during existing survey [N11]. The geological survey and drilling considering the proposed flow diagram was conducted at the CRIEPI Yokosuka site as a collaboration work with HLW implementer NUMO, and applicability of the flow diagram was estimated (Fig. 1). These results contribute to the NUMO activities.

2. Development of advanced element technology for site selection

Following element technologies thought to be important for the PI and the DI are developed.

(i) Ground water dating technology: Simple extraction method of ^{36}Cl from water sample was developed [N09028] and ^{36}Cl method together with ^{4}He method were applied to the Horonobe site in Hokkaido and ground water at the site can be estimated to be several million years old (Fig. 2) [N09027]. (ii) Controlled drilling technology: Horizontal drilling from 800m to 900m long and survey and test in the borehole were carried out and its applicability was demonstrated at the Hornobe site. (iii) Microbe effect assessment to the geochemical condition: Laboratory test using rock and water sample collected at the Horonobe site was carried out. As a result, a microbial reaction induced the decrease of oxidation-reduction potential (Fig. 3). (iv) Estimation of long term rock mechanical behavior around disposal cavern: World first centrifuge which can mount the model of disposal pit was newly developed and an acceleration test for estimating the ultra long term behavior was started (Fig. 4). Several months' operation of the centrifuge makes it possible to estimate rock deformation for several thousand years.

Research on controlled drilling and ground water dating was done under contracts awarded from METI (Ministry of Economy, Trade and Industry) and the on-site work was conducted in collaboration with JAEA (Japan Atomic Energy Agency).

Other reports [N09016], [N09020], [N09026]

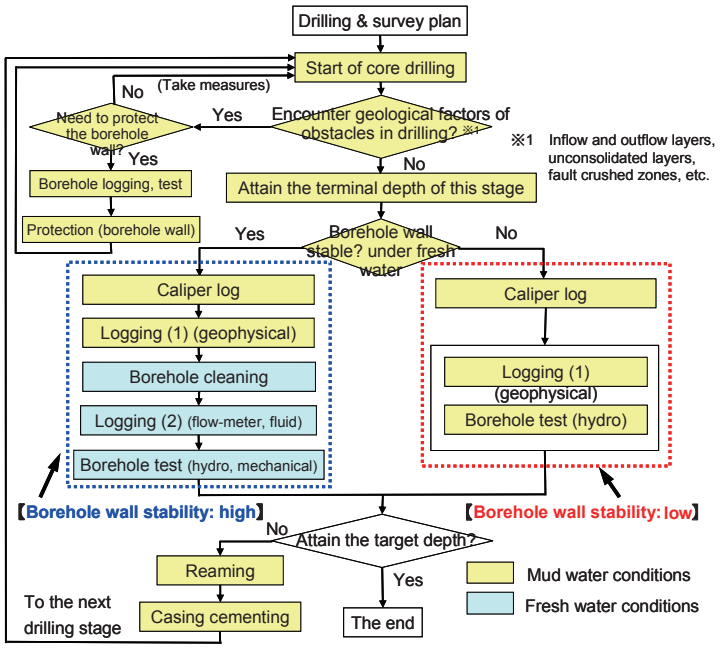

Fig. 1 Flow diagram of drilling and survey in the PI stage

From the results of a desk simulation based on real data and cooperative research "Yokosuka D&V project" at the CRIEPI Yokosuka, a systematic survey and estimation flow and operation manual for the PI was constructed.

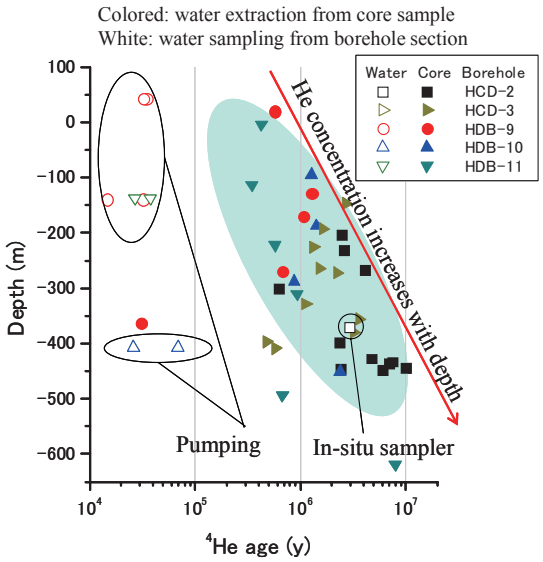

Fig. 2 ^{4}He age in Horonobe site

Ground water age calculated by ^{4}He contents and ^{4}He accumulating rate is equivalent to the age of the Wakkanai formation (2.9-13 Ma). This indicates that the ground water must be stagnant.

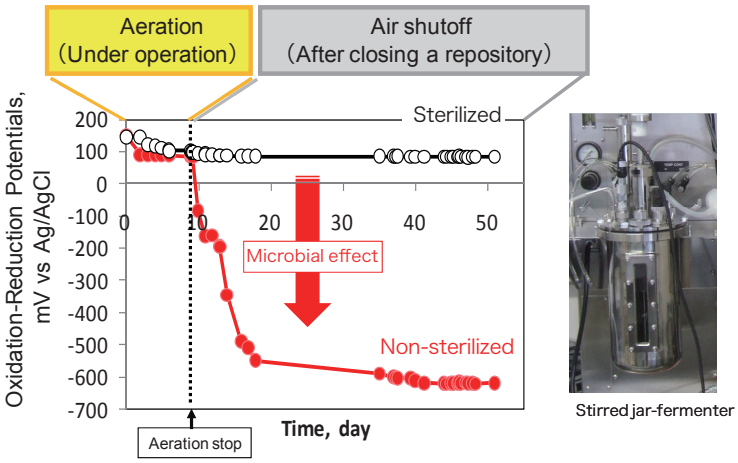

Fig. 3 Laboratory simulation of microbially mediated redox changes with Horonobe rock and groundwater.

Laboratory jar-fermenter experiment was conducted with rock and groundwater samples collected at Horonobe URL (G.L.-140m). As a result, after discontinuation of aeration, redox potentials decreased to ca. -600mV by microbial activities (i.e., aerobic respiration, iron reducing and fermentation), whereas sterilized slurry maintained high redox potential (ca. +100mV). This result shows that microbial activity affects groundwater evolution.

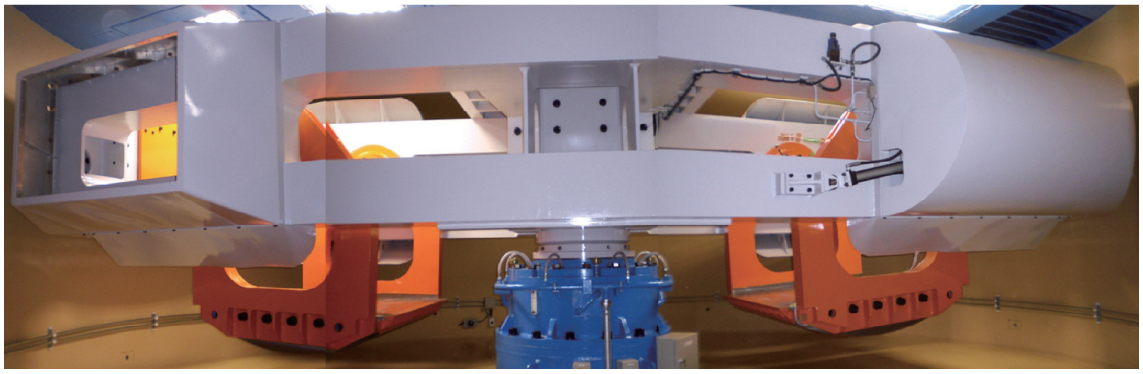

Fig. 4 Long term behavior of disposal pit

Controlling thermo-hydro-mechanical condition, the 1/30 scale centrifuge model test around deposition hole was started. Base on the similarity scaling law, it is possible to estimate several thousand years of mechanical behavior through the six month centrifuge model test.