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

Low-level Radioactive Waste Disposal

Background and Objective

A sub-surface disposal site constructed approx. 50–100 m underground is planned for low-level radioactive waste generated from operating and decommissioning of nuclear plants. In the safety evaluation of the sub-surface disposal facilities with pit disposal facilities, a long-term evaluation is necessary to be engineered.

In this project, we studied swelling pressure (which is caused by the infiltration of water) and the hydraulic conductivity of compacted bentonite. In addition, we studied the method for the estimation of the residence time of groundwater by using a recharge temperature for the natural barrier.

Main results

1 Development of a Swelling Model for a Bentonite-based Engineered Barrier during the Infiltration of Water and its Verification

Compacted bentonite-based material, which will be used as an engineered barrier in repositories for radioactive waste disposal, swells during the infiltration of underground water. Thus, events, such as the redistribution dry density and the displacement of containers of radioactive waste, will possibly occur. The accurate evaluation of these events is effective in decreasing uncertainty in the long-term safety evaluation of radioactive waste facilities. Thus, a swelling model of compacted bentonite during the infiltration of water is developed and the applicability of the model is investigated. Consequently, it is revealed that the developed model can simulate the swelling behavior of compacted bentonite during and after the infiltration of water (Fig. 1).

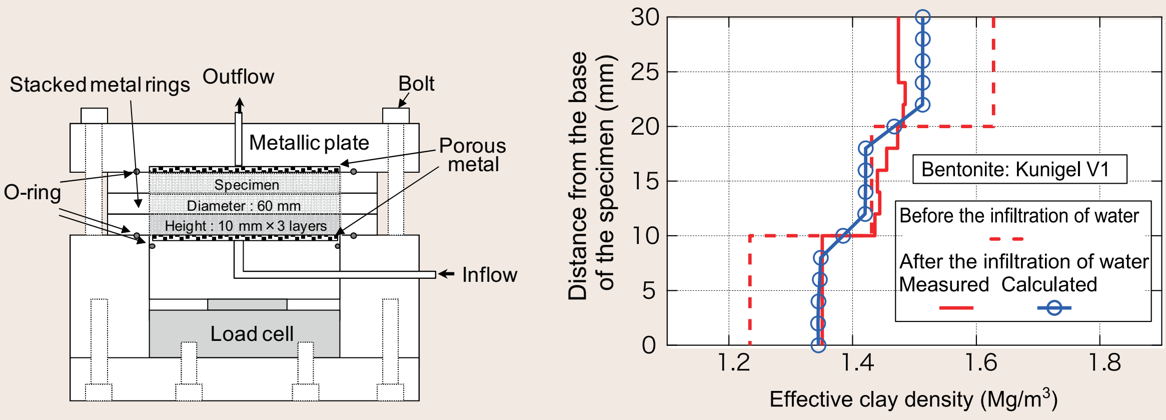
2 Development of an Investigation Method for the Redox Condition of Rocks Using the Self Potential (SP) Method

For the safety assessment of low-level radioactive waste disposal sites, it is necessary to evaluate the geochemical conditions of the natural barrier around such facilities. The geochemical conditions around a test cavern of the Rokkasho site was investigated using the self potential method. The results demonstrated that self potential change occurred around the oxidation front and that the oxidation condition can be detected using the self potential method (Figs. 2, 3, 4) (N11017).

3 Development of an Investigation Method for Underground Geochemical Conditions

To evaluate the geochemical conditions of the natural barriers around facilities, the geochemical condition around a test cavern at the Rokkasho site was investigated. For in-situ measurements of the geochemical condition, it is necessary to consider water quality change caused by excavations, the measurement method of the oxidation reduction potential in the reduced zone, and the deterioration of the sensors (Figs. 2, 3, 5) (N11043).

Other reports: (N10015), (N10048)



(a) Swelling pressure test apparatus

(b) Test results and calculated results

Fig. 1: Swelling pressure test for compacted bentonite with heterogeneous initial density

Since the calculated results coincide with the test results, it can be said that the redistribution of the effective clay density of compacted bentonite can be simulated by the developed model quantitatively.

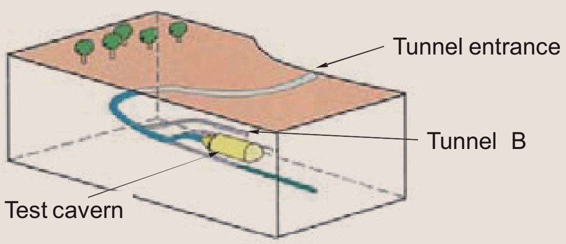


Fig. 2: Test cavern of the Rokkasho site

The test cavern and tunnels were excavated at depths of 50–100 m from the surface.

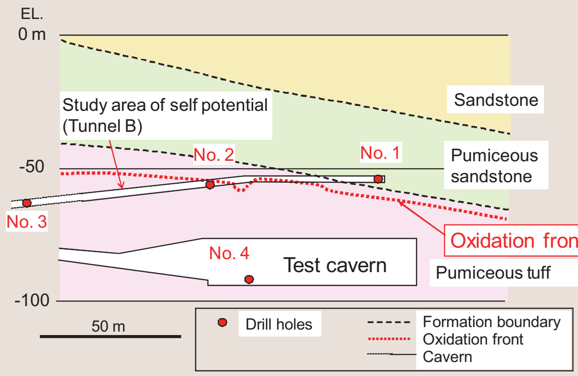


Fig. 3: Geological section of the site

Investigations were conducted in a tunnel near an oxidation front (rocks were changed to brown by weathering).

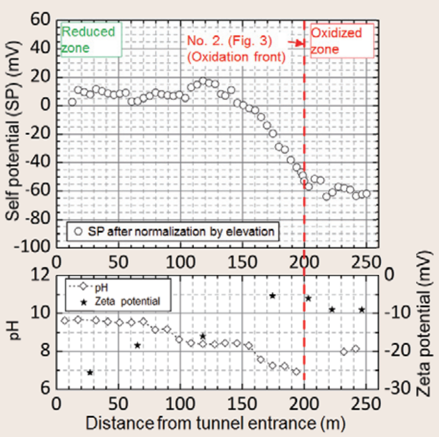


Fig. 4: Self potential and the zeta potential of rocks, along with the pH of groundwater

Self potential change occurred around the oxidation front. Zeta potential saw a correlation with the self potential or pH. (Zeta potential: Electric potential between a solid surface and a liquid)

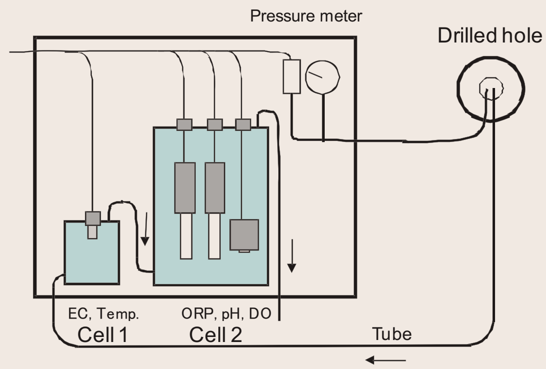


Fig. 5: Measurement using a monitoring system

Groundwater from drilled holes was measured in cells. Some problems regarding the closing of tubes by precipitation and the deterioration of sensors were improved for the in-situ measurements.