3–6 Estimating Long-Term Evolution of Environment and Materials around Radwaste in Deep Underground

— Development of Assessment Methodology Considering Geochemical Changes in the Near-Field —

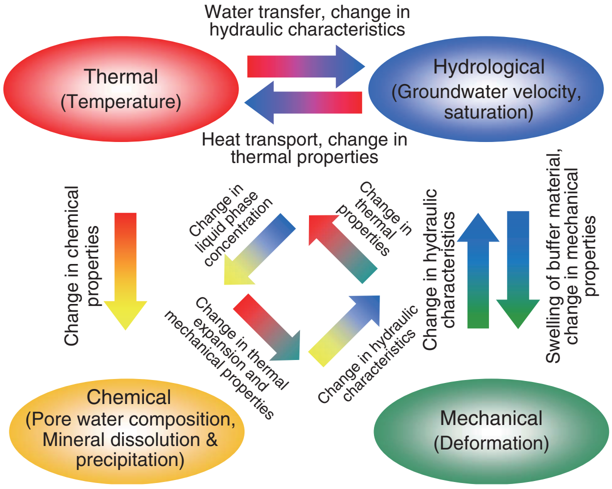

Fig.3-17 Conceptual model of coupled processes in near-field
It is believed that after an engineered barrier is set, a complicated condition involving heat release from vitrified waste, groundwater migration, swelling of buffer material, and geochemical reactions in pore water is induced.

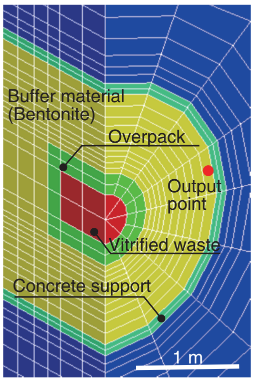

Fig.3-18 Analysis object
The red circle indicates output point in Fig.3-20. The layout assumes horizontal emplacement.

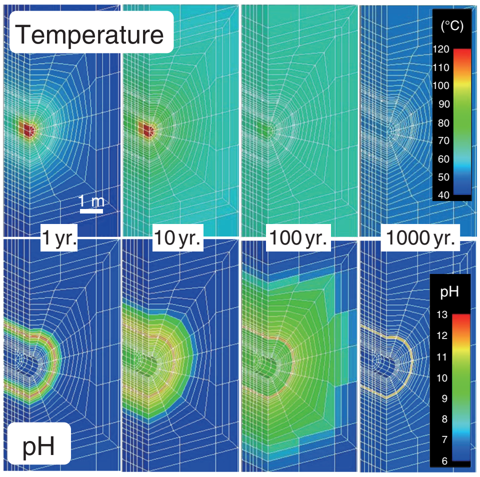

Fig.3-19 Analyzed example: evolution of temperature and pH in the near-field
The disposal system is assumed to be set in sedimentary rock 450 m in depth.

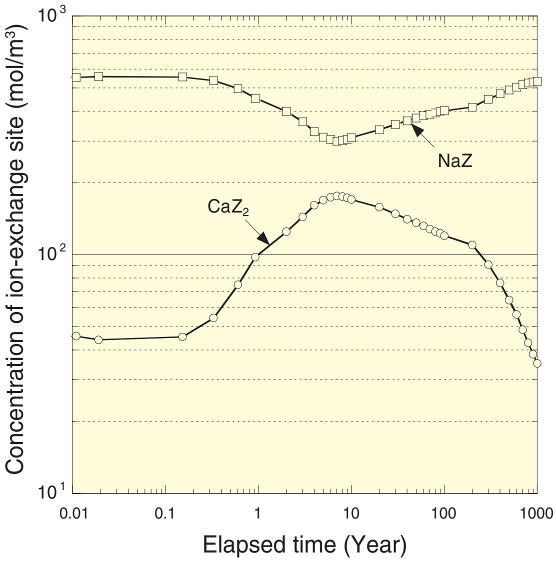

Fig.3-20 Analyzed example: history of concentration of ion-exchange sites in the buffer material
Z is an ion-exchange group. Na and Ca concentrations change to half and four times their initial values, respectively, in 10 years and are both restored to their initial values after 1000 years.

For the safety assessment of the geological disposal of high-level radioactive waste, it is necessary to quantify the coupled thermo-hydro-mechanical-chemical (THMC) processes in the near-field. Because laboratory and *in-situ* experiments cannot realize real phenomena, numerical models are used as a practical approach to bridging the gap between experiments and real phenomena in long-term near-field evolution, meeting the need for post-closure safety assessment.

This study investigated the geochemical changes arising from the infiltration of groundwater into a bentonite buffer under a thermal regime of radiogenic heating arising from vitrified waste using a computer simulation of a developed THMC model (Figs.3-17, 3-18).

From the analysis results, the temperature in the engineered barrier system (EBS) reached a maximum within 20 years. The temperature of the buffer material on the overpack side was approximately 95 °C. The temperature of the EBS is found to drop to 50 °C after 1000 years. Although the groundwater becomes alkaline under the influence of the concrete support, it returns to the initial pH until after 1000 years (Fig.3-19). In the event of infiltration by saline groundwater, sulfate precipitates as gypsum around the overpack in the buffer material, and the Na-type bentonite is changed to Ca-type by exposure to Ca ions released from the concrete supports (Fig.3-20). These results were consistent with the current scenarios assumed for geological disposal. It will be possible to estimate the extent of the overpack corrosion in the EBS using this developed THMC model.

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Reference

Suzuki, H., Nakama, S. et al., A Long-Term THMC Assessment on the Geochemical Behavior of the Bentonite Buffer, Genshiryoku Bakkuendo Kenkyu, vol.19, no.2, 2012, p.39-50 (in Japanese).