

Conceptual model development of long-term evolution of hydrogeology and geochemistry in Korean Peninsula for the disposal of high-level radioactive waste

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In Korea, research on the disposal of High-Level radioactive Waste (HLW) is being actively conducted, including selecting a generic URL site. To ensure the safe disposal of HLW for over 100,000 years, it is essential to develop technologies that can predict long-term geological environmental changes at disposal sites. To achieve this, a scenario-based integrated conceptual model for the long-term evolution of Korean Peninsula is being developed, including hydrogeological and geochemical changes. At the initial stage, previous case studies were analyzed to establish methodologies for long-term evolution scenarios in hydrogeology and geochemistry. And hydrogeological and geochemical data in Korean Peninsula were collected to assess long-term change characteristics.

Case studies from Sweden (SKB), Finland (POSIVA), and Japan (NUMO) were examined, where hydrological-hydrogeological system linkages were established for site selection, and conceptual models of long-term hydrogeological and geochemical changes were reviewed. A common approach among these cases is to develop models at various scales (regional, repository, and site scale) and apply long-term evolution scenarios, including temperate, glacial, and disposal operation periods. To ensure long-term safety assessments, boundary conditions such as sea level, recharge rates, and permafrost layers were incorporated into hydrogeological models, and their impacts on geochemical properties were evaluated.

To develop a methodology suitable for Korean Peninsula, it is necessary to incorporate domestic recharge characteristics, such as surface runoff, evapotranspiration, and groundwater usage, which are influenced by future climate change, and to link these factors with groundwater flow models. Using a recently developed Korean Peninsula-scale groundwater-surface water prediction model, a stepwise approach will be adopted, progressing from the peninsula scale to the site scale.

The study will integrate long-term change scenarios and boundary conditions, including crustal deformation, climate change, permafrost, and sea level variations, to conduct long-term safety assessments. Through this research, an optimized model and methodology for applying long-term evolution scenarios suitable for Korea's hydrological and hydrogeological environment will be developed, ensuring safe and effective HLW disposal.