An Evaluation of Climate Change Scenario for Safety Assessment of a HLW Repository

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1. Background

It might be expected that climate change in the future somehow affects the surface and geological environment around the repository system. Past geological and archaelogical evidence shows that, over the past million years, the Korean peninsula have experienced several cycles of climate change (four ice age cycles during the Quaternary, started since about 1.7 million years ago), varying from full glacial conditions to interglacial conditions warmer than or similar to the present condition. The similar pattern of climate change is likely to persist into the future over the timescales relevant to performance assessments since changes similar to those in the past are also expected to occur in the future. Therefore, it could be assumed that the present temperate climate is not the only climate condition in view of long term assessment of the repository system on the contrary of Reference Biosphere concept developed through BIOMASS.

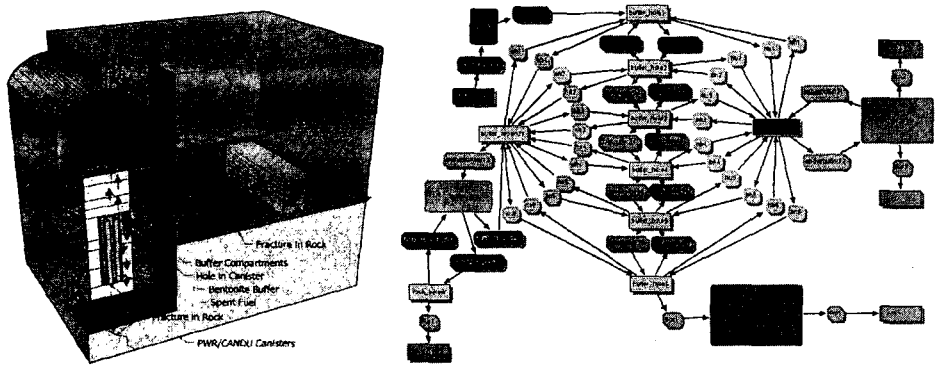
The future evolution of the repository system should be analyzed based on such climate change scenario since no other way is possible. The safety assessment also covers such long periods of time commonly up to millions of years, during which major climate changes are necessarily expected. To this end, a base case normal scenario where the repository is postulated to be built entirely according to present-day conditions in the surroundings, including climate (temperate climate all the time long) even though, in the event of climate change, repository evolution suffers all processes including thermal, hydraulic, mechanical and chemical processes. And then proper evaluation of the performance of the repository should be followed to see if the safety margin is still enough to isolate the nuclides in the canisters and to retard any releases of radionuclides when canisters are damaged. However currently due to lack of in-depth information, a simple scenario evaluation has conducted by utilizing simple parametric studies with selected two parameters; varying DCFs and path lengths, associated with biosphere and geosphere components, respectively. In the biosphere analysis the transfer of radionuclides in the surface biosphere and the potential exposure dose to humans are evaluated with varying DCFs in accordance with climate changes. Also it is assumed that as climates are changed, groundwater pathways and their path lengths are also changed.

Through this work, the dose exposure calculations for the temperate (or current) climate and a boreal climate condition appeared in turn are made by utilizing ACGEO, an AMBER template case file, which is a compartment model where the flow of radionuclides between the compartments is described by transfer coefficients expressed as flux per year as similarly done through a couple of past works.

A preliminary reference geologic repository concept considering such established criteria and requirements as spent fuel and generic site characteristics in Korea was roughly envisaged in 2003 through the works done at Korea Atomic Energy Research Institute since early 1997, from which a conceptual Korea Reference Repository System for direct disposal of nuclear spent fuel is to be introduced by the end of 2007. According to above basic repository concept, which is much similar to that of Swedish KBS-3 repository, nuclide release from the near-field system has been investigated through the previous study by calculating some possible nuclide fluxes through several possible conduits as shown in Fig. 1.

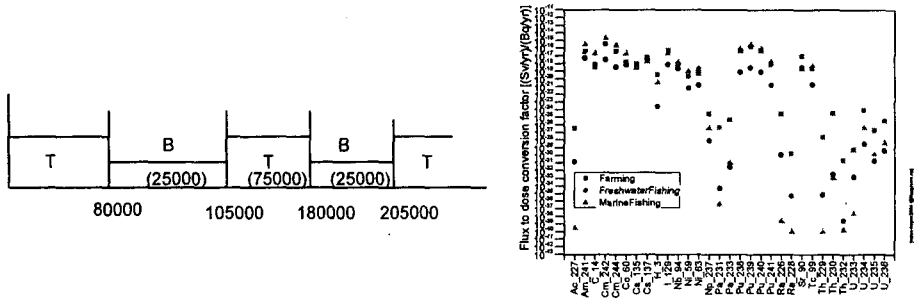
2. Calculation

Future possible changes both in the climate and the biosphere should be considered in the modeling and assessment for HLW in view of simple future climate change scenario. As climatic components of the biosphere will always change with time, not remained constant, such more detailed studies as Paleoclimatic and paleohydrologic investigations of Quaternary should be followed for anticipating the next glacial cycle. However through current study only a simple parametric study has been made: two cases where DCFs and/or travel lengths in far-field rock medium are varying, but are otherwise identical, under the assumption of periodic climate changes as depicted in Fig. 2. DCF_B (DCFs for boreal condition) was adopted from the literature, while DCF_T (DCFs for temperate condition) was evaluated using ACBIO, an AMBER case template.



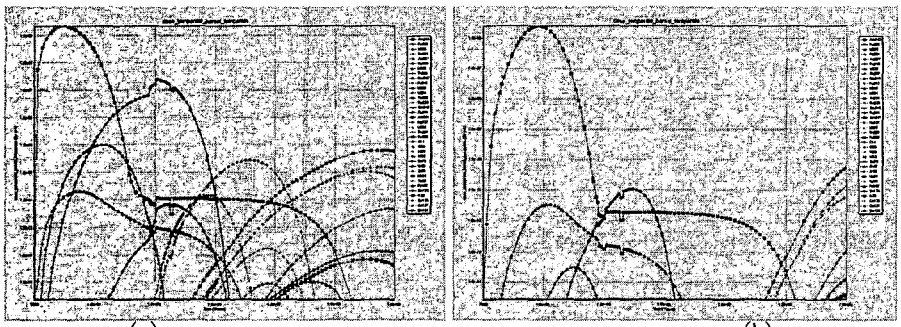
(a) (b)

Fig. 1. a: Schematic near- and far-field system domain; b: Compartment structure.



(a) (b)

Fig. 2. a: Time scale cycling assumed for calculation (T: Temperate climate period; B: Boreal climate period); b: DCF_T calculated and used for *Temperate period dose calculation*.



(a) (b)

Fig. 3. Doses due to climate change scenario (a: fracture length changes 200→100 m, DCF_T during Temperate Period and DCF_B during Boreal Period; b: no fracture length changed, DCF_T during Temperate Period and DCF_B during Boreal Period).

3. Conclusion

As seen in Fig. 3 the overall conclusion is that no great changes in peaks due to climate change scenario are not observed as was expected. Another conclusion of the current safety assessment is that ACGEO are very useful for such discrete time modeling showing a proper methodology that could be used in-depth safety assessments that will be based on data from completed site specific investigations. The results of the assessment also serve as a basis for some feedback not only to design concept of the HLW repository and but for site investigations for formulating functional requirements especially on the near-field barriers, and for prioritization of relevant research associated with HLW repository system.