A Nuclide Release Behavior from an HLW Repository due to a Human Intrusion

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1. Introduction

An evaluation program for the safety of a HLW repository which is conceptually modeled as shown in Fig. 1 has been developed by utilizing GoldSim[1] by which nuclide transports in the near- and far-field of a repository as well as a transport through the biosphere under various normal and disruptive release scenarios could be modeled and simulated. To demonstrate its usability, the influence of a possible disruptive event on a nuclide release behavior from a repository system caused incidentally due to a human intrusion has been investigated and illustrated as similarly done in a previous study.[2]

2. Illustrations and Discussion

Once a leakage from a damaged HLW canister through tiny holes happens, nuclides will spread out to the buffer material surrounding a canister as well as the backfill region in the tunnel before farther transporting into the flowing groundwater in the internal fractures and the major water conducting faults (MWCFs) of the far-field area of the repository. And then the nuclides will finally reach the human environment by passing over the geosphere-biosphere interface for an exposure to human bodies.

In view of a typical Korean geological situation two media could be characterized for the natural fractured rock media: First one is an internal fracture existing between the near-field zone of the repository and frequently modeled as a single fracture, and the other one is the MWCF zone through which all the nuclides released from the internal single fracture are assumed to transport upwards into the biosphere. Nuclide transport in the MWCF is also assumed to be dominated by an advection, facilitating in the application of a pipe pathway in the same way as the case of the internal fracture.

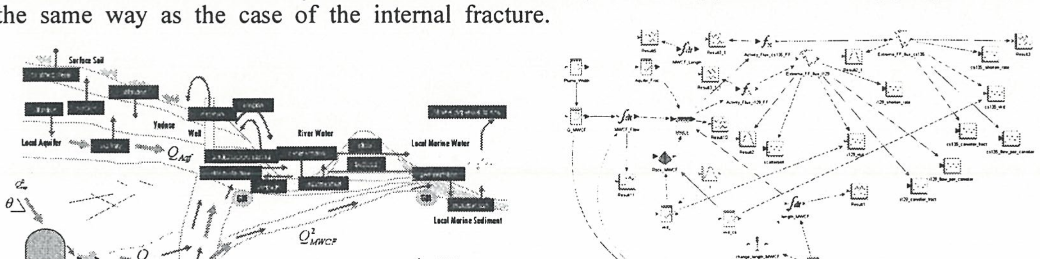


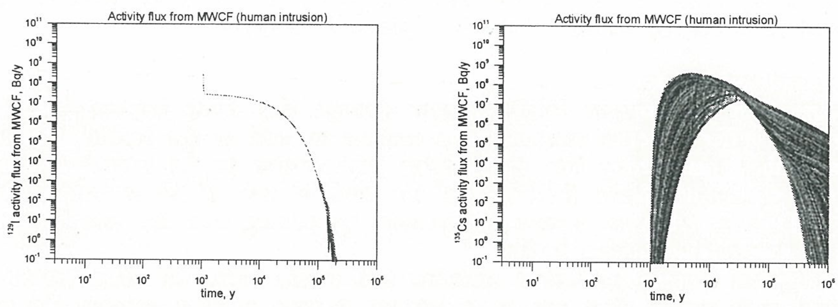
Fig. 1. Conceptual modeling scheme for the *GoldSim*TSPA model and a human intrusion implementation

When a human intrusion event first occurs, it is assumed that not only the length of the MWCF is assumed to be shortened to 90% of the initial distance, but also the flow rate in it is assumed to increase immediately by 10 times. However, this change is assumed to take place only once, with the first intrusion with an average rate of 10^{-4} per year based on a Poisson distribution of a random time interval.

In Fig. 2, breakthrough curves for ^{129}I and ^{135}Cs are plotted as a function of the time if a human intrusion occurs, in which ^{135}Cs shows a much larger influence than ^{129}I on a human intrusion due to its higher retardation in the MWCF, as similarly discussed previously. Peak flux rates for ^{135}Cs from the MWCF, which decease naturally as a retardation does, are plotted in Fig. 3a, as a function of the sorption coefficient in the MWCF, where the sorption coefficients for cesium in the far-field are assumed to vary loguniformly between $5 \times 10^{-2} \times (10^{-4})$ m^3/kg and $5 \times 10^{-2} \times$ (-10^{-4}) m^3/kg. Human intrusion is assumed to increase the flow rate in the MWCF and to decrease the MWCF distance (Fig. 3b) or it only decreases the MWCF distance without a change of the flow rate (Fig. 3c).

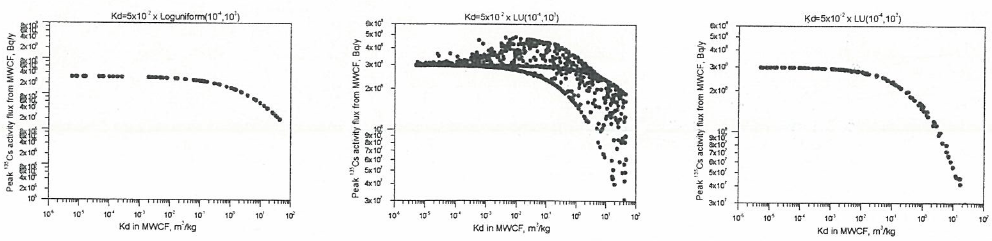
As shown in Fig. 3b, the peak fluxes for ^{135}Cs vary above the base case in Fig. 3a. And also this is almost identical to the case when only the flow rate is increased by keeping the distance unchanged, even though not shown here, indicating almost no dependency of a change in the length of the MWCF on the peak flux, as also seen from Fig. 3c.

For lower values of the sorption coefficients the peak fluxes do not seem to be influenced by a human intrusion. This might be due to a rather fast transport of ^{135}Cs in view of a rather slow frequency of a human intrusion, not causing an obvious influence on the peak fluxes. However as the sorption coefficients increase continuously, the peak fluxes also do so, even making the band much wider for greater sorption coefficient values, which implies there might bea remarkable impact of human intrusions on the fluxes.



(a) (b)

Fig. 2. Breakthroughs of the fluxes from the MWCF for (a) ^{129}I and (b) ^{135}Cs when a human intrusion occurs



(a) (b) (c)

Fig. 3. Scatterplots of the peak fluxes of ^{135}Cs due to the influence of a human intrusion when associated with the MWCF properties and a retardation in it: (a) when only Kd varies; (b) when the Kd and MWCF length vary and; (c) when Kd and both the MWACF length and flow rate vary

REFERENCES

[1] GoldSim Contaminant Transport Module, User's Guide, Version 4, GoldSim Technology Group, 2006.

[2] Y.M. Lee and Y.S. Hwang, "An Illustrative Nuclide Release Behavior from an HLW Repository due to an Earthquake Event," Trans. of the Korean Nuclear Society Autumn Meeting, Pyeong Chang, Korea, October 30-31, 2008.