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A Nuclide Release Model for a Deep Well Scenario near a Repository

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1. Introduction

Recently several template programs ready for the safety assessment of a high-level radioactive waste repository (HLW) and a low- and intermediate level radioactive waste repository (LILW) systems, that are conceptually modeled as shown in Fig. 1, have been developed by utilizing GoldSim[1] and AMBER[2] at KAERI. During the last few years, such template programs have been utilized for the evaluation of nuclide transports in the near- and far-field of a repository as well as transport through the biosphere under various normal and disruptive release scenarios with assumed data.[e.g. 3 and 4]

The GoldSim program, another template program by which influence due to a well located very near to the repository has been modeled and evaluated for an assumed case in order to simulate the worst exposure scenario. This seems very useful to evaluate an accidental event a long time after closure of the repository has been developed and illustrated.

2. Modeling Methodology

Normally, once a leakage from a damaged radioactive waste package of a canister through tiny holes happens, nuclides will spread out to the buffer material surrounding a canister, as well as the backfill or crushed rock 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.

Wells could be located anywhere in site where water for drinking and irrigation is available after the closure of the repository. Through this study an abnormal worst scenario of relatively shallow repository in the host rock with a deep well drilled very near it, among many possible others, is considered as sketched in Fig. 2.

The repository is assumed to be located around 100m below the surface. All groundwater flows out the repository is assumed to be available for the pumping well that reaches up the depth of the repository bottom.

The whole repository was assumed to be included in the cones of depression formed in the aquifer as well as in the host rock around the well during pumping. The groundwater table that is around a few meters below the surface with a thickness of 50m and assumed to be unconfined and also applicable to Darcy's law for the study. In such case the pumping capacity was calculated by Thiem's equation with assumed hydraulic data such as hydraulic conductivities for associated media and the well drawdown.

All contaminated groundwater flow out from the repository is assumed to enter the lower part of the deep well through a fracture network of the rock. But fresh groundwater in the aquifer moves toward the upper part of the deep well that occupied the whole thickness of the aquifer.

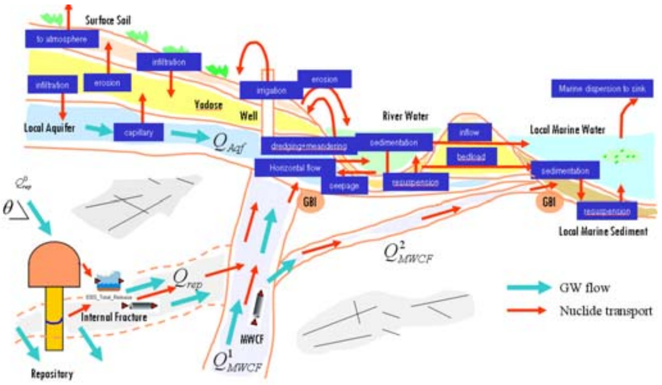

Fig. 1. Schematic Conceptual Modeling Domain for *GoldSim*

Modeling

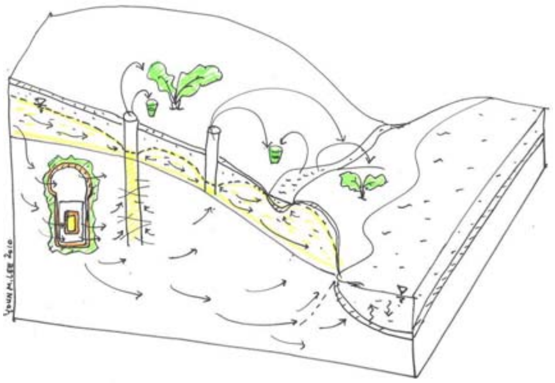

Fig. 2. A Deep and Shallow Wells in and around the Repository

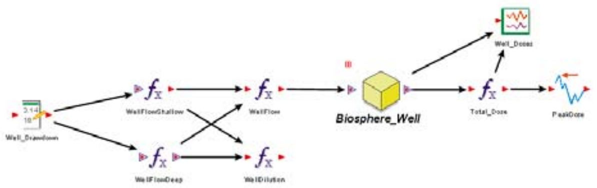

Fig. 3. A GoldSim Implementation for the Well Drilling Scenario

3. Illustrations

The scenario considered here is a simple case, the deep well has been drilled, because of this a farming exposure group could be exposed to nuclides in the pumping water for drinking and irrigation. To evaluate the impact of such well drilling, nuclide concentrations in the deep well for selective cases have been calculated.

When compared to Fig. 4, for the reference case, as seen in Figs. 5 through 6, nuclide concentrations seem to be sensitive to some extent both to the change of conductivity in aquifer and the drawdown in which the well pumping rate and dilution with aquifer water was closely involved.

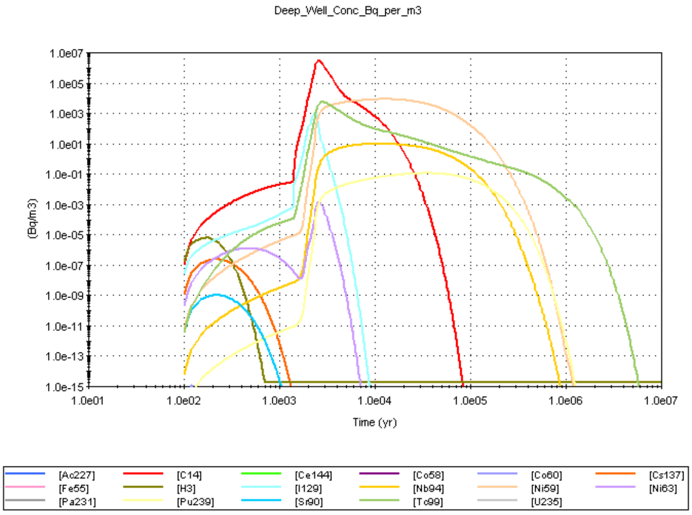

Fig. 4. Nuclide Concentrations in the Deep Well (Reference case: drawdown=25m; hydraulic conductivity in the aquifer=3×10^{-6} m/s)

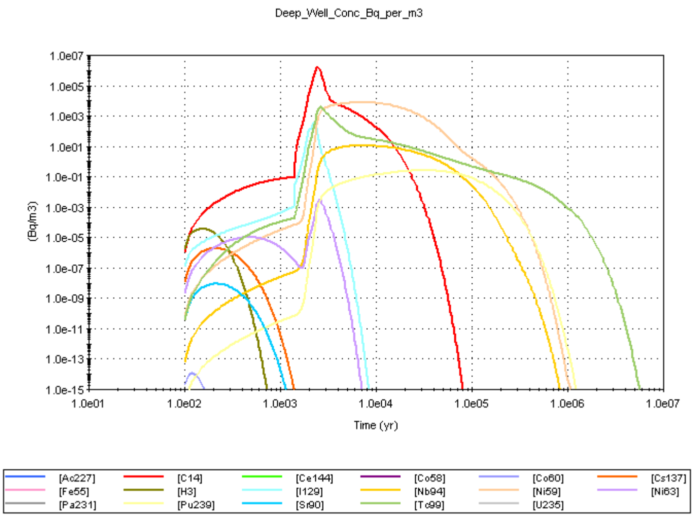

Fig. 5. Nuclide Concentrations in the Deep Well (drawdown=50m)

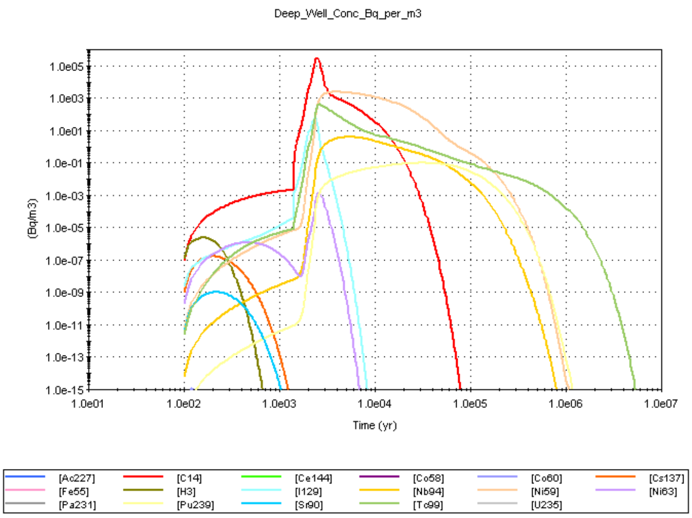

Fig. 6. Nuclide Concentrations in the Deep Well (hydraulic conductivity in the aquifer=3×10^{-6} m/s → 3×10^{-5} m/s)

References

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

[2] AMBER 4.4 Reference Guide, Enviros, U.K., 2002.

[3] Y.M. Lee et al., "Nuclide Release from an HLW Repository: Development of a Compartment Model," *Annals of Nuclear Energy*, 34, 782-791, 2007.

[4] Y.M. Lee et al., "A GoldSim Model for the Safety Assessment of an HLW Repository," Progress in Nuclear Energy, 51, 746-759, 2009.