PROBABILISTIC SAFETY ASSESSMENT FOR A GENERIC DEEP GEOLOGICAL REPOSITORY FOR HIGH-LEVEL WASTE AND LONG-LIVED INTERMEDIATE-LEVEL WASTE IN CLAY

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In the selection procedure for the search of a final site location for the disposal of radioactive wastes, the comparison and evaluation of different potentially suitable repository systems in different types of host rocks will be an essential and crucial step. Since internationally accepted guidelines on how to perform such quantitative comparisons between repository systems with regard to their long-term safety behaviour are still lacking, in 2007 the German Federal Office for Radiation Protection launched the project "VerSi" (Vergleichende Sicherheitsanalysen – Comparing Safety Assessments) that aims at the development of a methodology for the comparison of long-term safety assessments (BfS, 2009).

A vital part of the VerSi project is the performance of long-term safety assessments for the comparison of two repository systems. The comparison focuses on a future repository for heat-generating, i. e. high-level and long-lived intermediate-level radioactive wastes in Germany. Rock salt is considered as a potential host rock for such a repository, and one repository system in VerSi is defined similarly to the potential site located in the Gorleben salt dome. Another suitable host rock formation may be clay (e.g., Nagra, 2002; Andra, 2005). A generic location within the lower Cretaceous clays in Northern Germany is therefore chosen for the comparison of safety assessments within the VerSi project.

The long-term safety assessment of a repository system for heat-generating radioactive waste at the generic clay location comprises different steps, amongst others:

– Identifying the relevant processes in the near-field, in the geosphere and in the biosphere which are relevant for the long-term safety behaviour.

– Development of a safety concept for the repository system.

– Deduction of scenarios of the long-term evolution of the repository system.

– Definition of statistic weights, i. e. the likelihood of occurrence of the scenarios.

– Performance of a probabilistic safety assessment, including the probabilities of the scenarios.

– Evaluation of the significance of the results.

Probabilistic calculations of the radionuclide release from the wastes and the transport through the host rock formation and overlying rock are the basis for the derivation of indicator values that weight the resulting radiologic consequences of the radionuclide release in the biosphere. These indicator values will be used to perform the comparison of the safety assessments of the repositories at the clay site and at the salt site. For the clay site, using the Monte Carlo simulation software GoldSim (GoldSim, 2006) as platform for the system-level probabilistic simulations, the radionuclide release and transport is modelled in two steps (Figure 1): First, the 2-phase flow considering gas generation in the repository due to anaerobic steel corrosion is calculated using TOUGH2-MP. Besides the flow, the propagation of an ideal tracer that is released from the waste forms is simulated. In a second step, the resulting water flow out of the emplacement caverns is used as input in corresponding radionuclide transport calculations with the

numerical code VPAC (Nagra, 2008). VPAC simulates groundwater flow and radionuclide release and transport in fully saturated heterogeneous media in 3D, considering radioactive decay and ingrowth for the total set of safety-relevant radionuclides, solubility limitations, time-dependent hydraulic conductivities, time-dependent diffusion and time-dependent sorption.

Besides the gas-induced water flow from the repository, the distribution of the tracer as calculated with TOUGH2-MP is used as input to the VPAC calculations. Due to the large and complex architecture of the repository, a detailed 3D modeling of the radionuclide transport in the repository system and the entire host rock and overlying rock would require a tremendous computational effort. Therefore, only the transport along the dominating pathway is simulated using VPAC. This dominating pathway is identified for each simulation according to the resulting tracer distribution in the modeled system.

Results of the probabilistic 2-phase flow and radionuclide transport calculation will be presented and discussed focusing on the aspect of comparability of these results.

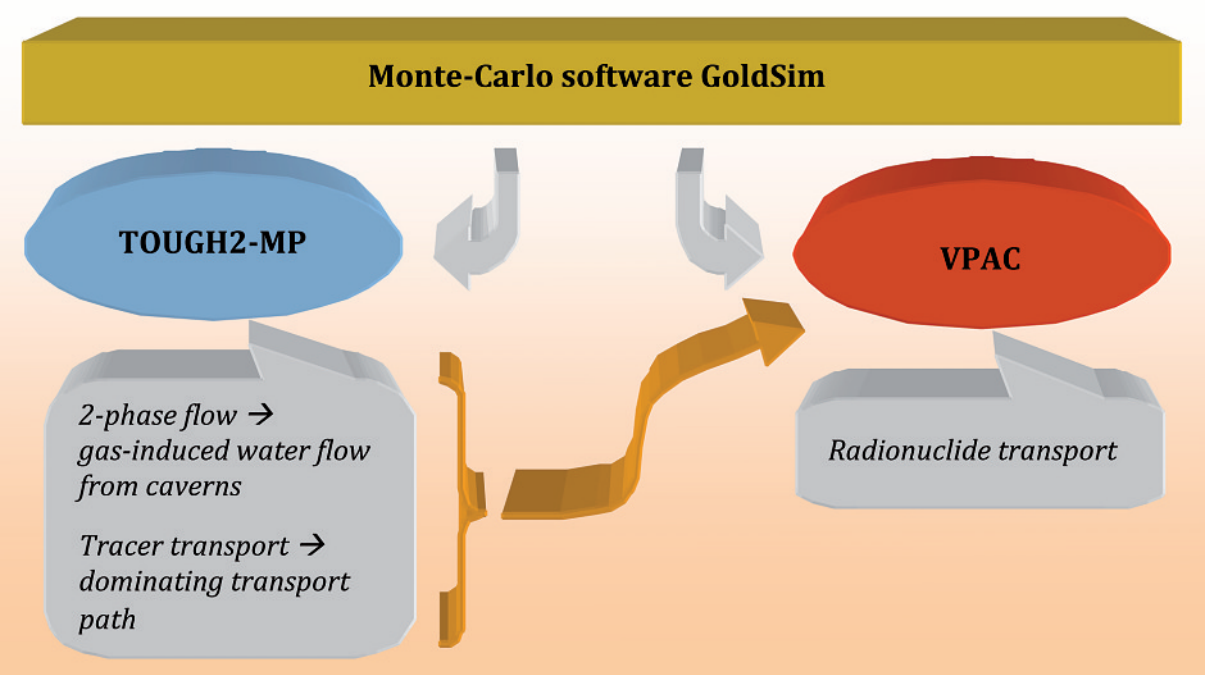

Figure 1: Model chain of the probabilistic radionuclide transport calculations.

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