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Climate scenarios, groundwater models, and uncertainties in long-term safety

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Climate scenarios, groundwater models, and uncertainties in long-term safety

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Introduction

Over the assessment period of one million years, a repository for high-level radioactive waste (HLW) is affected by various processes and developments that must be considered in long-term safety-assessments. The climatic development of a site has a significant influence on future development of a repository. However, predictions are complicated by the dynamics of the climate and are subject to uncertainties. The aim of this study is to evaluate uncertainties for climate-induced processes that are relevant for the safety-assessment based on numerical groundwater models.

Methods

- Model geometry and parameterization based on the generic site models for clay from the RESUS and ANSICHT projects [2], [3] (Fig. 1).
- Flow and transport code d'HE++ with advection, dispersion, diffusion, sorption, decay, and density driven flow taken into account [1].

Different climate states are represented by changing boundary conditions for flow and density driven flow:

1. Present climate (generic values from [2] and [3])
2. Permafrost (frozen water in upper layers reduce permeability)
3. Glacier (100 m and 1000 m; higher pressure on model surface)
4. Sea level changes (higher pressure on surface with salt water intrusion)
5. Glacial channels (areas with higher permeability in affected layers)

Results

- Flow velocities are to be assessed as favorable in the containment-providing rock zone (CRZ) according to the StandAG [4] in all modelled climate scenarios (Fig. 2 and 3).
- Permeability changes in upper layer for Permafrost has nearly no influence on flow velocity in CRZ and non-sorbing tracer concentration distribution (Fig. 3 and 4).
- Around 25 m above and below the repository represented as tracer source, the concentration after 100,000 years is proportionally 0.1 % of the entered tracer concentration; the concentration front has not reached the CRZ (Top Barremium at around -300 m) (Fig. 4).
- Slight distribution of concentration in flow direction and in depth because of the given boundary conditions; effect is stronger with thick ice sheet load of 1000 m (Fig. 4).

Conclusion and outlook

- Flow velocities changes through different considered climate states but also depending on generic boundary conditions.
- In low permeable claystone the concentration front is slow and does not reach the CRZ; future simulations with higher permeabilities.
- Running sea level change and glacial channel models and implement transient changes of parameters for climate cycles.
- Additional parameter variations simulations for example with adsorption to study the influence on flow and transport for the different parameters.

Literature