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Performance assessment of a generic repository in salt host rock based on Task F of DECOVALEX-2023 – BASE's lessons learnt and future work

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Performance assessment of a generic repository in salt host rock based on Task F of DECOVALEX-2023

BASE's lessons learnt and future work

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INTRODUCTION

- DECOVALEX (**DE**velopment of **CO**upled models and their **VAL**idation against **EX**periments) is an international cooperative project, initiated in 1992, that aims to help better represent coupled THCM processes in PA of disposal systems for HLW (www.decovalex.org)
- BASE co-funds and participates actively in Task F of DECOVALEX-2023 with the aim to exchange state-of-the-art modelling approaches and methodologies, develop further competence in process modelling, and assist in development of in-house PA tools
- This poster discusses selected aspects of BASE's contribution to Task F2 (disposal in saltrock) of DECOVALEX-2023

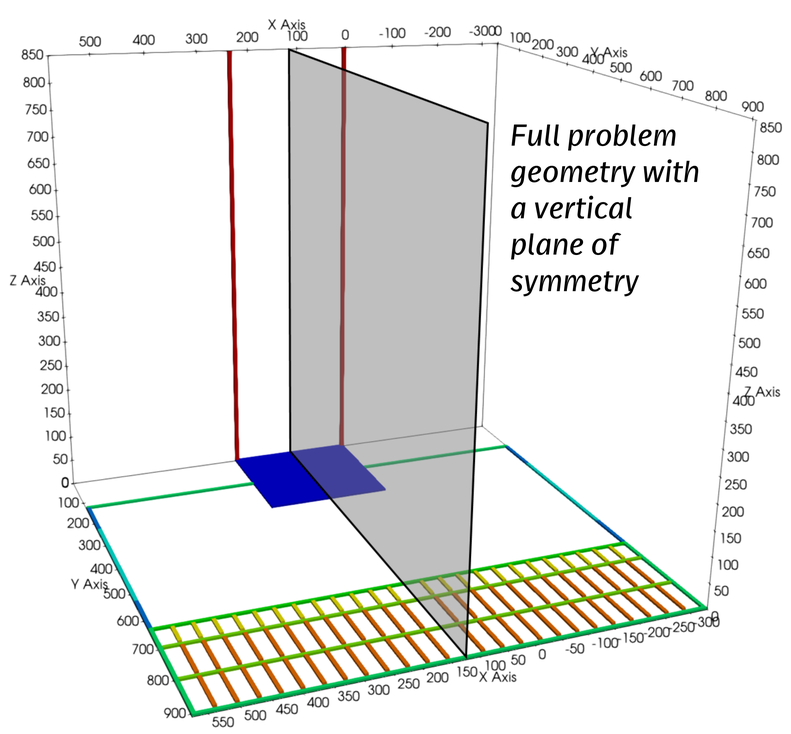
APPROACH and IMPLEMENTATION

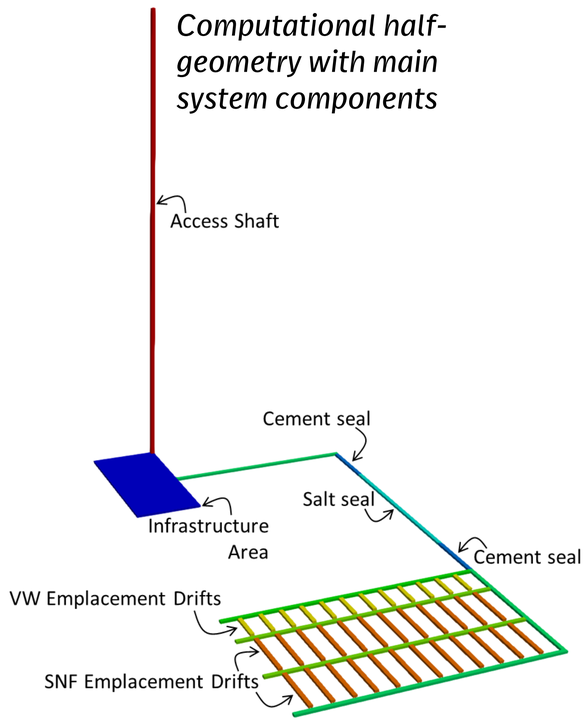
Overall approach:

- The problem was pre-defined by a detailed Task Specification document (publishing pending)
- Modelling was carried out by (largely) independent teams (no comparison shown here)
- Individual processes were tested and implemented in a step-wise manner

Main features of the model include:

- Implementation in the PFLOTRAN code
- Fully unstructured finite volume grids
- Evolution modelled over 100 000 years
- Canister failure and radionuclide release at 500 years
- Shaft failure and surface water ingress at 1 000 years
- Simplified salt convergence (porosity reduction) based on external model calculations
- Variably-liquid saturated, isothermal conditions
- Instant- and congruent waste dissolution release of I-129, Tc-99, U-238, U-234, Th-230 and Ra-226
- Radioactive decay and decay-chains
- Elemental solubility limits
- Transport by diffusion and advection in liquid phase

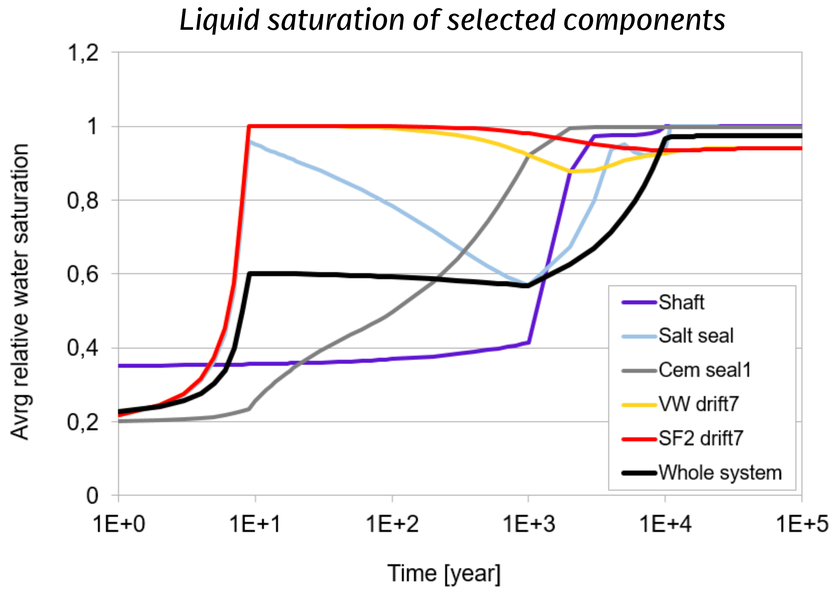




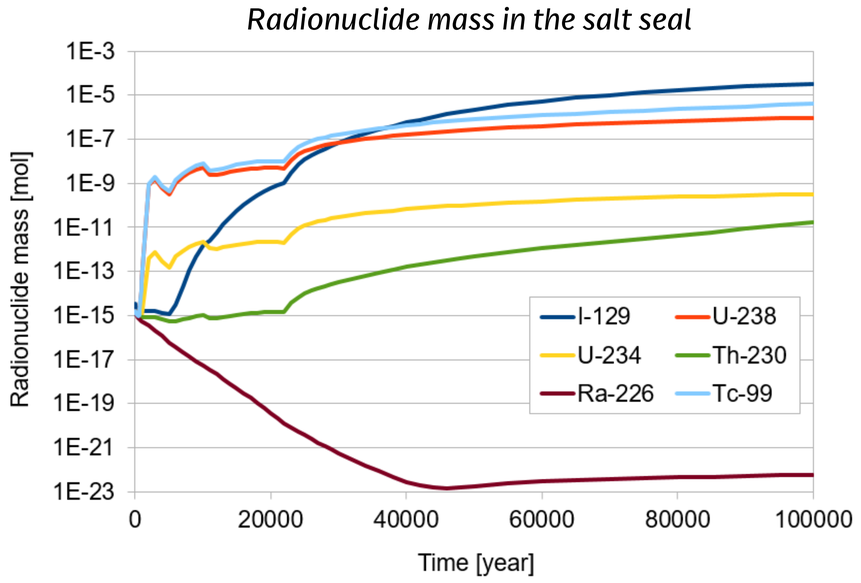
CONTRIBUTION and EXAMPLE RESULTS

- Model results require extensive post-processing and analysis
- BASE provided 21 pre-defined quantities of interest for inter-model comparison (Final Task Report)
- Many auxiliary quantities were additionally presented and used for system behaviour understanding

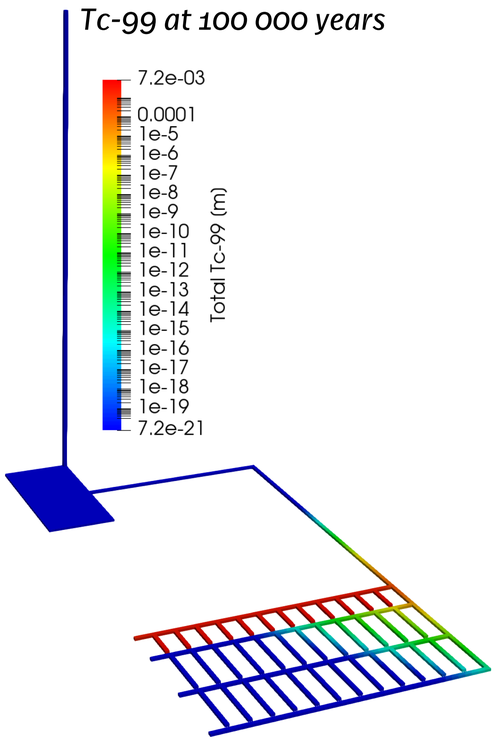
Liquid saturation of selected components



Radionuclide mass in the salt seal



Tc-99 at 100 000 years



LESSONS LEARNT

- A preliminary workflow allowing large-scale PA simulations (including pre- and post-processing) has been developed
- Valuable hands-on experience has been gained by comparing approaches and discussing problems with other teams
- Due to its coupled and non-linear nature, the model's behaviour is complex and highly sensitive to certain parameter values
- There are specific advantages and disadvantages to developing "fully integrated" and "nested" models
- Costs of model elaboration increase rapidly and need to be balanced vis-à-vis benefits
- Development of complex models requires maintaining and developing necessary competence and resources
- Synergies with existing in-house projects should be explored further and taken advantage of

OUTLOOK

- The computational workflow will continue to be elaborated (e.g. biosphere/dose model, probabilistic sampling, integration via scripting)
- Additional process (e.g. 2-phase flow, non-isothermal conditions) will be included
- Systematic sensitivity and uncertainty assessment will be carried out
- Comparison with simplified models will help evaluate the role of individual processes and their model representation
- High Performance Computing will be employed for more efficient numerical solution (e.g. probabilistic uncertainty analysis)