SKB Task Force GWFTS: Increasing the realism of solute transport modeling in fractured media – Task 9D

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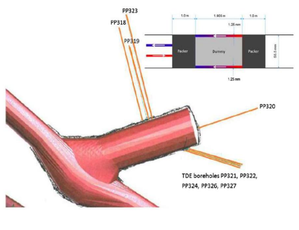
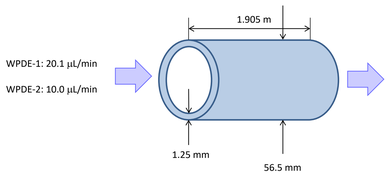
1. Introduction – Task 9D



The REPRO niche



Schematic view of WPDE setup

- The international **SKB Task Force on Modeling of Groundwater Flow and Transport of Solutes (TF GWFTS)** was established to support and interpret field experiments (www.skb.se/taskforce).
- Further objectives: To develop, test and improve tools for conceptual understanding and simulating groundwater flow and transport of solutes in fractured rocks.
- Work is organized in **collaborative modeling tasks**.
- Task 9 focuses on **realistic modeling** of coupled **matrix diffusion** and **sorption** in heterogeneous and fractured crystalline rock at depth.

- Task 9D: **Possible benefits** of **detailed modeling** of experiments in **safety assessment** calculations.
- Done by **upscaling** of Task 9A (Soler et al., 2019. SKB R-17-10) to conditions applicable for SA of nuclear waste repositories.
- Task 9A: Modeling of the **REPRO WPDE** performed at depth in the underground facility **ONKALO in Finland**.
- **WPDE** gave **valuable data for SA**.

2. Objectives and Teams

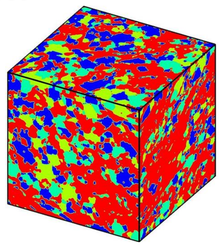
Objectives

- How do we condense complex site characterization models down to something practically useable for Safety Assessment (SA) modeling?
  - Is it possible on much larger spatial & temporal scales?
- How do the more complex behaviors observed in experiments scale to SA conditions & timescales?
  - Do they "vanish" or become less prominent?
- What are the consequences of neglecting microstructural heterogeneity on the Safety Case?
  - Confidence building

Team	Tool/Approach
Amphos21, Spain	MARFA with upscaling methodology
CFE, Sweden	DarcyTools
CTU, Czech Republic	GoldSim, analytical solution
KTH, Sweden	Multi-Channel model
PROGEO, Czech Republic	MODFLOW – MT3DMS/MT3USGS
TUL, Czech Republic	Flow123d
ÚJV, Czech Republic	GoldSim

3. Task description

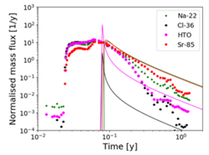
- Flatten the WPDE annulus to a ~**9 cm wide flow channel**
- Make the flowpath 1000 m long, i.e. **plausible SA distance**
- **Hydrodynamic** conditions and **flow-related resistance** (moderate F-factor) **as** SR-Site Central Corrosion Case (in **SA performed by SKB**)
- **Homogeneous** (Task 9D1a-b), & **heterogeneous** (Task 9D1c-d) **matrix properties**
- Modelling teams choose how to implement **hydrodynamic dispersion**
- Modeling teams free to model **matrix heterogeneity** however they see fit
- **Linear sorption**, with K_d proportional to **local mica content of rock**
- Hypothetical **tracers of increasing sorptivity** (& half-life) for Task 9D1
- **U-238 (4*n*+2) series** for Task 9D2



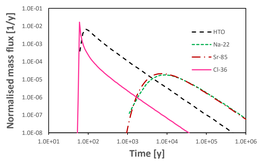
Mineral distribution with mica in red

4. Examples and Summary

Amphos21

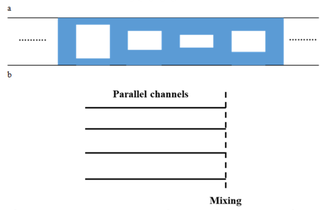


Modeling the experiment

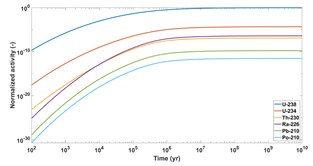


Extrapolating to SA conditions (Trinchero et al., 2020)*

KTH



Schematic, Multi-Channel Model



SA calculations

Summary

- Evaluation is still ongoing
- As predicted, not able to include all the details, but the most important processes
- It is beneficial to have several modeling teams addressing the same topics
- Tools capable of exploring impacts from processes and features of importance for SA
- Task 9D proved to be a useful exercise for SA and confidence building

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