SKB Task Force GWFTS: Pragmatic Validation Using Predictive Modeling Exercises

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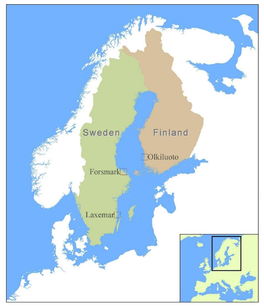
Abstract ID: 1131754

H52K-0610

1. SKB Task Force GWFTS



- The international **SKB Task Force on Modeling of Groundwater Flow and Transport of Solutes (TF GWFTS)** was established **1992** 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**.

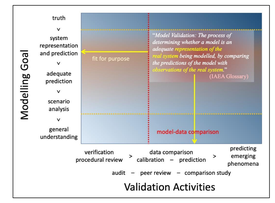
- The participating organizations in TF GWFTS: **BMWi** (Germany)**, DOE** (USA)**, NUMO** (Japan)**, NWMO** (Canada), **KAERI** (Korea)**, Posiva** (Finland)**, SKB** (Sweden) and **SURAO** (Czech Republic)
- The Modeling Teams are: BMWi: **GRS**; DOE: **LANL**; NUMO: **JAEA**; NWMO: **Uni. of Waterloo**; KAERI: **KAERI**; Posiva: **VTT**; SKB: **Amphos21, SU**; SURAO: **PROGEO**, **TUL**

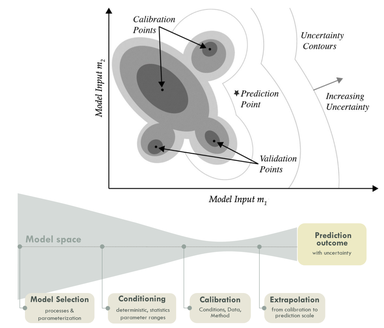
2. Task 10 – Pragmatic Validation

Task 10 focuses on **pragmatic validation*** of **hydrogeological** and **transport** models with **discrete features**. Of importance for Task 10 are:

- Pragmatic validation consistent with the IAEA definition of "**fit for purpose**" validation considering limited available data.
- Use of **multiple** conceptual and numerical **models** to quantify **uncertainties/sensitivities**.
- **Confidence building** considering model conditioning, calibration and rejection.
- Sensitivity and uncertainty assessment of **key parameters**.
- **Progressive validation** as additional data are collected.
- Robust **model audit** to identify and evaluate assumptions and limitations.
- **Prediction-outcome (P/O)** exercises to evaluate whether a model is an **adequate representation** of the real system.

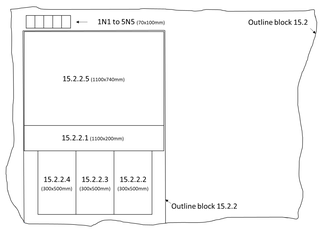
*) Finsterle S, Lanyon B. Pragmatic Validation of Numerical Models Used for the Assessment of Radioactive Waste Repositories: A Perspective. Energies 2022, 15, 3585. doi: 10.3390/en15103585





3. Task 10.2.1 – An ongoing P/O exercise

Data from rock blocks from the Flivik quarry in Sweden



The objectives of the Task 10.2 exercises are to:

- Develop **concepts and models** for flow and transport at the single fracture scale.
- Consider importance of **hydro-mechanical coupling** on flow and transport.
- Develop modelling approaches for **prediction** of:
  - **Flow and transport** in single fractures.
  - **Upscaled** fracture properties from **borehole to deposition hole scale**.
- Build starting points for pragmatic validation; Task 10.2.1 is a **prediction-outcome exercise**.

Fracture roughness

- **Predictions** of the **fracture roughness** distributions on the 1 m scale
- Calculate fracture roughness **Performance Measures** (PMs)
- Determine the **uncertainty range**
- **Compare** the results with acceptance criteria, i.e., expected spread of PMs

Fracture aperture

- **Predictions** of the **aperture** distribution
- Calculate fracture aperture **PMs**
- Determine the **uncertainty range**
- **Compare** the results with the expected spread of PMs

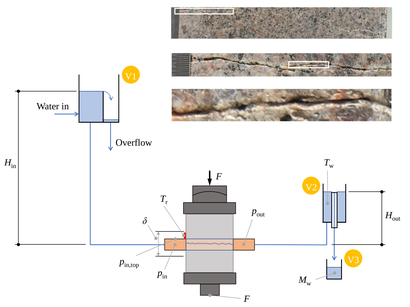
4. Task 10.2.2 – Another ongoing P/O exercise

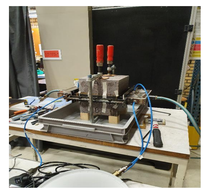
The main objectives of this subtask are:

- **Prediction** and **validation** of the **upscaled** fracture geometry from **borehole sized fracture geometry** and/or **fracture trace geometry**.
- **Prediction** and **validation** of **flow** along a fracture at different normal stresses.
- Support the **development** and **demonstration of pragmatic validation workflow** at the single fracture scale

In brief, the modelers are expected to:

- **Predict aperture distributions** at normal stresses of 0, 1 and 4 MPa and predict the **flow** in two orthogonal directions for these three normal stresses.
- Calculate the **flow rates** at normal stresses of 10, 20, 30 and 40 MPa in the 2-4 direction.
- Explore aspects to be tackled in subsequent subtasks (e.g., transport, or flow and transport on **deposition hole, block and tunnel scales**).
- Address the other items of the **Pragmatic Validation Workflow.**





The authors gratefully acknowledge the support from SKB, Posiva and the participating organizations BMWi, DOE, KAERI, NUMO, NWMO and SURAO in the SKB Task Force on Modeling Groundwater Flow and Transport of Solutes

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