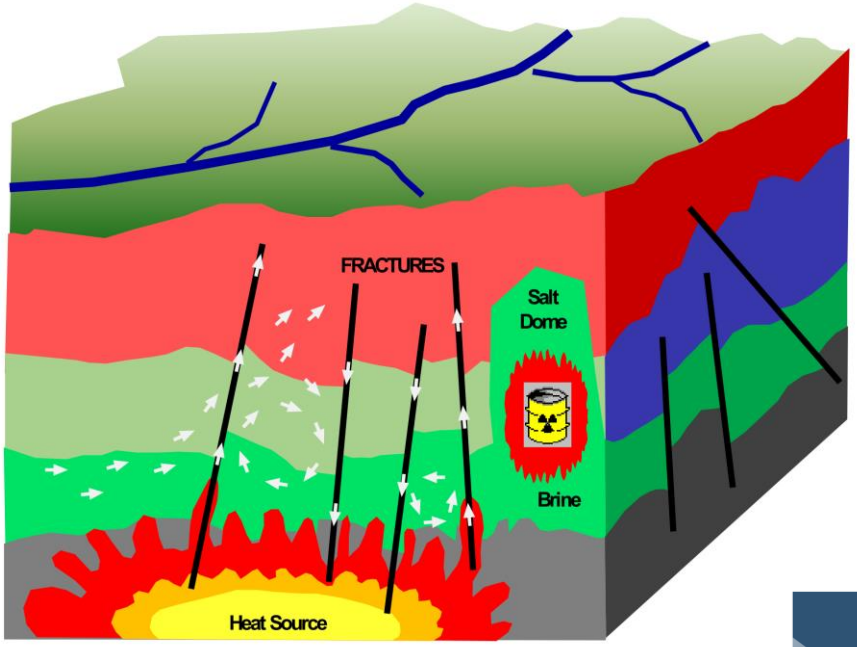
Risk-based Assessment of Salt Domes as Disposal Sites for Nuclear Waste (RADON)



Jonas Suilmann & Andrea Perin

Personal Background

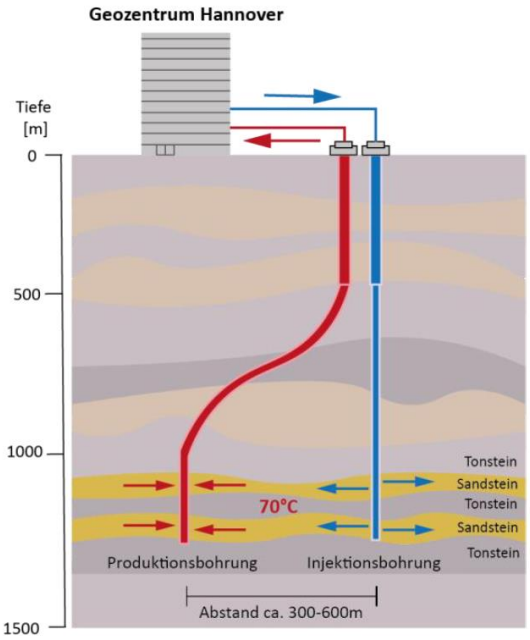
- **Master of Science**

Water Management, Environmental and Coastal Engineering
Leibniz University Hannover, 2021

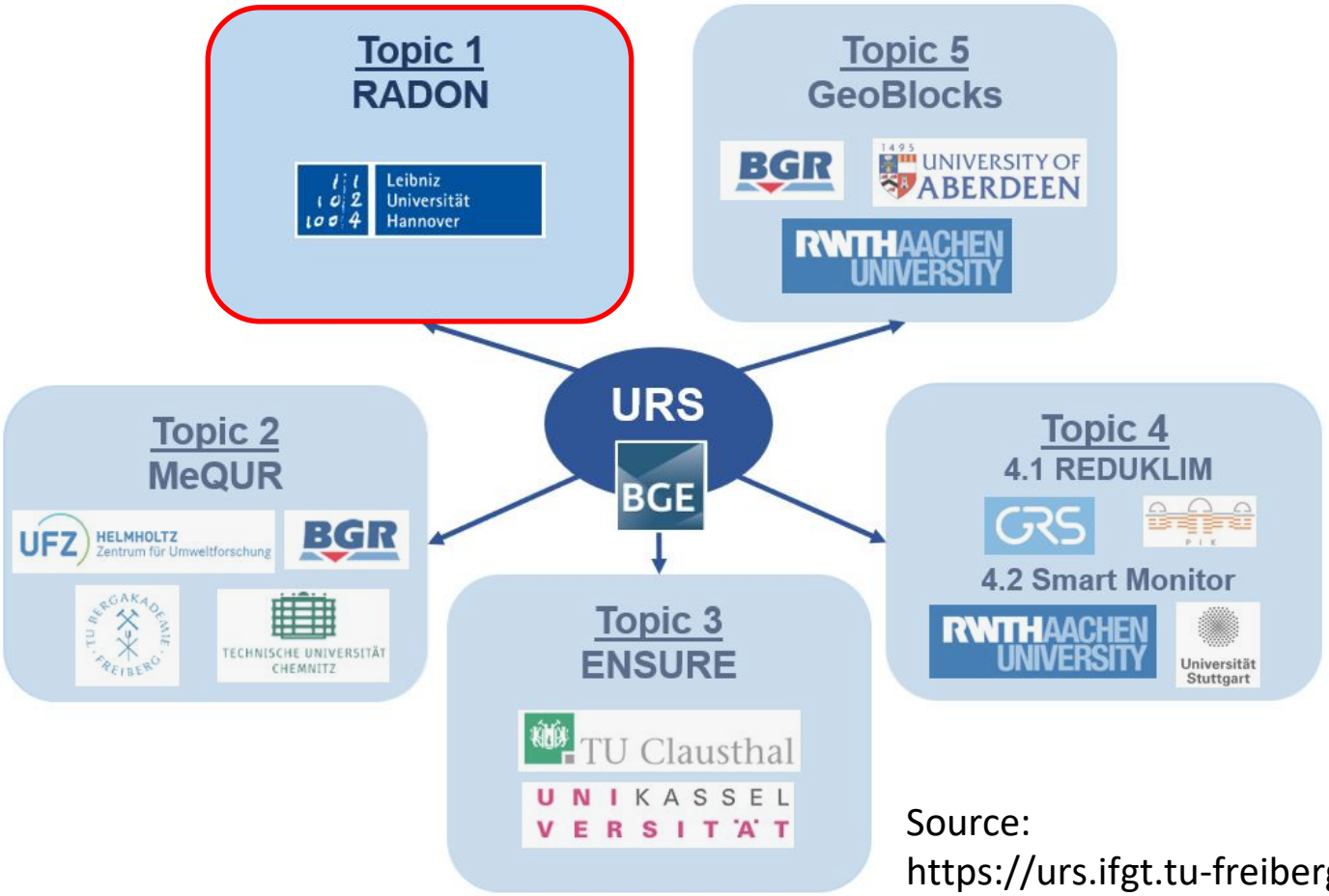
- **Master's Thesis**

" Scenario simulations of a geothermal doublet in mu tiple sandstone horizons - a case study in Hannover"

- Groundwater flow and heat transport
- Different production scenarios for well spacing design

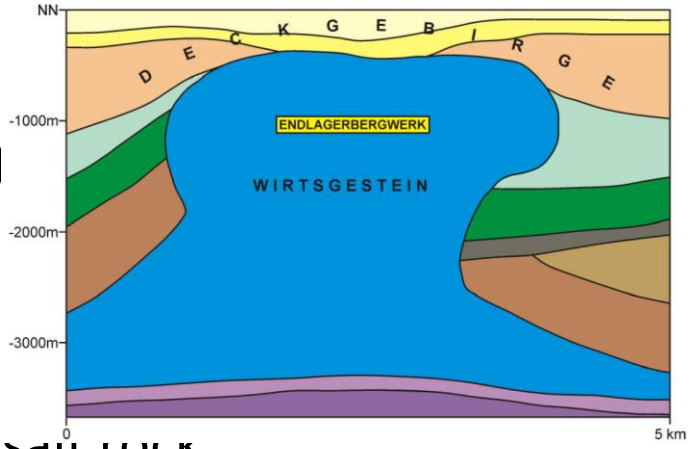


Uncertainties and Robustness with regard to the Safety of a repository for high-level radioactive waste



Source:
https://urs.ifgt.tu-freiberg.de/en/home

Motivation



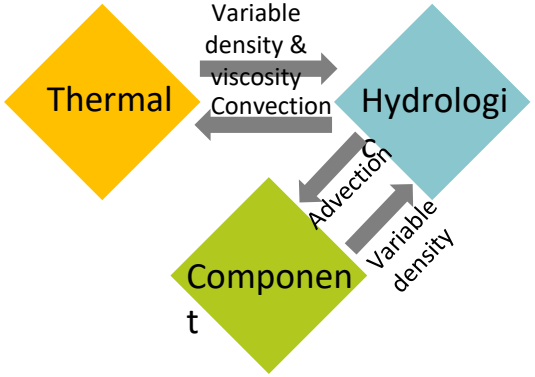
- Final disposal of high level nuclear waste (
  geological formations
- Isolating waste from biosphere
- Safety time span of 1 million years
- 3 possible host rocks: clay, cristalline and salt rock
- Multi-barrier-system approach

Goal: Develop a numerical framework for risk assessment of hazardous events of a final nuclear waste deposit in salt dome

- Salt rock (salt domes) have been investigated intensively in Germany (Gorleben)

adapted from Brasser et al. 2008

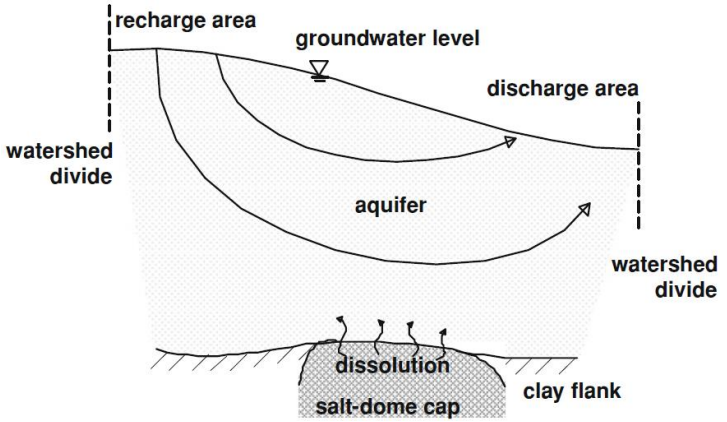
Numerical analysis



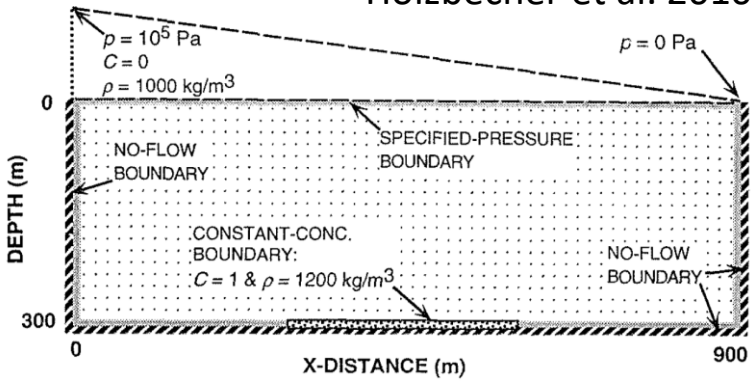
- THC simulations in fractured porous media
- Groundwater flow around salt domes
- Transport of a radionuclide and solute salt
- Heat transport due to geothermal gradient and heat generation of waste
- Variable density and viscosity flow: dependency on temperature and salt concentration
- Using heatflow-smoker code (John Molson, Université Laval)
- Coupling of THC processes

State of science

- **Salt dome problem** (Oldenburg and Pruess 1995, Kolditz et al. 1998, Herbert et al. 1988)
  - Grid analysis, dispersion, diffusion effects on salinity distribution and flow field
  - Salt domes dissolute and cannot be taken as fully impermeable
  - Diffusion can lead to escape of nuclides within thousands of years (Refifa et al. 2019)



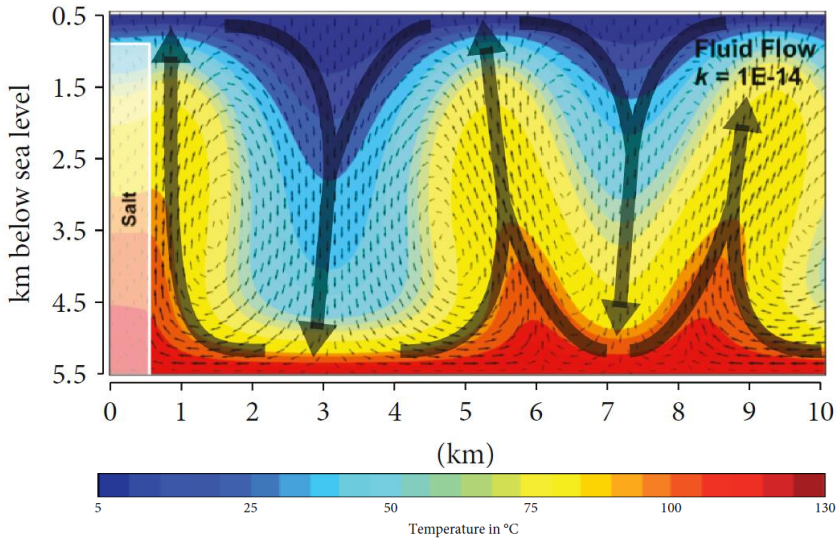
Holzbecher et al. 2010



Konikow et al. 1996

State of science

- Thermohaline salt dome problem (Diersch and Kolditz 1998)
  - Temp. and salinity distribution for various buoyancy ratios
- Thermohaline flow around salt dome (Jamshidzadeh et al. 2015)
- **Salt chimney effect** (Canova et al. 2018)
  - High th. conductivity of salt compared to surrounding rock
  - Heat and flow next to salt dome concerning:
  - Salt dome geometry, depth-dependent permeability and geological heterogeneity



1. Research objective

Groundwater age in original and thermohaline **salt dome problem**

- Investigate:
  1. **Grid convergence**
  2. Flow field & salt distribution
  3. **Groundwater age distribution** (for steady state flow)
  4. Transport of a radionuclide (code modification)

- Including:
  - Different dispersivities and diffusion coefficients
  - Different **hydraulic conductivities**

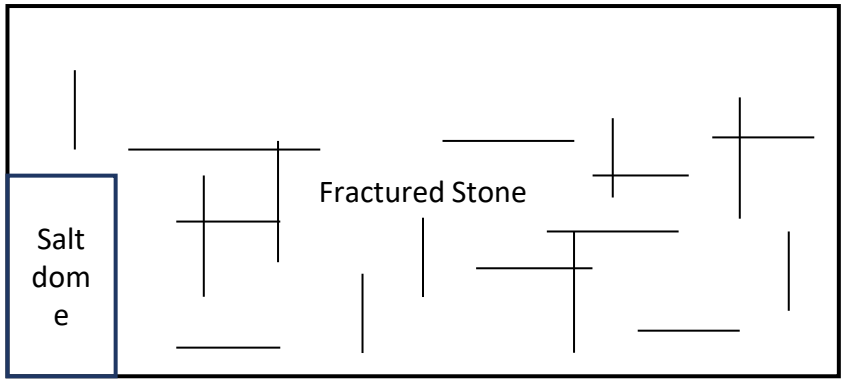
2. Research objective

Role of fractures on **salt chimney effect** around salt dome

- Investigate
  1. Influence of regular fractures (and microfractures)
  2. Influence of randomly distributed fractures (and fracture connectivity) on:
     - Flow field & salt distribution
     - Groundwater age distribution (for steady state flow)
     - Transport of a radionuclide (code modification)

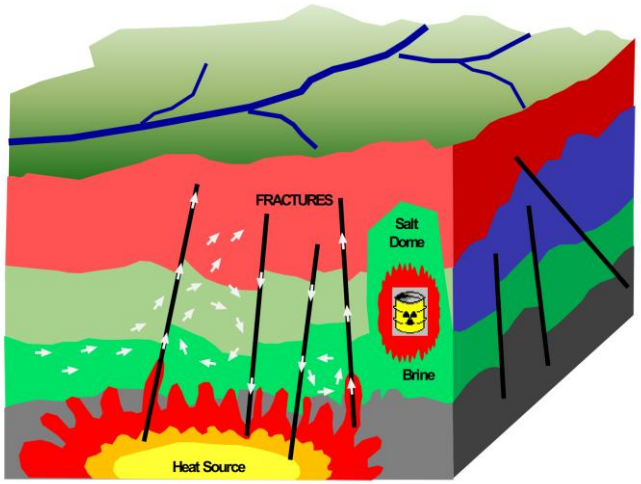
3. Research objective

- For the joint project:
- Create 2D testcases including a salt dome and thermohaline effects for the simulation of radionuclide propagation through fractures surrounding rock
- Determine influence of variable-density flow and thermohaline salt transport on the fate of a radionuclide (salt chimney effect)
- Role of fractures regarding the transport of a nuclide



3. Research objective

- For the joint project:
- Implementation of uncertainty
  - Time and amount of radionuclide release
  - Unknown fracture location, hydraulic parameters and boundary conditions for flow
- Determination of external **events** that occur with certain probability and obtain the probabilty distribution of the output of simulations



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