

Task 1.2 Reservoir Modeling and Validation: Overview of Current Projects

In cooperation with the CTI



Energy funding programme

Swiss Competence Centers for Energy Research



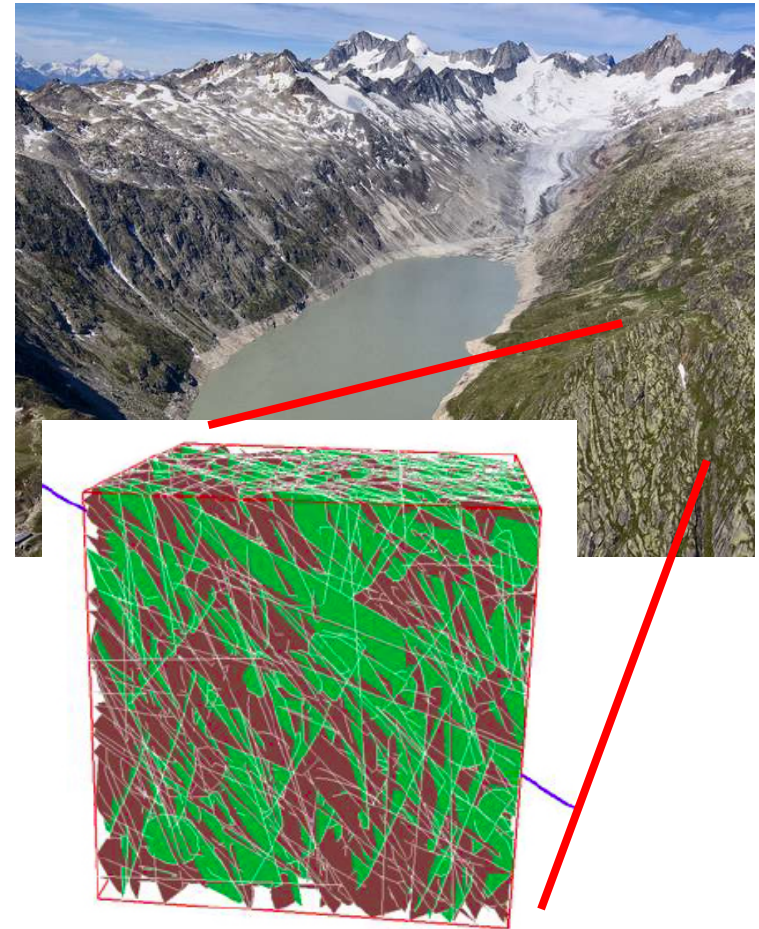
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Commission for Technology and Innovation CTI

Underground reservoir processes: tough challenges

- Coupled thermal, hydraulic, mechanical, and chemical (THMC) processes:
 - Vastly different scales
 - Lots of non-linearities
 - Tight couplings
 - Complex processes in complex geometries
- Numerical and experimental modeling:
 - Gain detailed insight
 - Aid prediction and upscaling



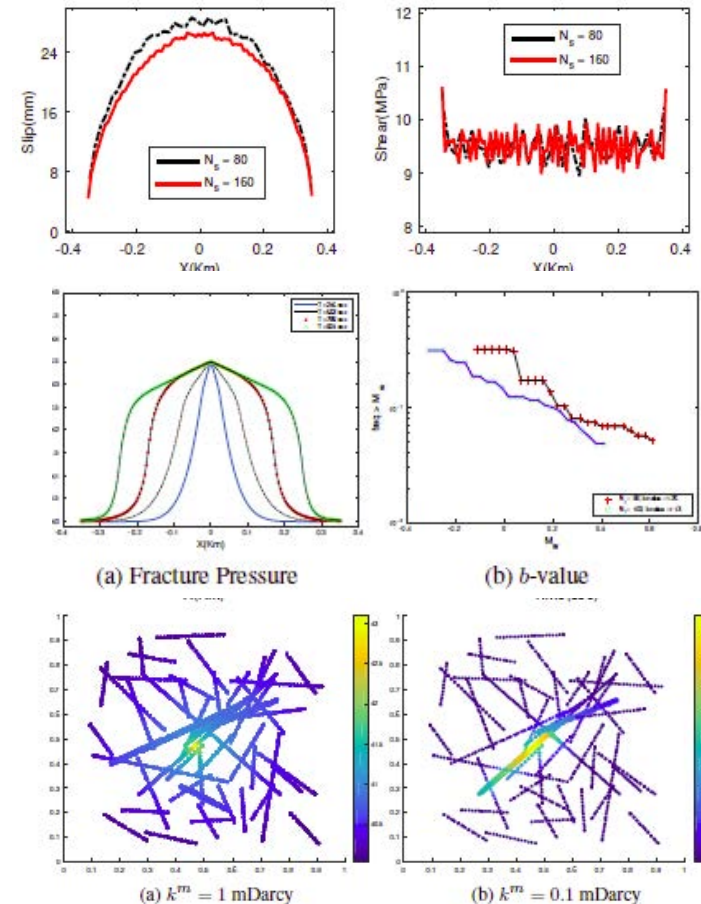
Current Focus Areas

- THM processes during hydraulic stimulation
- TH and THC processes during reservoir operation
- Material parameters and constitutive relationships on different scales
- International collaborations within IPGT

THM processes during hydraulic stimulation: I. Efficient algorithms

Rajdeep Deb & Patrick Jenny
(ETHZ, GEOTHERM-2):

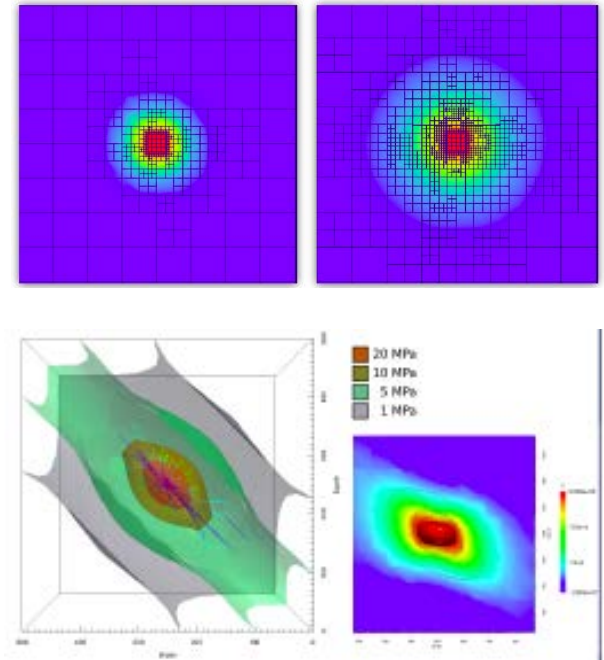
- Efficient reservoir-scale method
- Model shear failure without resolving grid near the fractures
- Pressure injection induced seismicity
- Approximates the shear failure effect on increasing permeability
- Link simulation of mechanics to b -value etc.



THM processes during hydraulic stimulation: II. Numerical methods for modern hardware architectures

*Gunnar Jansen, Boris Galvan,
Steve Miller (UniNE, NRP70&SCCER)*

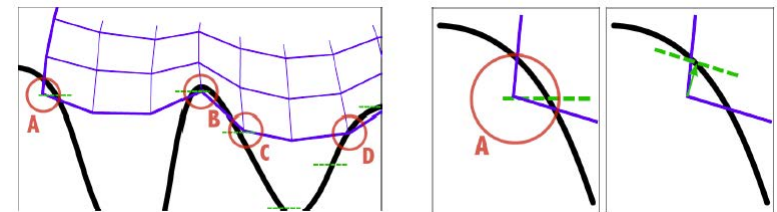
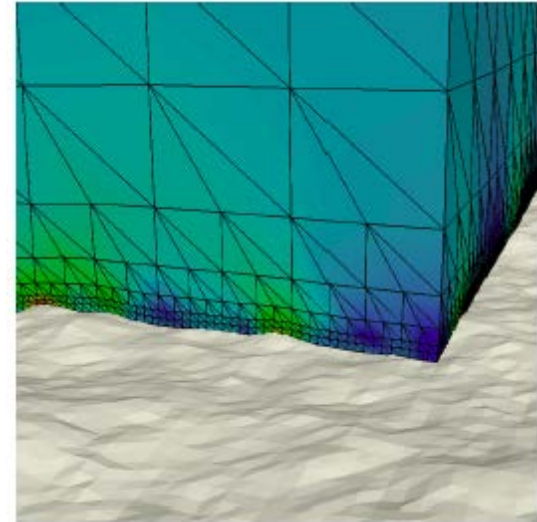
- GPU-based approaches
- Adaptive refinement strategies
- Fluid pressure migration, failure in complex fracture sets, permeability evolution



THM processes during hydraulic stimulation: III. Modeling contact-friction on rough fault surfaces

Cyrill von Planta, Alessandro Rigazzi
(USI, NRP70 & SCCER):

- Create tools that allow accurate study of slip process on rough fracture surfaces
- Goals: understanding self-propping properties of fractures, seismic vs. aseismic slip, channeling effects etc.



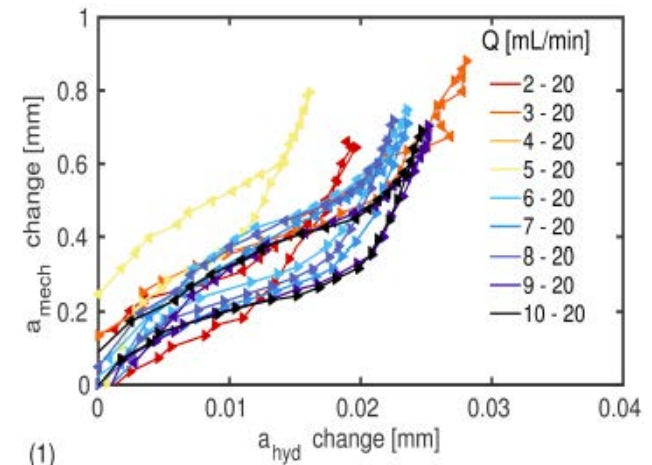
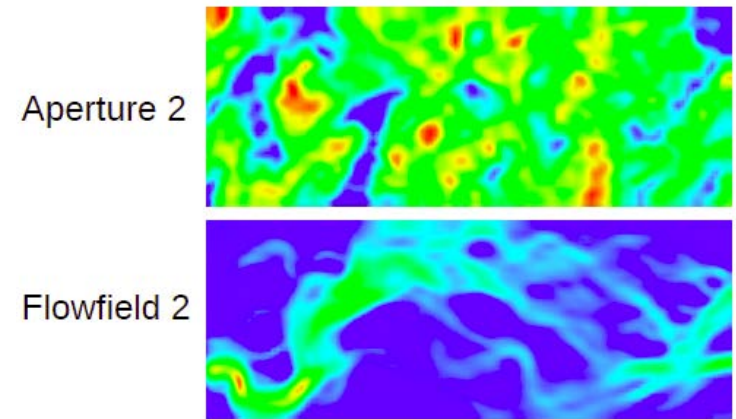
THM processes during hydraulic stimulation: IV. Fluid Flow in Heterogeneous Fractures

Daniel Vogler et al. (ETHZ)

Natural fractures have strongly varying aperture distributions due to their rough surfaces:

- Controls permeability changes when shearing
- Controls self-propping
- Channeling of flow

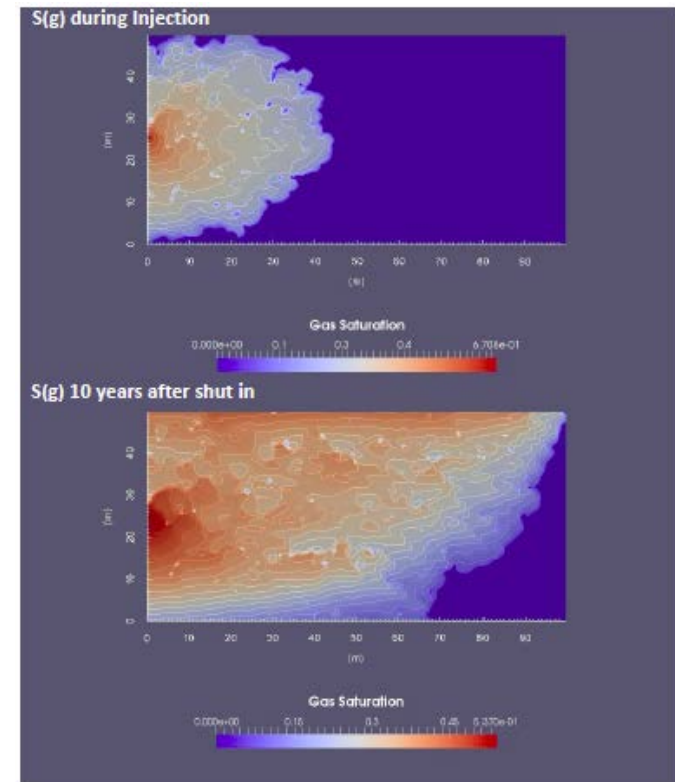
Experimental and simulation study to quantify these effects.



TH and THC processes during reservoir operation: I. Reactive transport and hydrology of CO₂ sequestration

Peter Alt-Epping (UniBE, SCCER)

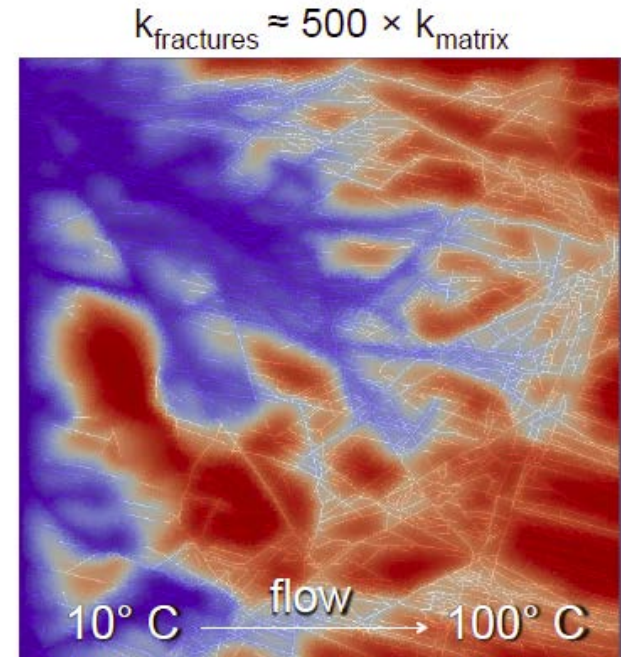
- CO₂, rocks, and formation fluids react chemically with each other.
- Feedbacks on porosity and permeability
- Affects plume migration and capacity for CO₂ storage as well as caprock integrity



TH and THC processes during reservoir operation: II. Heat transfer in fractured reservoirs

James Patterson (ETHZ, NRP70)

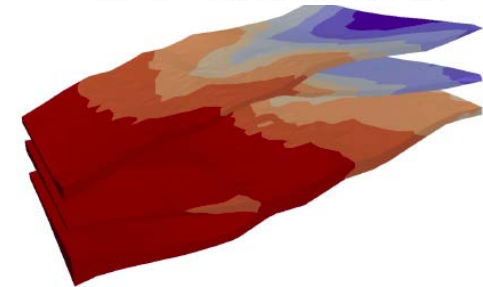
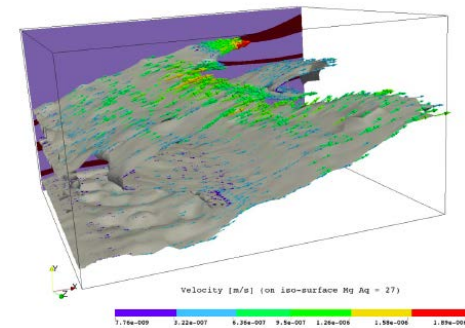
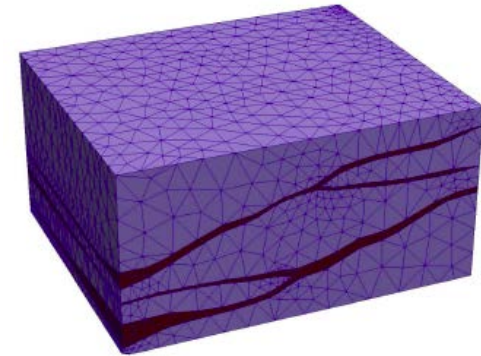
- (How) can heat be extracted from fractured reservoirs without early cold breakthrough?
- Optimal well placements in fractured reservoirs
- Response of reservoir hydrology to measures taken at wells



TH and THC processes during reservoir operation: III. Reactive transport in fractured reservoirs

Julian Mindel (ETHZ, SCCER & GEOTHERM-2)

- How do geochemical fluid-rock reaction affect long-term permeability evolution?
- Interaction chemistry with fracture geometry (aperture distribution) and mechanics (weakening or strengthening of faults)

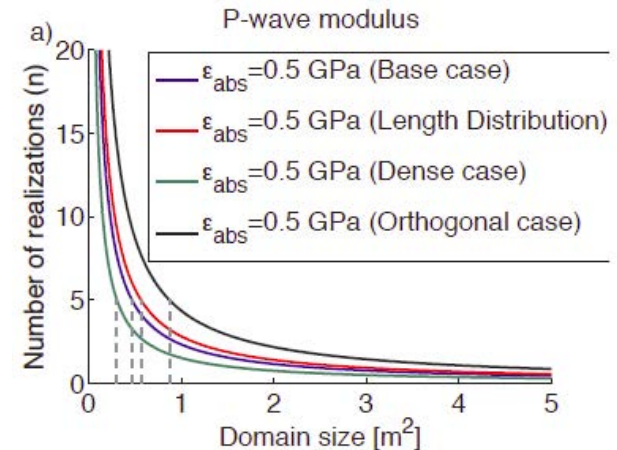
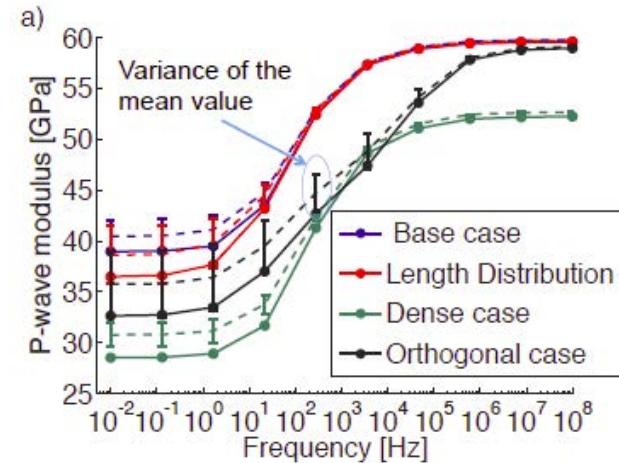


Material parameters and constitutive relationships on different scales: I. Seismic characteristics of fractured reservoirs

Eva Caspari et al. (UniL, SCCER)

Seismic characteristics of rocks with complex fracture networks poorly understood. Potentially crucial for exploration.

- Numerical upscaling, starting from poro-elasticity, applying to various fracture set geometries
- Determination of REV



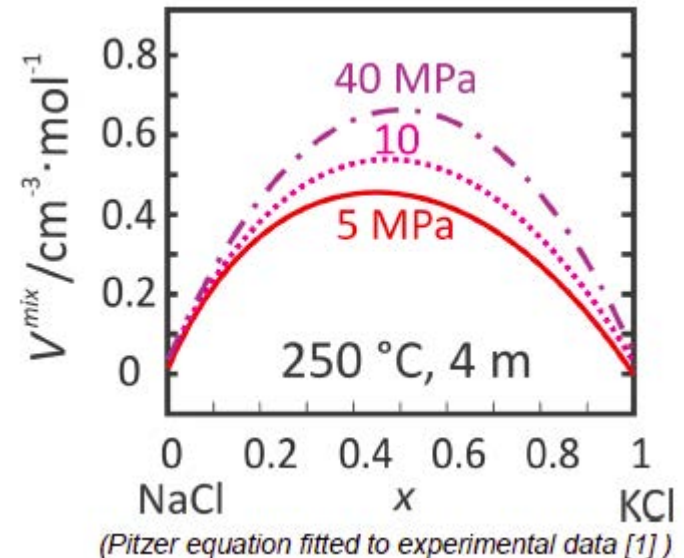
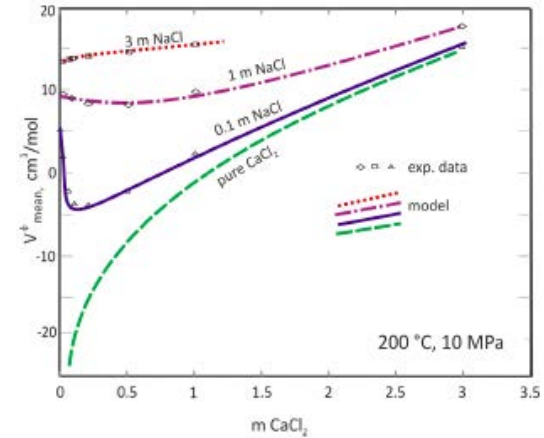
Material parameters:

II. Thermodynamic properties of brines at reservoir conditions

Denis Zezin (ETHZ)

Brines are a key agent in CO₂ sequestration as well as geothermal. Thermodynamic properties at reservoir conditions base on extrapolations.

- Measure pressure dependence
- Develop accurate and consistent thermodynamic models



International collaboration: COTHERM

COTHERM = COMbined hydrological, geochemical and geophysical modelling of geotHERMal systems.

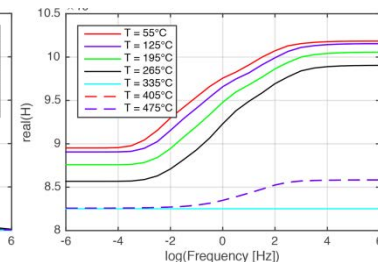
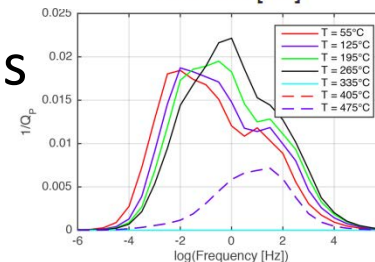
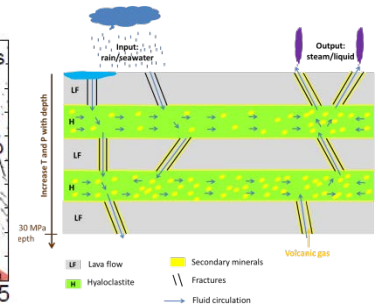
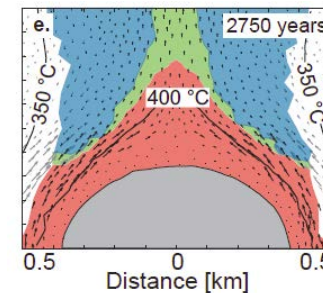
SNF Sinergia, IPGT collaboration with Iceland on natural, high enthalpy geothermal systems, mostly modeling

3 Posters:

Samuel Scott (ETHZ) on supercritical geothermal resources

Bruno Thien (PSI) on fluid-rock reactions

Melchior Grab (ETHZ) on seismic responded of fracture reservoirs



Many things not mentioned

- Intense collaborations between SCCER members, most posters in sections 1.1, 1.3 directly relate to work shown here
- Other international collaborations
- Concepts for next funding period
- ...