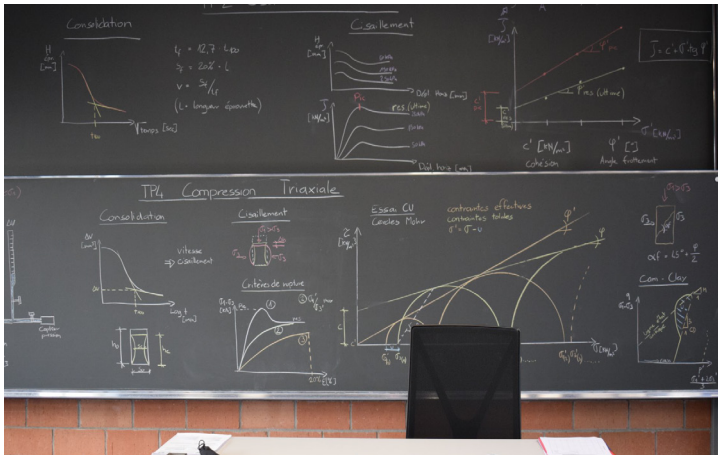


Geomechanics



PROJECTS AT LMS

PROF. LYESSE LALOU

Laboratory of soil mechanics - Fall 2025

Development of a machine learning approach to support the design and performance analysis of borehole heat exchangers

Context

- Borehole heat exchangers (BHEs)
- Machine learning approach

Objectives

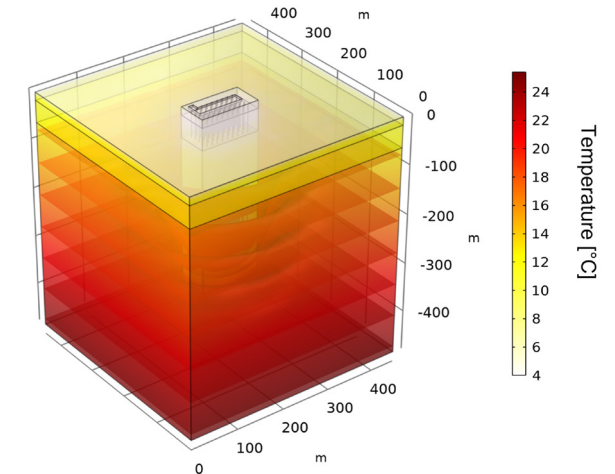
- Predict heat transfer performance of BHEs using machine learning techniques

Activities

- Familiarise with COMSOL Multiphysics
- Understanding of the current formulation of numerical models for BHEs
- Identification and development of machine learning technique for BHEs
- Report the results in a structured form

Contact

- If you are interested, please contact: Prof. Lyesse Laloui (lyesse.laloui@epfl.ch)



Development of a machine learning approach for sustainable operation of geothermal borehole fields

Context

- Borehole heat exchangers (BHEs)
- Machine learning approach

Objectives

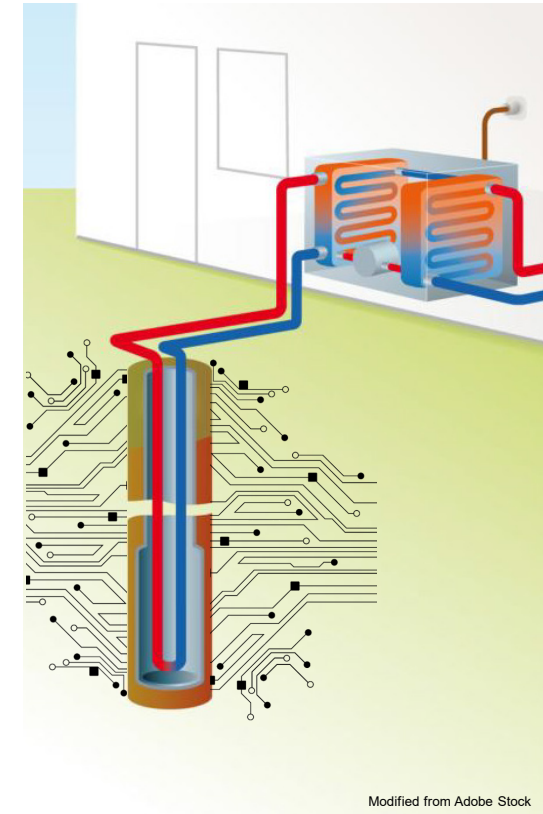
- Data collection from instrumented pilot installations
- Predict heat transfer performance of BHEs using machine learning techniques

Activities

- Installation of non-intrusive temperature sensors on hydraulic loops
- Verification of the quality and reliability of the measurements
- Identification and development of machine learning technique for BHEs
- Report the results in a structured form

Contact

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Consideration of soil-structure interaction for advanced seismic behavior analysis of existing buildings

Context

- Seismic behavior
- Soil-structure interaction (SSI)

Objectives

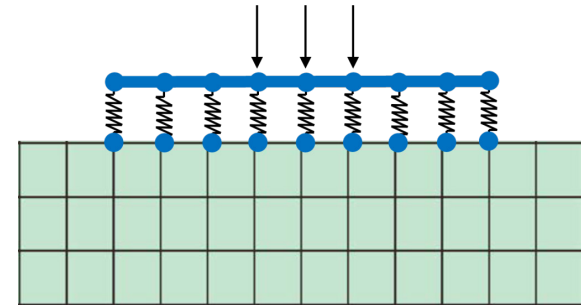
- Clarify when and how SSI should be accounted for to improve the reliability of seismic vulnerability and inform appropriate retrofit strategies

Activities

- Identify critical cases of SSI effects
- Develop more accurate modeling approaches that integrate SSI effects
- Apply these modeling approaches to a case study
- Report the results in a structured form

Contact

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Pore pressure changes in deep underground storage projects

Context

- Deep underground storage
- Pore pressure evolution

Objectives

- Develop a framework to model pore pressure evolution
- Analyse the resulting effective stress changes and derive corresponding stress paths

Activities

- Review pore pressure generation mechanisms
- Implement a poro-mechanical model to simulate pressure build-up and depletion
- Translate predicted pore pressures into effective stress evolution
- Compare representative scenarios (e.g. CO₂ storage, nuclear waste repositories)

Contact

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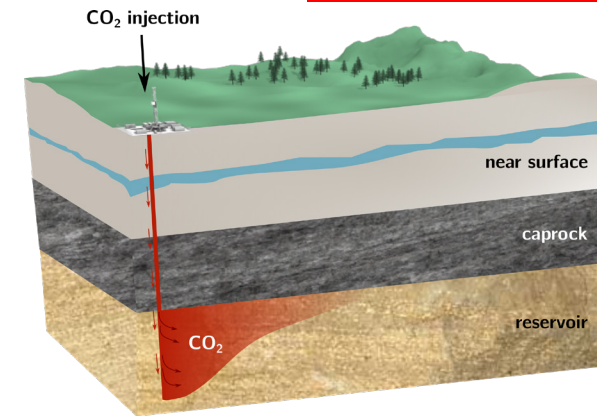


Illustration of GCS concept in deep porous reservoirs

Developing quality indicators for stress magnitude determination in deep in situ stress measurements

Context

- Deep underground storage
- In situ stress

Objectives

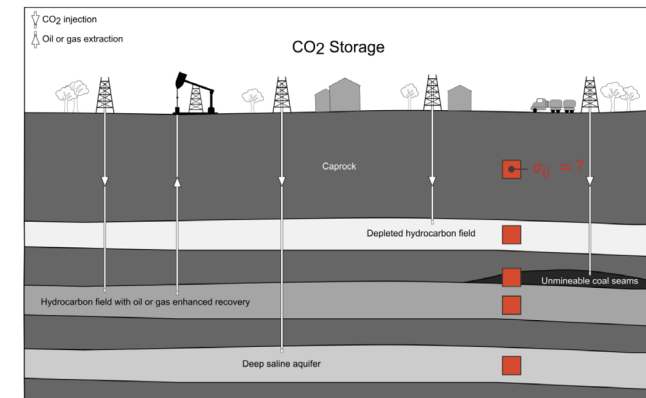
- Develop a robust framework to quantify, classify and communicate uncertainties associated with stress magnitude estimates, independent of the measurement technique

Activities

- Review existing stress measurement methods and quality indicators
- Identify key uncertainty sources affecting stress magnitude assessments
- Develop analytical or numerical sensitivity models to quantify uncertainty propagation
- Test the framework on synthetic or publicly available datasets.

Contact

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Post-processing of in situ stress measurements from the Mont Terri Rock Laboratory

Context

- Deep underground storage
- In situ stress

Objectives

- Support the post-processing and scientific interpretation of field measurements
- Contribute to the development of a robust and consistent data-analysis workflow.

Activities

- Review the fundamentals of in situ stress measurements
- Organise and post-process the incoming field dataset
- Compare results across depths and borehole orientations
- Assist in integrating the findings into the wider Mont Terri stress-assessment framework

Contact

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