CS-D experiment: CO2 injection and mobility within a fault zone in tight caprock at Mont Terri

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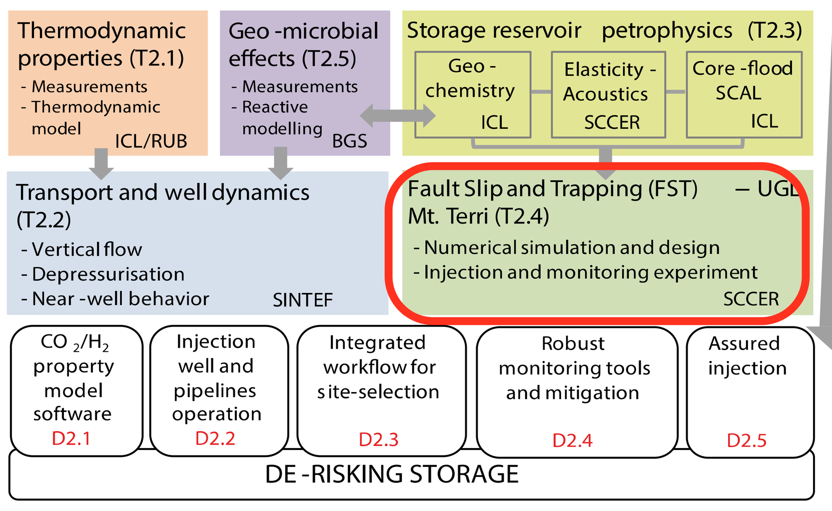
1. The Mont Terri experiment within ELEGANCY:

ELEGANCY (Enabling a Low-Carbon Economy via Hydrogen and CCS) is an European project within the ACT (Accelerating CCS Technologies) initiative, aiming at fast-track the decarbonization of Europe's energy system by exploiting the synergies between two key low-carbon technologies: CCS, and H_2.

The geological storage of CO_2 is an essential component for enabling the efficient generation of H_2 as a transport fuel. The large volumes of CO_2 produced in the natural gas reforming H_2 manifacture require a coupling with direct CO_2 separation techniques, and safe geological storage. In the Work Pakage dedicated to CO_2 storage, a field scale laboratory test is performed in the Mont Terri Underground Lab, in Switzerland.



Partners in CS-D:

Mont Terri Project

2. Aims of the experiment

Confirming the permanent containment of CO_2 is a key challenge for the storage of CO_2 in deep underground reservoirs. Faults in the cap rock of such reservoirs are considered to be a potential path for the CO_2 to escape. The Mont Terri experiment is investigating this aspect at the decameter scale.

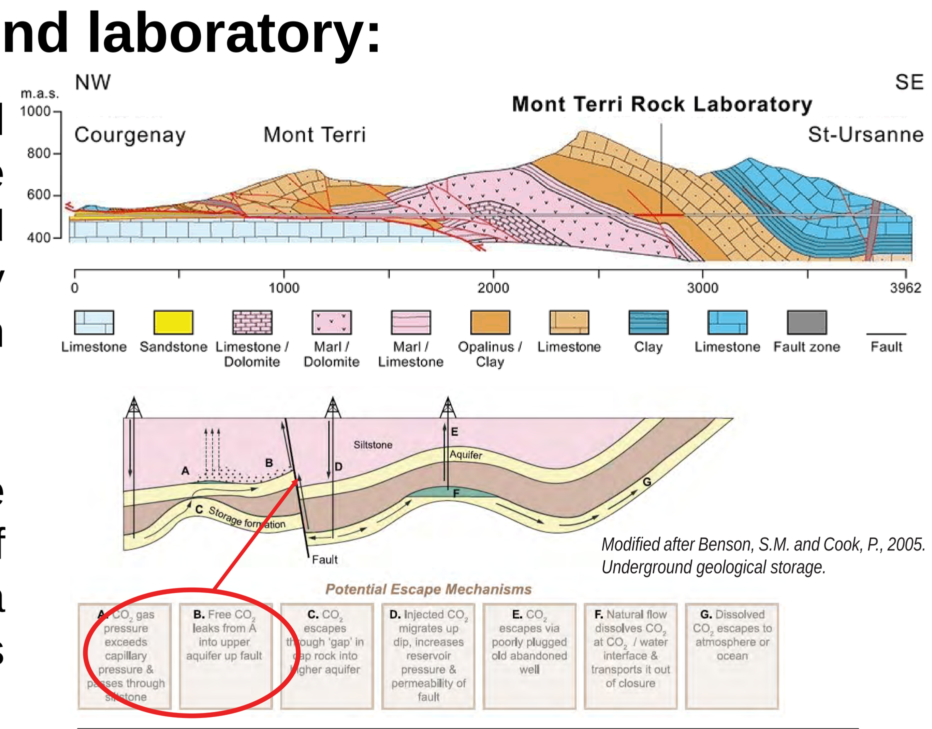
In the Mont Terri experiment, we are simulating the leakage of CO_2-enriched brine through a fault in the cap rock. With this experiment, we will:

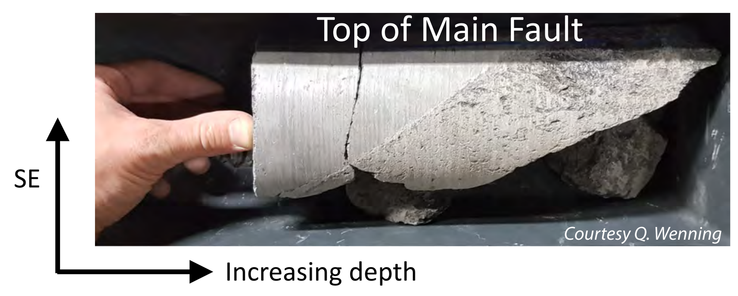
1. investigate how the exposure to CO_2-rich brine affects sealing integrity of a caprock, hosting a fault system (permeability changes, induced seismicity);
2. directly observe the fluid migration along a fault and its interaction with the surrounding environment;
3. validate instrumentation and methods for monitoring and imaging fluid transport.

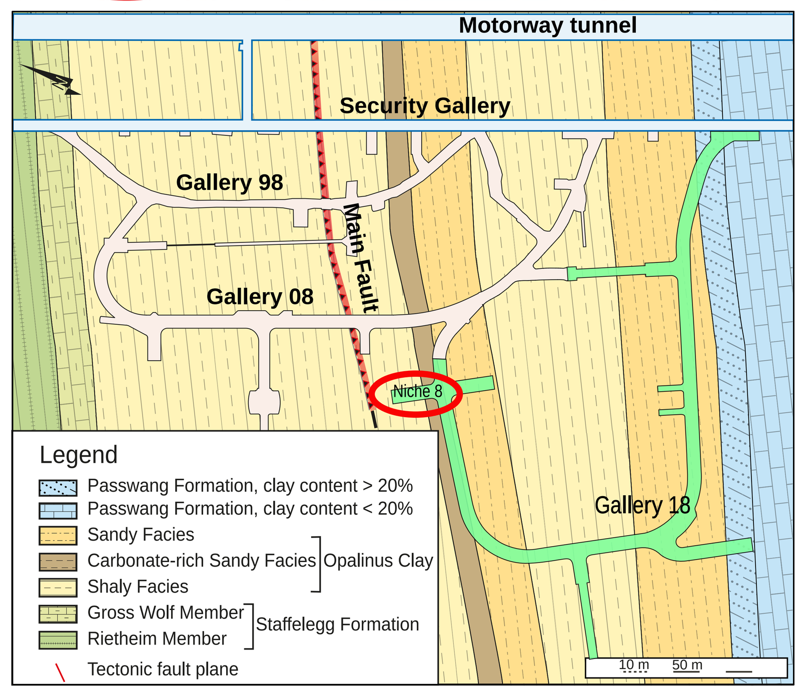
3. The Mont Terri underground laboratory:

The Mont Terri lab is an international research underground facility, for the hydrogeological, geochemical and geotechnical characterisation of a clay formation (Opalinus Clay). The lab is in Canton Jura, NW of Switzerland.

For the experiment, a new niche (Niche 8) has been drilled in the shaly facies of the clay. The fault below the niche has a thickness of 3 m and dips 60° towards SE. Its depth is at 12-30 m.





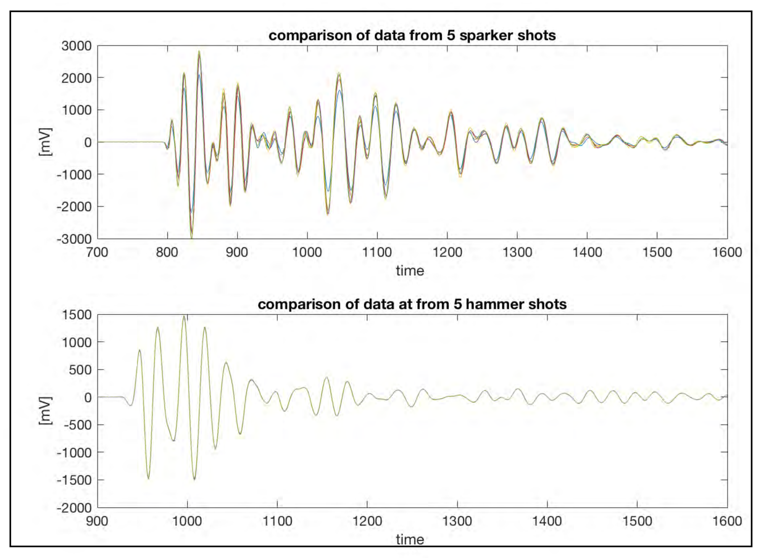


4. Experimental plan:

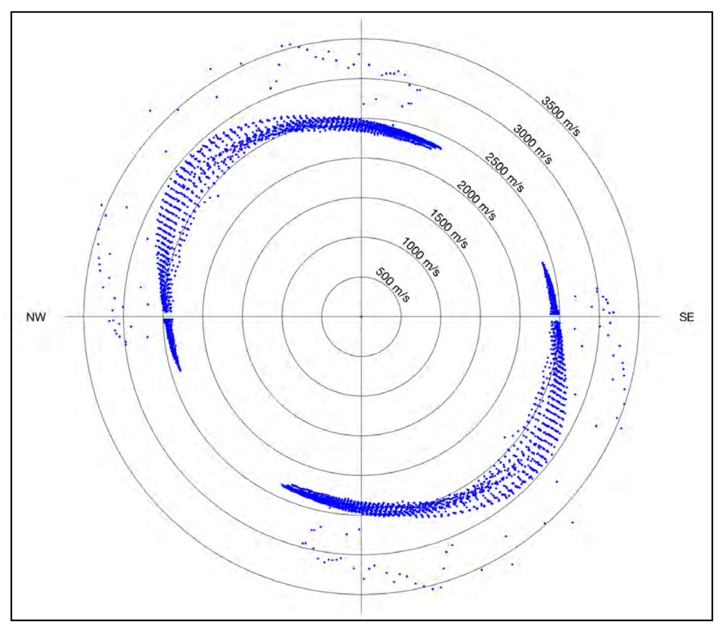
The experimental plan is:

1. Continuously inject CO_2 saturated water and tracer in fault for 8-10 months
   Pulse/ pressure increase steps (at beginning and at end of the injection phase);
2. Cores sampling before and after injection for petrophysical characterization;
3. Numerical simulation before, during and after injection;
4. Monitor injection effects: strain; Vp&Vs changes, CO_2 mobility through resistivity, pH, and tracers.

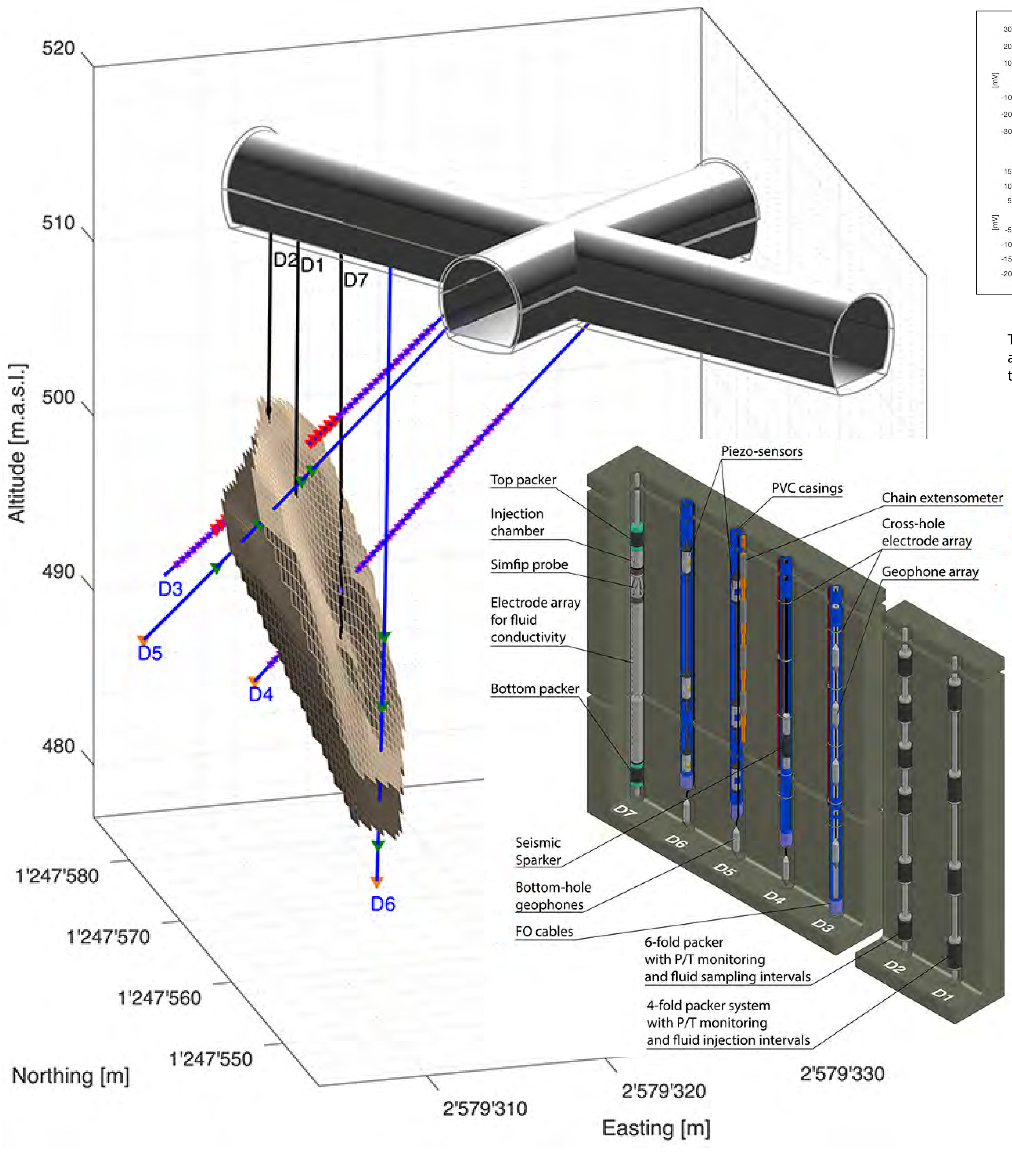
At present baseline measurements and injection tests are ongoing



The sparker and especially the hammer sources show an excellent repeatability, which is essential for time-lapse monitoring and imaging.



P-wave velocities within a vertical plane, striking NW-SE. This is parallel to the dip of the bedding plane. Note the strong variation of velocity (anisotropy)



5. Monitoring plan:

Fluid injection and monitoring:
- Fluid injection in borehole D1 with three injection intervals in the fault and one outside.
- Fluid pressure monitoring in two intervals of D1 and 6 intervals of D2
- Fluid sampling in six intervals in D2

Geophysical monitoring:
- Active seismic monitoring with geophone arrays in D3 and in the niche, and with single geophones in D4-D6
- Passive seismic monitoring with piezo-sensors in D5, D6 and in the niche
- Electrical resistivity monitoring (electrodes in D3 and D4)
- Extensometer in D5
- Fiber optic cable for strain and temperature sensing in all boreholes

Cooperation with LBNL:
- SIMFIP* probe in borehole D7

Acknowledgements:

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* Y. Guglielmi, F. Cappa, H. Lançon, J. B. Janowczyk, J. Rutqvist, C. F. Tsang, J. S. Y. Wang, (2014), ISRM Suggested Method for Step-Rate Injection Method for Fracture In-Situ Properties (SIMFIP): Using a 3-Components Borehole Deformation Sensor, Rock Mechanics and Rock Engineering, 47, 303-311