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Mont Terri CS-D experiment: an in-situ experiment to monitor for caprock and fault sealing

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Faults represent one of the possible leakage pathways for CO_2 to migrate out of the storage reservoir through the caprock. It is widely recognized that this pathway plays a key role for the safe, long-term containment of a CO_2 storage site, as well as for the phenomenon of induced seismicity. Thus, the presence of faults in caprocks will greatly affect the site characterization process in terms of the safety assessment, and consequently the monitoring, verification, and risk management plan (prevention, mitigation, remediation measures).

The Mont Terri rock laboratory, in north-western Switzerland, located 250 m underground in clay formation, offers a unique opportunity for a pilot-scale research through the injection of CO_2 into a fault. The CS-D experiment (August 2018 - July 2020) at the Mont Terri Lab, aims to investigate caprock integrity by determining CO_2-rich water mobility in a fault zone. We monitor for geochemical and geomechanical changes induced by fluid injection for prolonged time (approximately eight months), with the aim to better understand mechanisms of CO_2 leakage, and develop strategies to detect/monitor/predict it. Moreover, we focus on understanding the relative contribution of aseismic vs seismic slip associated with the fluid leakage in the fault zone. CS-D is in partnership with the FS B experiment (2019-2022), where the main aim is to imaging long-term fluid flow, permeability and stress variations during rupture along a minor fault, to better understand the role of fluids in earthquake rupture and fault reactivation. Thanks to this, we will continuing monitoring of the leaks in this fault zone for several years (at least until 2022).

The experiment offers a unique opportunity to develop improved, and more integrated monitoring technologies. In particular, a multi-component monitoring network of stress propagation within the fault will be integrated with the three-dimensional displacement probe, and will be employed in parallel with other monitoring systems (micro-seismicity and active seismic monitoring, cross-hole electrical resistivity monitoring, axial deformation, geochemical fluid sampling). The monitoring program will be continued after the end of injection in order to allow for studying not only the short-term poro-visco-elastic response, but also the geochemical and mineralogical changes within the damaged zone. This experiment will help improving the methods for monitoring and imaging fluid flow. Numerical simulation assists the different phases of the experiment and is calibrated by experimental (in-situ and laboratory) results.

Currently, the boreholes of the CS-D experiments are drilled and the permanent geophysical instrumentation is installed. We will present results of the first data recorded during the course of the instrumentation and the baseline measurements. We will present the details of the comprehensive geophysical instrumentation of the CS-D experiment and are confident to give a first overview of the preliminary result of repeated short pulse tests, where water is injected at different location within the fault zone.