The international Mont Terri rock laboratory: research in the field of radioactive waste disposal and CO2 sequestration

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The Mont Terri rock laboratory

The Mont Terri rock laboratory is located in an extended section of the security gallery of the Mont Terri motorway tunnel, close to the town of St-Ursanne in Canton Jura (Fig. 1). The main objective of the research being carried out in the laboratory is the hydrogeological, geochemical, and rock mechanical characterisation of the Opalinus Clay. Test results show that the Opalinus Clay is capable of confining radioactive substances and isolating them from the biosphere over very long time periods. The rock laboratory is operated by swisstopo in its capacity as a centre of competence and neutral organisation of the Swiss federal government. Seventeen partners from 8 different countries are involved in an extensive programme of experiments. The laboratory is focused exclusively on research purposes; disposal of radioactive in the facility does not come into question.

Experiments in the field of radioactive waste disposal

In our talk we describe the key experimental results from the rock laboratory over the last 20 years. These results detail the potential evolution of a repository in the Opalinus Clay (Bossart et al. 2017*)*. This potential evolution follows the example for a Swiss repository developed by Nagra (2002). During the construction of a repository, stress redistribution leads to formation of an excavation damaged zone (EDZ) around the galleries. The impact of heat producing waste has been and is being monitored with on-going THM-experiments. Heat transport into the surrounding rock may cause excess pore-water pressures and reduction of effective stresses in the near field due to the fact that expansion of pore-water is greater than expansion of the rock fabric. As time advances, heatflow will decrease leading to enhanced saturation in the near field and swelling of the bentonite buffer. These processes take place concurrently with self-sealing of the EDZ fractures. Redox conditions in the near field become clearly reducing and anaerobic corrosion of the steel canisters prevails together with concomitant hydrogen production. During this period, microbial activity becomes important: bacteria are involved in redox reactions, degrading hydrogen (e.g pore-water sulphates are reduced to sulphides such as H_2S). Experiments on radionuclide sorption and diffusion in the bentonite and the natural clay barrier track these long-term processes in repository evolution.

Experiments in the field of CO_2 sequestration

During the last 5 years, the focus has been on wellbore integrity, borehole sealants, and fault integrity experiments in the Opalinus Clay caprock. A small section of a wellbore has been implemented in the Opalinus Clay (Manceau et al. 2016), containing a carbon steel casing with common oil and gas well cements. Its sealing behavior was assessed by applying mechanical and chemical stresses followed by a CO_2-brine injection along the well, and finally by overcoring the whole system in order to identify the CO_2 flowpath. With pre-existing good integrity, exposure of the well to dissolved CO_2 results in an improvement of wellbore tightness. Reduced levels of integrity may result in increasing wellbore permeability and CO_2 leakage. Thus a new experiment to test novel sealants in test intervals of a leaky borehole was introduced (Goodman et al. 2016) with the aim of sealing induced leaks at casing-cement-claystone interfaces.

The loss of fault integrity is especially important considering that CO_2 stored in a lower aquifer could migrate through the caprock along a reactivated permeable tectonic fault, the latter induced by natural or artificial earthquakes. Fault reactivation experiments are on-going in the rock laboratory and focus on understanding conditions for slip activation and stability of clay faults, and the evolution of the coupling between fault slip, pore-water pressure, fluid chemistry and migration (Jeanne et al. 2018).

The question of public acceptance

The Mont Terri rock laboratory is an essential element in the dissemination of information and communication among implementers, safety authorities, and regulators as well as with the general public. Therefore, we take into account different ways of communication that address the comprehension gap between experts and non-experts

concerning questions of deep geological repositories (Stewart and Lewis 2017). Based on the feedback by visitors of the rock laboratory, we are developing a mixed-method design to focus on the different geo-cognitions of the subsurface. How far these mental maps influence the acceptance of radioactive waste disposal and CO_2 storage is being evaluated in moderated group discussions with all visitor guides of the Mont Terri Project partners. The analysis of the group discussions will foster a better understanding and improvement of geo-communication about the Mont Terri rock laboratory.

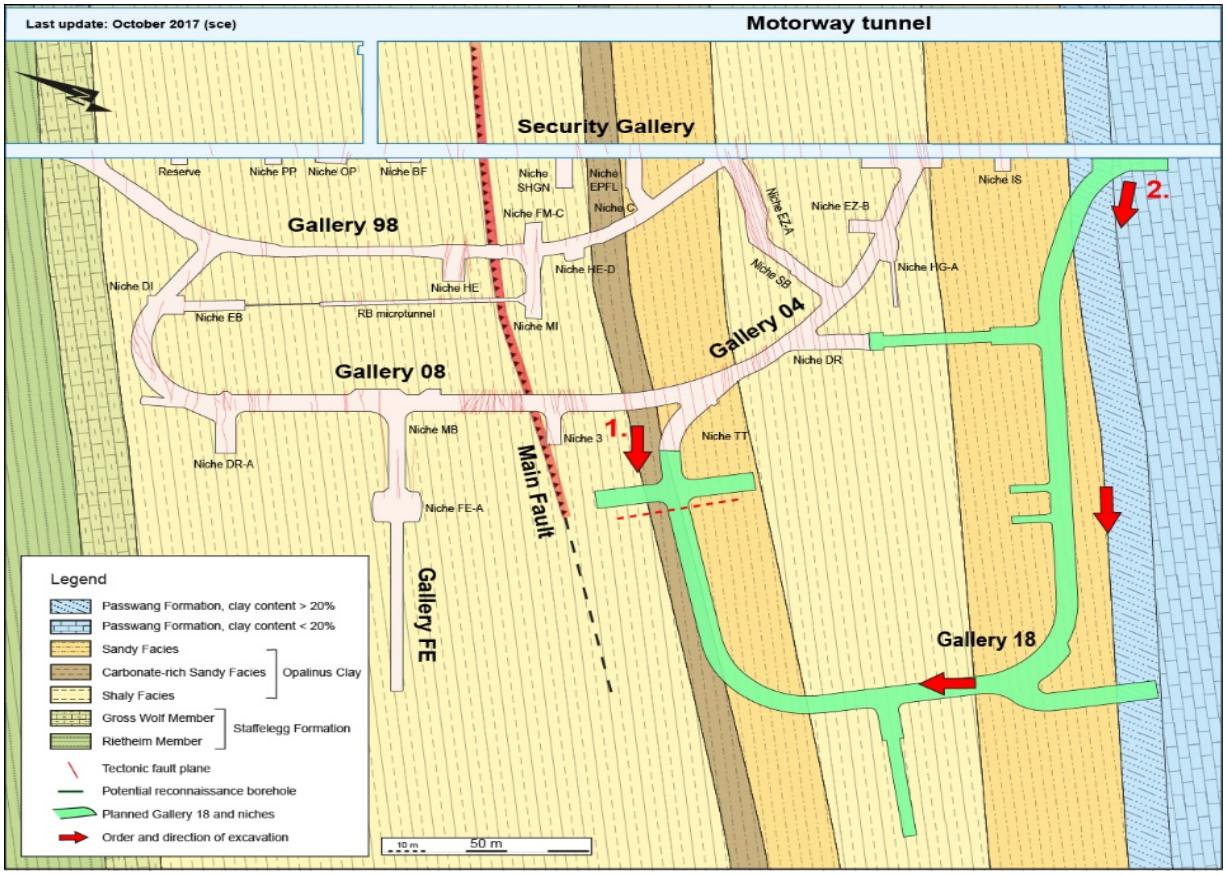

Fig. 1: Geological map of the Mont Terri rock laboratory. Red arrows mark the planned and on-going extensions in 2018/19.

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