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Media dossier CC 2017: FE Experiment

Experiment in the Mont Terri Rock Laboratory

One million datapoints every day

In the "Full-Scale Emplacement" Experiment (FE Experiment), practical experience is being gained for the future implementation of deep geological disposal of high-level waste. The main objective is to measure the effects of heat on granulated bentonite mixture and Opalinus Clay. Benoit Garitte, Project Manager in Nagra's (National Cooperative for the Disposal of Radioactive Waste) Field Investigations Section presents the interim results: "It is already clear that the measured data and model calculations lie very close together", says Garitte.

Trial run for a deep geological repository

The FE Experiment is a 1:1 demonstration experiment, with the main aim of measuring the effects of heat on the granulated bentonite mixture and the surrounding Opalinus Clay. The saturation of the bentonite and the evolution of the tunnel atmosphere are also of interest. "The FE Experiment is of great significance for repository development", says Garitte. It is the first experiment on this scale in Opalinus Clay. "The volumes of data being measured are huge", says Garitte, who is responsible for the running of the experiment and analysis of the data. Around one million datapoints are registered every day. The resulting measured data will allow existing computer models and simulations to be verified and compared; these models will be used at a later stage to make calculations for a deep geological repository. "We need to have a comprehensive understanding of the behaviour of the Opalinus Clay. However, this is not straightforward, particularly when the rock is influenced by engineering activities", explains Garitte. "The aim of the FE Experiment is to investigate the effects of temperature on hydraulic and mechanical processes in the Opalinus Clay", says Garitte. Such thermo-hydro-mechanical (THM) effects occur due to the heating of the bentonite and the surrounding rock. Before the start of the heating phase, a numerical model was developed based on existing data in order to simulate these effects in the FE Experiment. The experiment will allow the predictions to be checked and process understanding will be further developed.

Unique prototype

"An important monitoring phase is currently ongoing", explains Garitte. Although some deviations can be identified between the measured data from the experiment and the model calculations, these can all be explained, continues Garitte. For example, the model assumes a uniform temperature at the surface of the heater canisters. However, the FE Experiment shows that the temperatures on the underside of the canisters are cooler than those on the upper side. "We have found that the bentonite blocks have a higher thermal conductivity than the granulated bentonite", says Garitte. The model also assumes that the two outer canisters heat the middle canister, but the experiment shows that this is not the case. All three heater canisters have very similar temperatures. The dynamics of the experiment will naturally decrease with time: "In the first year, the temperature of the heater canisters rose from around 15 °C to around 130 °C. The temperature increase is currently between 2 and 5 °C per year", explains Garitte. After two years of heating, the data measured in the experiment

agree very well with the model calculations. “The information from the FE Experiment is important for the planning and design of the future repository”, says Garitte.

The FE Experiment – key facts
In 2011, a 50-metre long tunnel with a diameter of 3 metres was excavated in the Mont Terri Rock Laboratory and three heater canisters were placed on bentonite block pedestals in the tunnel. These heaters simulate the heat production of high-level waste. A specially developed machine was then used to backfill the tunnel with a granulated bentonite mixture. Heating started in December 2014 and the current output of one heater element is 1350 watts. Around 750 cables lead out of the tunnel and the surrounding Opalinus Clay. Several thousand sensors continuously measure temperature, humidity, pressure, deformations and gas composition in the bentonite and the surrounding rock. The tunnel was sealed with a concrete plug in March 2015 and data are now being collected, processed and analysed.

The FE Experiment is led by Nagra, working together with 6 partner organisations. The experiment is co-financed by the EU within the framework of the LUCOEX (Large Underground Concept Experiments) Project. The objective of LUCOEX is to build up practical experience with the emplacement and backfilling processes for a future repository.

According to Swiss nuclear energy legislation, the producers of radioactive waste are responsible for its safe management and disposal. In 1972, the nuclear power plant operators and the Federal Government set up the National Cooperative for the Disposal of Radioactive Waste (Nagra) to perform this task. Nagra, with headquarters in Wettingen (AG), is the national technical competence centre in the field of deep geological disposal of radioactive waste.

Out of a strong sense of responsibility for the long-term protection of man and the environment, 120 employees are involved daily in performing this important work. The high level of competence is secured by targeted research programmes in two Swiss underground rock laboratories and intensive international collaboration.