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A field-scale solute diffusion and retention experiment in Opalinus Clay: Processes, parameters, sensitivities

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Argillaceous formations are being considered worldwide as potential host rocks for the disposal of radioactive waste because of their favourable hydraulic and retention properties. The Mont Terri Rock Laboratory in the Swiss Jura Mountains offers the possibility to investigate the properties of Opalinus Clay, a candidate host rock formation in Switzerland, under in-situ conditions. In the last years, a number of diffusion experiments of increasing complexity have been performed at this field site. One of the main aims of these experiments is to verify diffusion and retention parameters that were obtained on small samples in the laboratory in column or batch studies. Field experiments involve somewhat larger spatial scales, but, most importantly, they are in general more representative of in-situ conditions with regard to the pore water chemistry, the mechanical stress, or the microbiology.
In this presentation, we focus on the ongoing DR (Diffusion and Retention) experiment, in which a series of tracers with very different retention behaviour–from mobile to strongly sorbing–was applied. The tracers (HTO, HDO, I, Br, Na-22, Sr-85, Ba-133, Cs, Cs-137, Co-60, Eu, and Eu-152) were injected as a pulse in the borehole solution, and their concentration decrease resulting from diffusion into and sorption onto the rock is being monitored as a function of time. At a later stage, overcoring and analysis of the surrounding clay rock is planned. The main objectives were (i) to check the diffusion and retention of the more strongly sorbing tracers, (ii) to verify the anisotropy of diffusion at the field scale, and (iii) to investigate possible effects of a borehole disturbed zone. With a numerical model, we investigated the sensitivity of the borehole and rock data to various parameters like the diffusion coefficient and the sorption capacity of the clay, or the filter properties. We could show that for strongly sorbing tracers, the resistance of the filter to diffusion plays an important role and slows down the decrease of the borehole concentration with time. It thus reduces the sensitivity of the borehole data to the clay sorption and diffusion parameters. The preliminary data available so far seem to be about consistent with data obtained at the laboratory scale. In some cases, the parameters need to be adjusted somewhat, which could be related either to the specific local pore water chemistry or to uncertainties in the modelling.