Results and modelling of the 4-year diffusion and retention (DR) experiment in Opalinus Clay in the Mont Terri URL

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Because of their favourable transport and retention properties, clays and clay rocks are considered worldwide as barrier materials for nuclear waste repositories. In the Mont Terri underground research laboratory (URL), a 4-year diffusion and retention experiment was performed. This DR experiment served to obtain transport and retention parameters at somewhat larger space and time scales as compared to laboratory investigations, and under more relevant in-situ conditions with respect to pore water chemistry, microbiology, and mechanical stress. The experimental set-up consisted of two tracer injection intervals, through which traced artificial pore waters were circulated, and a third pressure monitoring interval. The artificial pore waters included neutral tracers (HTO, HDO, H2O-18), anions (Br, I, SeO4), and cations (Na-22, Ba-133, Sr-85, Cs, Cs-137, Co-60, Eu, Eu-152). The majority of these tracers were added at the beginning, some at a later stage only. The hydraulic pressure in the injection intervals was adjusted according to the measured pressure in the third interval, such that no pressure gradients existed between the intervals and the surrounding rock. The tracers of the artificial pore waters spread then by anisotropic diffusion through the pore water of the surrounding rock. Two types of data were obtained: Concentrations within the injection intervals as a function of time (borehole concentrations), and 2D concentration distributions within the surrounding rock at the end of the experiment. The latter were obtained by overcoring and by subsampling parts of the overcore, which resulted in about 250 samples in total and about 1300 analyses. The combined large data set was then used to estimate diffusion and retention data of the different tracers. Because most tracers were injected at very low concentrations, single-species simulations were generally sufficient. Some simulations based on a more specific description of the geochemical system were also performed. The results of this field experiment generally confirmed data obtained in the laboratory.