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# Long term diffusion experiment (LTD) in Grimsel URL: Comparison of modeling and in-situ results

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Phase 1 (2005 –2008) of the long term diffusion experiment (LTD) project has taken place in the Grimsel underground research laboratory (GTS, Switzerland) in a joint effort between NAGRA (Switzerland), University of Bern (Switzerland), NRI Rez (Czech Republic), HYRL (Finland), JAEA (Japan) and AIST (Japan). The project aim was to study matrix diffusion of radionuclides relevant to performance assessments of deep geological repositories (DGR) of nuclear waste, and confirm the role of matrix diffusion for radionuclide retardation within the repository.

Work Package 1 of Phase 1 focused on the study of radionuclide diffusion from a single borehole into the undisturbed rock matrix. Within this framework a radionuclide cocktail was injected into a defined borehole interval sealed by packers (8 m depth from Grimsel URL tunnel) in June 2007. The cocktail consisted of a conservative tracer (3H), a weakly sorbing cation (22Na), a non-sorbing anion (131I) and a strongly sorbing cation (134Cs).

The injection was preceded by series of preliminary modeling studies. The predictive studies were performed using different codes, namely; a FORTRAN based code, created in NRI, a code based on SW GoldSim with radionuclide migration module integrated (NRI, JAEA), CrunchFlow (UniBern), Nflow (CSCI, Spain). Compiled results predicted 3H migration up to 30 cm depth from the borehole wall, 22Na and 131I migration up to several cms and 134Cs sorption within the first centimeter of the rock. A significant decrease of radionuclide activity level in the circulation water was only predicted only for 134Cs.

In reality, the radionuclide cocktail was left in contact with the undisturbed rock matrix under real crystalline rock conditions in GTS for 26 months (June 2007 to August 2009). The radionuclide activity level in the circulation water was checked by regular sampling of small aliquots of contact solution and by activity measurements at PSI.

As expected, significant activity decrease in in-situ circulation water was determined only for 134Cs. The activity decreased rapidly within 100 days down to the 35% of original level, which was far faster than predicted. Meanwhile short lived 131I (T1/2 8 days) decayed during the first few weeks, 3H and 22Na activity levels decreased down to 80% and 85% respectively of the original activity over the 2 year period.

Only the results of in-situ reservoir sampling can be compared and re-evaluated with the simulated results. The real extent of radionuclide migration into the rock matrix will be detected after borehole overcoring, followed by core sampling and activity measurements by the end of October 2009. The NRI FORTRAN based code, developed specially for LTD, was used for re-evaluation calculations. This is a 1-D model with cylindric coordinates, that is solved with a finite difference method. Translator G77/GFORTRAN was used for calculations, implementing the results of laboratory and analytical results.

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