Modelling the reactive transport of ^{14}C in a disposal for radioactive waste

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Radioactive waste may contain the radionuclide ^{14}C, which could generate gaseous species (e. g. CO_2, CH_4) and contribute to a potential radiation exposure. Therefore, an understanding of the transport of ^{14}C and chemical interactions during transport, is necessary to assess the safe containment of radionuclides in a disposal for radioactive waste.
Since possible host rocks in Germany could contain saline solutions as pore water, the chemical interactions between ^{14}C as $^{14}CO_2$ and highly saline solutions were modelled using the geochemical code PHREEQC [1]. The advective transport of the fluid phase (solution) was considered in this scoping safety analysis.
The chemical interactions between CO_2 and highly saline solutions form various aqueous species containing carbon. Since the pore solution contains $MgCl_2$, the solid phase $MgCO_3$(s) precipitates. Resulting in temporarily retained ^{14}C as carbonate in the solid phase and the transport of ^{14}C is delayed in time.
This ongoing study converts the model, which was developed for PHREEQC, into a model for the code TOUGHREACT to simulate the two-phase flow (solution, gas). Therefore, the model is extended to consider the two-phase flow and the impact of chemical interactions on the retention and transport behavior of ^{14}C can be studied in more detail. Future work includes additionaly the THC-coupled code MARNIE-PHREEQC to compare the results of both codes to assess the plausibility of results of model calculations [2].

[1] Weyand, Bracke & Reichert (2014), GRS-Report 323, https://www.grs.de/publikation/grs-323.
[2] Fischer, Seher & Bracke (2014), GRS-Report 334, https://www.grs.de/content/grs-334.