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Long-term subsurface disposal of sludges from uranium processing. Reactive transport simulations

GABRIELA ROMAN-ROSS[1], LARA DURO[1], MICHAËL MINET[2], MERITXELL GRAN[1], SALVADOR JORDANA[1], ALBA VALLS[1] AND DAVID GARCIA[1]

[1]Amphos 21 Consulting S.L.

[2]ORANO Group

Presenting Author: gabriela.roman@amphos21.com

The ORANO CE Malvési industrial site provides the first step in the conversion of uranium concentrate. The process generates effluents resulting from the conversion of yellowcake into uranium tetrafluoride (UF4). The effluents are currently disposed in decantation and evaporation basins and a long-term management solution is sought for safely store the waste.

Several options are being discussed for this purpose. The two different concepts currently under study for the long-term management of the waste consider subsurface disposal, to ensure proper isolation from the environment. This work presents the results of reactive transport models constructed to help in the process of decision taking with regards the best option for disposal of these wastes. For the sake of comparison, different host rocks are considered, upper and lower Oligocene, mainly differing in their chemical and hydrodynamic parameters, and the waste is in the models assumed to be disposed without previous treatment.

Hydrogeological and geochemical conceptual models have been developed and numerically implemented in a coupled reactive transport geochemical code COMSOL-PhreeqC [1]. The interactions of competing processes (solubility, sorption, cation exchange, diffusion, advection, etc.) at a range of spatial and time scales have been included. The results show the different behaviour of NO_3^-, pH/pe, Th, U, Pu, Tc, Ra, As, Cd, Mn, Mo, Ni, Pb and Se in the two disposal concepts, and the evolution of the whole system over 50 ky after disposal closure.

The main outcomes of this work point out that the evolution of contaminants in the natural environment depends on: 1) the source term, 2) the regional groundwater flow field and, 3) the retardation properties of the host rock. Hence, stable hydrogeological conditions and more active retardation processes lead to a higher performance of the waste disposal in the Upper Oligocene compared to the Lower Oligocene.

[1] Nardi, A., Idiart, A., Trinchero, P., de Vries, L.M. and Molinero, J., 2014. Interface COMSOL-PHREEQC (iCP), an efficient numerical framework for the solution of coupled Multiphysics and geochemistry, computers & geosciences, doi:10.1016/j.cageo.2014.04.011.