An Innovative Reactive Transport Modeling Approach for the Chemical Evolution of a HLW Cell in the Callovo-Oxfordian Formation

J. Molinero[1], D. García[1], M. Grivé[1], A. Nardi[1]

[1]Amphos 21 Consulting, Barcelona, Spain

Abstract

ANDRA (The French National Waste Management Agency) envisages the safe disposal of High-Level Waste (HLW) and Intermediate-Level Long-Lived Waste (IL-LLW) in deep geological storage using a multibarrier system. To ensure the containment of radioactivity, the principle of storage is based on a clay formation with low permeability, homogeneity and continuity (i.e Callovo-Oxfordian (COX) formation), properties that delay and limit the dispersion of the waste (Andra, 2013).

Although in recent years substantial efforts have been devoted to quantitatively describe the different components of a typical HLW cell, so far no models exist that account for the thermal and chemical evolution of the whole domain of a representative HLW cell and the surrouding COX formation. The objectives of this work have been to develope and settle up a geochemical model for quantifying the thermo-hydro-chemical (THC) processes in the whole domain, that could be later applied in reactive transport calculations to precisely evaluate the chemical interaction and migration of different radionuclides.

The geometrical set-up of this modelling work (Figure 1) is based on the repository layout defined in the Dossier Jalon 2009 (Andra, 2009). According to (Andra, 2009) four different geochemical domains (waste package, carbon steel, clay plug, COX formation) are defined. For each of those domains, a discussion is provided regarding its chemical properties and the main geochemical processes ocurring within them. Interactions among domains are discussed. All the geochemical processes considered in the conceptual model have been implemented in a powerful high performance computing framework, based on the coupling of COMSOL Multiphysics® and PHREEQC (Parkhurst et al, 1999) simulators (Nardi et al, 2012). 3D, long-term simulations, up to 100,000 years, have been performed sucessfully.

Reference

Andra (2013) Projet CIGÉO. Andra 504-DCOM/13-0028.

Andra (2009) JALON 2009. C.NT.AHVL.09.0005.B

Parkhurst, David L., and C. A. J. Appelo. "User's guide to PHREEQC (Version 2): A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations." (1999): 312.

Nardi, A., Trinchero, P., de Vries, L., Idiart, A., & Molinero, J. (2012). Coupling multiphysics with geochemistry: The COMSOL-PHREEQC interface. In COMSOL Conference, October.

Figures used in the abstract

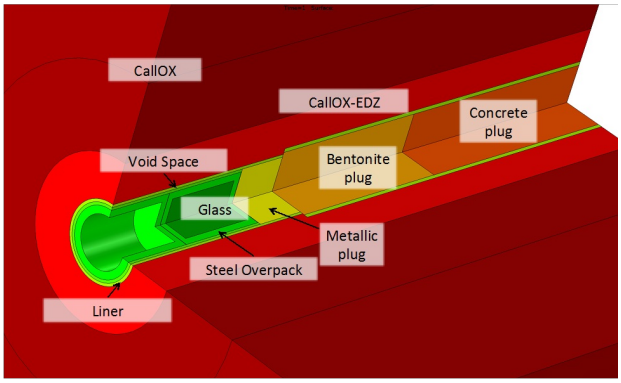

Figure 1: Geometrical domain included in the reactive transport simulations

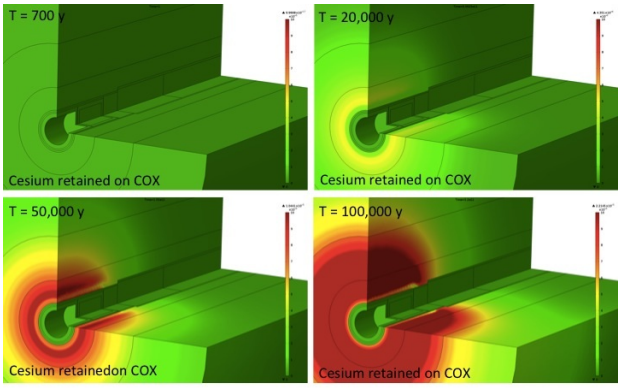

Figure 2: Evolution of exchanged Caesium in the geological formation during 100,000 years