Geochemical reactions and tritium transport in concrete cells for storing radioactive waste

M.C. CHAPARRO[1]* AND M.W. SAALTINK[2]

[1]Karlsruhe Institute of Technology (KIT), Institute for Nuclear Waste Disposal (INE), PO Box 3640, D-76021, Karlsruhe, Germany. (*correspondence: carme.chaparro@kit.edu)

[2]Universitat Politècnica de Catalunya (UPC), Department of Civil and Environmental Engineering, Jordi Girona 1-3, 08034, Barcelona, Spain.

Water with high concentration of tritium has been leaking from drains situated inside concrete cells storing radioactive waste at 'El Cabril', Spain's disposal facility for low and intermediate level radioactive waste. This indicated flow of water inside the concrete cells that stored the waste. 2D numerical models together with temperature and humidity measurements suggested that this leak of water is caused by a combination of thermo-hydraulic processes occurring in the unsaturated concrete, including capillary rise from the groundwater, evaporation and condensation due to temperature gradients caused by seasonal temperature fluctuations outside. To study the effect of these processes of condensation and evaporation on the tritium transport and the mineralogy of the concrete, a 1D reactive transport model was developed following the 2D thermo-hydraulic conceptual model. It included several mineral phases such as portlandite, ettringite, calcite, C-S-H and C-A-S-H. Model results showed that minerals precipitated and dissolved following the yearly fluctuations of condensation and evaporation. The model suggested that precipitation-dissolution can be particularly important near gaps of air in the concrete, where water condenses and evaporates more easily.