Impact of initial air and subsequent H2 gas migration in a radioactive waste repository

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Résumé

In a geological repository for high-level radioactive waste, corrosion of steel and water radiolysis leads
to generation and accumulation of hydrogen gas which may significantly affect long-term safety of the
repository. Numerical modeling can be used to predict the hydraulic and hydromechanical evolution of
such a disposal facility and to estimate the influence of excavation and generated gas on host clay rock
and sealings. While several modelling teams have studied gas migration (1), very few have considered the
initial presence of air and its impact on later hydrogen migration. Note that, during excavation, the COx
around the tunnels is disturbed, which creates an Excavation Disturbed Zone (EDZ), both hydraulically
(rock desaturation) and mechanically (fracturing, redistribution of stresses, natural convergence).
In our study, we have compared results obtained from TOUGH (2) modules (Equations Of States):
EOS5 for modeling two-phase flow with only water and hydrogen, and EOS7R for modeling a more com-
plex multi-component two-phase system with water, brine, air, and two radionuclides able to volatilize
and dissolve. This EOS7R model is tuned to attribute non-radioactive hydrogen gas properties to the
1rst radionuclide (brine and the 2nd radionuclide are turned off). The van Genuchten (1980) relative
permeability and capillary pressure functions are used.
The model is then run at the scale of a waste cell: Figure 1a. One challenge is to estimate the
peak gas pressure around the cell and check whether it exceeds lithostatic pressure at depth 630m. If
that is achieved, the mechanical stability of the engineered system and natural barriers may be affected.
The results indicate that hydrogen gas plume migration is impeded by the bentonite seal

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around the
canister. However, the migration of dissolved H 2 waway from the container is less impeded, as indicated
by Figure 1b. In future, this model will be extended to take into account hydromechanical coupling.