HM MODELLING OF IN-SITU GAS INJECTION TESTS IN BENTONITE AND ARGILLITE: THE PGZ EXPERIMENT

P. Gerard[1], R. Charlier[1], J.-P. Radu[1], R. de La Vaissière[2], J. Talandier[2], F. Collin[1,3]

1. Université de Liège, Département ArGEnCo, Ch. des Chevreuils 1, 4000 Liège, Belgique (pgerard@ulg.ac.be)
2. ANDRA, 92298 Châtenay-Malabry Cedex, France
3. FNRS Research Associate

During long-term repository of high and intermediate level nuclear waste in deep argillaceous geological formation, steel containers will corroded and organic material will be irradiated. The two processes lead mostly to hydrogen production. This study deals with the numerical modelling of the gas migration in both the host formation and a bentonite plug, with an emphasis on coupling between the gas transfer and the mechanical strains and stresses.

More particularly the study aims to support the design of the PGZ in situ experiment that will be performed by Andra in its underground laboratory at Bure. The objective of the experiment is the analysis of the dynamics of the bentonite plug resaturation, studying the competition between the liquid water coming from the argillite and a gas injection. The modelled experiment consists of a borehole drilled in rock clay, inside which a plug of MX-80 bentonite is set. The bentonite is naturally resaturated by water coming from the host formation. At the same time a gas pressure, higher than the initial water pressure in the host rock, is imposed at both ends of the plug (Figure 1).

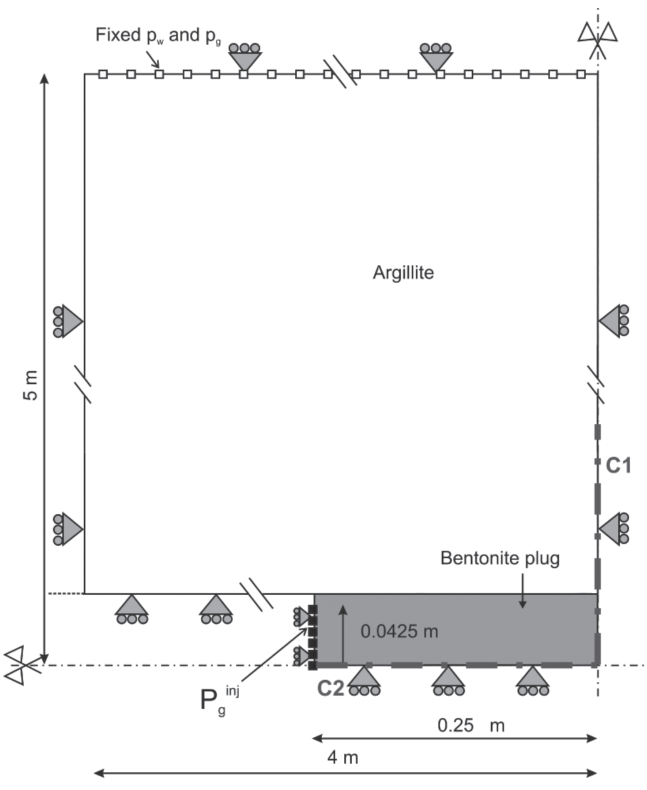

Figure 1: Geometry, boundary conditions of the problem and sections for the results.

The developed model takes into account the coupling between the mechanical behaviour and the water and gas transfers in undisturbed geomaterials. It manages explicitly liquid and vapour water, gaseous and dissolved hydrogen. Elastoplastic and non linear elastic model are used to model the behaviour of, respectively, the argillaceous rock and the bentonite.

The numerical results show the small desaturation obtained in bentonite and argillite (Figure 2). The influence of the coupling of the mechanic on the water and gas transfers is thus limited (due to the Bishop's effective stress). The swelling of the bentonite plug is not hindered by the gas migration and the confining effect of the engineered barrier is maintained (Figure 3).

An analysis is made of the influence of the main transfer rock properties on the gas pressure measured in the plug and in the argillite and the kinetics of the transfers. The influence of the water retention curve and the gas relative permeability expression in the quasi-saturated domain is evidenced. It emphasizes the need of the correct experimental determination of the relative permeabilities and the retention properties of the geomaterials in this range of saturation.

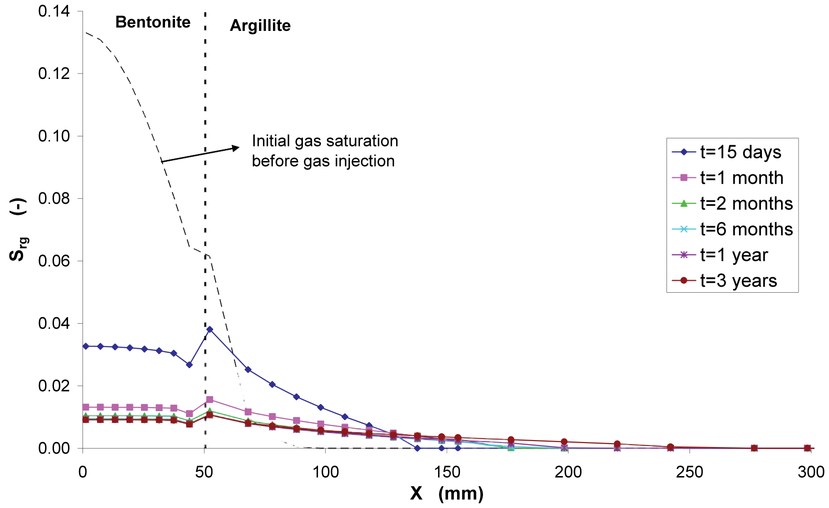

Figure 2: Gas relative saturation in bentonite and argillite - Section C1.

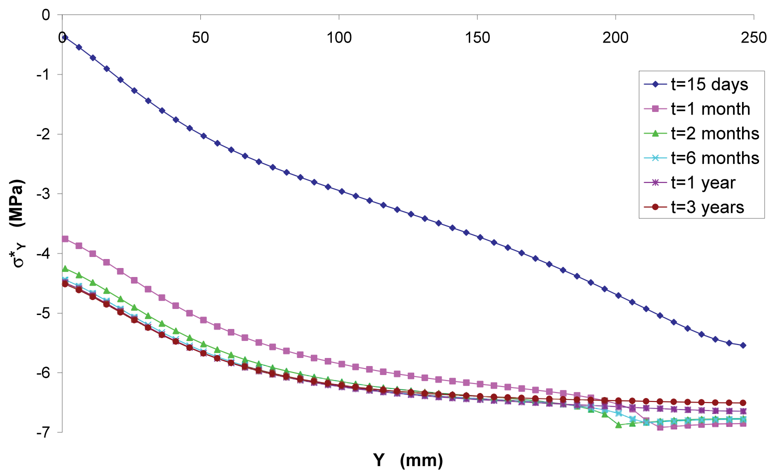

Figure 3: Axial net stress along the bentonite plug – Section C2.