GAS FLOW PROCESS IN THE CALLOVO-OXFORDIAN ARGILLITE: IN SITU EXPERIMENT PGZ1

R. de La Vaissière[1], J. Talandier[2], M. Piedevache[3], J.-M. Lavanchy[4], J. Croisé[4], R. Senger[5]

1. ANDRA, 55290 Bure, France (remi.delavaissiere@andra.fr)
2. ANDRA, 92298 Châtenay-Malabry Cedex, France (jean.talandier@andra.fr)
3. SOLEXPERTS AG, CH-8617 Mönchaltorf, Switzerland (mederic.piedevache@solexperts.fr)
4. AF-COLENCO Ltd, CH-5404 Baden , Switzerland (jean-marc.lavanchy@afconsult.com)
2. INTERA Inc, CH-5408 Ennetbaden, Switzerland (rsenger@intera.com)

The gas release from disposal system is classically described by four mechanisms i) advective-diffusive transport of gas dissolved in the porewater, ii) visco-capillary two-phase flow, iii) dilatancy-controlled gas flow and iv) gas transport in macroscopic tensile fractures. An in situ gas experiment in the French Underground Research Laboratory (URL) is dedicated to the observation of these four mechanisms. This experiment called PGZ1 (Perturbation induced by gas) has been installed during summer 2009.

SCOPING CALCULATION

Before drilling, the set-up i.e. location of the boreholes and intervals was verificated by scoping calculation performed by Intera and AF-Colenco. Numerical models are used for investigating the relevant phenomena associated with two-phase flow taking into account coupled HM processes associated with dilation and fracturing. The two codes include the two-phase flow simulator TOUGH2 (Pruess *et al.*, 2001) and the coupled two-phase geomechanical code GEOSIM (TAURUS Reservoir simulation Ltd.).

SET-UP

At the start of PGZ1, the experimental layout comprised three boreholes (Figure 1). Two boreholes drilled from GED drift PGZ1201 and PGZ1202 (28.59 and 28.28 m respectively), are equipped with a triple packer system to monitor water/gas pressure. They are parallel at a distance closed to 1 m, inclined at 35° versus horizontal. These boreholes are closed parallel to the maximal principle stress. PGZ1031, drilled from the GEX drift, is equipped with a multiple magnetic extensometers probe (MagX system®) for observation of the axial deformation (length 23.27 m). PGZ1031 is also inclined at 48° versus horizontal. This borehole crosses vertically above PGZ1201 at 2.2 m of distance.

TESTS SEQUENCE

All the test sequence will be done in the interval 2 of PGZ1201. The first test phase (HYDRO1) will be performed with synthetic water and includes first a pulse test and then a constant pressure test. After the recovery period, the water will be exchanged with gas (nitrogen) at equilibrium conditions (formation pressure). The second test phase (GAS1) is composed of a series of constant flux gas injections conducted at successively higher rates and separated by recovery periods. The maximal gas pressure will be less than the fracturation pressure (near 12.3 MPa), but should reach dilation conditions. The third test phase (HYDRO2) will be performed again with synthetic water after flushing the gas at the end of GAS1. The purpose of HYDRO2 is to identify any potential change in formation permeability after the gas tests performed under expected dilation conditions (GAS1). The fourth test phase (GAS2) is planned to be similar to GAS1 but the main difference is to create a macroscopic tensile fracture. The detailed test design of GAS2 will depend on the results of GAS1. The created fracture is supposed to be seen by PGZ1031. A fifths test phase (HYDRO3) will be performed again with synthetic water at the end of GAS2 to characterize the geometrical and hydraulic properties of the newly created fracture.

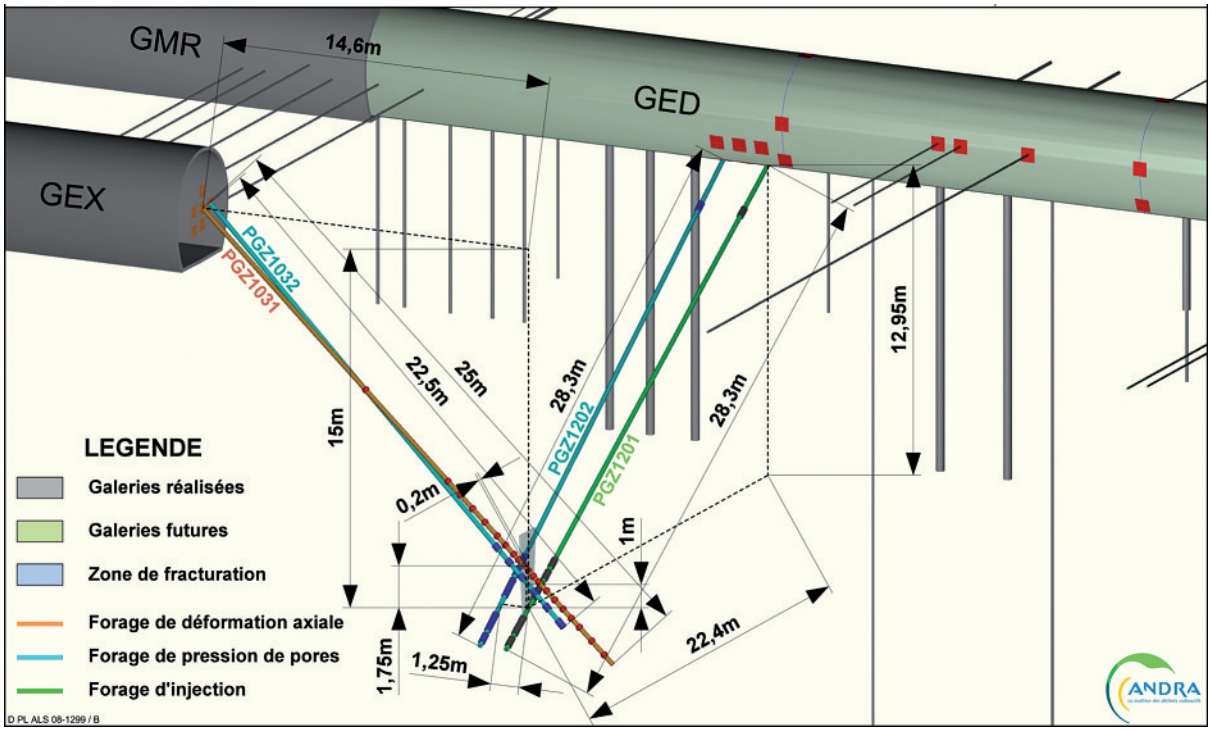

Figure 1: Set-up of PGZ1.

The whole experiment, fromHYDRO1 to HYDRO3 is expected to last around 2 years.

The comparison of the results obtained from HYDRO1 to HYDRO3 will give some information about the evolution of the system due to gas injection. An additional borehole, PGZ1032, nearly parallel to PGZ1031 will be drilled from the GEX drift in order to reach the gas created fracture. This borehole will be instrumented by a triple packer system with one test interval to be located on the fracture. Some gas and hydro tests will be performed in PGZ1201 to evaluate the permeability of the fracture. The subsequent sealing/healing of the fracture will be also investigated.

MODELING ACTIVITIES

A huge modeling activity has been planned to interpret and analysis all the results that will be obtained on PGZ1 experiment. Thereby, several groups will be involved in calculations such as AF-Colenco and Intera Inc (with TOUGH2 and GEOSIM) and also some partners within the framework of the FORGE project (Fate of Repository Gases). This European project that began in 2009 is specifically designed to tackle the key research issues associated with the generation and movement of repository gasses.

References:

Pruess, K., Oldenburg, C. and Moridis, G., 1999. TOUGH2 User's Guide, Version 2.0, Lawrence Berkeley National Laboratory Report LBNL-43134, Berkeley, CA.