WATER FLOW IN THE OXFORDIAN AND DOGGER LIMESTONE AROUND THE MEUSE/HAUTE-MARNE UNDERGROUND RESEARCH LABORATORY

Y. Linard[1*], A. Vinsot[1], B. Vincent[1,2], J. Delay[1], E. Scholz[1], M. Lundy[1], B. Garry[1], S. Wechner[3], R. de La Vaissière[1], M. Cruchaudet[1], S. Dewonck[1], G. Vigneron[1]

1. Andra, Centre de Meuse/Haute Marne, 55290 Bure, France (*yannick.linard@andra.fr)
2. Cambridge Carbonates Ltd, 14 rue du Mont, 52320 Marbéville, France
3. Hydroisotop GmbH, Woelkestr. 9; D-85301 Schweitenkirchen, Germany

INTRODUCTION

Within its scientific program to study the feasibility of a high level radioactive waste disposal in the Callovo-Oxfordian argillaceous rock (COx) of the eastern Paris Basin, Andra has conducted an extensive characterization of the Oxfordian and Dogger limestone formations above and below the COx. More than 35 wells ranging from 400 to 700 meters deep were drilled over 15 years to study a 400 km^2 area around the Andra's Meuse / Haute-Marne Underground Research Laboratory (URL) (Figure 1). An original methodology was applied in these wells to characterize the geology, the hydrogeology and the geochemistry of the Jurassic carbonates. This multidisciplinary effort provided a unique set of 3D data.

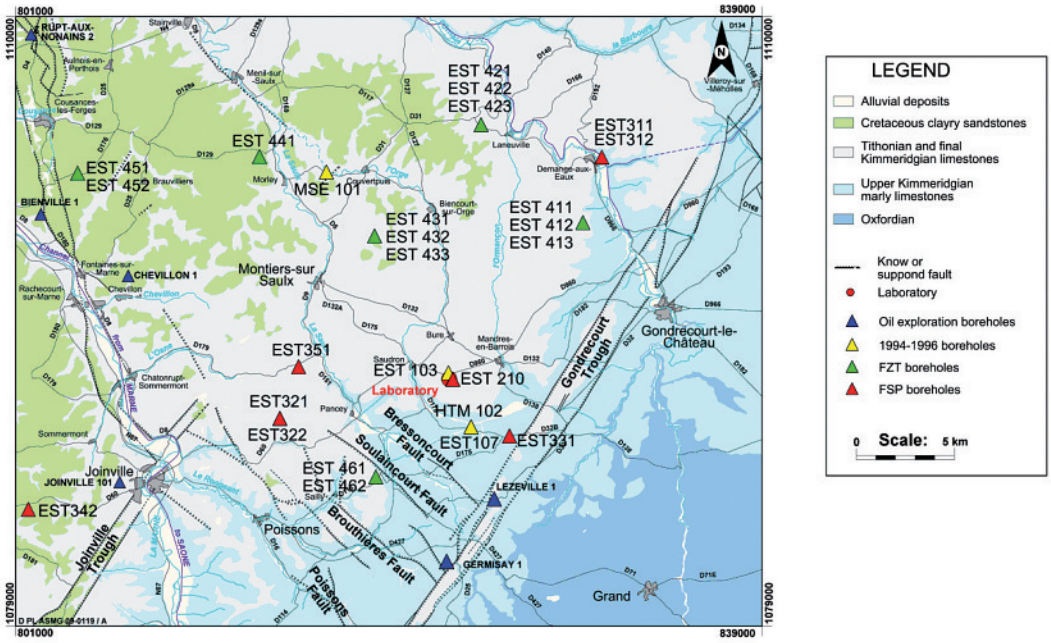

Figure 1: Geological map of the area investigated by Andra in the eastern part of the Paris Basin, with the location of the URL and boreholes (triangle).

DATA PRESENTATION

The first purpose of this study is to integrate the geological, hydrogeological and geochemical data into a water flow conceptual model. Geological data include the study of cored wells, complete modern wireline-log sets in both cored and uncored wells, and outcrop analogues. Hydrogeological data include transmissivity and hydraulic head measurements in the Oxfordian and Dogger limestone formations. Geochemical data include several on site measurements (pH, alkalinity, electrical conductivity, temperature) and chemical and isotopic analyses performed on water samples taken at selected depths.

More than one hundred hydraulic tests have been performed since 1994 to measure transmissivity distribution in the Oxfordian and Dogger limestone. Several hydraulic testing methods were used in each well: global pumping tests, fluid logging tests, thermal flow logging tests and packer tests. After completion of the hydraulic tests, hydraulic heads were deduced from long term pressure measurements in open wells or in multi-packer completions; pressure monitoring lasted between a few months and more than 10 years. Long term/high volume pumping tests were also performed after the hydraulic tests to obtain a stationary composition of the well water column. Dogger and Oxfordian formation waters were then collected. Sampling was performed by pumping, either at a low flow rate at the level of the water inflow with the "Diapo" device (Sornein *et al.*, 1992), or at the end of a Long Term Pumping test (LTP). Several types of deep samplers were also used occasionally. In addition, waters of 7 porous levels in the Oxfordian limestone were sampled during the sinking of the URL main shaft.

MAIN RESULTS

The geochemical characteristics of the sampled water were used in conjunction with the hydraulic measurements to propose a qualitative description of water flow in the Oxfordian and Dogger limestone on the studied area. Four main origins were identified for the water in the Oxfordian, whereas only two were identified in the Dogger limestone. The Oxfordian geological model reveals a clay-rich layer isolating two superposed aquifers in the North-East part of the studied area. Figure 2 presents the relationship between Mg^{2+} and SO_4^{2-} concentrations in the water sampled in the upper Oxfordian aquifer and in the unique Oxfordian aquifer in the South-West of the studied area. It showed that the meteoritic water recharging the upper Oxfordian aquifer in the North-East was enriched in Mg^{2+}, SO_4^{2-} and Na+. The later elements were come from the erosion of the Tithonien Purbeckian type facies. This enriched water mixed to the South-West with meteoritic water coming from the outcrops and/or infiltrating in the diffuse fracture area (Figure 1).

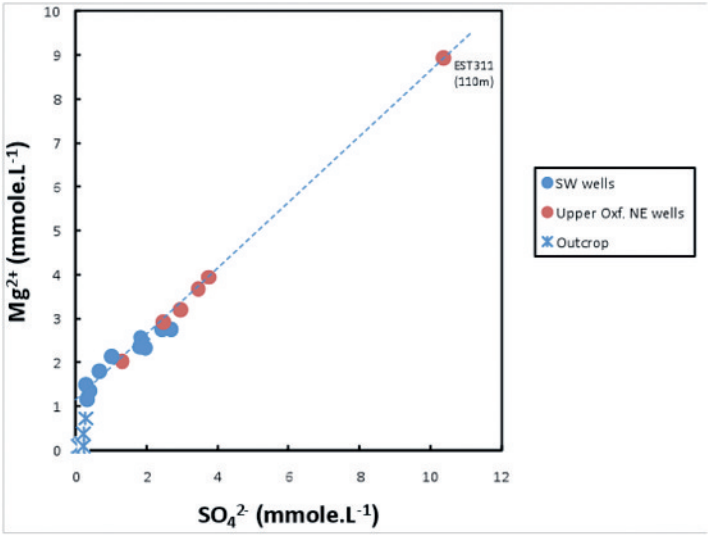

Figure 2: Magnesium versus sulfate contents in Oxfordian groundwaters.

Complementary analyses by several laboratories are in progress on the same samples. These further data will allow discussing the proposed water flow model.

Reference:

Sornein, J.F., Chiappini, R., Delay, J., 1992. DIAgraphie chimique des eaux par Pompage, Brevet CEA 92 03381.