

Characterization of deep saline aquifers for CO₂ storage in the Bécancour region (Québec)

Tien Dung TRAN NGOC^{1*}, Elena KONSTANTINOVSKAYA¹, René LEFEBVRE¹, Michel MALO¹ & Luc MASSÉ²

¹Institut National de la Recherche Scientifique, Centre Eau-Terre-Environnement, 490 rue de la Couronne, Québec, Qc, Canada, G1K 9A9

²Junex Inc., Québec, Qc, Canada

*tien_dung.tran_ngoc@ete.inrs.ca

Abstract:

The Bécancour region is located in the St. Lawrence platform, which represents the most prospective basin for CO₂ storage in Québec. Saline aquifers are found at depths between 800 and 2400 m in limestones of the Trenton Group, dolostones of the Beauharnois and Theresa formations, and sandstones of the Cairnside and Covey Hill formations. The overlying seals (shales and siltstones of the Lorraine Group and the Utica Shale) are 800 m thick with a low permeability ($\approx 10^{-4}$ mD). The regional northeast-trending Yamaska normal fault separates the reservoir units at depth into two distinct blocks.

The hydrogeological and petrophysical characterization of the Bécancour deep saline aquifers is based on drill stem tests, hydraulic well tests, well logging, fluid sampling and core analyses. Hydrostatic pressure measurements from different intervals and locations indicate an over pressured reservoir with a global pressure gradient of 12.17 kPa/m. Local lower (10.78 kPa/m) and higher (15.5 kPa/m) sub-basin pressure gradients are distinguished in the northeastern and the southwestern parts of the region, respectively. These pressures and the permeability anisotropy from core analyses ($k_{\text{horizontal}}/k_{\text{vertical}} \approx 10^2$) are indicative of preponderant horizontal hydraulic connectivity and that the Yamaska fault acts as a fluid conduit. Profiles of temperature, salinity, density, viscosity, porosity and permeability were established for each reservoir unit with their saturating brines. Minimum and maximum temperatures are 26.5°C for the Trenton and 61°C for the Covey Hill with an average geothermal gradient of 2.35 °C/100 m. Brine salinities range between 46 g/l and 340 g/l. Estimated brine density and viscosity are maximum in the Cairnside (1175 kg/m³ and 1.38 mPa.s) and minimum are 1075 kg/m³ (Covey Hill) and 0.91 mPa.s (Trenton). The saline aquifers are characterized by 1 to 6% porosity and 0.1 to 0.3 mD permeability. Net pay thicknesses in reservoir units range from 3 to 188 m. Results of this study form the basis of a conceptual model of the aquifers and provide indications about their suitability for CO₂ storage. A pilot site will be selected basing on geometry, size, effective carbon storage capacity and hydraulic boundary conditions.

Keywords : CO₂ geologic sequestration, hydrogeological – petrophysical characterization, deep saline aquifer, Bécancour-Québec.