Geological controls on the distribution of groundwater flow systems within the Middle-Devonian strata of the Northeast Athabasca Region

Pascale St-Germain
Imperial, Calgary, Alberta, Canada
István Almási
Dome GeoConsulting Inc., Calgary, Alberta, Canada
James D. Walker, Becky Rogala
Imperial, Calgary, Alberta, Canada

ABSTRACT
The middle Devonian aquifer system north of the Clearwater River and east of the Athabasca River has been the subject of regional and local scale hydro-geological investigations since the 1950's, mainly driven by oil sands development. Although areal distribution of hydro-geological and hydrochemical data is non-uniform, it is sufficient to provide a reasonable foundation for characterization of regional and local systems. The Devonian aquifer system was developed and enhanced by dissolution of the Prairie Evaporite Formation east of the Athabasca River. This hypogenic karstification resulted in a variably developed network of brecciation and fracturing of the over-lying strata. Both regional and local hydrochemical facies distribution patterns, as well as local stable isotope data, indicate that hypogenic karst processes are on-going. Pore pressure and hydrochemistry data suggests that the nested local and regional groundwater flow systems within the Devonian are gravity driven and connected to present day topography and water table configuration. Long-term depressurization monitoring indicates localized hydraulic connections between the Lower McMurray and the Devonian aquifers. The local groundwater flow systems within the Devonian aquifer/aquitard complex have important implications for the development of the Athabasca Oil Sands from a water management and geotechnical/mining risk aspect. Our research has allowed us to develop project-specific practical solutions to oil sands mining in a regional hydrogeological context.