

Hypogenic Karst Beneath the Athabasca Oil Sands – Controls on Aquifers and Aquitards

James D. Walker¹, Jennifer C. Cranshaw¹, István Almási¹, Ken Potma¹, and Frank A. Stoakes²

¹Imperial Oil, Calgary, Alberta, Canada

²Stoakes Consulting Group Ltd., Calgary, AB, Canada

Abstract

The Athabasca Oil Sands are located in northeast Alberta, Canada and contain an estimated 168 billion barrels of recoverable bitumen (Alberta Energy) that are developed through in-situ and mining operations. The bitumen-bearing reservoirs consist of a stacked sequence of Cretaceous-aged fluvial sediments that were deposited directly above subcropping middle and early upper Devonian limestones, dolostones, calcareous shales and evaporites. Regionally, dissolution of the middle Devonian evaporites was responsible for a dip reversal within the Devonian that created the Athabasca Anticline (Carrigy, 1959; Norris, 1963). It has been suggested that this structure was the primary trap for the hydrocarbon accumulation prior to extensive biodegradation (Ranger, 1994). Locally varying surface karst, combined with dissolution has resulted in complex structuring of the Devonian unconformity and both overlying and underlying stratigraphic units. Local collapse within the Devonian because of dissolution has been attributed to the development of sinkholes and release of water to surface from Devonian aquifers in active oil sands mining operations (Mahood et al, 2012).

The distribution of aquifers and aquitards within the Devonian has important implications for the ongoing development of the Athabasca Oil Sands. Devonian aquifers provide an opportunity for in-situ projects, which require both a reliable source of non-potable water for steam generation and a suitable disposal zone. Conversely, Devonian aquifers pose a significant risk to oil sands mining operations, where influx of non-potable water into the mine poses safety, environmental and economic risks to mining operations. Understanding the distribution of aquifers and the distribution and integrity of aquitards within the Devonian is therefore a fundamental requirement for successful oil sands operations. The adjacent in-situ and mining operations have almost opposite business drivers. This paper presents our current understanding of hypogenic karst beneath the Athabasca Oil Sands and raises some important questions about where the fluids go.

References Cited

Alberta Energy: Oil Sands Facts and Statistics: <http://www.energy.alberta.ca/oilsands/791.asp>.

Carrigy, M.A. (1959): Geology of the McMurray Formation, part III, general geology of the McMurray area; Research Council of Alberta, Geology Division, Memoir 1, 130 p. Mahood, R., Verhoef, M., and Stoakes, F.A. (2012): Paleozoic Stratigraphic Framework beneath the Muskeg River Mine (Twp 95, Rge 9-10W4): Controls and Constraints on Present Day Hydrogeology. Canadian Society of Petroleum Geology, Geo Convention 2012, 14–18 May 2012, Calgary Alberta, 8. pp.

Norris, A.W. (1963): Devonian stratigraphy of northeastern Alberta and northwestern Saskatchewan; Geological Survey of Canada, Memoir 313, 168 p.

Ranger, M.J. (1994): A Basin Study of the Southern Athabasca Oil Sands Deposit; PhD thesis, University of Alberta, 290p.