

## A new look at Devonian carbonates of western Canada by the Alberta Geological Survey

*Alex J. MacNeil*

*Alberta Energy Regulator/Alberta Geological Survey*

### Summary

Devonian carbonates of western Canada, for many decades, were of significant importance to the petroleum industry and a focus of extensive research by industry and various academic and government institutions. Hosting of the International Symposium on the Devonian System by the Alberta Society of Petroleum Geologists in 1967 and again in 1987 by the Canadian Society of Petroleum Geologists produced large volumes of publications and included multiple field trips for participants. Those were the heydays of carbonates in Canada and targeting of the Grosmont Formation circa 2006-2015, with its vast accumulations of bitumen, marked the last major activity by industry and various research groups. A lapse in industry activity from 2014-2022 combined with the demographic shift (aka “the great crew change”) and Covid-19 pandemic seemed to portend the end of carbonates in Canada’s energy industry.

Fast-forward to 2024 and there is a significant amount of renewed interest in carbonate successions found in western Canada, particularly the Middle and Upper Devonian. Current interest is being driven by emerging areas including the potential to extract brine-hosted minerals (e.g., lithium) at commercial scale, to store CO<sub>2</sub> in saline aquifers and depleted fields with enhanced oil recovery, and to use geothermal energy for power generation and heating. Identifying the need for an updated and fit-for-purpose understanding of Alberta’s potential in these emerging areas, the Alberta Geological Survey initiated several investigations in 2021-2022 that are ongoing. These include the Devonian Analogue Investigation, Leduc Formation CO<sub>2</sub> capacity estimation project, and geothermal favorability mapping, supported by no less than ten staff. This presentation introduces highlights of these studies and outlines how the Survey is providing relevant, credible information to support Alberta’s energy industry.

### Devonian Analogue Investigation

With a focus on Upper Devonian reef margins of the Leduc Formation in the Front Ranges, the Devonian Analogue Investigation will deliver some of the highest-resolution 3D digital outcrop models for carbonate successions in the world. The project is being driven by the need for high-resolution datasets of Devonian carbonate platforms that may be used as analogues for the construction of 3D geological models in the subsurface – key for development of brine-hosted mineral resources that rely on the accurate modeling of high-permeability zones. Similar applications also exist for conventional oil and gas reservoir modeling, CCUS injectivity studies, and some types of geothermal operations. In 2022 drone imagery was collected for the Cripple Creek margin and in 2023 imagery was collected for the Hummingbird, White Rabbit, and White Rabbit South margins. White Rabbit has always eluded detailed study because of its high, vertical cliffs. Attributes that are critical for modeling different margin geometries including facies belt widths, bed thicknesses, stacking pattern trends at fourth-order and higher resolution, the physical

nature of lateral facies changes and quantified dip geometries will provide industry and researchers modeling similar margins in the subsurface with parameters that otherwise are generally sources of uncertainty and significant speculation. The models, once public, will also provide valuable datasets for teaching many aspects of carbonate sedimentology and stratigraphy for a range of scientific and natural resource exploration and exploitation purposes.

## **CO<sub>2</sub> Capacity Estimates**

Moving into the deep subsurface, the Upper Devonian Leduc Formation has been utilized for CO<sub>2</sub> injection at the Clive Field by Enhance Energy as part of a Carbon Capture Utilization and Storage (CCUS) project since 2020. At the regional scale, the Leduc-Ireton storage complex is ideal for additional CCUS opportunities and in 2021 the Survey initiated an investigation into quantifying the resource capacity of the Leduc Formation for CO<sub>2</sub> storage and the sealing properties of the overlying Ireton Formation. The project utilized three methods and have determined that >1.6 Gt of CO<sub>2</sub> resource potential exists in the project's study area covering central Alberta. The sealing properties of the Ireton Formation have been found to be controlled by its thickness and percent carbonate mineralogy, properties that appear to be directly correlated to paleogeographic position relative to the Leduc buildups. This investigation refines our understanding of the Leduc Formation as a viable CCUS target and is preparing the regulator to ensure that applications can be evaluated with a high-degree of certainty around safety and containment assurance.

## **Geothermal Favourability Maps**

Considerable attention on the geothermal potential in western Canada has developed over the preceding ~six years and it is exciting times given recent advances in geothermal technology. In 2021, the Survey commenced a study of the geothermal potential in Alberta with a focus on several aspects of deeper stratigraphic intervals including temperature gradients, porosity trends, and thickness. A Geothermal Atlas of Alberta has recently been produced and a key component are a series of favourability maps including the Swan Hills/Slave Point and Leduc formation intervals. These maps are key inputs for estimating the thermal resource (heat-in-place) and electric power generation potentials of Alberta's subsurface, an important step in understanding alternative energy sources for Albertans.

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