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# Modeling the Devonian Shale Basin of Central NWT

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## Summary

The Devonian shale basin of central Northwest Territories is a structurally complex stratigraphic package situated in the deformed belt between the Mackenzie Mountains and Franklin Mountains. It includes the Horn River Group, which comprises the Hare Indian, Ramparts, and Canol Formations, and the Imperial Formation. This basin hosts the hydrocarbon resource at Norman Wells, and therefore has been extensively studied by government agencies, industry, and academia for decades. The resulting datasets, including publicly available well files, survey reports, and outcrop and well sample data, are used in this study for the creation of local and regional geological models. The main objective of this project is to use these models to better understand the regional hydrocarbon system by attempting to predict known resource accumulations.

## Workflow

The study area includes the Mackenzie Plain region and portions of the Peel Plateau, Peel Plain, Franklin Mountains, and Mackenzie Mountains. For the modelling project, a subset of available wells and outcrops were used to create local point models (Figure 1). Each point model comprises lithological data for each formation present, known unconformities with an estimate of removed section, and maturity data from analyzed samples if available (vitrinite reflectance was prioritized). A regional heat flow estimate was also used for the point models, in this case 80 $mW/m^2$ (Majorwicz et al., 1988). Point models were used to generate local burial and exhumation histories, which were calibrated with the available thermal maturity data. Thus, these point models provide the timing of hydrocarbon generation and migration at each point.

A regional 3-D model was built using geological surfaces created from interpreted seismic lines and a surface layer based on a regional digital elevation model. These surfaces include the tops of the Ramparts, Canol, Hare Indian, and Imperial Formations. The point models were subsequently added to help constrain the geological surfaces on a local scale. Other data used in the regional model included temperature and pressure values from borehole drill stem tests. These allow estimated regional pressure-depth and temperature-depth curves to be generated.

## Observations

Calibrating the resulting well and outcrop models using maturity data has provided reasonable correlations between simulated depth vs. maturity curves and sample results. Similarly, the current iteration of the 3-D regional model appears to predict known maturity trends in a broad sense, based on the input data (Figure 2). This model makes several assumptions and has limitations due to data density and availability. The regional model assumes a degree of homogeneity in lithology, porosity, permeability, and distribution of organic matter in each rock layer. This is clearly not realistic but is a necessary simplification due to the modelling software's limitations. Currently, lack of continuity for some surfaces (partly due to the model's interpolation

limits) impedes proper resource accumulation prediction even though interesting trends can be observed. Most of these issues are attributable to the relatively small and areally sparse data set and the sheer size of the geographical area being modeled. Additionally, the Gambill fault zone at the southern end of the study area can be considered to be a boundary for the basin. Data south of it is even more sparse and the heat regime appears to be very different from the rest of the modelled area.

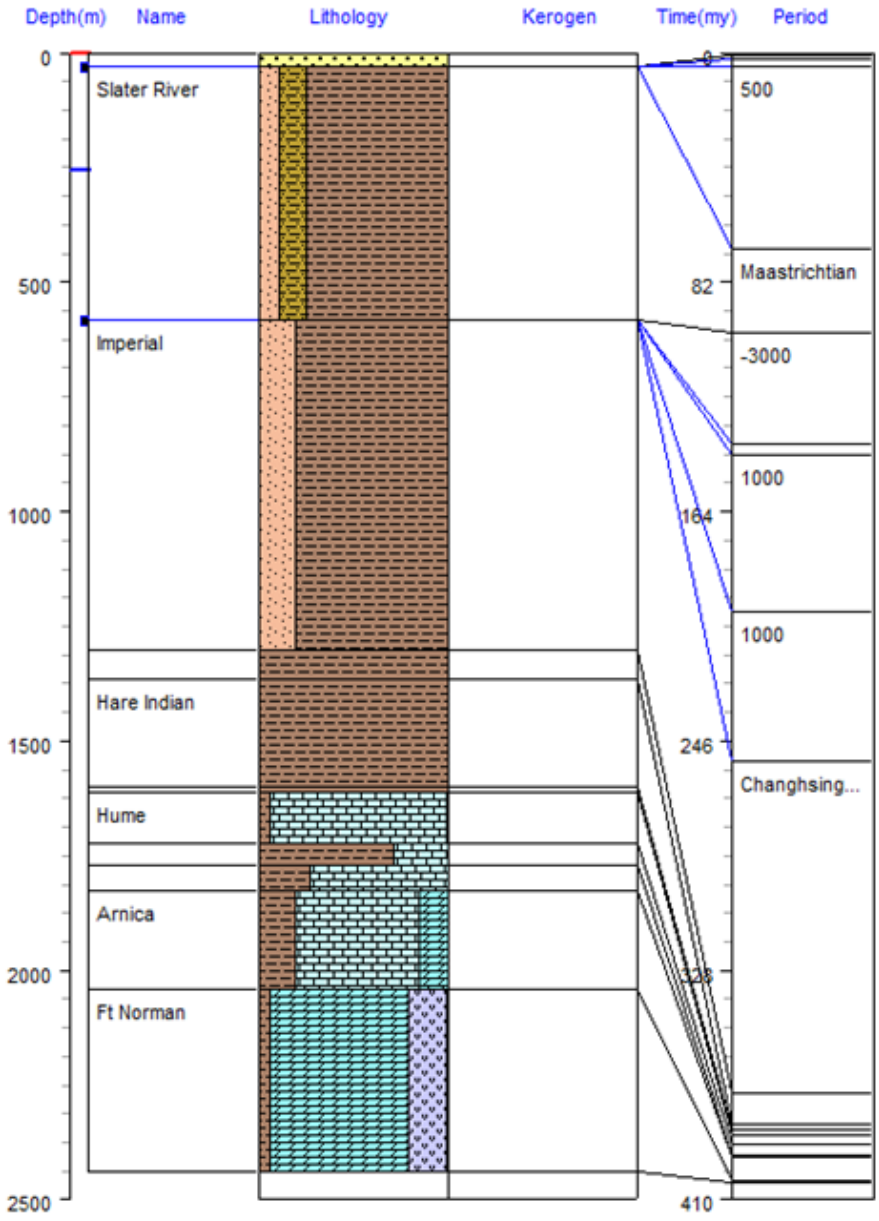


Figure 1: Point model of the Dahadinni D-65 well, showing age and proportional lithology of each formation. Blue lines represent unconformities/missing stratigraphy.

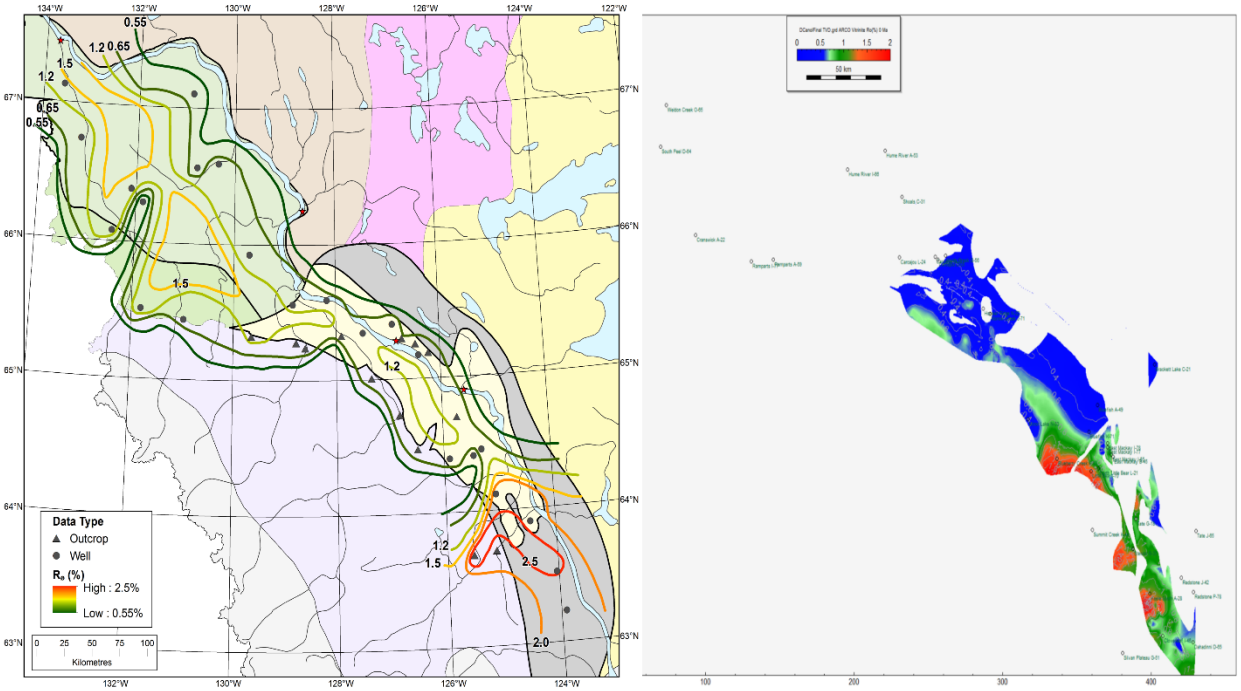


Figure 2: Regional maturity trend of the Canol Formation, contoured using select sample data on the left (Rocheleau et al., 2016), compared on the right with modelled vitrinite reflectance from this study (map is oriented with north at the top).

**References**

Majorowicz, Jacek & Jones, F & Jessop, A.. (1988). Preliminary geothermics of the sedimentary basins in the Yukon and Northwest Territories (60°N-70°N) - estimates from petroleum bottom-hole temperature data. Bulletin of Canadian Petroleum Geology. 36. 39-51.

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