geoconvention
Virtual Event
September 13 - 15
2021

Modelling the Devonian Horn River Group of the Central Mackenzie Valley, NWT

Jonathan Rocheleau
Northwest Territories Geological Survey

Summary

The Middle to Upper Devonian strata of the Horn River Group (HRG) in the Central Mackenzie Valley area of the Northwest Territories have been extensively studied by the Northwest Territories Geological Survey (NTGS), the Geological Survey of Canada, and industry. The resulting datasets, consisting of publicly available well files and outcrop data, are sufficient for the creation of local and regional scale geological models. The NTGS has initiated a 3-D basin modelling project for the HRG spanning the Mackenzie fairway using Zetaware. The goal of the project is to increase the understanding of the regional hydrocarbon system to determine how known resource was generated, migrated, and accumulated at its current location.

In the initial phase of the modelling project, well data were assessed for model input into Zetaware's Genesis module based on several criteria then selected for entry or discarded. The selected data were formatted into point models at the scale of individual wells or outcrops. These models rely on assumptions based on best available knowledge and were calibrated using existing maturity data. The models provide local snapshots of thermal and burial history, and will be incorporated into a regional model, which can be used to simulate hydrocarbon generation, expulsion, and migration. The results can be used to highlight areas where potential resource accumulation might exist within the region.

Methods

In the study area, which includes the Mackenzie Plain region and adjacent swathes of the Peel Plateau, Peel Plain, and Franklin Mountains, there are 584 wells, and approximately 30 outcrops with publicly available data. Each well to be entered into the model required a minimum of location coordinates, surface elevation, and rock units. Data for each well was assessed and wells that overlap or wells with insufficient or low-quality data were discarded. The list of wells to be included in the model was narrowed down to 100, with a focus on using the most recently drilled wells that had full geological reports submitted by the operator. Lithology for each formation is entered as a percentage of major components (sandstone, shale, limestone, etc.). To create these local models effectively, certain regional assumptions need to be made based on best available knowledge. The three most important are timing of unconformities, the amount of erosion that took place at the unconformities, and an estimate of regional heat flow. The unconformities or major erosional surfaces used in the models were the sub-Cretaceous unconformity (estimated 2.5 km – 3.5 km of erosion), sub-Slater River erosion (135 m), and end Little Bear erosion (75 m) based on work by MacLean and others (2015). For regional heat flow a value of 80 mW/m^2 was used (Majorwicz et al., 1988). Once each point model is fully set up in Genesis, a simulated depth versus maturity curve is produced. Comparing these generated curves to existing maturity data is the primary method of verifying the point models and regional assumptions.

Observations & Future Work

The process of correlating point models to available maturity measurements (either $\%R_o$ or T_{max}), can lead to revising the thickness of missing strata at one or more of the regional unconformity surfaces or adding a certain thickness of geologically recent erosion, which can be attributed to Tertiary glaciations (Figure 1). The final phases of the project involve incorporating the point models into a 3-D regional framework and the set up of a working hydrocarbon generation model in the KinEX module.

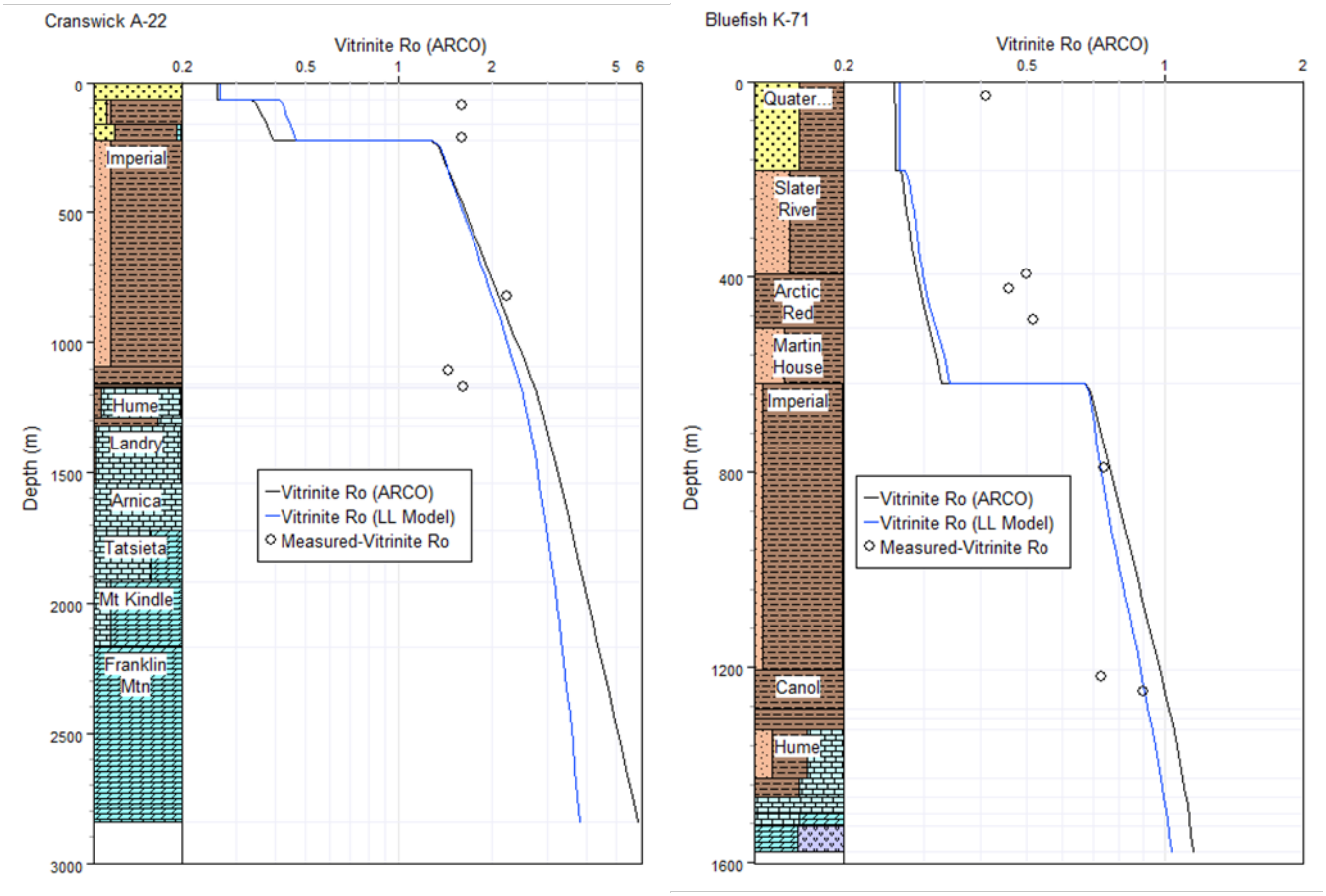

Figure 1: Two example depth versus maturity curves with superimposed sample data. The generated curve for the Cranswick A-22 well correlates reasonably well with existing $\%R_o$ measurements. The upper portion of the maturity curve for the Bluefish K-71 well does not correlate with reflectance data, suggesting that there was more post-Cretaceous erosion at this location and less along at the older unconformity surfaces.

References

MacLean, B.C., Fallas, K.M., and Hadlari, T., 2015. The evolution of Keele Arch, a multiphase feature of the northern mainland, Northwest Territories, Geological Survey of Canada, Bulletin 606, 39p.

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.