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Oil and Gas Resource Potential in the Mackenzie Corridor, Northern Mainland, Canada

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Summary

Phanerozoic and potentially Proterozoic sedimentary successions within the Interior Platform and Northern Foreland belt of the northern mainland of Canada constitute a hydrocarbon frontier province. This 'northern mainland' area of Canada comprises the northward extension of the prolific Western Canada Sedimentary Basin. Very conservative and preliminary estimates of total resource endowment for the Interior Platform are 7.7 billion barrels and 55.1 Tcf of in-place oil and gas, respectively. High petroleum potential is expected to occur in Cambrian sands in the Colville Hills area, the Kee Scarp fairway near Norman Wells and adjacent to the Presqu'ile Barrier complex in the south of the project area. In Liard Plateau of the Northern Foreland Belt, in-place resource potential for natural gas is 9.7 Tcf. With respect to nation-wide petroleum potential, the northern mainland has a low to moderate rating.

Introduction

The Phanerozoic sedimentary succession of Canada's northern mainland basin is separable into two distinct geological terrane types; the relatively undeformed platform underlying the plains area of Northwest Territories and the deformed fold and thrust belt of the Cordillera in western NWT and Yukon (Fig. 1).

Underlying the Phanerozoic succession throughout most of the northern mainland region is a thick Proterozoic sedimentary succession of unmetamorphosed siliciclastic and carbonate sediments. In the southern part of the Interior Plains, basement consists of Precambrian crystalline igneous and metamorphic rocks comprising the westward extension of the craton beneath Phanerozoic cover.

The most significant discoveries to date in the study area are large gas fields in the Liard Plateau of the northern Foreland Belt, an oil field in the Mackenzie Plain at Norman Wells, and gas discoveries in the Colville Hills of the Interior Platform. New discoveries in the region include a condensate and natural gas find made in 2004 at Summit Creek B-44 and natural gas in 2006 at Stewart D-57; both wells located at the eastern mountain front of the Mackenzie Range in central Mackenzie Valley. Over the past three years, the Geological Survey of Canada has acquired new hydrocarbon systems data, and compiled all previous relevant data in preparation for performing a comprehensive exploration play-based resource assessment.

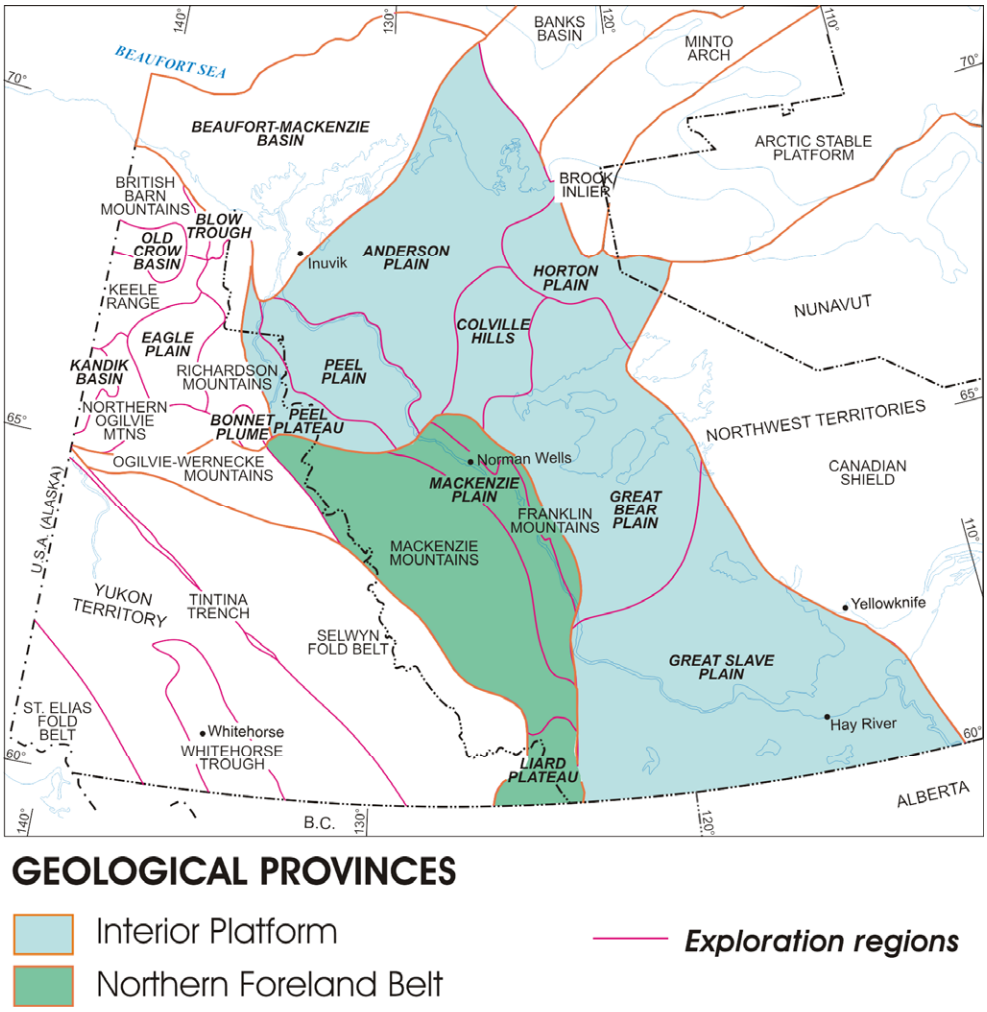

Figure 1: Geological provinces and exploration regions, northern mainland, Canada.

Hydrocarbon Systems in the Interior Platform

Commercial oil and gas discoveries have been made principally in the Great Slave Plain and Colville Hills region indicative of proven oil and gas hydrocarbon systems. Numerous proven and potential source rocks are present throughout the sedimentary succession (Fig. 2).

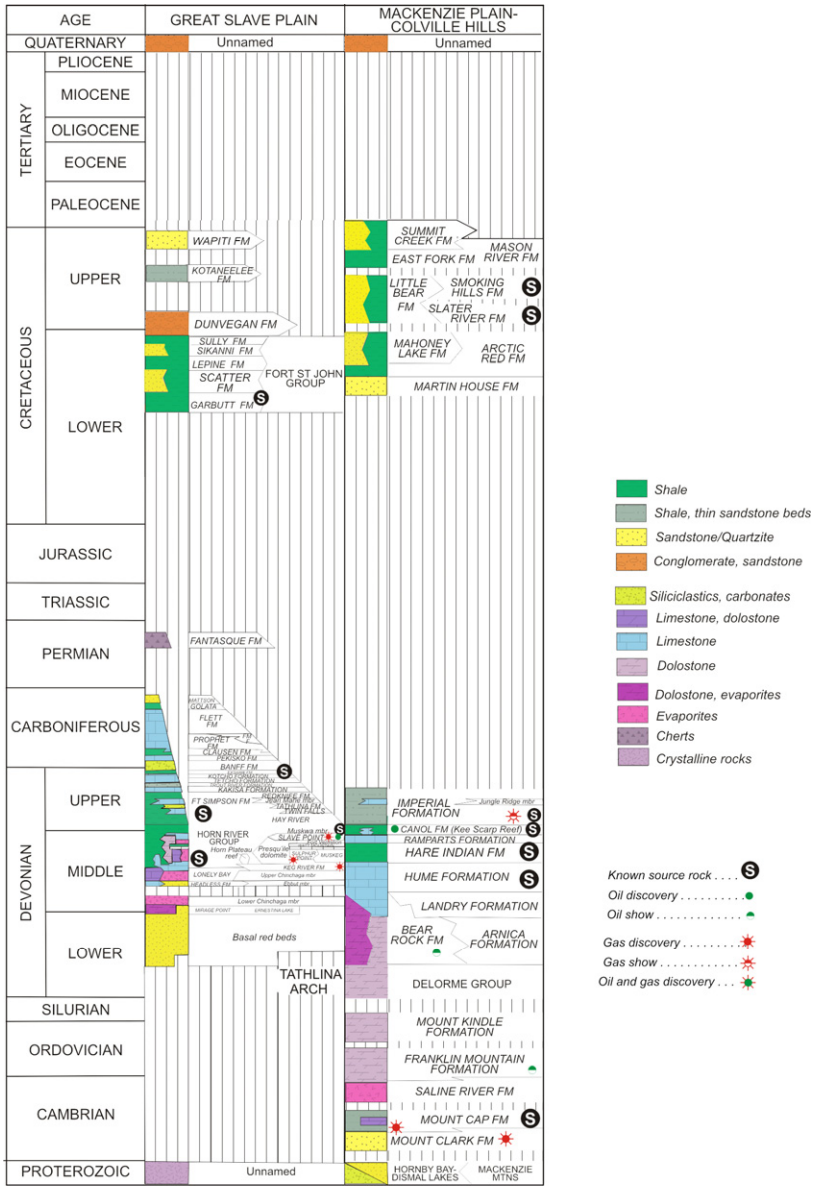

Figure 2: Correlation chart of Phanerozoic strata in the Mackenzie Corridor.

Known source rocks are algal-rich shales in the Cambrian Mount Cap Formation, the Middle Devonian Bluefish member of the Hare Indian Formation, Middle Devonian Horn River and Muskwa formations that are also shale gas targets, the Middle to Upper Devonian Canol shale, the Lower Cretaceous Garbutt Formation in Liard Basin, the Lower Cretaceous Slater River Formation, and oil-prone bituminous shales in the Upper Cretaceous Smoking Hills Formation.

Reservoir rocks are numerous and of high quality throughout the Interior Platform. Proven established reservoir rocks are Devonian reefal and dolomitized carbonate bodies in the Keg River to Slave Point interval along the edge of the Presqu'ile barrier complex, and Keg River, Sulphur Point and Slave Point reservoir-quality carbonate strata in back-barrier carbonate platforms and isolated reefs in shelf basins. Basal Cambrian sandstones host gas pools beneath Colville Hills. Dissolution of cements in quartz arenites has created highly porous and permeable sandstones in part.

Sediment thickness and burial is moderate throughout most of the Interior Platform suggesting potential source rocks are immature to marginally mature. However, the thickness of the succession increases to the west and southwest likely increasing thermal maturity culminating in overmature strata observed in Lower Paleozoic strata beneath Peel Plain and Plateau. Bitumen occurring in Cambrian sandstones at Colville Hills indicates an initial phase of oil generation and migration from adjacent source rock followed by the flushing of gas and condensate (Dixon et al., 2007). Gas in the numerous Devonian occurrences within and adjacent to the Presqu'ile barrier complex beneath Great Slave Plain was likely generated from Lower Paleozoic source rocks such as Muskwa and Horn River to the west. The gas migrated eastward updip through the barrier during Mesozoic-Cenozoic time (Dixon et al., 2007).

Hydrocarbon Systems in the Northern Foreland Belt

The initial recording of oil seeps along the banks of the Mackenzie River by Alexander Mackenzie in 1789 resulted in the first petroleum discovery in Canada's northern mainland at Norman Wells in 1920. The oilfield is estimated to contain about 620 million barrels of in-place oil (Johnson and McMillan, 1993).

Principal source rocks in the Foreland Belt are organic-rich siliceous shales and interbedded limestones within the Horn River Group and black shales of the Middle to Upper Devonian Canol Formation. There are many more potential source rocks throughout the succession (Fig. 2).

Reservoir rocks include the sole producing reservoir, the Middle Devonian Kee Scarp Formation in Mackenzie Plain hosting the Norman Wells oil field. Production occurs at the margin and crest of an atoll-type reef developed on the Ramparts limestone platform. Vuggy and fractured dolostones in Lower Paleozoic Franklin Mountain Formation contain oil at East McKay B-45. Porous sandstones in the Cretaceous Little Bear Formation host a new sweet gas discovery at Stewart D-57. There are numerous potential and proven reservoirs beneath Liard Plateau with fractured hydrothermal coarse-crystalline Manetoe dolomite hosting gas discoveries at Kotaneelee, Beaver River, Pointed Mountain, Bovie Lake, and Liard. Summit Creek B-44 discovered in 2004 hosts gas and condensate in Bear Rock carbonates.

Although data regarding organic maturity is sparse, recent summaries indicate a uniform trend of increasing maturation for Devonian to Cretaceous strata westward from the Interior Platform to the Mackenzie Mountains and Liard Plateau (Stasiuk and Fowler, 2002). Generally, higher stratigraphic levels exhibit lower organic maturation. Bitumen found in Paleozoic reservoirs may have been deposited by eastward migration of oils generated by Road River shales. Oil generation then gave way to gas generation during deeper burial and gas may be trapped in Paleozoic strata beneath impermeable Lower Cretaceous cover.

Conclusions

The Interior Platform in the northern mainland of Canada, a northern extension of the prolific Western Canada Sedimentary Basin, shares several common play characteristics with numerous established exploration plays in northern Alberta and British Columbia. Drilling density and successful exploration outcomes are much reduced in the project area due to access and costs. Natural gas exploration in Liard Plateau has been successful and the region is considered to have high potential. The Kee Scarp reef play hosting Norman Wells has had limited exploratory success. However, the recent discovery at Summit Creek in a structural play is encouraging for future hydrocarbon exploration in the central Foreland Belt.

References

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