

The Mackenzie Corridor Petroleum Province, Northern Mainland of Canada

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Summary

The Mackenzie Corridor, an area through which the proposed Mackenzie Valley gas pipeline would run, comprises the northern extension of the prolific Western Canada Sedimentary Basin. Although exploration has had a long and partially successful history in the region, the province is classified as frontier because of low overall seismic and drilling coverage. The Geological Survey of Canada has recently completed the first major comprehensive exploration play-based petroleum assessment of the region supporting the contention that this is a frontier petroleum province with significant potential.

Introduction

Canada's northern mainland basin is separable into two distinct geological terrains: a relatively undeformed platform area extending across the plains of Northwest Territories (the Interior Platform), and the Cordilleran deformed fold and thrust belt of western Northwest Territories and eastern Yukon (the Northern Foreland Belt). A total of 37 mature, immature and conceptual oil and gas exploration plays were defined and mapped in the study area, extending from south of the provincial-territorial boundary at the 60th parallel, northward to, but not including, the Mackenzie Delta. Sufficient information was available to complete quantitative probabilistic resource analyses for the majority of the 37 conventional plays.

The most significant discoveries to date within the study area are large gas fields in the Liard Plateau of the northern Foreland Belt, the Norman Wells oil field in Mackenzie Plain, and gas discoveries in the Colville Hills of the Interior Platform. Newer discoveries include an oil, condensate and natural gas find made at Summit Creek B-44 in 2004, and a follow-up natural gas discovery at Stewart D-57 in 2005. Both wells are located at the eastern front of the Mackenzie Range in central Mackenzie Valley. Oil was also discovered in Cambrian sands beneath the Colville Hills in 2004 at Lac Maunoir.

Petroleum Systems in the Mackenzie Corridor

A petroleum system is a natural system that includes all the essential geological elements and processes for the occurrence of petroleum accumulations and the oil and gas produced from it. The four essential elements of a petroleum system are source, reservoir, seal and overburden rocks. Essential processes are trap formation and the generation, migration and accumulation of petroleum.

All geological elements and processes of various petroleum systems have been identified and confirmed by the occurrence of numerous discoveries in the Mackenzie Corridor. Potential and proven source and reservoir rocks are found throughout the sedimentary succession. Conventional and

unconventional systems have been identified. The various conventional systems in the region show high quality mature source rocks and porous and permeable reservoirs. Numerous trapping configurations and high-quality seal rocks have been observed. The occurrence of preserved petroleum accumulations indicates, at least in some instances, trap formation preceded the generation, expulsion and migration of petroleum.

The Mackenzie Corridor may also include considerable unconventional oil and gas resources as significant shale gas, liquids-rich gas in shale and shale oil potential are expected in the region. A lower potential is anticipated for tight gas and coal-bed methane.

Example conventional oil and gas play

The Cambrian clastic gas play in the Interior Platform has proved successful in the Colville Hills area and is therefore an 'established immature play'. Four gas discoveries have been made in the Mount Clark Formation: Tedji Lake, Tweed Lake, Bele, and Nogha. A fifth Cambrian discovery was a small gas find in the Mount Cap Formation at Tweed Lake. Numerous additional wells have yielded gas during DSTs. A possible gas source may lie within the underlying Proterozoic sediments. The Cambrian reservoir is also an oil play, for an oil-prone source rock has been identified in algal-rich shales within the Mount Cap Formation and oil was discovered in 2004 in Cambrian clastics at Lac Maunoir C-34 (Price and Enachescu, 2009). Top and lateral seals for the play are considered to be of excellent quality due to the presence of thick evaporites in the overlying Saline River Formation and Mount Cap Formation shales. Trapping styles include flower structures, roll-over anticlines in grabens, stratigraphic pinchouts and onlap traps against basement highs. Principal exploration risks are adequate reservoir, source, and communication with source rocks at the prospect-level.

The largest predicted gas pool has a median volume of 646 Bcf. In this analysis, the size of the Mount Clark discovery at Tweed Lake matches the second largest pool, Nogha the 5th largest, and Bele the 10th. According to this prediction, therefore, one gas pool, larger than the largest accumulation found to date (Tweed Lake), remains to be found in this play. The mean prediction for the total number of pools in the play is 105. Potential for the Cambrian siliciclastic gas play ranges from 2.9 to 22.6 Tcf with a mean volume of 10.8 Tcf.

The oil play has an estimated in-place potential range of 96 to 2531 million barrels (P95-P5), with a mean volume of 952 million barrels. The mean value of the number of predicted pools is 15. The largest undiscovered pool is expected to contain 178 million barrels (median value).

Conclusions

Sufficient data was available for the majority of the 37 defined plays for a quantitative assessment to be made of their oil and gas endowment. This major study provides important information for stakeholders in the proposed Mackenzie Valley natural gas pipeline with respect to petroleum potential adjacent or proximal to its proposed route.

The report presents sufficient data in the form of overlapping play polygons for GIS spatial analyses of petroleum richness factors (BOE/km²) and thus, petroleum prospectivity over the entire study area.

Areas of very high to high prospectivity of the Interior Province lie in southwestern Great Slave Plain and along the northern fore-reef margin of the Presqu'île Barrier Complex. High to moderate

prospectivity is predicted for the northern and central Great Slave Plain, western Great Bear Plain south and southwest of Great Bear Lake, Colville Hills, and Peel Plain exploration regions.

Areas of very high to high prospectivity in the Foreland Belt include Liard Plateau and the immediate vicinity of Norman Wells in Mackenzie Plain. The prospectivity of the remainder of Mackenzie Plain is considered to be moderate.

References

Price, P.R. and Enachescu, M.E., 2009, The Maunoir oil discovery-a Cambrian clastic oil discovery within the Sahtu Settlement Region of the central Mackenzie valley, NWT: in, 37th Annual Yellowknife Geoscience Forum, Abstracts of Talks and Posters, V. Jackson and E. Palmer (comps.); Northwest Territories Geoscience Office, p. 52-53.