

GSC Hydrocarbon Studies in the Central Mackenzie Mountains, NWT: Source Rocks, Reservoir Facies, and Thermal Maturity

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Introduction

As part of its Secure Canadian Energy Supply Program, the Geological Survey of Canada has studied the petroleum potential of the central Mackenzie Mountains, NWT. Most previous workers have considered this region to present poor hydrocarbon potential (e.g., Gabrielse et al., 1973; Morrow, 1991) or have focused on the possibility of a regional-scale “Plateau Overthrust” (Plateau Fault) gas play (Cecile et al., 1982). The present work focused on assessing the hydrocarbon potential of the Plateau Fault and concluded that it is unlikely to be a large-scale play (MacNaughton et al., 2008). However, data gathered during that work suggest there may be potential for smaller, high-risk exploration targets in the region.

Source Rocks and Reservoir Facies

Proterozoic strata in the central Mackenzie Mountains are considered to be non-prospective for hydrocarbons. No source rocks have been identified within these strata and limited thermal-maturity data point to overmaturity with respect to hydrocarbon generation and preservation. The same is true of basal Cambrian siliciclastic formations.

Cambrian to Devonian strata comprise two regional-scale packages. These are demarcated by the paleo-shelf edge of the Mackenzie Platform, which runs roughly southeast-northwest across NTS map areas 95L, 105P, 106A, and 106B. Northeast of this boundary, the Mackenzie Platform succession is dominated by platform carbonate. Notably porous strata have been recorded within the Ordovician-Silurian Whittaker and Mount Kindle formations, and at the level of the Devonian Arnica and Landry formations, particularly where these latter units are affected by Manetoe facies dolomitization or development of solution-collapse

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breccia (Bear Rock Formation). No source rocks are known within the Mackenzie Platform succession but local pyrobitumin staining points to petroleum migration during the succession's history. Southwest of the paleo-shelf edge, the Selwyn Basin succession is dominated by fine-grained, siliciclastic strata of the Road River Group. These strata are post-mature with respect to oil generation but yield values of up to 8% TOC (Total Organic Carbon). Road River Group thus may contain potential source rocks. Some carbonate-dominated intervals southwest of the paleo-shelf edge preserve porosity and may be potential reservoirs.

Upper Devonian siliciclastic strata (the "turbidite basin" of Gordey and Anderson, 1992) are the youngest widely preserved strata in the study area. This interval contains the Hare Indian and Canol formations, both of which are shale dominated, locally organic rich, and may have potential as source rocks. The overlying Imperial Formation is also shale-dominated, with some sandstone-bearing intervals. North of the study area, sandstones in the upper Imperial Formation can be porous and have potential as reservoirs, but the presence of these beds in the central Mackenzie Mountains has not been demonstrated.

Thermal Maturity

Thermal maturity in the central Mackenzie Mountains has been constrained using colour-alteration data for microfossils, relying mainly on data archived in GSC Paleontological Reports. The isotherm that separates dry-gas-prone strata from overmature strata is irregular but across much of the study area it lies at a high angle to the structural grain and the paleo-shelf edge. As a result, it extends well into Selwyn Basin in northern 105P and 105O. Those regions, as well as most of 95M and the map areas to the north, are thus permissive of gas to dry-gas generation and preservation. This includes areas underlain by potential source rocks of the Road River Group, Upper Devonian siliciclastic strata, or both. In such regions, the major limiting factor on hydrocarbon accumulation is probably the scale of structures available for trap formation. In the absence of a large-scale Plateau Fault play, traps are likely small and exploration is likely to be a high-risk undertaking.

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