GSC Hydrocarbon Studies in the Central Mackenzie Mountains, NWT: Structural Assessment and Implications for Trap Development

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Introduction

During recent collaborative mapping by the GSC and the Northwest Territories Geoscience Office in the central Mackenzie Mountains, NWT, the Plateau Fault and its environs were remapped. The resulting reinterpretation of the Plateau Fault has implications for understanding the region's structural style and hydrocarbon potential.

Evidence

In the central Mackenzie Mountains, structural styles can be subdivided into two domains: a northeastern, fold-dominated domain and a southwestern, fault-dominated domain. Within the northeastern domain, broad, open, long-wavelength (8-12 km) folds predominate. Anticlines are cored by competent quartzite of the Proterozoic Katherine Group and are detached within shale and siltstone of the underlying Tsezotene Formation. Superimposed on the long-wavelength folds are shorter-wavelength (1 km) folds in Middle Devonian Nahanni Formation, most likely detached within shaley carbonate of the underlying Headless Formation. Locally, these folds are modified on one or both limbs by reverse or thrust faults with estimated displacements of less than 2 km. In the southwestern domain, faulting is more pervasive and long-wavelength folds are absent.

The transition between the two domains is marked by thrust faults that trend northwestward across Wrigley Lake (NTS 95M) and Mount Eduni (NTS 106A) map areas. Proterozoic strata in the hanging-walls of these faults have been thrust northeastward over folded Paleozoic strata. Due to its large stratigraphic separation and its long strike length, the Plateau Fault is the most notable of the faults within the transition zone.

Stratigraphic repetition across splays and anastomosing fault traces in the transition zone indicate greater displacements (5-15 km) than those recorded to the northeast. These displacements are significantly less than the 35 km estimate suggested by Cecile et al. (1982) for the Plateau Fault within the study area, but greater than the 2-6 km displacement estimate of Gordey (1981).

Structural overlap between Proterozoic strata in the hanging-wall and potential Paleozoic reservoir units in the footwall is constrained also by stratigraphic relationships. The identification of Windermere Supergroup strata in the footwall, combined with westward thickening of the Proterozoic succession from footwall to hanging-wall, greatly limits the area of the footwall in which Paleozoic strata may be preserved. Paleozoic reservoir units likely are preserved only in a narrow band (up to 4 km wide) along the leading edge of the fault, where they are folded and truncated against it.

The Gypsum and Rusty shale formations of the Proterozoic Little Dal Group lie directly above the fault surface of the Plateau Fault. The fault is detached at this stratigraphic level for a significant distance across strike. Similar faults in the region are detached at the same level or within the shaley strata of the Tsezotene Formation. Low-permeability strata at these two detachment levels may be a seal to any hydrocarbons trapped below the faults.

To trap hydrocarbons along the fault, structural complications are required to juxtapose Early Devonian and older porous facies against organic-rich shale of the Middle Devonian Canol Formation. This may be accomplished via buried fault repeats or overturned folds within the Paleozoic succession. Both geometries have been observed along the trace of the Plateau and similar faults, and may be buried along faults in the transition zone between the fold-dominated and fault-dominated domains. This would apply in particular to some segments of the Plateau Fault, or smaller thrust faults immediately to the east of it, where low-permeability Proterozoic strata have been emplaced upon Middle to Upper Devonian siliciclastic formations.

Conclusions

The Plateau Fault lies within a transition zone from fold-dominated to fault-dominated structures within the central Mackenzie Mountains. The Plateau Fault is a thrust, but revised shortening estimates are intermediate between previous estimates (Cecile et al., 1982, and Gordey, 1981). By implication, the “Plateau Overthrust” conceptual play model greatly overestimates the petroleum potential of the Plateau Fault but the potential for small plays along the fault remains.

Other faults in the transition zone have similar characteristics to the Plateau Fault. By analogy these faults also have a limited, high-risk potential for hydrocarbon trapping in their footwalls.

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References

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