

New Insights into Ordovician Oil Shales, Southampton Island, Nunavut

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Summary / Introduction

Southampton Island, part of Kivalliq Region, Nunavut, preserves the northern margin of Hudson Bay Basin, one of the largest Paleozoic sedimentary basins in Canada. Occurrences of Lower Paleozoic oil shales on Southampton Island have been known for more than 40 years, although there has been considerable debate on the number of oil shale intervals and their stratigraphic positions. To address these uncertainties and develop new insights into the hydrocarbon potential of the basin, a field-based project in 2007 was conducted to determine the number, stratigraphic positions, yield and maturity of the oil shales on the island.

The Upper Ordovician on Southampton Island is divided, in ascending sequence, into the Bad Cache Rapids Group, Churchill River Group and Red Head Rapids Formation; these consist mainly of carbonate and minor amounts of shale. Within this sequence, two of the oil shale intervals were informally named “Boas River shale” (Sanford in Heywood and Sanford, 1976) and “Sixteen Mile Brook shale” (Nelson, 1981) (Fig. 1).

Scientific Outcomes

In 2007, three oil shale intervals were discovered in the lower Red Head Rapids Formation, in spectacular outcrops in the Cape Donovan area, eastern Southampton Island (Fig. 1 and Fig. 2). The Cape Donovan sections not only confirm the number of oil shale intervals within the Paleozoic sequence on Southampton Island, but also provide lithostratigraphic and biostratigraphic evidence to relocate the positions of “Boas River shale” and “Sixteen Mile Brook shale” discovered forty years ago. The first (lower) oil shale interval at the Cape

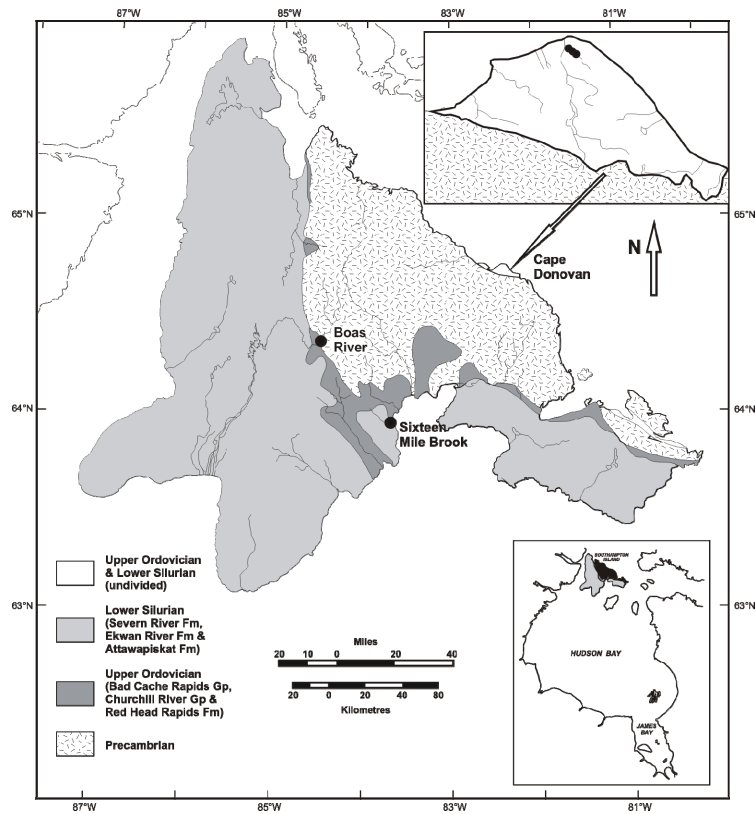


Figure 1: Simplified geological map of Southampton Island from Sanford (1976) with oil shale localities

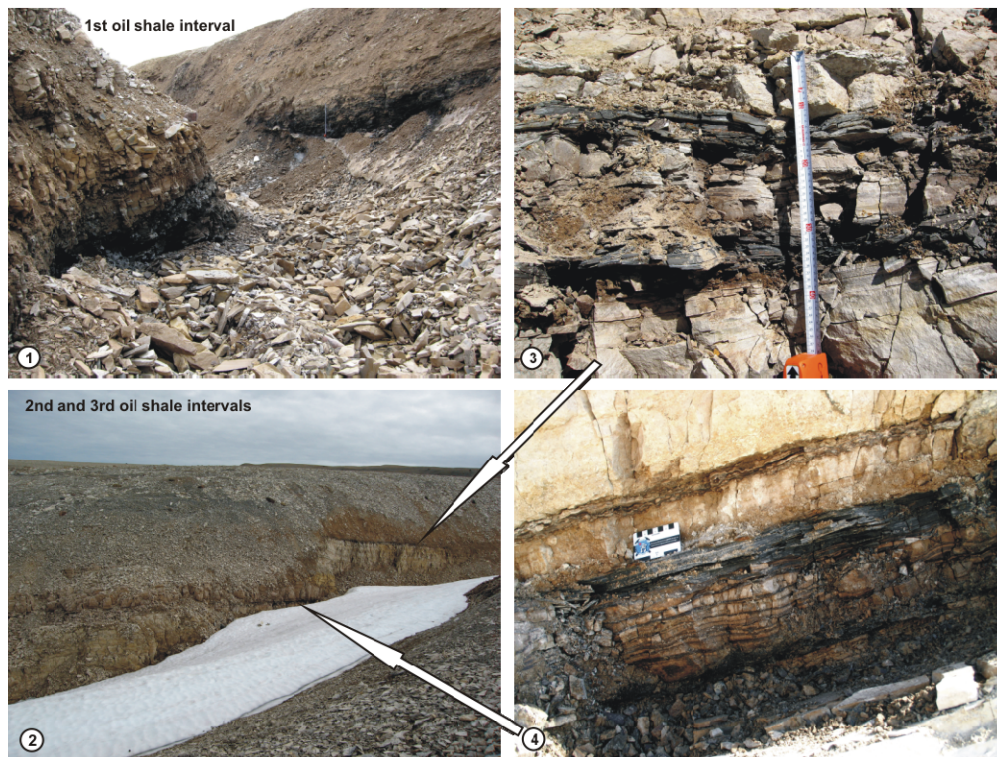


Figure 2: Three oil shale intervals found in Cape Donovan area, eastern Southampton Island

Donovan section can be related to the “Boas River shale”, whereas the second (middle) or third (upper) oil shale interval may be equivalent to the “Sixteen Mile Brook shale”. Therefore, work in 2007 demonstrates that both “Boas River shale” and “Sixteen Mile Brook shale” are within lower Red Head Rapids Formation, Upper Ordovician, but are not, as previous models suggested (e.g., Sanford in Heywood and Sanford, 1976; Neilson, 1981), positioned between the Bad Cache Rapids and Churchill River groups or on the top of Churchill River Group.

Hydrocarbon Exploration Potential

Forty samples were collected from three oil shale intervals in the Cape Donovan area for Rock Eval Pyrolysis. The preliminary data show:

- The shales from the three intervals contain Type I / II kerogen.
- 21 samples from the first (lower) oil shale interval (~ 1-m-thick, dark brown - black argillaceous limestone inter-bedded with black shale) have average and optimum yields of 58.5 kg/tonne and 112.5 kg/tonne, and average and optimum TOC of 9.8% and 17.3%.
- 8 samples from the second (middle) oil shale interval (~ 40-cm-thick, black shale having interbeds of argillaceous limestone) have mean and highest yields of 145.9 kg/tonne and 216.1 kg/tonne, and mean and highest TOC of 22.4% and 34.1%.
- 11 samples from the third (upper) oil shale interval (~ 40-45-cm-thick, black shale having interbeds of argillaceous limestone) have intermediate and greatest yields of 128.7 kg/tonne and 230.3 kg/tonne, and intermediate and greatest TOC of 18.3% and 31%.

Conclusions

- Three oil shale intervals within the Paleozoic sequence on Southampton Island are confirmed.
- The precise stratigraphic position of the oil shale intervals is established; they are within the lower Red Head Rapids Formation, Upper Ordovician.
- “Boas Rover shale” and “Sixteen Mile Brook shale” are correlated with the Cape Donovan first (lower) and second/third (middle/upper) oil shale intervals, respectively.
- The extremely high yields in the three oil shale intervals are identified.

The new insights, combined with the data from an ongoing study of Hudson Bay Basin, demonstrating that Lower Paleozoic rocks in the deeper parts of Hudson Bay Basin may have been buried to just within the petroleum generation window (Zhang et al., 2007), shed new light on the hydrocarbon prospectivity of Hudson Bay Basin.

Acknowledgements

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