Regional Characterization of Shale Gas and Shale Oil Potential, Northwest Territories, Canada

Brad J. Hayes

Search and Discovery Article #10426 (2012)

Posted July 23, 2012

*Adapted from poster presentation at AAPG Annual Convention and Exhibition, Long Beach, California, April 22-25, 2012

**AAPG©2012 Serial rights given by author. For all other rights contact author directly.

1Petrel Robertson Consulting Ltd., Calgary, AB, Canada (bhayes@petrelrob.com)

Abstract

Unconventional gas and oil plays, particularly those hosted by shales, demonstrate great resource potential and productive capacity in petroleum basins throughout North America. Where there is abundant conventional production and drilling, companies use existing wellbore and analytical data to identify and appraise shale gas and shale oil plays. Confirming resource potential and commercial producibility requires extensive analysis of these data, followed by field experiments to optimize drilling and completion procedures.

In more remote areas, such as the Northwest Territories, exploration and assessment work to date has focused almost exclusively on conventional reservoirs and petroleum systems. While it is apparent that NWT shales equivalent to producing or prospective shales in Alberta and B.C. must contain shale gas and oil, systematic efforts to quantify these resources are just beginning. Work proposal bids of more than $534 million on 11 parcels in the Central Mackenzie Valley, made by major operating companies in June 2011, indicate a high level of industry interest in shale prospectivity.

Petrel Robertson Consulting Ltd. and the Northwest Territories Geoscience Office have recently completed a study to systematically assess, at a regional level, shale gas and oil potential in the NWT. Analytical work and production information from equivalent shales in other areas, particularly in adjacent northeastern B.C., provide valuable insights in support of this analysis. Two study areas, based on stratigraphy and well control density, are defined: the southern Liard - Great Slave Study Area, and the northern Peel - Mackenzie Study Area. In Liard - Great Slave, good shale gas and oil potential is seen in the Devonian Muskwa-Horn River, Devonian/Mississippian Exshaw Formation, and Cretaceous Fort St. John Group. Other thick shales, such as the Fort Simpson, Kotcho, and Banff, do not contain sufficient organic material to present attractive targets. In Peel - Mackenzie, the Devonian Horn River Group and parts of the Cretaceous Slater River Formation are prospective for shale gas and oil, while the Imperial and Arctic Red shales are organic-lean, and thus less prospective.
Devonian Horn River shales are highly prospective for gas and liquids, and are currently being developed for oil production. Exploitation of these shales is being explored in the adjacent Carbonate Platform.

North-south-stratigraphic cross-section JJ-JJ shows thick Horn River shales (thickly-purplish colors) in the northern Liard basin passing southward into thin limestone intervals of the Slave Point Formation. Artic, organic-rich shales yield the Blackstone horizon, which may be better than the shallower above the Slave Point carbonates. Horn River strata are capped by thick, basin-filling shales of the Fort Simpson Formation in the Liard Basin.

SUMMARY LIARD – GREAT SLAVE AREA

BRIEF PROSPECTIVITY

WOODS PROSPECTIVITY

Ft St. John

• Moderate TOC – higher TOC in marginal calcrites in updip bounding faults

• Thickness – variable, but generally thick, from the Slave Point to the Fort Simpson

• Organic-rich shales in basin fill; no organic-rich intervals

• Maturity – dry gas to southwest; liquids-rich in the central and eastern areas

ULTRA-THIN STRATIGRAPHIC CROSS-SECTION JJ-JJ

Horn River shales are thin (less than 25m) in northern Liard Great Slave Basin area, but thicken to the southwest, where they are 200m + in the central and eastern areas. The Horn River thinning to the northwest is controlled by the subsidence rate and the thickness of the overlying younger carbonate and clastic sediments. The Horn River is thickest north of the Slave Point carbonate platform.

GROSS THICKNESS

Horn River shales are thickest (less than 25m) in the northern Liard Great Slave Basin area and transition to thin (less than 25m) in the southern Liard Great Slave Basin area. They are thickest (up to 105m) in the central and eastern areas.

DEPTHS TO FORMATION

Horn River shales are thickest in the northern Liard Great Slave Basin area, where they are up to 200m thick. The thickness decreases to the southeast, where they are thinner (up to 50m) in the central and eastern areas.

TOTAL ORGANIC CARBON (TOC)

TOC values are measured from core samples collected in well sites. There are relatively high values in the central and eastern areas, where the Horn River is thickest. Lower values in more basinward areas to the east are indicative of lower TOC. Some of the thinner sections have anomalously lower TOC values.

TMAX

TMAX indicates the presence of mature rocks. TMAX is the temperature at which the organic material has reached its maximum value. Higher TMAX values indicate that the organic material is more mature and has reached a higher level of hydrocarbon generation.
HORN RIVER PALEOGEOGRAPHY

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. This regional stratigraphy is best illustrated by the Horn River Formation, which is composed of Middle Devonian to Lower Carboniferous sediments. The Horn River Formation is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

HORN RIVER STRATIGRAPHIC COLUMN

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

SUMMARY

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

TOTAL ORGANIC CARBON (TOC)

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

POOR PROSPECTIVITY

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

MEDIUM PROSPECTIVITY

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.

GOOD PROSPECTIVITY

The Horn River section contains a thick, carbonate-dominated Paleozoic section, truncated beneath a pre-Cretaceous unconformity. The section is divided into two main members: the Plodden Member and the Imperial Member. The Plodden Member is characterized by thick, organic-rich shales, while the Imperial Member is dominated by carbonate sediments. The Horn River Formation is capped by the Fort Simpson Formation, which is a thick, basin-filling shale unit.
Regional Characterization of Shale Gas and Shale Oil Potential, Northwest Territories, Canada

Brad J. Hayes
Petrel Robertson Consulting Ltd.
Calgary, Alberta, Canada

Introduction

Unconventional gas and oil plays, particularly those hosted by shales, demonstrate great resource potential and productive capacity in petroleum basins throughout North America. Where there is abundant conventional production and drilling, companies use existing wellbore and analytical data to identify and appraise shale gas and shale oil plays. Confirming resource potential and commercial producibility requires extensive analysis of these data, followed by field experiments to optimize drilling and completion procedures.

In more remote areas, such as the Northwest Territories, exploration and assessment work to date has focused almost exclusively on conventional reservoirs and petroleum systems. While it is apparent that NWT shales equivalent to producing or prospective shales in Alberta and B.C. must contain shale gas and oil, systematic efforts to quantify these resources are just beginning. Work proposal bids of more than $534 million on 11 parcels in the Central Mackenzie Valley, made in June 2011, indicate a high level of industry interest in shale prospectivity.

Petrel Robertson Consulting Ltd. and the Northwest Territories Geoscience Office have recently completed a study to systematically assess, at a very regional level, shale gas and oil potential in the NWT. Analytical work and production information from equivalent shales in other areas, particularly in adjacent northeastern B.C., provide valuable insights in support of this analysis. Two study areas, based on stratigraphy and well control density, are defined: the southern Liard – Great Slave Study Area, and the northern Peel – Mackenzie Study Area. In Liard – Great Slave, the best shale gas and oil potential is seen in the Devonian Muskwa-Horn River, Devonian/Mississippian Exshaw Formation, and Cretaceous Fort St. John Group. Other thick shales, such as the Fort Simpson and Banff, do not contain sufficient organic material to present attractive targets. In Peel – Mackenzie, the Devonian Horn River Group and parts of the Cretaceous Slater River Formation are prospective for shale gas and oil, while the Imperial and Arctic Red shales are less prospective.

This poster focuses on the most prospective shale unit – the Devonian Horn River Formation, which is equivalent to the producing shales of the Horn River Basin in adjacent northeastern British Columbia.

Study Areas

Two study areas, based on stratigraphy and well control density, are defined: the southern Liard – Great Slave Study Area, and the northern Peel – Mackenzie Study Area. Each spans a number of exploration regions (labelled on the map), which reflect both subsurface geology and surface geographic features. For the Liard – Great Slave study area, regional cross-section JJ-JJ’ has been selected to illustrate subsurface stratigraphy, while cross-section SS-SS’ illustrates subsurface stratigraphy for Peel-Mackenzie.
Exploration in Northwest Territories is constrained by remote access, lack of infrastructure, and the limited (although substantial) size of conventional prospects. The enormous unconventional oil and gas resources of the Horn River shales have proven to be a “game-changer”, however, and several companies are actively prospecting. In June 2011, five companies posted work proposal bids totaling more than $534 million on 11 parcels of land covering almost 900,000 ha (2.22 million acres). Husky Energy, ConocoPhillips, and MGM Energy have all announced programs focused on oil potential from Horn River shales. Two additional parcels, totalling more than 154,000 ha (381,000 acres) have been posted for disposition in mid-2012. Additional lands may be posted in the future, depending upon strategic consultations with First Nations in the area.

CURRENT EXPLORATION STATUS

In 2011, five companies posted work proposal bids totaling more than $534 million on 11 parcels of land covering almost 900,000 ha (2.22 million acres). Husky Energy, ConocoPhillips, and MGM Energy have all announced programs focused on oil potential from Horn River shales. Two additional parcels, totalling more than 154,000 ha (381,000 acres) have been posted for disposition in mid-2012. Additional lands may be posted in the future, depending upon strategic consultations with First Nations in the area.

ACKNOWLEDGEMENTS

Adrienne Jones of Northwest Territories Geoscience Office initiated this study and provided valuable guidance throughout. Fil Ferr of the British Columbia Ministry of Energy and Mines, and Leanne Pyle of V.I. Geoscience Services Ltd. reviewed and suggested improvements to the report. Staff at PRCL provided research, data compilation, and drafting assistance. Project funding was provided by the Program of Energy Research and Development (PERD), under the direction of the Office of Energy Research and Development, Natural Resources Canada.

REFERENCES


