

An Overview of Shale Gas Potential in Northeastern British Columbia

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Numerous stratigraphic horizons and play areas in northeastern British Columbia have excellent potential for shale gas development. Focus in recent years has been on the Triassic Upper Montney and the Devonian Muskwa formations. Approximately 90% of the \$2.66 billion, acquired in British Columbia land sale bonuses in 2008, can be attributed to the Montney play area and the Devonian Horn River Basin. The Montney play region accounted for approximately 49% of the 2008 bonuses and 41% were from the Horn River Basin. Over the two year period from 2006 to 2008, total PNG sales in the Montney play area increased six fold, from \$218 million to \$1.32 billion. Likewise, in the Horn River Basin sales increased more than eight fold over this period, from \$126 million in 2006 to almost \$1.1 billion in 2008.

The Montney Formation is estimated to hold several hundred trillion cubic feet (Tcf) of original gas-in-place (Walsh et al., 2006) and is considered by many to be the most significant unconventional gas resource play in North America (Canadian Discovery Digest, 2008a). The gas potential of the Devonian shales of the Horn River Basin is less well understood due to relatively little drilling data, but original gas-in-place estimates in excess of 350 Tcf have been made (Canadian Discovery Digest, 2008b). In this paper, the geology of these plays and other prospective shale targets will be reviewed (Figure 1).

Most shale gas exploration activity in British Columbia has been in the Horn River Basin and Cordova Embayment (north of Fort Nelson) and in the Upper Montney play region (west of Fort St. John and Dawson Creek). The Montney is a hybrid gas play that grades from a tight siltstone in the east to shale in the west. Industry interest in these plays is illustrated by the sale of petroleum and natural gas (PNG) rights in recent years. PNG sales in the Montney play area dramatically increased from \$218 million in 2006 to \$526 million in 2007 and \$1.32 billion in 2008. The average price per hectare in the same period increased from \$1,163 to \$10,890. Likewise in the Horn River Basin, PNG sales increased from \$126 million in 2006 to \$359 million in 2007 and \$1.1 billion in 2008. The average price per hectare increased from \$1,271 in 2006 to \$3,897 in 2008. These dramatic increases in the value of PNG rights per hectare are mainly due to shale gas.

PROSPECTIVE HORIZONS

	Formations	Description	Depth	Average Thickness	Total Organic Carbon	Gas in Place
LOWER CRETACEOUS	Wilrich and Buckingham shales	Potential interbedded sand/siltstone	800 to 1,200 metres	100 metres	2.3%	60 Bcf per section
JURASSIC	Nordeg and Fernie shales	Recognized source rocks	1,200 to 2,500 metres	Up to 30 m organic rich section	up to 14%	>20 Bcf per section
TRIASSIC	Doig, Doig Phosphate and Montney	Montney turbidites may increase permeability Phosphate units have high TOC and are excellent source rocks	1,200 to 3,000 metres	300 to 500 metres	0.5 to >10%	10 to 110 Bcf per section
DEVONIAN	Exshaw, Besa River, Fort Simpson and Muskwa	Exshaw and Muskwa are widely distributed organic shales Fort Simpson and Besa River are thick basin-filling shales	1,800 to 3,500 metres	Huge thicknesses are common with some high TOC intervals	0.5 to >10%	10 to 100 Bcf per section

GEOLOGIC ANALOGUE

MISSISSIPPIAN	Barnett Shale (Fort Worth Basin)	Marine-shelf deposit	2,000 to 2,500 metres	100 metres	4.5%	140 Bcf per section
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Figure 1: Selected geological characteristics of prospective shale gas horizons in northeast British Columbia and comparison with the Mississippian Barnett shale in Texas.

While shale is abundant throughout northeastern British Columbia, information on the geology and gas potential of the shales is limited. Consequently, much shale gas exploration in the province has been approved for experimental scheme status, allowing for an extended confidentiality period of three years. Interest by numerous companies in the shale gas potential of the province continues to mount with testing of several units ongoing. The main formations of interest include the Devonian Muskwa and Evie shales in the Horn River Basin and Cordova Embayment, the Lower Mississippian and Upper Devonian Besa River, Exshaw, and Fort Simpson shales, the Triassic Doig play at Groundbirch and the Upper Montney play in the Swan, Bisette and Dawson areas.

Devonian shale units are widespread in northeast British Columbia, covering approximately 80,000 square kilometres. Organic rich units within the Exshaw, Muskwa and Evie formations are the main targets of experimental schemes and exploration activity in the Horn River Basin and Cordova Embayment. An assessment of the Devonian shale gas potential in northeastern British Columbia focused on the organic

content, thermal maturity, sorption capacity and clay mineralogy of the Exshaw, Besa River, Fort Simpson and Muskwa formations (CBM Solutions, 2005). Areas of interest included parts of the Liard Plateau and Basin and Prophet Trough in northeastern BC, and western extensions of the Peace River Arch/ Embayment in eastern central BC. The Exshaw Formation is a widely distributed, organic rich, shale up to about 86 m thick. The richest organic interval is 2-10 metres thick with maximum total organic carbon (TOC) content of 6% by weight. The Muskwa Formation is up to 75 m thick with TOC up to 5.9% and an average of 3.1%. Low TOC values are characteristic of the transition zone from the underlying Otter Park and Slave Point formations and into the overlying Fort Simpson Formation. The Besa River Formation is up to 1600 m thick with individual organic rich sections up to 30 m thick and a maximum TOC of 8.8%. The Ft Simpson shale is a thick (up to 800 m) but organic lean unit.

The Triassic Upper Montney Formation is currently producing from a number of pools in northeast British Columbia. The details of the play are presented by Walsh et al. (2006). The Triassic Doig and Montney formations extend over seven million hectares of northeast British Columbia, are up to 500 metres thick and are found at depths of 400 to over 4400 metres. The main play area covers approximately 1 million hectares (2.5 million acres) in the Ft St John – Dawson Creek region. Both the Montney and Doig formations contain significant quantities of organic carbon that is concentrated in phosphatic shale tens of metres thick or dispersed in low concentration within shale several hundreds of metres thick. The Upper Montney, in particular, has seen exceptional growth in production in recent years. Producing fields include the Swan, Dawson, Saturn and Monias. The Upper Montney play area is limited by depth, shallowing to the northeast and deepening to the southwest. Walsh et al. (2006) provided original gas-in-place estimates 30-200 Tcf for the Upper Montney, 50-500 Tcf for the Lower Montney, 40-200 Tcf for the Doig Formation and approximately 70 Tcf for the organic rich Doig Phosphate unit. Walsh et al. (2006) cautioned that gas-in-place estimates must be taken in context and can not be compared directly with estimates for conventional plays as critical reservoir characteristics are poorly understood.

Other shale formations of interest in northeast British Columbia include the organic rich (up to 12% TOC) Jurassic Gordondale (Nordegg) shale and shallow widespread marine Cretaceous shales of the Fort St John Group (the Harmon/Wilrich/Buckinghamhorse shales).

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