Saskatchewan Ministry of Energy and Resources

PROSPECT SASKATCHEWAN

Natural Gas in Coal

Exploring New Energy Sources

INTRODUCTION

Demand for natural gas is projected to have the highest growth among all fossil fuels. At the same time, conventional gas sources are becoming increasingly difficult to find. As natural gas is an important commodity for Saskatchewan, the province is assessing the economic potential of developing non-conventional gas sources like Natural Gas in Coal (NGC, also known as Coal Bed Methane). In 2003, Saskatchewan Industry and Resources (SIR) initiated a series of preliminary assessments focused on mapping the geographic distribution of coals in the Upper Cretaceous Belly River Formation and Lower Cretaceous Mannville Group. This issue summarizes geological work done to date. The petrophysical characteristics of the Belly River and Mannville coals in Saskatchewan are, as yet, poorly understood so NGC-production capabilities for Saskatchewan coals are currently uncertain. The increasing demand and price of natural gas are motivating industry to examine the potential of NGC in Saskatchewan's coal-bearing strata.

COALS IN SASKATCHEWAN

There are three main coal-bearing units in Saskatchewan: the Tertiary Ravenscrag Formation, the Upper Cretaceous Belly River Formation, and the Lower Cretaceous Mannville Group (Figure 1). Both the Mannville Group and the Belly River Formation in Saskatchewan are successions of sandstones, shales, and coals intercalated with and encased in marine shales. Each of these intervals contains numerous coal seams having ranks primarily in the sub-bituminous A to sub-bituminous C range.

Coals of the Ravenscrag Formation are mined at surface in southeastern Saskatchewan and rarely exceed depths of 150 m. The lignite coal in the Ravenscrag is currently not considered a viable target for production of NGC.

This is the third in a series of informational brochures released by the Petroleum Geology Branch of Saskatchewan Ministry of Energy and Resources. These brochures are intended to highlight prospective areas in the province as identified by staff geologists. It is hoped these will be useful introductions to regions and concepts for explorationists to further develop the oil and natural gas resources of Saskatchewan. To receive additional copies or new releases, please email Dan Kohlruss at dan.kohlruss@gov.sk.ca.

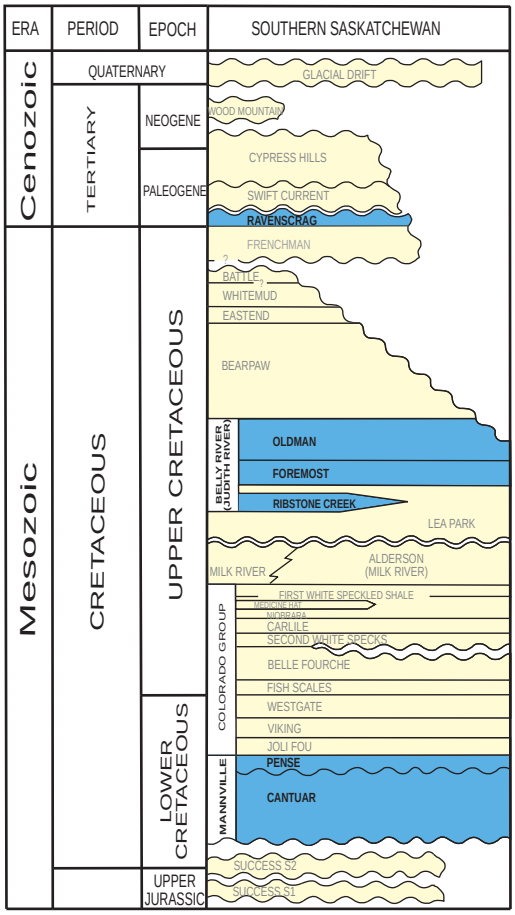


Figure 1 - Stratigraphy of southern Saskatchewan; coal-bearing strata are shown in blue.

BELLY RIVER COALS

The Upper Cretaceous Belly River Formation of southwestern Saskatchewan contains numerous coal seams that have potential for the production of NGC. The Belly River Formation is an eastward-thinning wedge of clastics that is present primarily within the western half of the province (McLean, 1971). Initial investigation of the Belly River Formation in southwest Saskatchewan identified coals in an area south of T15 and west of R20W3, with seams mainly concentrated in the upper part of the formation. Coals in the Belly River are deepest, at around 550 m, along an east-west trend within T7, 8, and 9 (Figure 2).

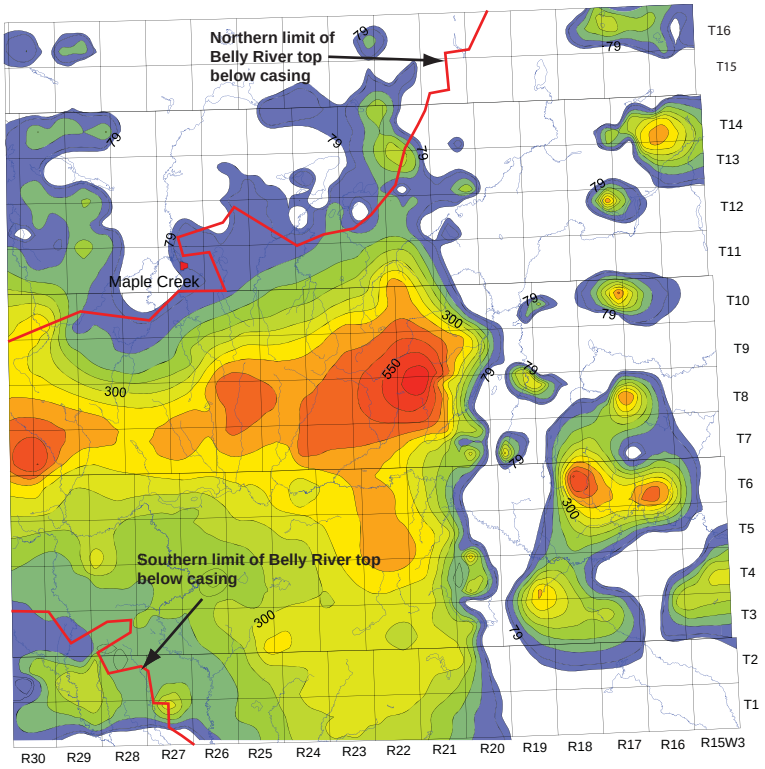


Figure 2 - Isopach map of interval from KB to top of uppermost identified Belly River coal; contour interval 50 m (from Frank, 2005).

In the northwest and southwest corners of the Figure 2 map, it is possible that the shallowest coal seams are hidden behind surface casing and, therefore, cannot be identified. Within the main southwestern coal-bearing area, up to 20 coal seams are present, ranging in thickness from 0.1 to 3.3 m (Figure 3). The number of seams decreases eastward in conjunction with an overall thinning of the Belly River Formation.

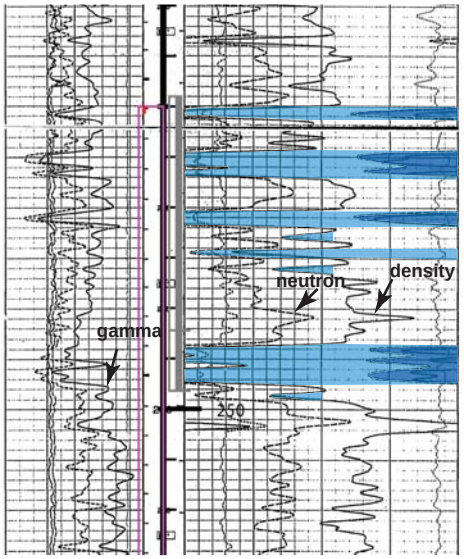


Figure 3 - Neutron-density log for Belly River Renaissance Senate 10-10-2-27W3. Coal shaded in blue.

The net coal isopach map (Figure 4) shows that net coal thicknesses greater than 2 m are largely confined to the area south of T15 and west of R20W3. This area lies immediately south of the Hatton Gas Pool, and west of the southwest Saskatchewan oil-field trend. The net coal isopach exhibits a northerly trend, with the thickest net coal interval between R25W3 and 27W3. Net coal thicknesses along this trend are around 5 to 9 m, but locally reach 12 m. It should be noted that no data for coal are available in four townships (T11 R23, T9 R24, T9 R23, T8 R24) on the northern part of this trend line so that the actual net coal thickness in these areas is unknown. The apparent thinning of the net coal isopach in the far southwest corner of the study area coincides with a group of wells in which the Belly River top occurs above the casing. Thus, the isopach values in this area should be considered as minimum values only.

In core, the Belly River coal displays a wide spectrum of lithotypes, from carbonaceous shale to bright-banded, well-cleated coal (Figure 5). The few cores available have been extensively sampled for desorption experiments and so a true representation of the lithotypes is unavailable. Measured gas contents from desorption studies of Belly River coals for Nexen

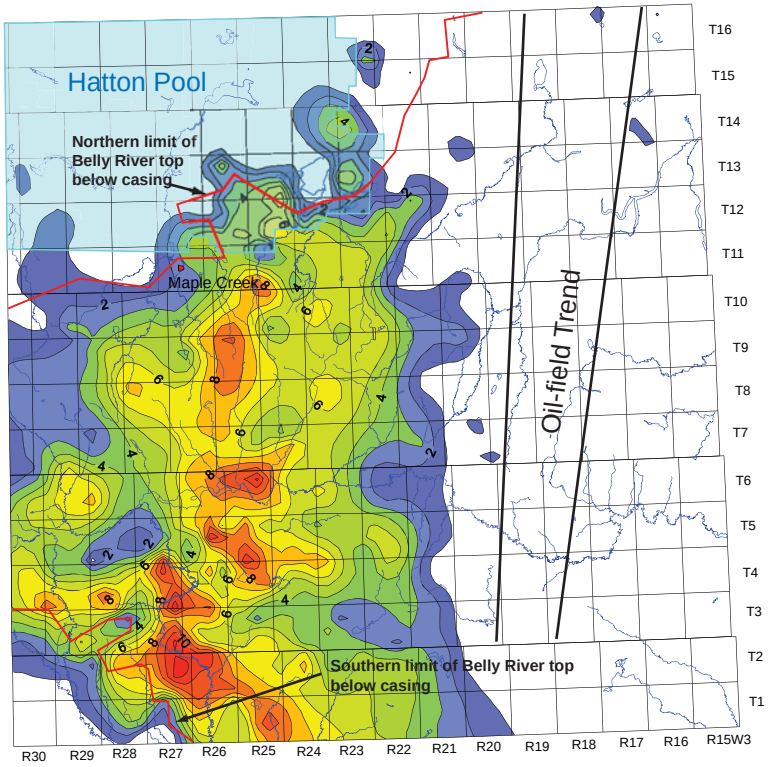


Figure 4 - Net coal isopach map (from Frank, 2005); 2 m contour interval. In the northwest and southwest corners of the map area, the Belly River top occurs above surface casing; thus in these areas isopach values represent minimum values only.

Figure 5 - Core from Nexen Battle Creek 7-2-4-27W3; Belly River coal; depth 235.2 to 235.4 m.

Battle Creek West 7-2-4-27W3 and Nexen Vidora 6-4-5-25W3 (Coal Gas Technology Ltd., 2004a, 2004b) indicate a mean gas content of 0.97 m^3 of gas per m^3 of coal. Gas composition tests indicate average methane content of 95%, carbon dioxide from 1 to 5%, and minor amounts of ethane and propane. Hydrogen sulphide was not detected.

MANNVILLE COALS

In general, the sub-bituminous coals of the Lower Cretaceous Mannville Group in Saskatchewan form seams of variable thickness and lateral extent that are spread over a wide geographical area (Figure 6). Mannville coals range in depth from near surface in the northeast corner of Figure 6 to 850 m in the west. Within the Mannville, there are two types of coal occurrence: thin regional paralic coals generally less than 2 m thick, and thicker coal bodies within paleovalleys and embayments that occur along the margins of the Unity, Kindersley, and Swift Current paleouplands (Figure 7). The most significant coals in these areas lie in the lower part of the stratigraphic interval (Figure 8) where individual coal seams can be more than 5 m thick, such as near Kindersley and the eastern Kerrobert Paleovalley. Some thick coal units may have resulted from deposition in paleotopographic lows related to subsidence associated

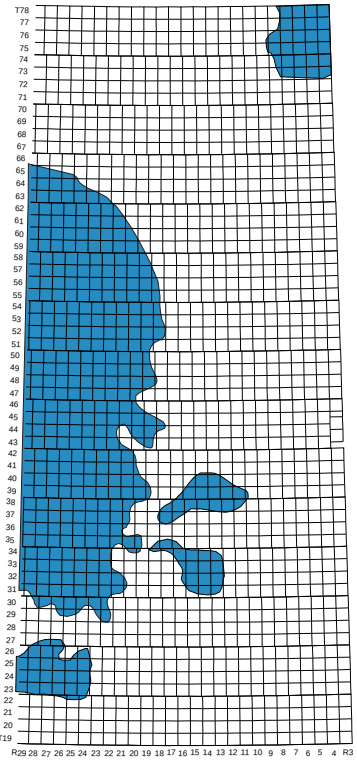


Figure 6 - Approximate known geographic location of Mannville coals in western Saskatchewan (from Christopher, 2003; Bend and Frank, 2004). Map covers area from T19 to 78, R3 to 29W3.

with dissolution of underlying salt beds. These thickened coal beds, more lacustrine than paralic in nature (Christopher, 2003), escaped the limitation on thickness imposed by simple fluctuations in sea level. In 1987, Luscar studied four coalfields in the Kerrobert Paleovalley to assess the feasibility of mining these underground coal resources (SIR Assessment File 72N-001). The report estimated coal tonnage within the four coalfields at 1715 million tonnes in place. Preliminary studies have also identified the Winter-Senlac area and the Empress Coal Basin as sites of laterally continuous coal (Bend and Frank, 2004).

Coal lithotypes of the Mannville Group are similar to Belly River coals in that they range from carbonaceous shale to bright banded coal. Petrographic analyses for coals within the Rosetown Coalfield indicate bright coals are high in vitrinite content, whereas dull coal is dominated by mineral matter and macerals from the inertinite group (Bend and Frank, 2004). Figure 9 shows the relative proportions of macerals from wells in the Rosetown and Kerrobert areas.

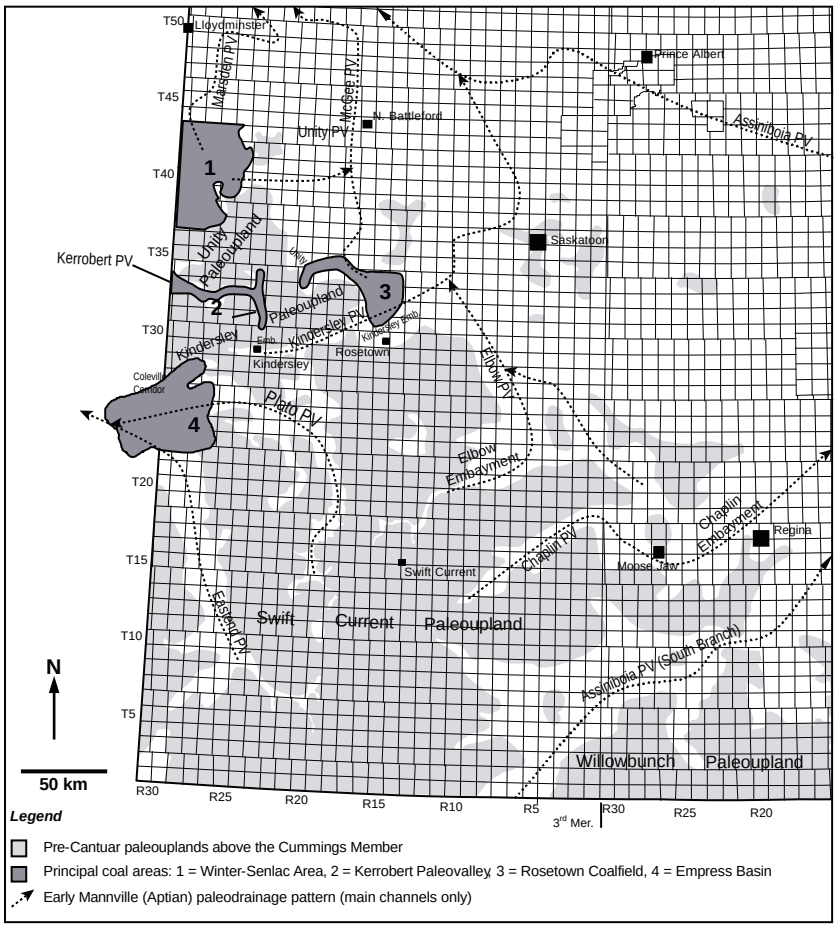


Figure 7 - Map outlining locations of four principal coal areas and their relationships to paleovalleys (PV), paleouplands, and paleoembayments (modified from Bend and Frank, 2004).

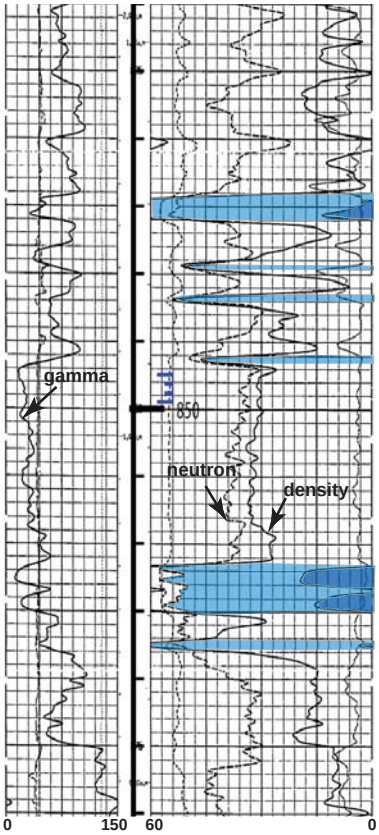
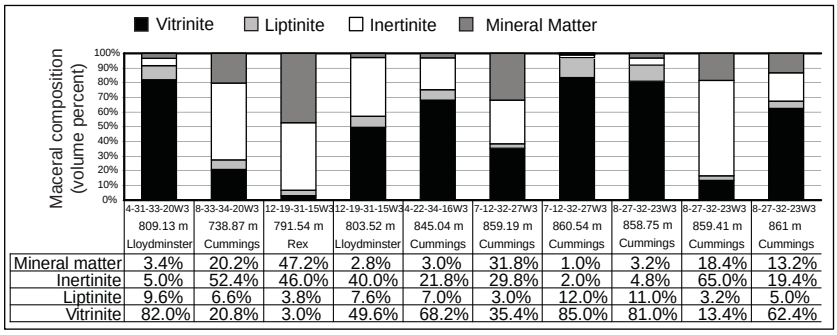


Figure 8 - Neutron-density log for Baytex Prairiedale West A3-31-32-26W3. Coal shaded in blue.



	4-31-33-20W3 809.13 m Lloydminster	8-33-34-20W3 738.87 m Cummings	12-19-31-15W3 791.54 m Rex	12-19-31-15W3 803.52 m Lloydminster	4-22-34-16W3 845.04 m Cummings	7-12-32-27W3 859.19 m Cummings	7-12-32-27W3 860.54 m Cummings	8-27-32-23W3 858.75 m Cummings	8-27-32-23W3 859.41 m Cummings	8-27-32-23W3 861 m Cummings
Mineral matter	3.4%	20.2%	47.2%	2.8%	3.0%	31.8%	1.0%	3.2%	18.4%	13.2%
Inertinite	5.0%	52.4%	46.0%	40.0%	21.8%	29.8%	2.0%	4.8%	65.0%	19.4%
Liptinite	9.6%	6.6%	3.8%	7.6%	7.0%	3.0%	12.0%	11.0%	3.2%	5.0%
Vitrinite	82.0%	20.8%	3.0%	49.6%	68.2%	35.4%	85.0%	81.0%	13.4%	62.4%

Figure 9 - Maceral analyses for select boreholes from the Rosetown Coalfield and Kerrobert Paleovalley. Each bar graph shows the relative proportion of mineral matter and of macerals from the three maceral groups. The accompanying table gives the sample depth, associated stratigraphic unit, and the corresponding analytical data (Bend and Frank, 2004).

The Geological Survey of Canada is currently undertaking a study to more clearly define the geographic distribution the Mannville coals along the western edge of the province. Release of this information is anticipated in early 2006.

THE NGC WORKING GROUP

A Saskatchewan government interdepartmental Natural Gas in Coal (NGC) Working Group was formed in March 2005, with a mandate to encourage industry to explore for potential NGC resources in Saskatchewan under terms that are fair and effective for industry, government, local stakeholders, and the general public.

The goals of the group are threefold:

1) To improve geological knowledge regarding potential NGC-producing beds. This brochure presents an overview of the latest geological findings by the group. More detailed information will be published as an SIR Open File 2005-33.

2) To study NGC from a regulatory standpoint. An investigation of *The Petroleum and Natural Gas Regulations, 1969* has shown that the province is prepared for this new industry from a legal standpoint. The current regulations are sufficient to guide the potential new NGC industry.

3) To keep the public informed as to the nature of the NGC industry. A public-awareness campaign, which includes a website and information sheets, has been undertaken. The goal is to educate and inform the public proactively so that effective consultation processes can take place.

SUMMARY

- Mannville and Belly River coals have the highest potential for the production of NGC. Coals rank from sub-bituminous A to sub-bituminous C.
- Belly River coals are well developed in the southwestern corner of the province, and have tested mean gas contents of 0.97 m^3 of gas per m^3 of coal.
- Mannville coals are broadly distributed, but have not been tested for gas content. Preliminary mapping indicates four major areas of thick coal deposits.
- The current regulations are sufficient to guide the emerging NGC industry.

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Bend, S.L. and Frank, M.C. (2004): CO_2 sequestration and coalbed-methane potential of lower Mannville Group (Lower Cretaceous) coals, southern Saskatchewan – preliminary investigations; *in* Summary of Investigations 2004, Volume 1, Saskatchewan Geological Survey, Sask. Industry Resources, Misc. Rep. 2004-4.1, CD-ROM, Paper A-12, 17p.

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