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Coalbed methane producibility from the Mannville coals in Alberta, Canada: A comparison of two areas

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Abstract

The Mannville coals in the Fenn area, Alberta Plains, have desorbed gas content averaging 8.57 cm^3/g (275 scf/t), which is similar to the same coals in the Corbett Creek area, almost 400 km away. Vitrinite reflectance values are also similar, although the coals at Corbett Creek are situated about 300 m shallower, which points to a rank excursion from Hilt's burial law curves at Corbett Creek. Coals from both areas are within the "oil window". The Medicine River Seam in the Fenn area has higher total inertinite content and greater proportions of inertodetrinite and detrovitrinite, suggesting that peat deposition occurred in swamps and marshes and were prone to periodic flooding. At Corbett Creek, the Mannville coal seams are characterized by greater concentrations of telo-inertinite, which contributes to coal meso-porosity and the potential for free gas storage in the open cell lumens, and to an increased gas flow along lithotype boundaries (horizontal permeability). Non-fluorescing vitrinite was present mostly in the Upper Medicine River Seam, which was deposited in a regressive environment. The Lower Medicine River Seam, which formed during a marine transgressive phase, contained greater amounts of fluorescing vitrinite. The Mannville coals in the Fenn area are moderately under-pressured in relation to those at Corbett Creek, which may have an impact on gas retention capacity. The difference in absolute coal permeability (1–3.5 mD at Fenn versus 3–4 mD at Corbett Creek), which is likely the result of higher in-situ stresses in the deeper Mannville coals at Fenn, has had an effect on both gas and water production rates from these coals. However, the largest impact on gas production volumes has been made by the application of horizontal drilling technology, initially at Fenn, and more recently by multiple horizontal wells drilled at Corbett Creek.

Keywords: Coalbed methane; Mannville coals; Alberta; Petrology; Permeability; Horizontal wells

1. Introduction

The Western Canada Sedimentary Basin (WCSB) (Fig. 1) contains large volumes of coal. The Canadian Gas Potential Committee estimates that CBM in-place resources are about 14 trillion m^3 (about 500 TCF), 75% of which is located in Alberta (National Energy Board Report, 2006; www.neb-one.gc.ca/energy/EnergyReports/EMAGasTDeliverabilityCanada2006_2008_e.pdf). The Energy Resources Conservation Board (ERCB) of Alberta [formerly known as the Alberta Energy and Utilities Board (AEUB)] reports the Alberta NGC resource potential to be 500 TCF, 64% (320 TCF) of which is estimated to be in the Lower Cretaceous Mannville Formation coals (ERCB Report ST98-2006; http://www.ercb.ca/docs/products/STs/st98-2006.pdf). In addition, the Upper Cretaceous Horseshoe Canyon (HSC) Formation coals may contain 71 TCF of methane, the Belly River Formation coals 147 TCF, and the Ardley Formation coals about 57 TCF (ERCB Report ST98-2006; http://www.ercb.ca/docs/products/STs/st98-2006.pdf). The recoverable amount of CBM remains unknown although some experts believe that 20 to 100 TCF could ultimately be recovered. CBM production in Western Canada was estimated to be 4.5 million m^3/D (160 MMCF/D) (million cubic feet per day) at the end of 2004, representing less than 1% of the total Canadian natural gas production. Publicly available data indicates that only 240,000 m^3/D (8.5 MMCF/D) was produced from the Mannville Formation coals in 2006.

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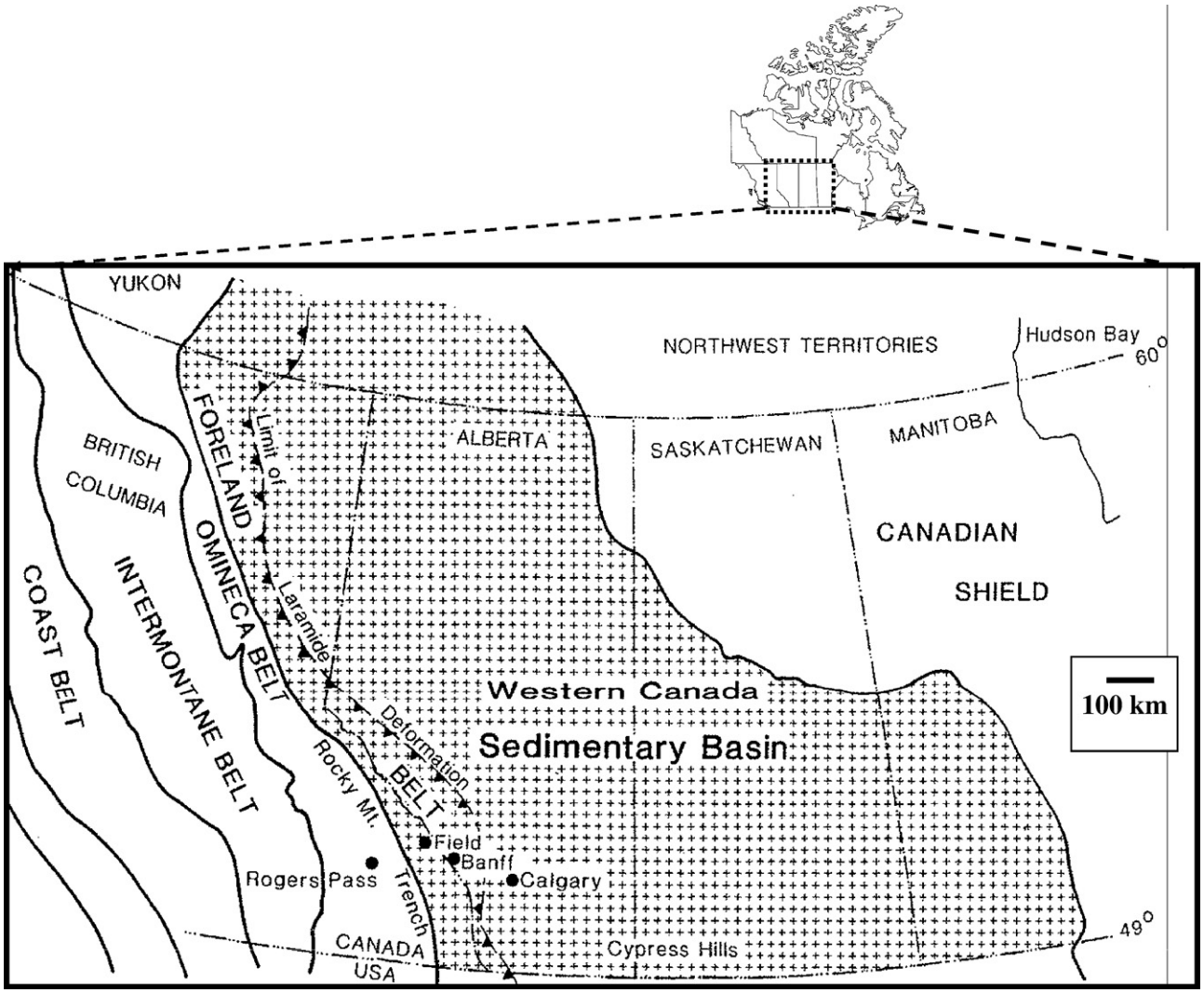

Fig. 1. The outline of the Western Canada Sedimentary Basin (WCSB).

1.1. Historical CBM production from the Mannville coals in two areas in Alberta

The history of Mannville CBM development in Alberta has evolved from vertical fracture-stimulated wells to single horizontals and then to multiple horizontal wells. In the mid-1990s, the Mannville coal seams at Fenn–Big Valley (refer to as Fenn in Fig. 2) were fracture stimulated by Gulf Canada Resources. Initial gas rates from vertical wells ranged from 20,000 to 28,000 m^3/D (0.7 to 1.0 MMCF/D) but declined within 2–3 days and stabilized at 563 to 1690 m^3/D (20–60 MCF/D). Produced water rates were only 1–2 BW/D, an indication that the coals in this area are "dry", possibly because of low permeability. In 2002–2004, Trident Exploration Corp. and its partner Nexen Inc. drilled almost 100 vertical CBM wells in the Corbett Creek area (Fig. 2). A typical vertical Mannville well produced 1127 m^3/D (40 MCF/D), and a good vertical well about 5633 m^3/D (200 MCF/D) (Simpson, 2005). Recovery rates from vertical wells were low and ranged from 21–38%. Produced water volume was high, about 250 BW/D during the first 3–4 months of production, a clear indication that the Mannville Formation coals at Corbett Creek are not only "wet" but also possess reasonable permeability. Public data from the Alberta EUB show that more than 100 horizontal Mannville wells were drilled in 2005–2006, the vast majority in the Corbett Creek area. Three horizontals drilled in one section of land (640 acres) had combined production of 76,000 m^3/D (2.7 MMCF/D), while eleven horizontals drilled in a radial (spoke) pattern over 4 sections of land had total production of over 140,000 m^3/D (5 MMCF/D). Horizontal wells shortened the dewatering period at Corbett Creek to four months. CDX Canada, Co. drilled a horizontal CBM well in the Medicine River coal seam of the Mannville Group in the Oberlin area (Fig. 2), located very close to Fenn. The well has been producing an average of 28,000 m^3/D (1 MMCF/D) since April 2004. This well became the first commercial horizontal CBM well in the deep (>1300 m) and low permeability Mannville coals.

Unlocking the Mannville CBM has been a priority because of the high GIP (gas-in-place) potential in these coals, which ranges from 4–10 BCF/section based on coal thickness and gas content. The main challenge has been the low permeability of the coals as a result of burial depth and high in-situ stresses. The