Current Status of CBM in Western Canada

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AJM Petroleum Consultants

Canadian Institute –
Coalbed Methane Symposium
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Canada’s Natural Gas Production
(Bcf/d Adapted from CAPP Data)

Record Prices
Record Activity
Production flat to declining
Not Sustainable
Resource Triangle

Conventional Reservoirs

Obvious Traps

Small Resource
High Quality
Difficult to find
Easy to develop
Low cost
High margin

W.C.S.B.

Unconventional Reservoirs

Oil
Shale
Gas
Hydrates

Basin Maturity
Better Technology
(Higher prices)

Large Resource
Low Quality
Easy to find
Difficult to develop
High cost
Low margin

Conventional Reservoirs

Small Resource
High Quality
Difficult to find
Easy to develop
Low cost
High margin

Unconventional Reservoirs

Obvious Traps

W.C.S.B.
Canada’s Resources and Reserves
Natural Gas
(Conventional data adapted from CGPC 2001)

592 Tcf

Total Conventional + Unconventional

340 Tcf

Discovered Raw Gas Sales Gas

204 Tcf

Remaining Reserves

58 Tcf

(Unproduced (>95% WCSB))

Rate of Conversion:
Accessibility Technology
Price Motivation

Ultimate Resources

Total

>1,000 Tcf

Conventional + Unconventional

592 Tcf

Discovered

340 Tcf

Raw Gas

Sales Gas

204 Tcf

Unproduced

58 Tcf

(>95% WCSB)
Understanding Remaining Gas Resources
– Accessible and Economically Available

<table>
<thead>
<tr>
<th>Available at current prices</th>
<th>Accessible</th>
<th>Accessible with restrictions</th>
<th>Inaccessible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presently Available Resources</td>
<td>Presently Available Resources</td>
<td>Future Available Resources</td>
<td>Unavailable Resources</td>
</tr>
<tr>
<td>Future Available Resources</td>
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<td>Future Available Resources</td>
<td>Unavailable Resources</td>
</tr>
</tbody>
</table>

Can apply this approach to Conventional and Unconventional Resources

Source: Russum, CSEG Recorder, June 2003
Unconventional Gas Reservoirs

- Any methane not trapped in a porous, permeable, buoyancy driven system
- ‘More Challenging to extract’
- Characteristics – extremely variable
- (Often)
  - Methane not freely dispersed
  - Source rock and reservoir closely related
  - Large, low concentration resources
  - Unusual pressure regimes
  - Low or heterogeneous permeability
Unconventional Gas - Producibility

- Low productivity, often low decline rates
- Low recovery factors
- Require greater drilling density
- Environmental issues
- Technologically challenging to produce:
  - Area and resource specific solutions
  - Low risk once specific solutions identified
- Relatively high development and operating costs
Unconventional Gas - Types

- Shallow Biogenic Gas
- ‘Tight’ Gas
  - includes Deep Basin and Basin Centred Gas (BCG)
- Coalbed Methane (CBM)
  - Also called Natural Gas from Coal (NGC)
- Shale Gas
- Gas Hydrates – in molecular structure of ice
- Inorganic Methane
- Continuous generated Methane
# Unconventional Gas – Status and Resources

(*From various sources)

<table>
<thead>
<tr>
<th></th>
<th>Status USA</th>
<th>Resource in Canada*</th>
<th>Status Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow Biogenic Gas</td>
<td>On-going Production</td>
<td>30Tcf</td>
<td>Production since 1905</td>
</tr>
<tr>
<td>Tight Gas</td>
<td>Growth Opportunity</td>
<td>600Tcf</td>
<td>Production since 1976</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>On-going Production</td>
<td>400Tcf</td>
<td>Production since 2002</td>
</tr>
<tr>
<td>Shale Gas</td>
<td>On-going Production</td>
<td>100Tcf</td>
<td>Experimental activity</td>
</tr>
<tr>
<td>Gas Hydrates</td>
<td>Experimental Research</td>
<td>5,000Tcf</td>
<td>Experimental Research</td>
</tr>
<tr>
<td>Inorganic Methane</td>
<td>?Theoretical</td>
<td>?</td>
<td>?Theoretical</td>
</tr>
<tr>
<td>Continuously Generated Methane</td>
<td>Pilot Projects</td>
<td>400Mmcf/d</td>
<td>Pilot Projects</td>
</tr>
</tbody>
</table>
Contribution of Unconventional Gas Production, WCSB, December 2004

Unconventional: 33%

Source: PetroCube 2005
Canada’s CBM Opportunities

• Significant coal bearing basins from Vancouver Island to Nova Scotia
• Best opportunities in WCSB especially where infrastructure available and environment familiar with gas activity
• 4 primary coal intervals identified:
  – Ardley Coals, Scollard Formation, Upper Cretaceous/Tertiary
  – Horseshoe Canyon Coals, Edmonton Group/Belly River Group, Upper Cretaceous
  – Mannville Coals, Lower Cretaceous
  – Kootenay Coals, Lower Cretaceous/Upper Jurassic
• Major challenge is finding sufficient permeability
### WCSB Coalbed Methane

<table>
<thead>
<tr>
<th></th>
<th>Resource Potential</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ardley Coal WC Alberta</td>
<td>Low/Moderate</td>
<td>Limited activity, Best potential is relatively remote</td>
</tr>
<tr>
<td>Horseshoe Canyon Coal McNair</td>
<td>High</td>
<td>Focus of current activity, readily accessible, dry gas</td>
</tr>
<tr>
<td>Mannville Coal WC Alberta</td>
<td>Very High</td>
<td>Experimental activity, requires de-watering eg. Trident, Corbett Creek.</td>
</tr>
<tr>
<td>Mannville Coal NE BC</td>
<td>Moderate?</td>
<td>Experimental activity, - 7 permits granted, confidential results</td>
</tr>
<tr>
<td>Kootenay Coal SE BC</td>
<td>Moderate</td>
<td>Experimental, Encana, Devon. Coal continuity and environmental problems</td>
</tr>
</tbody>
</table>
Mannville CBM – Current Status

- Still experimental
- ‘Conventional’ CBM requiring dewatering
- Not yet producing at economic rates
- Need to find ‘sweet spots’ – better permeability
- Main area of interest T60-66, R1-11W5
  - Starting to see experimentation over a wider area
- Main Operators
  - Trident - Corbett Ck
  - Apache
  - Thunder Energy
  - Nexen
  - APF
Mannville CBM Production
AJM Database wells producing Mar 2005

CBM producing well count: 56, Water 2000 bbls/Mmcf
Horseshoe Canyon CBM
Coal-bearing Formations of the Interior Plains

Horseshoe Canyon

- PASKAPOO, SCOLLARD, RAVENSCRAG FORMATIONS (and correlatives)
- EDMONTON GROUP (and correlatives)
- BELLY RIVER GROUP (and correlatives)
- WAPITI GROUP
- MANNVILLE GROUP, SWAN RIVER FORMATION (and correlatives)
Horseshoe Canyon Coals

Drumheller/Red Willow Coal Zone
Total Cumulative Coal

• Median depth ranges from 300m to 600m
• Drill and complete 3 wells per day
• 10 to 20 seams of 1-2m thickness
  Stimulated by Nitrogen gas fracture treatment
• 3 to 4 week flow testing
• No water production – dry gas
• Range 20 to 500 Mcf/d
• Well head pressure < 5psi
• Compression facilities required
• Four wells per section
• 1 to 4 BCF/section in place
AJM’s CBM Database

• Focused currently on Horseshoe Canyon
• Reviewed all wells in CBM Fairway
• Excludes confidential wells as of 31st March 2005 (underestimates total wells but gives better confidence in data)
• Assignments are independent of Board data
• Producing wells split into:
  – Pure coalbed methane wells
  – Wells with commingled perforation and production from coal and adjacent sands
  – Wells where there is a contribution from CBM but information is incomplete
  – Confidential wells licensed as CBM
Horseshoe Canyon – Producing Wells

- Ferrybank – Encana
- Nevis, Clive – Apache, Fairborne
- Entice – Encana, MGV
- Irricana – MGV
- Strathmore – Encana

- Bashaw – Apache
- Fenn – Thunder, MGV
- Trochu – Trident
- Redland, Entice – Encana
- Rockyford, Gayford – MGV

Legend:
- Red: CBM Pure
- Purple: CBM + Sand
- Cyan: CBM Undefined
Horseshoe Canyon
All CBM – Producing Well Count To Mar 2005 excluding Confidential Wells

Source: AJM, 2005
Horseshoe Canyon CBM – Producing well count

<table>
<thead>
<tr>
<th>Wells producing Pure CBM</th>
<th>Horseshoe Canyon Producing Well Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells producing from Coal + Sand</td>
<td>951</td>
</tr>
<tr>
<td>Wells producing from Coal + Sand</td>
<td>547</td>
</tr>
<tr>
<td>Wells producing from coal but ins</td>
<td>183</td>
</tr>
<tr>
<td>and insufficient data to define</td>
<td></td>
</tr>
<tr>
<td>whether production also from</td>
<td></td>
</tr>
<tr>
<td>adjacent sand</td>
<td></td>
</tr>
<tr>
<td>Confidential wells probably</td>
<td>384</td>
</tr>
<tr>
<td>producing from coal</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2065*</td>
</tr>
</tbody>
</table>

* Compares to 1470 wells identified by AEUB as CBM wells

Source: AJM Database, Mar 31 2005
Horseshoe Canyon CBM Production

CBM producing well count (excludes confidential): 1675, Water <1bbl/Mmcf
Horseshoe Canyon Production
- Observations

• Considerable variation in production profiles
• Varies between wells, between areas and between operators
• Relative productivity greatly influenced by line pressure
  – Need very low line pressure
  – Noise from compression is major environmental challenge
• Early phase of development limits accurate prediction of ultimate productivity
• Developing tools to better understand and predict results
Horseshoe Canyon Current Productivity

Avg Daily Production vs Production Days

Days on Production

Gas Production (mcf/d)

Trendline
<table>
<thead>
<tr>
<th></th>
<th>Pmean Daily Production</th>
<th>P10</th>
<th>P50</th>
<th>P90</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM Pure</td>
<td>100</td>
<td>186</td>
<td>81</td>
<td>32</td>
</tr>
<tr>
<td>CBM + Sand</td>
<td>104</td>
<td>202</td>
<td>80</td>
<td>44</td>
</tr>
<tr>
<td>CBM Unconfirmed</td>
<td>100</td>
<td>172</td>
<td>81</td>
<td>35</td>
</tr>
</tbody>
</table>
HSC CBM wells data to March 2005
- 5 or more wells on production

All CBM Producing Wells - with Data to March 2005

+ 26 Operators with <5 wells on Production

Source: AJM Database, 2005
Average HSC Productivity for main CBM Producers

- Encana
- MGV
- Trident
- Fairborne
- Thunder
- CNRL
- EOG
- Mustang
- Resolute
- Enermark
- Baytex
- Glacier
- Centrica
- Devon

- Producing Wells
- Average Daily Production

AVG all wells all producers
Horseshoe Canyon CBM – How significant?

• Fairway with >4m net aggregate coal covers approximately 12,000 sq miles

• 4 wells per sq mile = 48,000 well

• If 24,000 wells on production at one time @ 100mcf/d = 2.4Bcf/d

• 48,000 wells @ 300mcf = approx. 15Tcf of Marketable gas
In Conclusion:

• Typical Horseshoe Canyon CBM well produces 100mcf per day

• Considerable variations in the productivity by area and Company

• AJM will continue to gather data on CBM as it evolves in Canada to identify trends, productivity and ultimately reserves per well
More Information?

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